Degeneration of Subcortical White Matter in Alzheimer’s Disease: Atlas-Based Automated Mapping and Its Diagnostic Utility Based on Multi-Variate Model

Takashi Yoshiura1, Akio Hiwatashi1, Koji Yamashita1, Hironori Kamano1, Yukihsa Takayama1, Eiki Nagao1, Tuvsjinjargal Dashjamts1, Hiroshi Honda1
1Department of Clinical Radiology, Kyushu University, Fukuoka, Japan

We measured mean diffusivities (MD) in subcortical white matter (WM) in 78 different cortical regions using an atlas-based mapping method in 33 patients with Alzheimer’s disease (AD) and 28 healthy control subjects to determine whether the topographical pattern of the diffusion abnormalities can be used to diagnose AD. Uni-variate analysis in which discrimination was attempted based on MD in the single region resulted in the accuracy of 88.5%. Multi-variate analysis in which a linear discriminant function based on MDs from multiple cortical regions increased the accuracy up to 96.7%.

Deterioration of Abstract Reasoning Ability in MCI and Alzheimer’s Disease: Correlation with Local Gray Matter Volume Loss Using DARTEL VBM Analysis

Takashi Yoshiura1, Akio Hiwatashi1, Koji Yamashita1, Hironori Kamano1, Yukihsa Takayama1, Eiki Nagao1, Tuvsjinjargal Dashjamts1, Hiroshi Honda1
1Department of Clinical Radiology, Kyushu University, Fukuoka, Japan

We estimated brain regions whose damages are responsible for the deterioration in abstract reasoning ability measured by Raven’s colored progressive matrices (CPM) in 37 patients with Alzheimer’s disease (AD) (n=19) and mild cognitive impairment (MCI) (n=18) using VBM with non-linear registration based on DARTEL algorithm. A multiple regression analysis was used to map the regions where gray matter volumes were correlated with CPM scores. Significant correlations were seen in 14 regions with the strongest correlation in the left middle frontal gyrus. Results suggested that damages of multiple regions are responsible for deterioration of abstract reasoning ability in AD and MCI.

MRI Shape Analysis Predicts Progression from Mild Cognitive Impairment to Alzheimer’s Disease

Donald Louis Collins1, Vladimir Fonov1, Simon Duchesne2,3
1McConnell Brain Imaging Center, Montreal Neurological Institute, Montreal, QC, Canada; 2Centre de Recherche Université Laval - Robert Giffard, Quebec, Canada; 3Dépt. de Radiologie, Faculté de Médecine, Université Laval, Quebec, Canada

A method is presented to predict conversion from mild cognitive impairment to Alzheimer’s disease using shape analysis of baseline T1w MRI data. Using 100 MCI subjects from the ADNI database, PCA analysis of deformation fields required to register to a minimum deformation template is used to build a shape model of the aging brain. LDA of the eigenvalues is used to build a classifier to identify converters and non-converters. Testing with 100 additional MCI subjects demonstrates accuracies of 65% at 12 months and 64% at 24 months. Adding baseline HC volume increases accuracy to 73% and 69%, respectively.

Ultra-High Field MRS in Healthy Aging and Early Cognitive Impairment

Mary Charlotte Stephenson1, Mirjam I. Schubert2, Maryam Abaei2, Antonio Napolitano2, Rob G. Jones3, Peter G. Morris1, Dorothee P. Auer2
1SPMMRC, School of Physics and Astronomy, University of Nottingham, Nottingham, Nottinghamshire, United Kingdom; 2Academic Radiology, University of Nottingham, Nottingham, Nottinghamshire, United Kingdom; 3School of Community Healthy Sciences, University of Nottingham, Nottingham, Nottinghamshire, United Kingdom

Metabolic profiles in the posterior cingulate cortex (PCC) have been found to be altered due to healthy aging and in many neurodegenerative diseases. The purpose of this study was to use increased spectral resolution and signal, available at higher field, to measure changes in the PCC metabolic profile due to healthy aging and cognitive impairment. Atrophy corrected levels of N-acetyl aspartate, glutamate and aspartate were found to significantly decrease with healthy aging. Levels of phosphocreatine were greatly reduced in patients with cognitive impairment, supporting a crucial role for Creatine Kinase dysfunction in dementia.

Cerebral Blood Flow in Alzheimer’s Disease by Arterial Spin Labeling QUASAR

HKF Mak1, Queenie Chan2, Zhipeng Zhang2, Esben Petersen1, Deqiang Qiu1, Xavier Golay4, Leung-Wing Chu1
1Diagnostic Radiology, University of Hong Kong, Hong Kong, Hong Kong; 2Philips Healthcare; 3Clinical Imaging Research Centre, National University of Singapore, Singapore, Singapore; 4UCL Institute of Neurology, University College of London, United Kingdom; 1Medicine, University of Hong Kong, Hong Kong

Arterial Spin Labeling MRI is a non-invasive method in studying cerebral blood flow, which can be used as an indirect marker of glucose metabolism. In our local Chinese cohort of 13 Alzheimer’s disease (mean age- 76.3, MMSE- 16.3) and 15 cognitively normal
elderly adults (mean age- 70.8, MMSE- 28.4), QUASAR sequence showed impaired cerebral blood flow in middle & posterior cingulate, bilateral inferior frontal, bilateral superior frontal, right inferior parietal and left superior temporal gyri in AD as compared to controls. This distribution of perfusion impairment is characteristic of moderate Alzheimer’s disease, analogous to regional hypometabolism in Positron Emission Tomography.

1943. **Co-Analysis of Structural Imaging and DTI in Alzheimer’s Disease**

*Valerie A. Cardenas*, *Duygu Tosun*, *Kristine Taffe*, *Bruce Miller*, *Norbert Schuff*, *Michael W. Weiner*

1Radiology and Biomedical Imaging, UCSF, San Francisco, CA, United States; 2San Francisco VA, San Francisco, CA, United States; 3Neurology and Psychiatry, UCSF, San Francisco, CA, United States; 4Memory and Aging Clinic, UCSF, San Francisco, CA, United States

A voxel-wise co-analysis of structural imaging and DTI is presented and compared to analyses with a single modality only, to determine whether a multi-modality analysis detects effects due to Alzheimer’s disease with greater sensitivity. Results show that co-analysis with FA does not detect greater AD-related disease than structural analysis alone.

1944. **Parental History of Alzheimer Disease Predicts Abnormal White Matter in Regional Differences were identified in the corpus callosum and parietal white matter in those individuals with confirmed parental history of DAT. These findings support the hypothesis that white matter abnormalities precede the clinically apparent onset of dementia, representing either early pathophysiological changes or fundamental differences in white matter integrity which may place individuals at risk for subsequent development of Alzheimer Disease.

1945. **Discrimination of Alzheimer's Disease from Cognitively Healthy Individuals: An Arterial Spin Labeling MRI Study**

*Mike P. Wattjes*, *Nelleke Tolboom*, *Menno Schoonheim*, *Jose Maria Garcia-Santos*, *Joost P. Kuijer*, *Bart N. M. van Berckel*, *Philip Scheltens*, *Frederik Barkhof*, *Ernesto J. Sanz-Arigita*

1Dept. of Radiology, VU University Medical Center, Amsterdam, Netherlands; 2Dept. of Neurology, VU University Medical Center; 3Dept. of Nuclear Medicine, VU University Medical Center

These specific perfusion patterns measured by ASL-MRI suggest fundamental differences in the brain perfusion between AD patients and cognitively healthy subjects and could contribute to the diagnoses of AD-related dementia.

1946. **Resting State Functional Patterns in AD and Their Correlation with Regional Amyloid-β Distribution.**

*Ernesto Sanz-Arigita*, *Nelleke Tolboom*, *Jolanda Boverhoff*, *A.A. Lammtserma*, *R. Boellaard*, *M. Yaqub*, *A.D. Windhorst*, *Cornelius S. Stam*, *Philip Scheltens*, *Frederik Barkhof*, *Bart van Berckel*

1Radiology, VUmc, Amsterdam, North Holland, Netherlands; 2Nuclear Medicine and PET Research, VUmc, Amsterdam, Netherlands; 3Neurophysiology, VUmc, Amsterdam, Netherlands; 4Neurology, VUmc, Amsterdam, Netherlands; 5Radiology, VUmc, Amsterdam, Netherlands

Alzheimer-related differences in basal functional brain networks are likely be related to the regional distribution of neuropathology. To explore this relationship, we have scanned the same population of AD patients and age-matched controls both with fMRI in resting state condition and PET, employing two different amyloid-b tracers: 11C-PIB reveals the distribution of neurofibrillary tangles and 18F-FDDNP binds predominantly to amyloid plaques. The functional networks affected in AD, and the distribution of neuropathology largely overlaps. We will demonstrate the specific relationship between either type of amyloid pathology and particular functional networks.

1947. **Pulsed Arterial Spin Labeling Perfusion in Healthy Aging and Early Dementia**

*Christine Preibisch*, *Annette Förschler*, *Afra Wohlschläger*, *Christian Sorg*, *Timothethy Grimmer*, *Hans Förstl*, *Alexander Kurz*, *Claus Zimmer*, *Panagiotis Alexopoulos*

1Abteilung für Neuroradiologie, Klinikum rechts der Isar der Technischen Universität München, Munich, Germany; 2Klinik und Poliklinik für Psychiatrie und Psychotherapie, Klinikum rechts der Isar der Technischen Universität München, Munich, Germany

Problem: PASL was used to study cerebral perfusion changes in patients with MCI and AD. Methods: Resting CBF maps were obtained from 16 young (30±10a) and 15 elderly (65±5a) cognitively normal controls, 13 patients with MCI (69±9a) and 7 patients with mild dementia in AD (70.9±11.2a). Results: Hypoperfusion was detected in parietal cortex and right angular gyrus when patients were compared to controls. A significant perfusion decrease in parietal cortex and left caudate was also detected in elderly compared to young controls. Conclusion: This suggests that PASL is capable to investigate the transition from normal ageing to dementia.
1948. Fully-Automated MRI Quantification of Lateral-Ventricle Volume and Volume-Change in Patients with Alzheimer’s Disease
Zografos Caramanos1,2, Vladimir S. Fonov1, Jacqueline T. Chen,2,3 Simon J. Francis,2,3, Alexandre Carmel-Veilleux3,4, Sridar Narayanan,2,3 D Louis Collins3, Douglas L. Arnold,2,3
1McConnell Brain Imaging Centre, Montreal Neurological Institute, McGill University, Montreal, Quebec, Canada; 2NeuroRx Research, Montreal, Quebec, Canada; 3McConnell Brain Imaging Centre, Montreal Neurological Institute, McGill University, Montreal, Quebec, Canada; 4NeuroRx Research, Montreal, Quebec, Canada

Precise and accurate quantification of the volume, and longitudinal change in volume, of the lateral ventricles (LV) based on MRI data is an important goal in understanding the natural progression of neurodegenerative disorders such as Alzheimer’s disease (AD) and multiple sclerosis. In the present study, we provide evidence from 270 AD patients for the accuracy of a novel, fully-automated, MRI-based technique for LV segmentation. Furthermore, we provide preliminary evidence (from a subset of 33 of these patients) for the validity and precision of two novel, fully-automated, MRI-based techniques for the estimation of longitudinal change in LV volume.

1949. A Study of APOE and Cerebral Perfusion in Adult Offspring of Patients with Alzheimer’s Dementia Using Dynamic Susceptibility Contrast MRI
Rachel DiAnne McKinsey1, Zhifei Wen1, Alan McMillian1, Beth Meyerand1, Sterling Johnson2, Sean Fain1,3, Cindy Carlsson2
1Medical Physics, University of Wisconsin-Madison, Madison, WI, United States; 2GRECC, Veteran Administration Hospital, Madison, WI, United States; 3Radiology, University of Wisconsin-Madison, Madison, WI, United States

APOE and vascular dysfunction are associated with increased risk of AD. Changes in perfusion have been identified in APOE carriers verse non-carriers. The application of DSC perfusion with intravenous gadolinium contrast injection to investigate perfusion changes in AD has the ability to provide CBF, CBV, and MTT perfusion maps. We investigated the ability of DSC MRI to measure CBV, CBF, and MTT changes in non-demented children with increased risk for AD due to one or more risk factors: APOE and/or family history.

1950. Alteration of Integrity and Patterns of the Memory Modules in Mild Cognitive Impairment and Alzheimer’s Disease
Guangyu Chen1, Piero Antuono2, Shi-Jiang Li1
1Biophysics, Medical College of Wisconsin, Milwaukee, WI, United States; 2Neurology, Medical College of Wisconsin, Milwaukee, WI, United States

We tested a hypothesis that the integrity and organization patterns of specific modules (HIP-TP) responsible for memory processing are altered in Mild Cognitive Impairment (MCI) and Alzheimer’s disease (AD) subjects, in comparison with cognitively normal (CN) subjects. HIP-TP in CN is very well organized and has highly directed connected bilateral symmetric regions, but the MCI and AD HIP-TP module have fewer directed left and right connections, and the modules are hardly symmetric and organized. There is a potential that patterns of the HIP-TP modules could be employed to distinguish MCI subjects from CN subjects.

1951. Dynamic Changes in Causal Strength in Memory Encoding Networks in Alzheimer’s Disease Detected by Granger Causality Analysis
Guangyu Chen1, B. Douglas Ward1, Shi-Jiang Li1
1Biophysics, Medical College of Wisconsin, Milwaukee, WI, United States

A quantitative Granger causality analysis, which can measure the causal strength among different time series, was employed to identify and quantify the directional hippocampus and default model network in cognitively normal subjects, and detect the changes in the directional network in AD patients. Interestingly in AD subjects, the functional afferents of parahippocampal gyrus is significantly decreased but the efferents of that are increased. And the abnormal network are correlated with abnormal behaviors.

1952. Diffusion Tensor Imaging in Patients with Alzheimer’s Disease and Mild Cognitive Impairment
Sidy Fall6, Souraya El Sankari2, Roger Bouzerar2, Bertille Perin1, Marc-Etienne Meyer2, Olivier Baledent6
1Imaging and Biophysics, University Hospital, Amiens, Picardie, France; 2Institute of Neuroscience, Cliniques Universitaires Saint-Luc, Brussels, Belgium; 3Imaging and Biophysics, University Hospital, Amiens, Picardie, France; 4Institute of Neuroscience, Cliniques Universitaires Saint-Luc, Brussels, Belgium; 5Imaging and Biophysics, University Hospital, Amiens, Picardie, France; 6Institute of Neuroscience, Cliniques Universitaires Saint-Luc, Brussels, Belgium

We used DTI to investigate inferior fronto-occipital fasciculus (IFO) alterations in patients with Alzheimer’s disease and Mild Cognitive Impairment (MCI). Within each group, we compared DTI parameters between the two hemispheres in IFO. We found no differences in DTI parameters between the two patient groups. Our results reveal that the longitudinal and radial diffusivities,
fractional anisotropy and apparent diffusion coefficient were significantly higher on the right lobe than on the left lobe in AD group. While, Within the MCI group, only FA and radial diffusivity were higher on the right lobe than on the left lobe.

**1953. Association of White Matter Hyperintensities with White Matter Changes in Alzheimer’s Disease as Studied by DTI**

Liya Wang, Felicia C. Goldstein, Hui Mao

1Radiology and Emory Center for Systems Imaging, Emory University School of Medicine, Atlanta, GA, United States; 2Neurology, Emory University School of Medicine, Atlanta, GA, United States

White matter hyperintensities (WMH) provide an additive effect is considered to be a risk factor of Alzheimer’s disease (AD). We investigated which DTI indices: fractional anisotropy (FA), mean diffusivity (MD), radial diffusivity (DR) and axial diffusivity (DX) values were more sensitive to differentiate AD from normal control and how different levels of WMH may contribute to AD in specific areas of the white matter. FA and DR were helpful to discriminate AD with different grade of WMH. Different level WMH contributed AD in different regions and extent. The increased DR may provide measurement of demyelination of AD in pathology.

**1954. Reduced Regional Fractional Anisotropy in Cognitively Normal Individuals with Biochemical and Imaging Evidence of Cerebral Amyloid Deposition**

Joseph Mettenburg, David N. Daniels, Yvette I. Sheline, Beau Ances, Huling Peng, Abraham Z. Snyder, John C. Morris, Mark A. Mintun, Tammy L.S. Benzinger

1Mallinckrodt Institute of Radiology, Washington University in Saint Louis; 2Psychiatry, Washington University in Saint Louis; 3Neurology, Washington University in Saint Louis; 4Mallinckrodt Institute of Radiology, Washington University in Saint Louis, St. Louis, MO, United States

Amyloid plaque deposition in the brain is one of the key pathological hallmarks of Alzheimer’s disease. Recently, CSF amyloid beta42 peptide levels and PET scans using C-11 Pittsburgh Compound B (PIB) have been established as potential biomarkers for dementia of the Alzheimer’s type (DAT). Using DTI, we evaluated white matter microstructure in subjects with and without established DAT and identified differences in both the corpus callosum and precuneus. The same white matter findings were identified in non-demented subjects with positive CSF and PIB-PET, suggesting that microstructural abnormalities in white matter integrity may precede cognitive changes in DAT.

**1955. White Matter Disruption and Its Relationship with Cognitive Function and Cortical Atrophy in Alzheimer’s Disease**

Hao Huang, Xin Fan, Kristin Martin-Cook, Guanghua Xiao, Laura Lacritz, Myron Weiner, Roger Rosenberg

1Advanced Imaging Research Center, University of Texas Southwestern Medical Center, Dallas, TX, United States; 2Department of Neurology, University of Texas Southwestern Medical Center, Dallas, TX, United States; 3Department of Clinical Sciences, University of Texas Southwestern Medical Center, Dallas, TX, United States; 4Department of Psychiatry, University of Texas Southwestern Medical Center, Dallas, TX, United States

The purpose of this study is to find an effective white matter biomarker of Alzheimer’s disease (AD) which may indicate disease severity and progression. In this study, DTI and T1 weighted images were acquired from 38 subjects (20 AD, 18 controls). We surveyed all white matter tracts by labeling of the ICBM-DTI-81 digital atlas and correlated FA values of individual white matter tract with cognitive testing score and cortical atrophy map respectively. The correlation analyses show that tracts in the limbic system, namely fornix and cingulum, are the most sensitive tract to cognitive testing scores and cortical atrophy.

**1956. Quantitative 7T Relaxographic, Volumetric and DCE Assessment of Thalamic Changes in Early Alzheimer’s Disease**

Valerie C. Anderson, David P. Lenar, Joseph F. Quinn, William J. Woodward, Jeffrey A. Kaye, William D. Rooney

1Neurological Surgery, Oregon Health & Science University, Portland, OR, United States; 2Neurology, Oregon Health & Science University, Portland, OR, United States; 3Advanced Imaging Research Center, Oregon Health & Science University, Portland, OR, United States

Longitudinal water proton (1H2O) relaxation time constants (T1) are strongly associated with macromolecular volume fraction. Here, we report that 1H2O T1 values are increased in the thalamus of subjects with early AD compared to age-matched, cognitively normal controls. Further, we find that the increased 1H2O T1 values in early AD reflect, at least in part, neurodegenerative (macromolecular loss) processes and that contributions to the increased 1H2O T1 values from altered blood water content (via dilation or increased vessel density) are small.

**1957. Dementia Induces Correlated Reductions in White Matter Integrity and Cortical Thickness: A Multivariate Neuroimaging Study with Sparse Canonical Correlation Analysis**

Brian Avants, Phil Cook, Lyle Ungar, James Gee, Murray Grossman

1University of Pennsylvania, philadelphia, PA, United States

We present a novel, unsupervised method, sparse canonical correlation analysis for neuroimaging (SCCAN), that automatically locates correlated sets of voxels in complementary imaging modalities. The method reveals significant and syndrome-specific cortical thickness-diffusion tensor imaging networks in two neurodegenerative diseases, AD and FTD. Subject diagnosis was confirmed by autopsy or CSF-biomarker ratios. The SCCAN summary correlates, in AD, with MMSE reduction and, in FTD, with reduced verbal fluency. Thus, SCCAN identifies disease-specific networks of effects in white matter and cortical thickness that appear in anatomy suspected to be involved in these diseases and that relate specifically to impaired cognitive processes.
1958. **Resting-State FMRI Contributes to Differentiate Patients with Dementia with Lewy Bodies from Those with Alzheimer’s Disease**

Barbara Basile1, Mara Cercignani2, Laura Serra2, Roberta Perri3, Camillo Marra4, Lucia Fadda4, Carlo Caltagirone3, Marco Bozzali2

1Neuroimaging Laboratory, Santa Lucia Foundation, Rome, Italy; 2Neuroimaging Laboratory, Santa Lucia Foundation, Rome, Italy; 3Clinical and Behavioural Neurology Laboratory, Santa Lucia Foundation, Rome, Italy; 4Department of Neurosciences, Catholic University of Rome, Roma, Italy, Italy; 5Department of Neurosciences, University of Torvergata, Rome, Italy, Italy

Resting-state fMRI was used to investigate changes of functional connectivity (FC) within specific resting-state networks (RSNs) in the presence of Alzheimer’s disease (AD) and dementia with Lewy Bodies (DLB) as compared to normal aging. Using ICA analysis, we identified 10 RSNs across subjects. AD patients revealed reduced FC in the posterior cingulate, within the default-mode-network. Conversely, DLB patients showed reduced FC in occipital areas, within the visual network. These findings respectively account for brain disconnection between medial temporal lobes and other association cortices in the development of AD symptoms, and for occipital abnormalities potentially responsible for visual hallucinations in DLB.

1959. **On Using Optimized MRS Acquisitions for Improved Mild Cognitive Impairment Diagnosis**

Ileana Hancu1, John Cowan2, Earl Zimmerman2

1GE Global Research Center, Niskayuna, NY, United States; 2Albany Medical Center, Albany, NY, United States

Accurate and repeatable ml measurements may offer a simple means for diagnosing or monitoring treatment in mild cognitive impairment (MCI) patients. Unfortunately, such repeatable measurements are difficult to obtain in vivo. The current report investigates the capability of CPRESS to better separate MCI subjects from normal controls (NC’s). With only 12 subjects in each of the MCI and NC categories, p-values separating the two classes decrease from 0.03 to 0.002 when using CPRESS instead of a short TE PRESS sequence. The impact of more repeatable ml concentration measurements in diagnosing or monitoring MCI evolution or treatment is discussed.

1960. **Classification of AD, MCI and Controls Using Large-Scale Network Analysis**

Gang Chen1, Barney Douglas Ward1, Chunming Xie1, Zhilin Wu1, Wenjun Li1, Jennifer Jones3, Malgorzata Fraczak3, Piero Antuono3, Shi-Jiang Li3

1Department of Biophysics, Medical College of Wisconsin, Milwaukee, WI, United States; 3Department of Neurology, Medical College of Wisconsin, Milwaukee, WI, United States

There has been great interest in developing objective biologically based markers that can be used to predict risk, diagnose, stage, or track the course and treatment of dementia and other neurodegenerative diseases. Alzheimer disease (AD) is the most common form of dementia. Mild cognitive impairment (MCI) is a transitional state between normal aging and dementia, and is often considered a risk factor for AD. In this study, we employed resting-state MRI connectivity methods and the large-scale network analyses to discriminate between AD, MCI and healthy control subjects.

1961. **Investigating Parkinson’s Disease Using Rotating Frame MRI**

Silvia Mangia1, Timo Liimatainen1, Igor Nestrasil3, Michael Garwood1, Paul Tuite3, Dennis Sorce1, Shalom Michaeli1

1CMRR - Dept. of Radiology, University of Minnesota, Minneapolis, MN, United States; 3Department of Biotechnology and Molecular Medicine, A.I. Virtanen Institute for molecular Medicine, University of Kuopio, Kuopio, Finland; 1Dept. of Neurology, University of Minnesota, Minneapolis, MN, United States

Rotating frame relaxation (T1rho and T2rho) were measured under a variety of RF pulses (namely continuous-wave, and frequency swept pulses in the adiabatic and subadiabatic regime) on twenty one Parkinson’s disease (PD) subjects at 4T. Results demonstrate that different RF pulses significantly modulate the rotating frame relaxations in the substantia nigra (SN), providing the opportunity to extract fundamental parameters of the system based on theoretical modeling of the relaxation channels. The greatest sensitivity to identify sub-regions of the SN was achieved by the so-called RAFF pulse, which combines T1rho and T2rho relaxation mechanisms. Measurements from ferritin samples were additionally performed.

1962. **Parkinson’s Disease and Imaging of the Substantia Nigra Structure with 7.0T MRI**

Dae-Hyuk Kwon1, Hye-Jin Jeong1, Se-Hong Oh1, Jong-Min Kim1, Syung-Yeon Park1, Young-Bo Kim1, Beom-Seok Jeon2, Zang-Hee Cho1

1Neuroscience Research Institute, Gachon University of Medicine and Science, Incheon, Korea, Republic of; 2Movement Disorder Center, Seoul National University Hospital, Seoul, Korea, Republic of

T2* weighted MR image is influenced by iron deposition, so that SN shows up iron-related MRI contrast for all that SN is gray matter. Therefore T2* MR imaging shows great potential in PD study using ultra high field (UHF) 7.0T. And 3D T2* Gradient Echo (GE) sequence makes it possible to study a volumetric analysis and a structural morphometry for SN. This method is validated, despite the reduced SNR associated with fast imaging techniques. And 3D model of the SN shows quite well structural changes in PD case.
**1963. Perfusion Networks in Parkinson's Disease Revealed Using Arterial Spin Labeling**


1Van der Veer Institute for Parkinson's and Brain Research, Christchurch, New Zealand; 2Medicine, University of Otago, Christchurch, New Zealand; 3Physics and Astronomy, University of Canterbury, Christchurch, New Zealand; 4Christchurch Radiology Group, Christchurch, New Zealand; 5GE Healthcare, Menlo Park, CA, United States; 6Beth Israel Deaconess Medical Center, Boston, MA, United States; 7Psychology, University of Canterbury, Christchurch, New Zealand

Pseudo-continuous ASL was used to investigate cerebral blood flow in 44 Parkinson’s disease (PD) patients and 26 controls. Principal component analysis produced a set of covariance patterns which were used to form a perfusion network that successfully distinguished PD from control. The PD-related network was characterized by decreased perfusion in PD versus controls in bilateral posterior parietal-occipital regions, posterior medial cortices, precentral and bilateral middle frontal gyri, and left caudate. Preserved perfusion occurred in bilateral globus pallidus. This ASL-derived PD network provides a marker to objectively gauge disease severity and serves as a potential method to longitudinally track disease progression.

**1964. Abnormal Spontaneous Brain Activity in Early Parkinson's Disease Revealed by ALFF Analysis**

Hong Yang, Xu-ning Zheng, Yu-feng Zang, Yi-lei Zhao, Yue Wang, Min-ming Zhang

1Department of Radiology, First Affiliated Hospital of College of Medical Science, Zhejiang University, Hangzhou, Zhejiang, China; 2Department of Neurology, First Affiliated Hospital of College of Medical Science, Zhejiang University, Hangzhou, Zhejiang, China; 3State Key Laboratory of Cognitive Neuroscience and Learning, Beijing Normal University, Beijing, China

Using a new biomarker, the amplitude of the low frequency fluctuation (ALFF), the current study is to explore the abnormal spontaneous neural activity of resting state in early PD. Ten early PD patients were compared with eleven gender- and age-matched controls. Data processing was performed using DPARS software. In this study, abnormal ALFF demonstrate that spontaneous neural activity in the resting state is changed in patients with early PD, furthermore, those abnormal neuronal activity should be considered in explaining findings in behavior deficits in early PD. This method is a potential tool to monitor the progression of PD.

**1965. Investigation of Brain Iron Content in Patients with Parkinson's Disease Using Phase and R2* Obtained with Multi Echo Susceptibility Weighted Imaging**

Christian Denk, Samantha Palmer, Martin J. McKeown, Alexander Rauscher

1UBC MRI Research Centre, University of British Columbia, Vancouver, BC, Canada; 2Brain Research Centre, Vancouver, BC, Canada; 3Pacific Parkinson's Research Centre, Vancouver, BC, Canada

The main pathologic feature of Parkinson's disease (PD) is the loss of dopaminergic neurons in the substantia nigra pars compacta (SNC). There is increasing evidence that iron-mediated oxidative stress via the Fenton reaction is responsible for this loss of neurons. Iron's paramagnetism leads to changes in the relaxation rates R1, R2 and R2* and the phase of susceptibility weighted images (SWI). The aim of this study was therefore to use multi echo SWI for the investigation of both phase and R2* relaxation in deep brain structures of patients with PD. The strongest correlation with phase to the UPDRS score of -0.5 was found in the medial SN pars compacta as well as the largest phase differences between PD patients and controls. A smaller correlation was found with R2*, which is in agreement with previous studies of cerebral R2* in patients with PD.

**1966. Susceptibility Mapping of the Substantia Nigra in Parkinson Patients at 7T**

Andreas Schäfer, Derek VM. Ott, Almut Focke, Johannes Schwarz, Robert Turner, Sonja A. Kotz

1Max-Planck-Institute for Human Cognitive and Brain Sciences, Leipzig, Germany; 2University Hospital Leipzig, Leipzig, Germany

Parkinson’s disease is the second most common neurodegenerative disorder in humans. It has been previously demonstrated that an increase in the relaxation times change in Parkinson patients, supporting pathological findings of increased iron content in the substantia nigra. However, relaxation time is a quite indirect measure of changes in iron concentration, and hard to quantify. Recent studies have also used phase images to study neurodegenerative diseases, but this method has the disadvantage that field perturbation maps derived from phase data are non-local. Our study demonstrates that local susceptibility maps, directly indexing iron concentration, can be calculated from phase image data in Parkinson patients.

**1967. A Single-Center, Phase 1, Open Label, Dosage-Escalation Study of Creatine Monohydrate in Subject with Amyotrophic Lateral Sclerosis**

Eva-Maria Ratal, Nazem Atassi, Stuart Wallace, Jeffery Bombardier, David Greenblatt, Merit Cudkowicz, Allitia Dibernardo

1Department of Radiology, A. A. Martinos Center for Biomedical Imaging, Massachusetts General Hospital, Charlestown, MA, United States; 2Harvard Medical School, Boston, MA, United States; 3Neurology, Massachusetts General Hospital, Charlestown, MA, United States; 4Psychiatry, Massachusetts General Hospital, Charlestown, MA, United States; 5Pharmacology & Experimental Therapeutics, Tufts University School of Medicine, Boston, MA, United States

The purpose of this study was to evaluate the serum pharmacokinetics of orally administered creatine in subjects with ALS and to assess whether oral intake produces increased concentrations of creatine in the brain utilizing in vivo MR Spectroscopy. Six ALS
Patients were enrolled in this open-label pilot study. Patients escalated weekly through 3 different dose levels. Creatine serum levels increased with daily use of 5, 10, 15 gm BID. MR Spectroscopy results are suggestive that creatine crosses the blood brain barrier when given at a high dose of 15 gm BID. Furthermore, glutamine and glutamate levels decreased post treatment.

1968. Cross-Sectional and Longitudinal Voxel-Based Relaxometry Study in ALS

Don Charles Bigler¹, Claire Flaherty-Craig⁵, Yaman Aksu⁵, Byeong- Yeul Lee⁶, Kevin R. Scott⁷, Helen E. Stephens⁷, Jeffrey J. Vesek⁵, Jianli Wang⁵, Michele L. Shaffer⁶, Paul J. Eslinger¹,², Zachary Simmons¹, Qing X. Yang⁵,⁷

¹Psychiatry, Penn State Hershey Medical Center, Hershey, PA, United States; ²Neurology, Penn State Hershey Medical Center, Hershey, PA, United States; ³Electrical Engineering, Penn State University, State College, PA, United States; ⁴Bioengineering, Penn State Hershey Medical Center, Hershey, PA, United States; ⁵Radiology, Penn State Hershey Medical Center, Hershey, PA, United States; ⁶Public Health Sciences, Penn State Hershey Medical Center, Hershey, PA, United States; ⁷Neurosurgery, Penn State Hershey Medical Center, Hershey, PA, United States

The objectives of this study were to identify regions of T2 change in ALS cross-sectionally using VBR and determine the relationship of T2 with time, disease duration, and disease severity longitudinally. T1-weighted and multi spin-echo images were acquired from 12 control and 12 ALS at baseline, 7 at 6 months, and 6 at 12 months. After post-processing clusters of significant T2 increase cross-sectionally were found in frontal and temporal areas. Longitudinally, increased T2 was associated with disease duration mainly in frontal areas. Increased T2 in ALS is likely due to atrophy in cortical areas and acute inflammation in subcortical regions.

1969. Regional and Global Cerebral Blood Flow Is Reduced in Patients with Post-Stroke

Dementia

Jiabao He¹, Michael J. Firbank², Rajesh N. Kalaria², Baldev Singh², Paul Danson², John O’Brien², Andrew M. Blamire¹

¹Newcastle MR Centre and Institute of Cellular Medicine, Newcastle University, Newcastle upon Tyne, United Kingdom; ²Institute for Ageing and Health, Newcastle University, Newcastle upon Tyne, United Kingdom

Stroke is one of the most important risk factors for dementia. In stroke survivors who do not have immediate, severe cognitive impairment, the risk of developing dementia is significantly increased. Stroke may also exacerbate or trigger the development of neurodegenerative pathology. Small vessel vascular effects may be an important factor in neurodegeneration. We compared CBF in post-stroke patients with and without cognitive decline, patients with Alzheimer’s disease and healthy controls. Regional and global deficits in CBF were found in patients with post-stroke dementia resembling patterns of change in AD patients, while cognitively intact post-stroke patients had normal CBF.

1970. The Effects of ApoE4 Allele and Age on Subcortical Brain Atrophy in HIV Positive

Subjects

Linda Chang¹, Marilou Andres², Jeff Sadino¹, Caroline Jiang¹, Helenna Nakama³, Ute Feger¹, Thomas Ernst¹

¹Department of Medicine, John A. Burns School of Medicine, University of Hawaii at Manoa, Honolulu, HI, United States; ²Pacific Biomedical Research Center, University of Hawaii at Manoa, Honolulu, HI, United States; ³Department of Psychiatry, John A. Burns School of Medicine, University of Hawaii at Manoa, Honolulu, HI, United States

The presence of apolipoprotein (Apo) E4 allele may accelerate the progression of HIV disease, and increase the risk for developing HIV associated neurocognitive disorder (HAND). Whether Apo E4 allele and age may influence subcortical brain atrophy in HIV patients are unknown and were evaluated in this study. Smaller subcortical structures were found in HIV patients with HAND, less so in those with normal cognition. ApoE4 genotype was associated with greater atrophic effects in the younger but not older HIV patients, which suggests that ongoing neuro-inflammatory processes may be more robust and have stronger deleterious effects in the younger patients.

1971. Increased Folding Complexity of the Left Temporal Pole in Temporal Lobe Epilepsy

Epilepsy

Natalie L. Voets¹,², Boris C. Bernhardt², Hosung Kim¹, Andrea Bernasconi²

¹University of Oxford FMRIB Centre, Oxford, Oxfordshire, United Kingdom; ²Montreal Neurological Institute and Hospital, McGill University, Neuroimaging of Epilepsy Laboratory and McConnell Brain Imaging Centre, Montreal, Quebec, Canada

Converging histological and radiological data suggest neurodevelopmental abnormalities may play a role in the pathogenesis of drug-resistant temporal lobe epilepsy (TLE). Using surface-based cortical curvature measures, we identified abnormally increased cortical folding in the left temporal pole of patients with both left and right TLE as compared to healthy controls. Increased left temporo-parietal folding was associated with abnormal positioning of the ipsilateral hippocampus in left TLE patients, and associated with unfavourable surgical outcome in patients with a right-sided seizure focus. These results suggest abnormalities in global limbic network connectivity may play an important role in temporal lobe epileptogenesis.
1972. **1H NMR Metabolomics Study of Cerebrospinal Fluid (CSF) in Amyotrophic Lateral Sclerosis (ALS) Patients**

Lydie Nadal-Desbarats, Helene Blasco, Segolene Veau, Patrick Vourc'h, Caroline Moreau, David Devos, Philippe Corcia, Christian R. Andres

1Laboratoire de RMN, INSERM U930-CNRS 2448 - Université François Rabelais, Tours, France; 2Laboratoire de Biochimie et Biologie moléculaire, Inserm U930-CNRS 2448 - Université François Rabelais, Tours, France; 3Service de Neurologie et Pathologie du Mouvement, EA2683, Hopital R. Salengro - CHRU Lille, Lille, France; 4Centre SLA, CHRU Bretonneau, Tours, France

Amyotrophic lateral sclerosis is a progressive neurodegenerative disease. Pathophysiological mechanisms involved in this disease are complex but remain for the most part unknown. This lack of knowledge might explain the absence of reliable biological marker. CSF could be a source of biomarkers. The aim of this study was to analyze CSF of patients with ALS by 1H NMR in order to identify biomarkers in the early stage of the disease, and to evaluate the biochemical factors involved in this disease. We quantified 18 metabolites like amino-acids, organic acids and ketonic bodies. Higher concentrations of metabolites such as ketone bodies contribute to the PCA separation between the two populations.

1973. **T1-Weighted Images Detect Motor Neuron Degeneration in ALS**

Govind Nair, John D. Carew, Sharon Usher, Michael Benatar, Xiaoping P. Hu

1Department of Biomedical Engineering, Emory University and Georgia Institute of Technology, Atlanta, GA, United States; 2Institute for Health Studies, Carolinas HealthCare System, Charlotte, NC, United States; 3School of Public Health, Emory University, Atlanta, GA, United States; 4Department of Neurology, Emory University, Atlanta, GA, United States; 5Department of Epidemiology, Emory University, Atlanta, GA, United States

Amyotrophic Lateral Sclerosis (ALS) is a progressive neurodegenerative disease affecting the motor neurons in the brain and spinal cord. VBM analysis performed on T1-weighted images of the brain revealed significant changes in the motor cortex and supporting white matter of ALS patients compared with age-matched healthy control subjects. ROI analysis revealed a significant decrease in signal intensity from these regions, with signal intensity of ALS group showing significant correlation with clinical measures of disease severity. These findings suggest that T1-weighted images may have utility as an imaging biomarker of disease progression in ALS.

1974. **31P and 1H MR Spectroscopic Studies on Changes of Cerebral Brain Metabolism Induced by Alcoholism and Detoxification**

Ulrich Pilatus, Joerg Magerkurth, Nicole Schwann, Tilmann Wetterling, Barbara Schneider

1Institute of Neuroradiology, University Hospital, Goethe-University, Frankfurt, Germany; 2Department of Psychiatry, University Hospital, Goethe-University

Cerebral metabolites at day 1 and day 7 of alcohol detoxification therapy were studied using 1H and 31P spectroscopic imaging. Particularly for prefrontal brain, metabolite concentrations correlated with the withdrawal syndrome. The results suggest that less severe symptoms support neuronal recovery while a less pronounced deviation from control values for energy or membrane related compounds is correlated with more severe symptoms.


Denis Peruzzo, Gianluca Rambaldelli, Alessandra Bertoldo, Marcella Bellani, Roberto Cerini, Sivilia Marinò, Roberto Pozzi Mucelli, Michele Tansella, Paolo Brambilla

1Department of Information Engineering, University of Padova, Padova, Italy; 2Inter-University Center for Behavioural Neurosciences, University of Verona, Verona, Italy; 3Department of Medicine and Public Health, University of Verona, Verona, Italy; 4Service of Radiology, Policlinico GB Rossi Hospital, Verona, Italy; 5Department of Morphological and Biomedical Sciences, University of Verona, Verona, Italy; 6Inter-University Center for Behavioural Neurosciences, University of Udine, Udine, Italy; 7Scientific Institute, IRCCS “E. Medea”, Udine, Italy

Abnormalities of Cerebral Blood Flow (CBF) and Volume (CBV) have been observed in schizophrenia patients, suggesting that a disruption of the vascular system may occur in this disease. However, cerebral perfusion is also influenced by several physiologic parameters, not necessarily connected to the pathology. We performed a DSC-MRI analysis to study the role of the demographic information on perfusion parameter estimates between patients with schizophrenia and normal control subjects. We found that differences (i.e. between-subject variability) in CBF and CBV are partially explained by the age and/or by a difference in the subject health conditions.

1976. **Early Magnetic Resonance Spectroscopy Renormalized of Prefrontal Cortex and Anterior Cingulated Cortex Metabolites in Hepatic Encephalopathy After Liver Transplantation**

Haiyan Lou, Desheng Shang, Minming Zhang

1Department of Radiology, the First Affiliated Hospital, School of Medicine, Zhejiang University, Hangzhou, Zhejiang, China; 2Department of Radiology, The First Affiliated Hospital, Hangzhou, Zhejiang, China

none

Margaret R. Lentz1, Mona A. Mohamed2,3, Hyun Kim1, Jennifer A. Short1, Mahaveer N. Degaonkar1, Elkan Halpern1, Katherine Conant1, Ned Sacktor3, Ola Sehdes1, Peter B. Barker2,3, Martin G. Pomper2

1Department of Neuroradiology/A. A. Martinos Center for Biomedical Imaging, Massachusetts General Hospital, Boston, MA, United States; 2Russell H. Morgan Department of Radiology and Radiological Sciences, Johns Hopkins Medical Institutions, Baltimore, MD, United States; 3F. M. Kirby Center for Functional Brain Imaging/Kennedy Krieger Institute, Johns Hopkins Medical Institutions, Baltimore, MD, United States; 4Department of Neuroscience, Georgetown University Medical Center, Washington, DC, United States; 5Department of Neurology, Johns Hopkins Medical Institutions, Baltimore, MD, United States

The application of combined antiretroviral (ARV) therapy has been shown to change viral and immune signaling kinetics, indicating that correlations between these and MR measures observed in cross-sectional studies may not last. MRSI, global deficit scorings (GDS) and CSF HIV RNA levels of 51 chronically HIV-infected subjects examined over 10 months of a new ARV administration were included in this study. Mixed model regression analysis indicated that later improvements in subjects’ GDS were associated with earlier improvements in neuroaxonal function and CSF viral load, suggesting that ARV-mediated decreases in CSF viral levels and neuroaxonal recovery precede improvements in cognitive functioning.

**1978.** Hippocampus Perfusion Studies of Gulf War Veterans Using OPTIMAL FAIR

Xiufeng Li1, Subhendra N. Sarkar2, David E. Purdy1, Qihua Lin4,5, David M. Buhner5, Richard W. Haley1,5

1Radiology, UT Southwestern, Dallas, TX, United States; 2Radiology, Beth Israel Deaconess Medical Center, Boston, MA, United States; 3Radiology, Beth Israel Deaconess Medical Center, Boston, MA, United States; 4Siemens Healthcare, Malvern, PA, United States; 5Clinical Sciences, UT Southwestern Medical Center, Dallas, TX, United States; 6Internal Medicine, UT Southwestern Medical Center, Dallas, TX, United States

To verify the previous findings and facilitate further investigation of the pathological characteristics of Gulf War Illness, a semi-blind hippocampus perfusion study with physostigmine challenge was performed for veterans with Gulf War Syndromes 1, 2 and 3 and healthy veterans in two sessions two days apart: the first session with saline infusion and the second session with physostigmine infusion. New study results are similar to those found in the SPECT studies performed in 1997-1998, indicating that the physiological effects upon hippocampal blood flow still persist a decade later.

**1979.** White Matter Abnormalities in Tourette Syndrome Extend Beyond Motor Pathways

Irene Neuner1,2, Yuliya Kupriyanova3, Tony Stöcker2,4, Oleg Posnansky2, Frank Tittgemeyer3, N. J. Shah2,5

1Department of Psychiatry and Psychotherapy, RWTH Aachen University, Aachen, Germany; 2Medical Imaging Physics, Institute of Neuroscience and Medicine - 4, Forschungszentrum Juelich, Juelich, Germany; 3Max-Planck-Institut für Neurologische Forschung, Cologne, Germany; 4JARA – Translational Brain Medicine, Germany; 5Department of Neurology, Faculty of Medicine, RWTH Aachen University, Aachen, Germany

White matter abnormalities in patients with Tourette syndrome are investigated using diffusion tensor imaging, Tract-Based Spatial Statistics and correlation analysis. Our results indicate that TS is not restricted to motor pathways alone but affects association fibres such as the inferior fronto-occipital fascicule, the superior longitudinal fascicule and fascicle uncinatus as well. The detected abnormalities in Tourette patients complement the idea of the developmental character of the disorder. They show a pathological pattern reaching beyond the corticospinal tract. The alteration pattern of decreased fractional anisotropy and increased radial diffusivity might indicate a deficit myelination as one pathophysiologic factor in Tourette.

**1980.** Persistent Basal Ganglia NAA/Cr Ratio Differences in Gulf War Illness

Sergey Cheshkov1,2, Audrey Chang1, Hyeon-Man Baek1, Sandeep Ganji1, Evelyn Babcock1, Richard Briggs1,2, Robert Haley2

1Radiology, UT Southwestern Medical Center, Dallas, TX, United States; 2Internal Medicine, UT Southwestern Medical Center, Dallas, TX, United States

Decrease in the N-acetylaspartate to creatine ratio (NAA/Cr) was previously measured via magnetic resonance spectroscopy at 1.5T in bilateral basal ganglia, pons, and in left hippocampus of Gulf War Illness patients. The Seabees cohort veterans (controls, Syndrome 1, 2, and 3 patients) studied in 1997-1998 recently participated in a follow-up study at 3T. The group comparison of this new spectroscopic data indicates reduced NAA/Cr ratio in all three Syndrome groups compared to the control group, the decrease is significant in the left and nearly significant in the right basal ganglia. This finding indicates possible neuronal damage in the affected population.
Previous studies have shown higher cooling and warming thresholds in hands and feet of Gulf War (GWI) veterans. In this study, brain activation to warm sensation stimuli and hot pain stimuli was measured with a quantitative sensory testing (QST) fMRI paradigm, in GWI veterans with Syndromes1 (Syn1), Syn2 and Syn3, as well as age-matched controls. Syn2 and Syn1 groups exhibited significantly decreased brain activation during warm sensation compared to controls. On the other hand, Syn2 and Syn1 groups evoked significantly higher activation to hot pain stimuli in a number of pain processing areas.

Relaxation times are often an assumed value in spectroscopy studies, despite their potential diagnostic value and usefulness in quantifying metabolite concentrations. The purpose of this study was to measure the transverse (T2) relaxation times of the major brain metabolites (NAA, Cr, and Cho) in left and right basal ganglia of veterans with Gulf War Illness (GWI) and age-matched veteran controls to determine if the T2 values differ between ill veterans and controls or among the three syndrome variants of GWI.

Memory loss is a common complaint among veterans with Gulf War Illness (GWI), and preliminary studies have documented hippocampal dysfunction in GWI. Abnormal functional connectivity to hippocampus has also been observed in various other diseased populations. This study used resting state or functional connectivity MRI (fcMRI) to examine functional connectivity of the hippocampus in GWI subjects. GWI veterans exhibited significantly reduced connectivity to left and right hippocampal body in a number of brain regions, indicating disruption of hippocampal networks and/or damage to hippocampus in GWI.

neuGRID is developing a new user-friendly Grid-based research e-Infrastructure enabling the European neuroscience community to carry out computer intensive research required for the pressing study of degenerative brain diseases (for example, the Alzheimer disease). In neuGRID, the archiving of large amounts of imaging data is paired with hundreds of CPU’s and a variety of software packages. Neuroscientists will be able to identify neurodegenerative disease markers through the analysis of 3D magnetic resonance brain images via the provision of sets of distributed medical and GRID services. The infrastructure is designed to be expandable to Grid services for other medical applications and is compliant with EU and international standards regarding data collection, data management, and Grid construction.
We used Large Deformation Diffeomorphic Metric Mapping in order to improve the registration of brains with enlarged ventricles from patients with Alzheimer's disease. By employing a second channel of information comprised of the lateral ventricle segmentation maps, obtained semi-automatically and automatically, we were able to increase the accuracy of the mappings. The degree of accuracy was calculated by comparing the results of the manual segmentation of lateral ventricles and a neighboring structure, lingual gyrus, with the single and dual-channel registration-based segmentation. This approach can be a powerful tool for improving registration of images.

The aim of this study has been to optimize the contrast parameters of the MPRAGE sequence for fully automatic brain tissue segmentation. The goal has been to achieve as reliable and reproducible volumetric measurements of the human brain as possible. The optimization was carried out on a 3 T MRI unit using 2 different multi array head coils (12 and 32 channels) and 9 healthy young volunteers. The study also includes a comparison of the reproducibility in measurement between the two head coils. The results show that it is possible to achieve good reproducibility in measurement for the total brain volume and the 12 channel head coil gives slightly more reproducible results.

The aim of this study has been to optimize the contrast parameters of the MPRAGE sequence for fully automatic brain tissue segmentation. The goal has been to achieve as reliable and reproducible volumetric measurements of the human brain as possible. The optimization was carried out on a 3 T MRI unit using 2 different multi array head coils (12 and 32 channels) and 9 healthy young volunteers. The study also includes a comparison of the reproducibility in measurement between the two head coils. The results show that it is possible to achieve good reproducibility in measurement for the total brain volume and the 12 channel head coil gives slightly more reproducible results.

We demonstrated excellent tissue contrast of the lateral geniculate nucleus (LGN) with suppression of signals from the surrounding white matters, such as optic radiation using an (inversion-recovery) MPRAGE sequence with appropriate TI at 3T and 7T. The LGN was superiorly delineated with a high SNR at 7T, as compared to 3T. An imaging method that allows for accurate and reliable volume measurement of LGN is essential for the investigation of the association between LGN atrophy in vivo and neurodegenerative glaucoma.

A method is described to measure the partial volume fraction of cerebrospinal fluid for each voxel in a complete brain volume within a scan time of 5 to 6 minutes, based on quantification of the relaxation rates R1 and R2 and proton density. This measurement allows to accurately segment the brains ventricular system independent of image resolution and without user-dependent image thresholding.
1991. Quantitative MR at 3.0 T of Patients with Non-Symptomatic Localization-Related Epilepsy: Association with Generalized and Partial Seizures

Jacobus FA Jansen1, Marielle Vlooswijk2, H Majoie2, Paul Hofman2, Marc De Krom2, Albert Aldenkamp2, Walter H. Backes2

1Medical Physics, MSKCC, NY, United States; 2MUMC, Maastricht, Netherlands

Although cognitive dysfunction is a prevalent co-morbidity in patients with chronic epilepsy, it is not clear whether these patients display cerebral abnormalities that are related to the cognitive impairment that can be detected with in vivo magnetic resonance (MR) techniques. This report study aims to determine neuronal determinants of cognitive impairment in patients with chronic epilepsy.

Quantitative MR, comprising T2 relaxometry, diffusion tensor imaging, and spectroscopic imaging, was applied to detect possible neuronal correlates in terms of micro-structural and metabolic abnormalities.

1992. Deformation Based Morphometry (DBM) in Temporal Lobe Epilepsy with and Without Mesial Temporal Sclerosis

Cathy Scanlon1, Susanne G. Mueller2, Duygu Tosun2, Ian Cheong2, Michael W. Weiner2, Ken D. Laxer3

1Center for Imaging of Neurodegenerative Diseases, Dept. of Radiology and Biomedical Imaging, University of California, San Francisco, CA, United States; 2Center for Imaging of Neurodegenerative Diseases, Dept. of Radiology and Biomedical Imaging, University of California, San Francisco, CA, United States; 3Pacific Epilepsy Program, California Pacific Medical Center, San Francisco, CA, United States

Deformation-based morphometry (DBM) was applied to 2 sub-groups of temporal lobe epilepsy (TLE); 15 patients with mesial temporal sclerosis (TLE-mts) and 14 with normal MRI on visual inspection (TLE-no). TLE-mts demonstrated extensive extra-hippocampal abnormalities when compared with controls (n=33). TLE-no demonstrated more subtle but significant findings not previously reported with a similar analysis in voxel based morphometry (VBM). This may suggest DBM to be a more sensitive approach to detect subtle volume changes in this group.

1993. Quantification of Microtubule Stabilizing Drug Treatment Effect on Axonal Transport Rate in a Transgenic Mouse Model of Alzheimer's Disease

Jieun Kim1, In-Young Choi1,2, Mary L. Michaelis3, Sang-Pil Lee1,2,4

1Hoglund Brain Imaging Center, University of Kansas Medical Center, Kansas City, KS, United States; 2Neurology, University of Kansas Medical Center, Kansas City, KS, United States; 3Pharmacology & Toxicology, University of Kansas, Lawrence, KS, United States; 4Molecular & Integrative Physiology, University of Kansas Medical Center, Kansas City, KS, United States

Axonal transport impairment has been implicated as a common mechanism of Alzheimer's disease progression. A newly developed microtubule stabilizing agent, TH237-A, is known for protecting neurons against Aβ toxicity, decreasing abnormal tau phosphorylation in cultured neurons, and permeating the blood-brain barrier. We have investigated the efficacy of TH237-A in preserving axonal transport integrity in an animal model of AD, 3xTg-AD mice, over one year by measuring axonal transport rates in olfactory bulbs using manganese enhanced MRI. Results show that the drug does not reverse axonal transport deficits but may be effective in preventing further axonal transport impairment.

1994. Imaging Correlates of Neuropsychological Tests in Minimal Hepatic Encephalopathy Due to Extrahepatic Portal Vein Obstruction

Santosh Kumar Yadav1, Amit Goel1, Vivek A. Saraswat1, Arti Srivastava1, Sanjay Verma4, Ram Kishore S. Rathore1, Michael A. Thomas4, Chandra M. Pandey1, Kashi N. Prasad4, Rakesh K. Gupta1

1Radiodiagnosis, Sanjay Gandhi Post Graduate Institute of Medical Sciences, Lucknow, Uttar Pradesh, India; 2Gastroenterology, Sanjay Gandhi Post Graduate Institute of Medical Sciences Lucknow India, Lucknow, UP, India; 3Gastroenterology, Sanjay Gandhi Post Graduate Institute of Medical Sciences Lucknow, Lucknow, Uttar Pradesh, India; 4Mathematics and Statistics, Indian Institute of technology, Kanpur, UP, India; 5Mathematics and Statistics, Indian Institute of technology Kanpur, Kanpur, Uttar Pradesh, India; 6Radiological Sciences, UCLA School of Medicine, Los Angeles, CA, Los Angeles, CA, United States; 7Biostatistics, Sanjay Gandhi Post Graduate Institute of Medical Sciences, Lucknow, UP, India

Thirty-one EHPVO patients along with 23 controls were included in this study. All subjects underwent for neuropsychological tests, measurement of blood ammonia, MR imaging, 1H-MR spectroscopy. Serum cytokines were measured only in 10 patients and 8 controls. MHE was present in 45% patients. Significantly increased ammonia, Glx/Cr, and cytokines and MD with decrease in mI/Cr and MTR with no change in Cho/Cr were noted in patients with MHE compared to controls. Significantly increased Glx/Cr and blood ammonia indicates its central role in the pathogenesis of EHPVO related MHE. The presence of significant increased serum cytokines in these patients suggest that inflammation also play an important role in the pathogenesis of MHE.
**1995. Understanding Difference in Biochemical, Neuropsychological and Brain MR Imaging Profile of Minimal Hepatic Encephalopathy Secondary to Cirrhosis and Extrahepatic Portal Vein Obstruction**

Santosh Kumar Yadav, Amit Goel, Vivek A. Saraswat, R KS Rathore, M A. Thomas, A Yadav, K N. Prasad, C M. Pandey, Rakesh Kumar Gupta

1Radiodiagnosis, Sanjay Gandhi Post Graduate Institute of Medical Sciences, Lucknow, Uttar Pradesh, India; 2Gastroenterology, Sanjay Gandhi Post Graduate Institute of Medical Sciences, Lucknow, Uttar Pradesh, India; 3Mathematics and Statistics, Indian Institute of technology Kanpur, Kanpur, Uttar Pradesh, India; 4Radiological Sciences, UCLA School of Medicine, Los Angeles, CA, Los Angeles, CA, United States; 5Microbiology, Sanjay Gandhi Post Graduate Institute of Medical Sciences, Lucknow, Uttar Pradesh, India; 6Biostatistics, Sanjay Gandhi Post Graduate Institute of Medical Sciences, Lucknow, Uttar Pradesh, India

Thirty-three cirrhotic MHE and 14 EHPVO MHE with 23 age/sex matched control were included in final analysis. Liver function test, NPT, CFF, blood ammonia, proinflammatory molecules, MR imaging and 1H MR spectroscopy were recorded in all patients. MHE was significantly higher in cirrhosis than EHPVO. Significantly increased blood ammonia, proinflammatory molecules, Glx/Cr and MD with decreased mlNs/Cr was observed in both form of MHE as compared to controls, however Cho/Cr significantly decreased only in cirrhotic MHE as compared to EHPVO MHE and controls. Increased blood ammonia, proinflammatory molecules, Glx/Cr and MD with decreased mlNs/Cr is common in both form of MHE and involved the pathogenesis of MHE, however Cho/Cr depletion was observed only in cirrhotic MHE, confirms that Cho/Cr depletion is related to liver dysfunction and is unrelated to MHE. Our study confirms that there are differences in biochemical, proinflammatory molecules and MR profile in MHE of cirrhosis and EHPVO.

**1996. Amygdala Network Dysfunction Links Depressive Symptom and Memory Deficit in Elderly with Amnestic Mild Cognitive Impairment**

Chunnung Xie, Wenjun Li, Joseph Goveas, Piero Antuono, Jennifer Jones, Guangyu Chen, Malgorzata Franzczak, Zhilin Wu, Shi-Jiang Li

1Medical College of Wisconsin, Milwaukee, WI, United States; 2Neurology, School of Clinical Medicine, Southeast University, Nanjing, Jiangsu, China

The purpose of this study was to identify neural correlates of depressive symptoms and memory deficits in the amygdala functional connectivity network (AFCN) in elderly with or without amnestic mild cognitive impairment (aMCI) using the resting state functional connectivity MRI technique. aMCI subjects showed abnormal AFCN activity and the significant different correlation patterns in the distinct nodes within the AFCN correlated to depressive symptoms and memory deficits. This suggests the AFCN has dual effects that link depressive symptoms and memory deficits. The altered neural substrates of the AFCN underlying the emotional and cognitive functions mediation were associated with disease state.

**1997. Assessing the Effect of Age on Voxel-Based Relaxometry of Epileptic Patients**

Rachel Sharkey, Robert Karl Kosior, Paolo Federico, Richard Frayne

1Seaman Family MR Research Centre, Foothills Medical Centre, Calgary, AB, Canada; 2Radiology and Clinical Neurosciences, Hotchkiss Brain Institute, University of Calgary, Calgary, AB, Canada; 3Biomedical Engineering, University of Calgary, Calgary, AB, Canada

Our objective was to assess the effect of age on T2 for voxel-based relaxometry (VBR) analysis. Regressions of T2 versus age were run on data from healthy controls with a voxel-based analysis and with regions of interest. For controls and epileptic patients, VBR was performed once with age included as a nuisance variable, and once without. The correlation was variable across the brain, and significant (p < 0.05) in four regions, including the hippocampus (decreasing T2 with age). Without adjusting for age, discrepancies in VBR findings are found in younger and older patients.

**Normal Aging Brain**

Hall B Wednesday 13:30-15:30

**1998. A Multiparametric Study of White Matter Integrity and Cognition in Old Age**

Susana Muñoz Maniega, Lars Penke, Maria C. Valdés Hernández, Catherine Murray, Natalie A. Royle, Alan J. Gow, Jonathan D. Clayden, John M. Starr, Mark E. Bastin, Ian J. Deary, Joanna M. Wardlaw

1Clinical Neurosciences, University of Edinburgh, Edinburgh, United Kingdom; 2Psychology, University of Edinburgh, Edinburgh, United Kingdom; 3Institute of Child Health, University College London, London, United Kingdom; 4Geriatric Medicine, University of Edinburgh, Edinburgh, United Kingdom; 5Medical Physics, University of Edinburgh, Edinburgh, United Kingdom

Using diffusion MRI tractography we segmented white matter tracts thought to be related with cognition in a cohort of healthy older people. We registered the tract segmentations to parametric maps of magnetization ratios and T1 relaxation times and used these parameters, as well as fractional anisotropy and mean diffusivity, to characterise the white matter integrity of the tracts. The study of how tract integrity relates to cognition in old age revealed new relationships not shown by diffusion parameters only. This work suggests that a multi-parameter approach could unravel the effects of ageing on the brain and cognition better than the lone use of diffusion MRI.
Estimations on age-related rate of changes of brain tissues have mostly been gathered from cross-sectional MRI studies. A limitation of cross-sectional design is the inability to directly assess intra-individual change. Longitudinal studies on brain tissues and age in large population cohorts are lacking. We compared estimated rates of cross-sectional and longitudinal changes with age in brain tissues in a population-based cohort of 4614 older persons. The longitudinal data show a substantially higher age-related rate of change in tissue volumes when compared to the cross-sectional estimates and show that the cross-sectional data underestimates the rate of change in brain tissues.

VBM analysis of grey matter distribution within the healthy adult brain was undertaken, in a sample of 31 males and 35 females (age range: 20-72 years) to investigate sex differences in the effect of brain ageing. Data were analysed using a full factorial analysis (2x2x2). There were no significant sex by age effects. Within sex regression analyses revealed that females showed age related GM decrements within several frontal regions tending medially, whereas males showed age related decrements in bilateral structures including IFG (BA44/45). These findings are discussed.

Intensity of white matter lesions (WMLs) on structural MRI may be linked to the severity of underlying white matter damage, and hence to old age cognitive decline. Here we investigate relationships between the volumes of intense (i) and less-intense (Li) WMLs within a unique cohort of 721 subjects in whom cognitive ability is available in both youth (11 years) and old age (72-73 years). iWMLs were predominant located in frontal areas, while LiWMLs were mainly located posteriorly. iWMLs had a stronger relationship with cognition than LiWMLs in both youth and old age. These findings support the frontal ageing hypothesis.

To test the correlations of aging, sex, and aortic stenosis (AS) degree with the severity of pre-existing white matter and ischemia-like lesions. Aging was associated with rapidly progressive cerebral ischemic disease; female sex accounted for a 56% increased in lesion volume over men; while the severity of AS did not demonstrate statistical significance in influencing lesion volume, univariate analysis demonstrated an important trend of increasing lesion volume with increasing severity of AS.

We present a novel technique applying probabilistic diffusion tensor tractography on longitudinal data to assess white matter structural integrity in ageing subjects over a period of two years. Our method was able to consistently extract white matter tracts associated with...
working memory over time and between two ageing cohorts (middle-aged and elderly). Tract connections were found between the fronto-temporal, fronto-parietal and temporo-parietal lobes. Our study suggests a decrease in white matter structural integrity of these tracts with age could be related to the decline in working memory performance.

Mark E. Bastin1, Maria Valdès Hernandez2, Susana Muñoz Maniega1, Catherine Murray1, Alan J. Gow1, Paul A. Armitage2, Joanna M. Wardlaw1, Ian J. Deary1
1Medical Physics, University of Edinburgh, Edinburgh, United Kingdom; 2Clinical Neurosciences, University of Edinburgh, Edinburgh, United Kingdom; 3Psychology, University of Edinburgh, Edinburgh, United Kingdom

White matter lesions are a common finding on T2- and FLAIR-weighted MRI scans of older subjects, but their etiology and relationship to cognitive function remains unclear. The aim of this pilot study was to characterize differences in magnetization transfer ratio and spin-lattice relaxation time between macroscopically normal-appearing white matter and white matter lesions in a subset of a unique cohort of aging subjects, the Lothian Birth Cohort 1936.

2005. Hypertension, Arterial Health and Neuronal Integrity in Midlife
Andreana P. Haley1,2, Tarumi Takashi3, Jun Sugawara3, Hirofumi Tanaka3
1Psychology, The University of Texas at Austin, Austin, TX, United States; 2UT Imaging Research Center, Austin, TX, United States; 3Kinesiology, The University of Texas at Austin, Austin, TX, United States

The present study bridges the gap between midlife hypertension and late-life cognitive impairment, a relationship that has long been documented but remains poorly understood. We demonstrate that midlife hypertension and associated arterial thickening relate to cerebral measures of neuronal health and viability in middle-aged adults with intact cognitive performance.

Tae-Hoon Kim1, Gwang-Woo Jeong1,2, Han-Su Bae1, Gwang-Won Kim1, Heoung-Keun Kang1, Jong-Chul Yang1, Kwangsung Park1
1Interdisciplinary Program of Biomedical Engineering, Chonnam National University Medical School, Gwangju, Korea, Republic of; 2Radiology, Chonnam National University Medical School, Gwangju, Korea, Republic of; 3Psychiatry, Chonbuk National University Hospital, Chonbuk, Korea, Republic of; 4Urology, Chonnam National University Medical School, Gwangju, Korea, Republic of

With menopause, women underwent changes of overall hormones, leading to functional changes of organs. A majority of menopausal women experience some changes in sexual function. Using fMRI technique, menopausal a few papers concerning differential brain activation patterns between premenopausal and menopausal women were published. However, it is unclear how brain metabolite change in menopause affects sexual arousal.

The purpose of this study was to investigate the brain metabolic changes associated with visual sexual arousal in premenopausal and menopausal women using functional MR spectroscopy (fMR).

2007. Motion Detection in Healthy Young, Middle-Aged, and Elderly Adults Using a Water Signal Based Navigator Echo: A 1H MRS Study
Sarah Andrea Wijtenburg1, Kathleen L. Fuchs1, Virginia I. Simnad2, Jack Knight-Scott1
1Radiology, Children's Healthcare of Atlanta, Atlanta, GA, United States; 2Neurology, University of Virginia, Charlottesville, VA, United States; 3Neurology, Evergreen Hospital Medical Center, Kirkland, WA, United States

Here, we build upon our earlier work incorporating a CHESS pulse into a STEAM sequence by presenting a new method for analyzing and interpreting motion data collected from three age groups: healthy young (HY), healthy middle-aged (HM), and healthy elderly (HE). Our results show that listed in increasing order of motion during a 1H MRS STEAM spectroscopy examination: HY, HM, and HE.

2008. Cross-Site Reproducibility of 1H-MRS
Irene Margaret Vavasour1, Cornelia Laule1, Burkhard Maedler1, Trudy Harris1, David K.B. Li1, Anthony L. Traboulsee1, Alex L. Mackay1
1Radiology, University of British Columbia, Vancouver, BC, Canada; 2Physics and Astronomy, University of British Columbia; 3Medicine, University of British Columbia

Quantitative assessment of 1H-MRS metabolite concentrations has the potential to be an in-vivo marker for disease progression and treatment efficacy in pharmaceutical trials. The present study examines cross-site reproducibility of 1H-MRS metabolite concentrations measured on the same 5 people at 6 sites. Average percent differences of inter and intra-site reproducibility was <10% for n-acetyl-aspartate and myo-Inositol, <7% for creatine; <8% for choline and <21% for glutamate and glutamine. All percent differences between sites were of a similar magnitude increasing confidence in comparing results from across the sites.
2009. Aging Effects on the Functional Connectivity in the Resting Brain
Zhengjun Li1, Anisheh Kadivar2, John Pluta3, Holly D. Soares4, Murray Grossman5, John Detre5, Ze Wang1
1Dept. of Biomedical Engineering, Shanghai Jiao Tong University, China; 2Dept of Psychiatry, University of Pennsylvania, United States; 3Dept of Neurology, University of Pennsylvania, United States; 4Pfizer Inc, United States; 5Dept of Psychiatry, University of Pennsylvania, Philadelphia, PA, United States

Functional connectivity (FC) and the default mode network represents two recent active research directions in fMRI. Previous studies have shown the aging effect in resting FC based on independent component analysis or concurrent task involved fMRI defined region-of-interests (ROIs). No published work has assessed the aging effects on resting FC in the DMN using the seed region based method. To meet this gap, we here report some preliminary results of the aging inter-region FC in the normal brain using resting fMRI and found age-dependent FC decrease in anterior cingulate cortex and posterior cingulate cortex.

2010. Correlation Between Venous Blood T1 and BOLD FMRI in Young and Elderly
Subjects
Lirong Yan1, Yan Zhuo1, Bo Wang1, Cheng Li2, Jiampfujang Wang2
1Institute of Biophysics, Chinese Academy of Sciences, Beijing, China; 2Department of Radiology, University of Pennsylvania, Philadelphia, PA, United States

We investigated the relationship between in vivo measurement of venous blood T1 and BOLD signal changes during visual stimulation in two groups of young and elderly subjects. There was a significant negative correlation between venous blood T1 and BOLD activation across subjects. Upon including venous blood T1 as a covariate, the differences in BOLD activation between the two age groups weakened, suggesting that aging effects on BOLD fMRI may be partly attributed to baseline hematocrit variations.

2011. Increased Resting State Connectivity Between Left and Right Hemispheres with Increasing Age
Daniel Joshua Cox1,2, Rafat S. Mohtasib1, Daniela Montaldì1, Laura M. Parkes1,2
1Imaging Sciences and Biomedical Engineering, School of Cancer and Imaging Sciences, The University of Manchester, Manchester, Lancashire, United Kingdom; 2Biomedical Imaging Institute (BII), The University of Manchester, Manchester, Lancashire, United Kingdom; 3Magnetic Resonance and Image Analysis Research Centre (MARIARC), University of Liverpool, United Kingdom; 4School of Psychological Sciences, The University of Manchester, Manchester, Lancashire, United Kingdom

This study aims to investigate changes in resting state functional connectivity with increasing age. 40 healthy subjects (aged 20 – 76) participated. Gradient echo EPI images were collected during a Stroop task and active regions were found across the group. The BOLD amplitude in the right middle frontal gyrus (MFG) increased with age, reducing laterality of activation. Partial correlation was used to investigate functional connectivity between bilateral MFG, which was found to increase with age between bilateral MFG in adults aged 40yrs+. Increased connectivity was also associated with improved accuracy, suggesting alterations in functional connectivity may be important for performance.

2012. Age-Related Effects on Resting State Default, Executive and Salience Networks
Reveal Different Pruning Mechanisms – a Resting State FMRI Study.
Vesa Kiviniemi1, Harri Littow2, Ahmed Abou-elseoud2, Katarina Mankinen2, Jukka Rahko3, Jukka Remes2, Juha Nikkinen2, Tuomo Starck2, Juha Veijola2, Christian Beckmann3, Osmo Tervonen1
1Diagnostic Radiology, Oulu University Hospital, Oulu, Finland; 2Pediatric department, Oulu University Hospital, Oulu, Finland; 3Child Psychiatry, Oulu University Hospital, Oulu, Finland; 4Psychiatry, Oulu University, Oulu, Finland; 5Clinical Neuroscience, Imperial College, London, United Kingdom

Resting state networks undergo various age related changes both in strength and spatial distribution. Some occur in adolescence while many changes also occur later in adulthood. A salience network splits without much strength in any age group. These different findings reflect multiple normal ageing processes of the central nervous system.

2013. Age-Related Differences of Brain Activation Patterns Upon Imaginary Walking
Ekkehard Küstermann1,2, Markus Ebke3, Katja Dolge3, Natascha Lohr3, Dieter Leibfritz2, Manfred Herrmann1
1ZKW/Neuropsychologie, Universität Bremen, Bremen, Germany; 2Organische Chemie, Universität Bremen, Bremen, Germany; 3Neurologie, Klinikum Bremen-Mitte, Bremen, Germany; 4JCLLaID, Jacobs University Bremen, Bremen, Germany

The steadiness of walking decreases in elderly with advancing age. This study was designed to explore changes in the activation pattern during walking. Healthy young and elderly subjects performed imagined walking tasks while being scanned. Elderly subjects exhibited stronger and larger activations as compared to younger subjects with a marked increase in the IPL. During imagined walking, negative BOLD signal changes were only observed in younger, but not in elderly subjects.

2014. Naming Errors and Gray Matter Structural Variations
Katie McMahon1, Anna Holmes2, Shiree Heath1, Anthony Angwin3, Lindsey Nickels4, Eril McKinnon2, Sophie Van Hees2, David Copland2,3
1Centre for Magnetic Resonance, University of Queensland, Brisbane, Queensland, Australia; 2UQ Centre for Clinical Research, University of Queensland, Australia; 3School of Health and Rehabilitation Sciences,
The frequency of naming errors increases in normal aging. In this study we examined an elderly cohort of subjects; classified their naming difficulties and correlated this with high resolution structural MRI images. Different regions were structurally correlated for reduced semantic, phonological and visual perception errors, including the inferior temporal lobe, middle temporal lobe, and occipital-parietal regions.

2015. **Correlations Between Semantic Priming, Word Recognition and Gray Matter Density**

Katie McMahon¹, Anthony Angwin², Anna Holmes³, Shiree Heath⁴, Sophie Van Hees⁵, David Copland²,³

¹Centre for Magnetic Resonance, University of Queensland, Brisbane, Queensland, Australia; ²School of Health and Rehabilitation Sciences, University of Queensland, Australia; ³UQ Centre for Clinical Research, University of Queensland, Australia

A normal elderly cohort was examined with MRI and a lexical access/semantic priming task. The priming effect (semantically related vs unrelated prime-target pairs), and the word (semantic + unrelated response times) versus non-word targets were calculated. These variables were covaried with the individual subjects' high resolution MRI images, to investigate any possible structural dependencies. Structures of areas associated with attentional and semantic priming networks were significant when compared against non-word responses, and areas of conceptual object knowledge and familiarity when compared with the priming effect.

2016. **The Hemodynamic Response Characteristics Underlying the Age-Related Change of Brain Activation During Motor Execution**

Toshiharu Nakai¹, Makoto Miyakoshi¹, Epifanio Bagarinao¹, Chikako Nakai², Kayako Matsuo³

¹Functional Brain Imaging Lab, National Center for Geriatrics and Gerontology, Ohbu, Aichi, Japan; ²School of Health Sciences, Toyoshashi Sozo University, Toyoshashi, Aichi; ³Psychology, National Taiwan University, Taipei, Taiwan

The characteristics of the hemodynamic response function underlying the age-related change was investigated to estimate its contribution to the statistical evaluation of fMRI by using motor tasks. It was suggested that the neuronal demanded was augmented to support cognitive processing for motor regulation rather than motor execution itself. Augmented activation in the elderly subjects mostly depended on the increased BOLD signal amplitude between the initial and post-stimulus peaks. It will be recommended to consider the potential bias induced by the non-linear dynamics of HRF to assess the age-related change of brain activation.

2017. **Differences in GABA to Creatine Ratio Between the Occipital and the Medial Prefrontal Cortices**

Jan Willem W. van der Veen¹, Paul J. Carlson¹, Jun Shen¹

¹NIH, NIMH, MAP, Bethesda, MD, United States

GABA and Glx were measured in 28 volunteers using a PRESS-based two step J editing sequence. Two voxels located in the medial prefrontal cortex (MPFC) and the occipital lobe (OCC) were studied. The GABA/Cre ratio was significantly higher (P<0.001) in the OCC (0.115 +/- 0.008) than in the MPFC (0.102 +/- 0.009). Co-edited Glx/Cre ratio was significantly (P<0.001) lower in the OCC (0.0806 +/- 0.006) than in the MPFC (0.0974 +/- 0.009). Our results, combined with previously reported Cre distribution in brain, show that there are significant differences in GABA and Glx between MPFC and OCC.

**Developing Brain & TTS Abnormalities**

Hall B Thursday 13:30-15:30


Amy Louise Kotsenas¹, David W. Stanley², Dan W. Rettmann², John D. Port¹

¹Dept. of Radiology, Mayo Clinic, Rochester, MN, United States; ²GE Healthcare, Proctor, MN, United States; ³GE Healthcare, Rochester, MN, United States

The double inversion recovery (DIR) sequence supresses both cerebrospinal fluid and white matter signal which is of benefit in detecting subtle malformations of cortical development. Using the TI parameters from our adult DIR protocol did not provide optimum white matter signal suppression in pediatric patients as the TI of the white matter varies with the degree of myelination. We were able to determine approximate TIwm values for use in DIR sequence to optimize the grey-white matter contrast in patients aged 1 year to 7.5 years. We were unable to optimize white matter suppression in children under 1 year of age.

Peter Kochunov1, David Purdy5, Duff Davis1

1Research Imaging Institute, UTHSCSA, san antonio, TX, United States; 2Siemens Healthcare USA, Malvern, PA, United States

Because non-human primates (NHPs) and humans share a highly orchestrated pattern of cerebral development, imaging of fetal brain maturation in NHPs provides an excellent opportunity to validate theories regarding gyrrification of the cortex. Compared to human studies, structural imaging in NHPs is challenging because of the small brain size, and spatial sampling comparable to human studies (~1.0 mm3) requires brain-size-adjusted sampling volumes of ~150 microns3. Longitudinal studies of in utero NHP brain were accomplished with a true FISP isotropic 3D protocol having superior signal-to-noise ratio, low SAR, and good contrast among gray matter, white matter, CSF, and amniotic fluid.

2020. Diffusion Spectrum Tractography and Histology: Developing Connectivity in the Cat Brain

Emi Takahashi1, Guangpang Dai2, Ruopeng Wang2, Kenichi Okki3, Glenn D. Rosen4, Albert M. Galaburdaa, Rebecca D. Folkertth, Van J. Wedeen2, P. Ellen Grant1,6

1Department of Medicine, Children's Hospital Boston, Harvard Medical School, Boston, MA, United States; 2Department of Radiology, Massachusetts General Hospital; 3Department of Neurobiology, Harvard Medical School; 4Department of Pathology, Children's Hospital Boston; 5Department of Radiology, Children's Hospital Boston

The transient subplate (SP), located just below the immature cortex, is crucial for the formation of neuronal circuits, but it has been challenging to image abundant crossings running through the SP. Using high-resolution diffusion spectrum imaging (DSI) tractography, we successfully imaged 3-dimensional cortical/subcortical pathways in P0 (newborn), P35 (pediatric), and P100 (adult) cats and compared the findings to histology. In some regions, perpendicular to the projecting pathways, emergence of long association fibers was also imaged. These results show the potential of DSI in fixed pathological specimens at any stage of myelination to provide information on developing organization and connectivity.

2021. Diffusion MRI of in Utero Mouse Embryos

Lin Zhao1, Scott E. Fraser3, J. Michael Tyszka1

1California Institute of Technology, Pasadena, CA, United States

In utero MR microscopy of developing mouse embryos is complicated by maternal respiratory motion and by the general lack of tissue contrast between embryonic tissues, particularly in the CNS. We explore here the use of volumetric diffusion-weighted MR microscopy to visualize the embryonic brain in utero at later development stages.

2022. Prenatal MR Imaging of Focal Cortical Gyration Anomalies at Early Stage of Development

Andrea Righini1, Cecilia Parazzini1, Chiara Doneda1, Laura Avagliano2, Filippo Arrigoni1, Mariangela Rustico2, Gaetano Bifulcamate2, Fabio Triulzi1

1Radiology and Neuroradiology, Children's Hospital V. Buzzi, Milan, Italy, Italy; 2Pathology, San Paolo Hospital, Milan, Italy, Italy

We report the MRI patterns of focal cortical gyration anomalies, as they appear at a very early stage of the sulcation process (when fetal brain is almost “lyssencephalic”). 22 cases (gestational age between 21 and 24 weeks) showed focal gyration anomalies, which could be divided in four basic patterns of cortical rim distortion: “wart-like”, “saw-tooth”, major aberrant invaginating sulcusi, single or multiple bumps. Most of these cases presented similarities to the rat model of experimentally induced polymicrogyria. The present cohort shows how focal cortical gyration anomalies can be detected even at very early sulcation process stage.

2023. Fetal Imaging with Multitransmit MR at 3.0T: Preliminary Findings

Christopher G. Filippi1, Alisa Johnson2, Joshua P. Nickerson3, Betsy Sussman1, Jay Gonyea, Trevor Andrews6

1Radiology, University of Vermont School of Medicine-Fletcher Allen Health Care, Burlington, VT, United States; 2Radiology, Fletcher Allen Health Care, Burlington, VT, United States; 3Radiology, University of Vermont School of Medicine, Burlington, VT, United States; 4Radiology, University of Vermont School of Medicine, Burlington, VT, United States; 5Radiology, Philips Health Care, Cleveland, OH, United States

Multitransmit MR corrects B1 inhomogeneity which lessens dielectric shading, and a more uniform flip angle reduces focal SAR hot spots and allows for safe fetal MR imaging at 3.0 T for brain anomalies, and using multitransmit MR with SENSE allows for faster scan times and better signal to noise. We present 3 cases comparing 3.0T fetal MR imaging with and without multitransmit to follow-up MR imaging in the perinatal period to assess the accuracy, image quality, and clinical feasibility of multitransmit MR imaging of the fetus at 3.0T.

2024. Fetal Cortex Extraction Using Subject Specific Priors

Paul Aljabar1, Melissa S. Damodaram1, Mary A. Rutherford2, Daniel Ruecker1, Joseph V. Hajnal3

1Visual Information Processing group, Department of Computing, Imperial College London, London, United Kingdom; 2Division of Surgery, Oncology, Reproductive Biology and Anaesthetics, Imperial
Automatic segmentation of the cortex from fetal brain MRI has potential as a significant tool in developmental neuroscience. We developed an accurate and robust method for extracting the cortex based on creating subject specific cortical priors using label propagation from automatically produced neonatal atlases. The method was tested on 12 fetal subjects with gestational age range from 20 -30 weeks, imaged using single shot Fast Spin Echo sequences with Slice to Volume (SVR) 3D reconstruction. The method was validated against manual segmentation and found to yield a mean error of 1.15±1.03mm.

2025. White Matter Maturation of Normal Human Fetal Brain-An in Vivo Diffusion Tensor Imaging Tractography Study

Emilie ZANIN1, Jean-Philippe Ranjeva1, Sylviane Confort-Gouny1, Maxime Guye1, Danielle Denis2, Patrick J. Cozzone2, Nadine GIRARD2
1CRMBM UMR CNRS 6612, Marseille, France; 2CHU Nord, Marseille, France

Objective of this study was to demonstrate the ability of DTI tractography, to assess in vivo and in utero a crucial stage of human fetal brain development: the white matter maturation. We observed that evolution of diffusion characteristics during gestation were different for cortical spinal tract, optic radiations, anterior, middle and posterior part of corpus callosum reflecting the presence of structural heterogeneity between these large WM tracts during gestation. Non-linear curve fittings of normalized longitudinal and radial water diffusivities as a function of age identify 3 different phases of maturation with specific dynamics for each WM bundle type.

2026. Birth the Hardest Journey in Life and a Brain Warping Experience. a Deformation Field Morphology Study of Fetal Brain During Labor

Peter Kochunov1, Carlos Castro2, Gerald Schatten2, David Purdy3, Duff Davis1
1Research Imaging Institute, UTHSCSA, san antonio, TX, United States; 2Ob / Gyn and Reproductive Sciences, University of Pittsburgh School of Medicine, Pittsburgh, PA, United States; 3Pittsburgh Development Center, University of Pittsburgh School of Medicine, Pittsburgh, PA, United States; 4Siemens Medical Solutions, Malvern, PA , United States

Neonates of Old World monkeys have the longest gestational development phase among comparably sized mammals, and as a consequence, neonatal heads approach the size of the birthing canal. This can lead to cephalo-pelvic limitation, a situation in which the size of the birthing canal presents a physical limit on the size and shape of neonate during parturition. An unexpected labor provided a rare opportunity to map deformations experienced by the neonatal brain during these normal contractions. A deformation field analysis produced a 3-D array of 3-D displacement vectors, showing dramatic regional deformation of the fetal brain during normal labor.

2027. Mapping the Development of the Human Connectome

Patric Hagmann1, Olaf Sporns2, Stephan Gerhard1, Rudolph Pienaar3,4, Jean-Philippe Thiran1, Leila Cammoun1,6, Neel Madan2, P Ellen Grant3,4
1Department of Radiology, CHUV-UNIL, Lausanne, VD, Switzerland; 2Department of Psychological and Brain Sciences, Indiana University, Bloomington, IN, United States; 3Signal Processing Laboratory 5, EPFL, Lausanne, VD, Switzerland; 4Division of Newborn Medicine and Department of Radiology, Children’s Hospital Boston, Boston, MA, United States; 5Athinoula A. Martinos Center for Biomedical Imaging, MGH-Harvard, Boston, MA, United States; 6Department of Radiology, MGH-Harvard, Boston, MA, United States

From birth to early adulthood the brain undergoes dramatic modifications resulting in network development and optimization. In the present study we investigate the development of the human connectome but measuring myelination trajectories of individual connections over the entire brain structural network using high b-value diffusion imaging and tractography. We found significant changes in several network measures that support increased integration and efficiency. We also observe that the network doesn’t myelinate at a uniform rate but with different myelination speeds dependant on the type of cortex.

2028. Mapping Primary Gyrogenesis. In-Utero, High-Resolution Structural MRI Study of Brain Development in Fetal Baboons

Peter Kochunov1, Carlos Castro2, David Purdy3, Yi Zhang1, Duff Davis1
1Research Imaging Institute, UTHSCSA, san antonio, TX, United States; 2Ob / Gyn and Reproductive Sciences, University of Pittsburgh School of Medicine, Pittsburgh, PA, United States; 3Siemens Medical Solutions, Malvern, PA , United States

Primary gyrogenesis is a poorly-understood developmental process that transforms the lissencephalic cortex of a maturing mammalian brain toward its mature, gyrencephalic state by sculpting an intricate pattern of folds (gyri) and burrows (sulci). A novel in utero MRI protocol developed specifically for high-resolution imaging of fetal brain was used for precise tracking of global and regional gyriofication in fetuses of baboons, information that would otherwise be difficult to obtain. These studies revealed a disparity in the growth rates of revealed a disparity of the growth rates in sulcal length and depth.
Central and Cortical Gray Mater Segmentation of Magnetic Resonance Images of the Fetal Brain

Meritxell Bach Cuadrado, Marie Schaer, Gabriele Bonano, Anouk André, Laurent Guibaud, Stephan Eliez, Jean-Philippe Thiran
1Signal Processing Laboratory (LTSS), Ecole Polytechnique Federale de Lausanne (EPFL), Ecublens, Vaud, Switzerland; 2Service Médico-Pédiatrique, Psychiatry Department, University of Geneva School of Medicine, Switzerland; 3Imagerie pédiatrique et fétale, Hôpital Debrousse, Lyon, France

In this work we present our methodology to segment central (basal ganglia) and cortical gray mater of brain in magnetic resonance fetal imaging. This is a key step in the study of early human brain development. The results for basal ganglia segmentation are quantitatively validated in 4 cases from 29 to 32 gestational weeks. Cortical brain surface is evaluated qualitatively in a case study. Our efforts are now in testing such approach on a wider range of gestational ages that we will include in the final version of this work and studying as well its generalization to different scanners and different type of MRI sequences.

Correction Strategy for Infants' Diffusion-Weighted Images Corrupted with Motion

Jessica Dubois, Ghislaine Dehaene-Lambertz, Lucie Hertz-Pannier, Giovanna Santoro, Jean-François Mangin, Cyril Poupon
1U562, Inserm, Gif-sur-Yvette, France; 2LBIOM, CEA, Gif-sur-Yvette, France; 3IFR49, Paris, France; 4UM663, Inserm, Paris, France; 5LNAO, CEA, Gif-sur-Yvette, France

Diffusion Tensor Imaging (DTI) offers the possibility to study the developing white matter non-invasively. However, diffusion-weighted images obtained in non-sedated infants are often corrupted with motion artifacts. We propose a post-processing methodology which takes advantage of the high diffusion orientation count and corrects these images before the computation of diffusion maps. The strategy relies on three successive steps: two steps of correction of corrupted slices (using decomposition on a spherical harmonics basis), separated by a step of 3D motion registration. This approach was validated on DTI data from 15 infants, by reliably evaluating the corpus callosum maturation with tractography-based quantification.

Characterization of the Pig Brain as a Neuroimaging Model for Early Human Brain Development: A Combined Structural MRI and DTI Study

Jeff D. Winter, Jelena Lukovic, Andrea Kassner
1Physiology and Experimental Medicine, The Hospital for Sick Children, Toronto, Ontario, Canada; 2Medical Imaging, University of Toronto, Toronto, Ontario, Canada

In this study, we explored the potential of the swine brain for neurodevelopmental imaging by MRI characterization of structural and microstructural changes. We collected anatomical and diffusion tensor images from 11 juvenile (1-12 wk) pigs. A significant, positive logarithmic relationship existed between body weight and tissue brain volumes, as well as the surface folding index, a measure of cortical folding. Similar to humans, fractional anisotropy exhibited a logarithmic increase with body weight for all regions investigated. No mean diffusivity changes existed. These results suggest the swine brain may provide an informative model for translational studies of early human brain development.

Quantitative Fiber Tracking in the Premature at Term Age Shows a Correlation with MRI Findings, Gestational Age and Head Circumference

Carola van Pul, Britt van Kooij, Gijs Hoskam, Linda de Vries, Manon Benders, Anna Vila Nova, Floris Groenendaal
1Clinical Physics, Maxima Medical Center, Veldhoven, Noord-Brabant, Netherlands; 2School of Medical Physics and Engineering, Eindhoven University of Technology, Eindhoven, Noord-Brabant, Netherlands; 3Neonatology, Wilhemina Children's Hospital, Utrecht, Netherlands; 4Biomedical Engineering, Eindhoven University of Technology, Eindhoven, Noord-Brabant, Netherlands

We studied 92 prematurely born neonates (<31 weeks) at term equivalent age using quantitative Fiber Tracking (FT), generated on 3.0T MRI. Patients were divided into three groups, based on scoring of the conventional MRI's. Using a general linear model, the effects of factor (group) and variables (gestational age, birth weight and head circumference) were tested. For the FA and ADC in corpus callosum fiber bundle, a significant relation with MR group was observed. Furthermore, for the corpus callosum, volume, CI and length depended significantly on the gestational age, suggesting an influence of age at birth on brain maturation.

High Angular Resolution Diffusion Imaging (HARDI) Analysis of the Motor Pathway in Infants

Jeffrey I. Berman, Sonia L. Bonifacio, Roland G. Henry, Donna M. Ferriero, Hannah C. Glass, A James Barkovich, Duan Xu
1Radiology and Biomedical Imaging, University of California San Francisco, San Francisco, CA, United States; 2Pediatrics, University of California San Francisco, San Francisco, CA, United States; 3Neurology, University of California San Francisco, San Francisco, CA, United States

High angular resolution diffusion imaging (HARDI) was used to examine white matter microstructure in 3 and 6 month old infants with a history of birth asphyxia. Residual-bootstrap probabilistic q-ball tractography was used to delineate the motor pathway. As in adults, the motor tract intersects other white matter tracts in the centrum semiovale and q-ball fiber tractography could traverse these regions. Diffusion parameters were measured in the 3D region defined by fiber tractography. This study demonstrates the feasibility of using in-vivo HARDI to discriminate complex white matter architecture in infants within a reasonable exam time.
Vein Quantification of SWI in Infants with Hypoxic-Ischemic Encephalopathy (HIE)
Samuel Barnes¹,², Chantal Lunderville², Gene Kitamura², Stephen Ashwal³, Andre Obenaus²
¹Wayne State University, Detroit, MI, United States; ²Loma Linda University, Loma Linda, CA, United States

The use of susceptibility weighted imaging (SWI) in hypoxic-ischemic encephalopathy (HIE) can give additional information about the varying amounts of deoxyhemoglobin in cerebral veins as an indicator of metabolic stress. Abnormal levels of deoxyhemoglobin (low or high) are correlated with poor clinical outcome. This work compares different qualitative and quantitative measures of venous visibility as an indicator of deoxyhemoglobin levels and how it correlates with clinical outcome.

Gender Differences in the Rate of White Matter Microstructural Development During Late Childhood and Adolescence
Jonathan D. Claydon¹, Sebastian Jentschke¹, Monica Muñoz¹, Janine Cooper¹, Tina Banks², Faraneh Vargha-Khadem¹, Chris A. Clark¹
¹Institute of Child Health, University College London, London, Greater London, United Kingdom; ²Radiology Department, Great Ormond Street Hospital, London, Greater London, United Kingdom

There is evidence for various changes in white matter microstructure during development, in some cases specific to certain pathways. In this study we report what we believe to be the first evidence of gender differences in the rates of change of diffusion MRI parameters, in a healthy group of 8-17 year old children.

Clinical Application of Readout-Segmented (RS)-EPI for Diffusion-Weighted Imaging in Pediatric Brain
Samantha J. Holdsworth¹, Kristen Yeom¹, Stefan Skare¹, Patrick David Barnes¹, Roland Bammer¹
¹Radiology, Stanford University, Palo Alto, CA, United States

Readout-segmented (RS)-EPI has been suggested as an alternative approach to EPI for high resolution diffusion-weighted imaging (DWI) with reduced distortions. Here we implemented GRAPPA-accelerated RS-EPI DWI on 35 pediatric patients at 3T. We compared these images with standard accelerated (ASSET) EPI DWI used routinely for pediatric clinical studies. Images were categorized by resolution, distortion level, SNR, lesion conspicuity, and diagnostic confidence. RS-EPI out-performed ASSET EPI and demonstrated that it may be a useful method for DWI for evaluating lesions such as hypoxic-ischemic brain injury, diffuse axonal injury, tumors, dermoid/epidermoid, and skull base/orbital pathology.

Assessment of Structural Maturation of the Optic Radiation in Children with Probabilistic Tractography
Michael Dayan¹, Chris A. Clark¹
¹Radiology & Physics, UCL Institute of Child Health, London, United Kingdom

The optic radiation (OR) is a component of the visual pathway assumed to mature before 3 years old. This study aimed at evaluating diffusion tensor (DT) metrics within this tract, notably fractional anisotropy (FA) and radial diffusivity (RD), as a function of age, hemisphere and gender in children aged from 7 to 18. DT probabilistic tractography based on 10000 iterations was carried out for this purpose. A one sample t-test demonstrated a hemispheric dependence for RD (p < 0.01) but not for FA (p > 0.96). A multiple regression analysis did not show any gender effect for any DT indices. A significant age dependence was found for FA (p < 0.001) and RD (p < 0.04). These findings suggest an age-related effect from 7 to 18 years well after the OR is myelin mature, which suggests that maturational and/or developmental changes occur in the OR long after myelination.

Anatomical Assessment of the Optic Radiation in Children with Probabilistic Tractography
Michael Dayan¹, Chris A. Clark¹
¹Radiology & Physics, UCL Institute of Child Health, London, United Kingdom

Temporal lobectomy, a surgical procedure notably carried out in children affected by intractable epilepsy, may be associated with visual field defects if the optic radiation (OR) is damaged. The lack of data in children on the spatial dimensions and location of this pathway with highly variable anterior aspect, Meyer’s loop (ML), lead us to reconstruct the OR in children in the age range 7 to 18 with probabilistic tractography. The segmentation was assessed by computing two reference anatomical distances, the distance from ML to the temporal pole (ML-TP) and to the occipital pole (ML-OP), and comparing them with other tractography and dissection studies in adults. A one sample t-test showed a hemispheric dependence for ML-TP and ML-OP (p < 0.02) and a multiple regression analysis demonstrated a gender dependence but no age effect. The distances reported in this study were similar to tractography and dissection studies in adults. These data and the statistically significant dependence on gender and hemisphere are envisaged to be relevant when considering neurosurgical planning for temporal lobectomy in children.
2039. White Matter Properties Predict the Speed of Neural Processing and Cortical Maturation in Children

Colleen Dockstader1,2, William Gaetz3, Conrad Rockel1, Donald Mabbott1
1Dept of Psychology/Division of Haematology/Oncology, The Hospital for Sick Children, Toronto, ON, Canada; 2Dept of Anesthesia and Pain Medicine, The Hospital for Sick Children, Toronto, ON, Canada; 3Biomedical Imaging Laboratory, Children's Hospital of Philadelphia, Philadelphia, PA, United States

We investigated age-related changes in the latency of the P100m visual response in occipital cortex and the biophysical properties of white matter in eleven healthy children to determine the impact of white matter growth on the maturation of neuronal signaling. Using TBSS, we found a significant relationship between FA and P100m latency in the dorsal processing stream. The latency of the P100m was inversely related to FA and positively related to age. Our findings suggest that simple measures of evoked latency on a visuomotor-attention task reflects dorsal stream integrity that is related to stage of cortical maturation in healthy children.

2040. Precision and Accuracy of Arterial Spin Labeling Perfusion MRI in the Pediatric Population

Varsha Jain1, Mariel Giannetta1, Michael Langham1, Sharon Xie1, Daniel Licht1, Joan Giannetta1, Timothy Roberts2, John Detre1, Hallam Hurt2, Felix Wehrli1, Jiongjiong Wang1
1University of Pennsylvania, Philadelphia, PA, United States; 2Children's Hospital of Philadelphia, Philadelphia, PA, United States

We evaluated the precision and accuracy of absolute CBF measurements using two arterial spin labeling (ASL) techniques, pulsed ASL (PASL) and pseudo-continuous ASL (pCASL) in a typical developing cohort of 18 healthy children 7 to 17 years old. Longitudinal reproducibility (precision) was assessed by repeated scans 2-4 weeks apart, while accuracy was assessed by comparison with total blood flow volume measured by phase-contrast (PC) MRI at the labeling plane. The results demonstrate excellent precision (ICC=0.62) and accuracy (ICC=0.77) of quantitative CBF measured by pCASL.

2041. Optimisation of Fast Quantitative T2 Imaging of the Premature Brain: A Fantom Study

Laetitia Maurin1,2, Dominique Sirinelli3, Jean Philippe Cottier, 1,3, Laurent Barantin1,2
1NMR Department, UMR Inserm U 930 - CNRS ERL 3106 - Université François Rabelais de Tours, TOURS, France; 3Pediatric Radiology, CHRU de TOURS, TOURS, France; 3Neuroradiology, CHRU de TOURS, TOURS, France

The aim of this work was to optimize and compare different T2 sequences so we could find one suitable for quantitative study of premature newborn brain. Four sequences were tested. After mathematical correction, T2 values found for each sequence were comparable to those calculated by the reference sequence. We choose the SSFSE sequence for premature T2 maps due to its duration. This sequence was optimized in order to decrease final acquisition time. This work allowed us to create a sequence, SSFSE 4 echoes, reliable and reproducible to calculate pediatric neurologic T2 maps with duration suitable for routine clinical practice.

2042. Investigating the Need and Feasibility of Cardiac Triggering for Diffusion Imaging Data in Neonatal Subjects

Lajos R. Kozak1, Gábor Rudas3, Zoltán Vidnánszky1,3, Zoltán Nagy3
1MR Research Center, Semmelweis University, Budapest, Hungary; 3Neurobiotics Research Group, Hungarian Academy of Sciences - Pázmány Péter Catholic University - Semmelweis University, Budapest, Hungary; 3Welcome Trust Centre for Neuroimaging, UCL Institute of Neurology, London, United Kingdom

The feasibility of cardiac triggered diffusion data acquisition in a pediatric population was investigated. Data was collected with and without cardiac triggering either along the z gradient direction and then subjected to bootstrap statistics (3 subjects) or in 15 non-collinear directions and fitted to a tensor model (3 subjects). We found that cardiac triggering decreases the variability in the data without a significant increase in acquisition time in the investigated pediatric population.

2043. RF Shield Coat for Mother to Be in the Magnet with Her Child.

Shin-ichi Urayama1, Naozo Sugimoto2, Hidenao Fukuyama1
1Human Brain Research Center, Kyoto University, Kyoto, Japan; 2School of Health Sciences, Faculty of Medicine, Kyoto University, Kyoto, Japan

For pediatric imaging, accompanying scan, in which an accompanying person wearing an RF shield coat is in the magnet with the child, was examined. Although there are two problems, peripheral nerve stimulation and SNR reduction, this technique is proved to be a feasible solution to avoid risks in pediatric imaging.
Preterm birth with very low birth weight (VLBW, ≤ 1500 g) is associated with reduced white matter integrity and connectivity in childhood and adolescence. These changes in white matter are correlated to motor, sensory and neuropsychological impairments. This study demonstrates that preterm birth with VLBW results in significant and long-term irreversible changes in white matter microstructure that may interfere with neuropsychological functioning. Lower birth weight and perinatal problems requiring prolonged treatment on mechanical ventilator and/or intensive care have permanent negative effects on white matter integrity.

**2045. Fractional Anisotropy Correlates with Total IQ and Visual Perception in Young Adults Born with Very Low Birth Weight**

*Live Eikenes*, *Jon Skranes*, *Ann-Mari Brubakk*, *Asta Håberg*

1Department of circulation and medical imaging, Norwegian University of Science and Technology, Trondheim, Norway; 2Department of Laboratory Medicine, Children’s and Women's Health, Norwegian University of Science and Technology, Trondheim, Norway; 3Department of Neuroscience, Norwegian University of Science and Technology, Trondheim, Norway

Perinatal brain injury caused by very preterm birth with very low birth weight (VLBW, ≤ 1500 g) is associated with changes in white matter integrity and connectivity, and to a variety of neurodevelopmental problems including cognitive impairments and visual perceptual deficits in childhood and adolescence. Widespread correlations between fractional anisotropy and total IQ and visual perception scores was detected in a young adult VLBW group, demonstrating the pervasive nature of the reduction in cognition and perception in this group. The results demonstrate that the neuroimpairments persist into adulthood.

**2046. The Rate of Reduction in Cerebral Cortical Diffusion Anisotropy Reflects the Rate of Brain Development**

*Lindsey A. Leigland*, *Christopher D. Kroenke*

1Oregon Health & Science University, Portland, OR, United States

Throughout the human gestational period, morphological differentiation of cortical neurons and glial cells cause water diffusion anisotropy within the developing cerebral cortex to decrease with age. Herein, the loss of cortical fractional anisotropy (FA) reported by several research groups in five different species is referenced against a systematic comparative study of the timing of several milestones in brain development. It is found that, when the loss of cortical FA is approximated as an exponential decay with age, the time constant reflecting the rate of FA change is in agreement with independent estimates of the rate in which developmental events occur.

**2047. MRI Characterization of Cleft Lip and Palate Resulting from Hedgehog Signaling Antagonism in Mice**

*Rob Lipinski*, *Chihwa Song*, *Jerry Gipp*, *Wade Bushman*, *Ian Rowland*

1Bowles Center for Alcohol Research, University of North Carolina, Chapel Hill, NC, United States; 2Medical Physics, University of Wisconsin, Madison, WI, United States; 3Urology Department, University of Wisconsin, Madison, WI, United States; 4Department of Radiology, University of Wisconsin, Madison, WI, United States

In utero Hedgehog (Hh) signaling antagonist exposure causes a spectrum of birth defects including holoprosencephaly (HPE) and cleft lip and palate (CLP). High resolution MRI and standard histological methodologies were used to characterize the CNS phenotype of GD16.5 mouse fetuses exposed to Hh antagonists. HPE fetuses exhibited incompletely separated cerebral hemispheres and complete pituitary and olfactory bulb agenesis. Those with CLP exhibited olfactory bulb hypoplasia and anterior pituitary aplasia. These results demonstrate phenotypic fidelity of the mouse model to known clinical phenotypes and highlight subjective CNS abnormalities as are expected to occur in a subset of clinical CLP populations.

**2048. Impaired Neurodevelopmental Outcome Associated with Increased White Matter Chol/Cr in Preterm Infants**

*David Price*, *Giles Simon Kendall*, *Alan Bainbridge*, *Samantha Johnson*, *Cornelia Hagmann*, *Ruxanna Gunny*, *Xavier Golay*, *Ernest B. Cady*, *Nicola Jane Robertson*, *Enrico De Vita*

1Medical Physics & Bio-Engineering, UCL Hospitals NHS Foundation Trust, London, United Kingdom; 2Academic Neonatology, EGA UCL Institute for Women’s Health, London, United Kingdom; 3Neuroradiology, Great Ormond Street Hospital for Children; 4Institute of Neurology, University College London; 5Lysholm Department of Neuroradiology, UCL Hospitals NHS Foundation Trust, London, United Kingdom

Infants born prematurely have a higher incidence of neurodevelopmental disorders. Diffuse white matter injury is the commonest MR finding in preterm infants, and has been described qualitatively and quantitatively; the clinical correlate of diffuse white matter injury is currently unknown. In the current study raised Cho/Cr and Lac/Cr, and reduced Na+/Cho were significantly associated with composite motor outcome at 12 months corrected age, and accounted for by significant associations with gross motor development.
The raised choline could be attributed to delayed myelination, astrogliosis; the raised Lac/Cr suggests impaired oxidative phosphorylation, and the reduced Naa is in keeping with neuronal loss.

2049. Developmental Coordination Disorder: A Voxel-Based MRI Study of Neural Correlates

William Lloyd¹, Mark Mon-Williams², Gordon D. Water³, Justin H. G. Williams⁴
¹Aberdeen Biomedical Imaging Centre, University of Aberdeen, Aberdeen, AB25 2ZD, United Kingdom; ²Institute of Physiological Sciences, University of Leeds, Leeds, United Kingdom; ³Aberdeen Biomedical Imaging Centre, University of Aberdeen, Aberdeen, United Kingdom; ⁴Department of Child Health, University of Aberdeen, Aberdeen, United Kingdom

Developmental Coordination Disorder (DCD) is a common childhood disease that affects roughly 6% of the population and can have a long-term impact for sufferers. The role of specific brain areas in DCD has long been postulated from behavioural studies, yet the underlying aetiology of the disease remains poorly understood. We used MRI to investigate correlations between regional brain volumes and psychometric measures in a DCD population. The research presented here provides, to the best of our knowledge, the first structural neuroimaging evidence of the role of regional brain structure in DCD.

2050. Diffusion Tensor Imaging Study of Adolescents with Spina Bifida

Xiawei Ou¹, John J. Hall¹, Charles M. Glasier¹, Jeffrey H. Snow¹
¹Radiology Department, Arkansas Children's Hospital, Little Rock, AR, United States; ²Department of Radiology, University of Arkansas for Medical Sciences, Little Rock, AR, United States; ³Psychology Section, Department of Pediatrics, University of Arkansas for Medical Sciences, Little Rock, AR, United States

Diffusion tensor imaging study was performed on adolescents with spina bifida and age matched controls. The study was aimed to detect the abnormalities in cerebral white matter microstructures in spina bifida patients. We found significantly elevated mean diffusivity of water in major white matter tracts, as well as decreased fractional anisotropy in the corpus callosum and callosal fibers. In addition, significant changes of white matter DTI parameters were observed in the cerebral hemisphere with ventricular shunt in spina bifida patients. Our study provides useful information of brain development affected by spina bifida.

2051. Ornithine Transcarbamylase Deficiency with Persistent Abnormality in Cerebral Glutamate Metabolism

Napapon Sailasuta¹, Andrea L. Gropman², Kent Harris¹, Osama Abulseoud³, Brian D. Ross¹,⁴
¹Clinical MR Spectroscopy, Huntington Medical Research Institutes, Pasadena, CA, United States; ²Neurology, Children's National Medical Center, Washington D.C., United States; ³University of Southern California, Keck School of Medicine, Los Angeles, CA, United States; ⁴Rudi Schulte Research Institute, Santa Barbara, CA, United States

Despite effective treatment of hyperammonemia, children and adult survivors of ornithine transcarbamylase deficiency (OTCD) a frequent enzyme defect of the hepatic urea cycle, exhibit a wide variety of neurological, neuropsychological, neuroimaging and neurochemical abnormalities. Most recently, in addition to proton MRS abnormalities of sub-clinical hepatic encephalopathy, residual deficits in glutamate neurotransmission have been identified by non-invasive 13C MRS studies after ‘loading’ tests with 1-13C and 2-13C glucose. The results point to a hitherto unrecognized defect in cerebral glucose metabolism. Successful therapies of this new lesion may improve long term neurological outcome for this and other defects of urea synthesis.

2052. Diffusion MRI Detects Different Developmental Trajectory in the Thalamus of Adolescents with Attention-Deficit Hyperactivity Disorder (ADHD) Compared with Typically Developing Controls

Maria Fatima Falangola¹, Vitria Adisetiyo¹, Wende R. Gelb¹, Jens H. Jensen¹, Caixia Hu¹, Ali Tabesh¹, Francisco X. Castellanos³, Adriana DiMartino³, Joseph A. Helpern¹,²
¹Radiology, New York University Langone Medical Center, New York, NY, United States; ²Center for Advanced Brain Imaging, Nathan Kline Institute, Orangeburg, NY, United States; ³Child Study Center, New York University Langone Medical Center, New York, NY, United States

Since the neuroanatomical basis of attention deficit-hyperactivity disorder (ADHD) is postulated to involve the frontal cortical-basal ganglia-thalamic-cerebellar circuits, we decided to examine the microstructural integrity of the thalamus in adolescents with ADHD using diffusion MRI, including a new technique called diffusional kurtosis imaging (DKI). We report that for a typically developing adolescent (12-18 yr), there are age-related diffusion changes in the thalamus, but no diffusion changes in the ADHD group, which suggest that there may be a difference in the trajectories of structural development in the thalamus between typically developing and ADHD adolescents.
Cerebellar Vermis Impairment in Children Treated for Brain Malignancies

Alena Horska1, Ashley LaClair2, Mona Mohamed1, Carolyn T. Wells2, Todd McNutt1, Moody Wharam1, E Mark Mahone4, Wendy Kates2

1Johns Hopkins University, Baltimore, MD, United States; 2SUNY Upstate Medical University, Syracuse, NY, United States; 3Children's National Medical Center, Rockville, MD, United States; 4Kennedy Krieger Institute, Baltimore, MD, United States

The goal of this prospective longitudinal study in children receiving brain radiation involving the cerebellum was to evaluate vermal volumes and performance on neuropsychological tests associated with cerebellar function. In patients, lower mean vermal volumes and impaired performance on visual-spatial and fine motor tasks were detected at baseline. At 6-months post-radiation, further decrease in vermal volumes was detected in medulloblastoma patients; the vermal volumes decrease was not associated with reduction in neuropsychological performance compared to baseline. Regression analyses of the 6-months follow-up data from all subjects revealed better performance on the Purdue Pegboard tests with larger vermal volumes.

Susceptibility-Weighted Imaging in Pediatric Epilepsy

Masahiro Ida1, Hisashi Yoshizawa1, Shunsuke Sugawara1, Yuko Kubo1, Keiko Hino1, Naoya Yorozu1

1Department of Radiology, Tokyo Metropolitan Ebara Hospital, Tokyo, Japan

Susceptibility-weighted imaging (SWI) exploits phase shift itself to enhance contrast caused by the susceptibility differences between tissues. SWI provides high-spatial resolution, blood-oxygen-dependent contrast without requiring contrast media. We present two pediatric patients who showed prominent cortical veins with marked hypointensity on SWI in the acute stage after onset of generalized seizure. SWI findings reflect transient misery perfusion secondary to hyperexcitation in status epilepticus. SWI directly detect impaired oxygen metabolism caused by increased oxygen demand of the cerebral tissue in pediatric patients with epileptic seizures. SWI has the possibility to diagnose acute postictal encephalopathy, before cytotoxic edema occurs on DWI.

Changes of Fractional Anisotropy in Ischemic White Matter in Childhood Moyamoya Disease: Correlation with Perfusion MRI.

Moyamoya Disease: Correlation with Perfusion MRI.

Hyeon Tae Jeong1, Jinna Kim1, Hyeon Seok Choi1, Eun Soo Kim1, Seung-Koo Lee1

1Department of Radiology, Yonsei University College of Medicine, Seoul, 250 Seongsanno, Seodaemun-gu, Korea, Republic of

The purpose of this study is to evaluate the clinical relevance to FA measurement in white matter suffering from decreased perfusion in moyamoya disease, through the correlation between FA value and perfusion MRI. In the areas of chronic hypoperfusion in Moyamoya disease, FA was decreased significantly although overt infarct was not demonstrated. Diffusion tensor imaging can be used in the assessment of integrity of white matter suffering from chronic ischemia.

Measurement of Brain Water in Children During and After Treatment for Diabetic Ketoacidosis

Ketoacidosis

Michael H. Buonocore1, Sandra L. Wootton-Gorges2, Nathan Kuppermann3, Ryan Caltagirone, Nicole S. Glaser

1Radiology, UC Davis Imaging Research Center, Sacramento, CA, United States; 2Radiology, UC Davis Medical Center, Sacramento, CA, United States; 3Emergency Medicine and Pediatrics, UC Davis Medical Center, Sacramento, CA, United States

The purpose of this study was to measure brain water in children undergoing treatment for DKA to assess cerebral edema. Brain water was measured on a 3T system using FSPGR scans with five different flip angles, followed by non-linear curve fitting to derive proton density (M0) maps, and calibrating regional M0 map values with the values from 100% water reference vials placed within the imaged volume. Results from seven children suggest that regional brain water is elevated early in the course of treatment, confirming a degree of cerebral edema. Edema increases during the course of treatment with fluids and insulin, and then resolves after the child recovers.

Regional Grey-White Matter Volume Abnormalities in Children with Histories of Early Deprivation

Regional Grey-White Matter Volume Abnormalities in Children with Histories of Early Deprivation

Jeong-Won Jeong1,2, Michael Behen1,2, Piti Sinsoongsud1,2, Otto Muzik,2,3, Benjamin Wilson1,2, Harry T. Chugani,2,3

1Pediatrics and Neurology, Wayne State University, Detroit, MI, United States; 2PET center, Children's Hospital of Michigan, Detroit, MI, United States; 3Pediatrics, Neurology, and Radiology, Wayne State University, Detroit, MI, United States

A previous 18FDG-PET study revealed that children with histories of institutional rearing showed significantly decreased glucose metabolism in neumerous brain regions. Dysfunction in these regions may result from severe stress of early deprivation. This study presents an atlas-based analysis to assess specific volumetric changes in predefined brain regions of the children with histories of early deprivation and examines associations between regional findings and cognitive, socioemotional, and behavioral difficulties that commonly are observed in the orphans. Significant bilateral volume reduction in grey-white matter was observed in the orphan group. It was highly correlated with their externalizing behavioral deficit and perceptual functioning.
2058. Aberrant Change of Arcuate Fasciculus Geometry in Children with Angelman Syndrome: Diffusion Tensor MRI Study

Jeong-Won Jeong¹, Senthil Sundaram¹,², Benjamin Wilson¹,², Harry T. Chugani,²,³
¹Pediatrics and Neurology, Wayne State University, Detroit, MI, United States; ²PET center, Children's Hospital of Michigan, Detroit, MI, United States; ³Pediatrics, Neurology, and Radiology, Wayne State University, Detroit, MI, United States

Angelman syndrome (AS) is a genetic disorder characterized by mental retardation, speech impairment, and gait apraxia. Speech impairment is universal but severity differs, which can be characterized by myelination delay or deficits of white matter associated with language production and conception, especially of arcuate fasciculus (AF) bridging Broca’s and Wernicke’s areas. This study presents new DT-MRI methodology to identify aberrant shapes of arcuate fibers and quantify abnormal tracts in terms of their geometry. We found that the AF of AS patients have steeper lateral-curvatures causing them not to reach Wernicke’s area and also their FA values were significantly reduced.

2059. DTI Evaluation of Language Tracts in Autistic Patients with and Without Language Impairment Compared to Typically Developing Children

Lidia M. Nagae¹, John Dell¹, Robert A. Zimmerman¹, Timothy P.L. Roberts¹
¹Radiology, Children’s Hospital of Philadelphia, Philadelphia, PA, United States

The superior longitudinal fasciculus (SLF), related to language, was evaluated using diffusion tensor imaging in autistic patients, in particular in a specific group of autistics patients with language impairment (ASD+/LI), compared to autistic patients without language impairment (ASD-/LI), and typically developing children and adolescents (TD). Mean diffusivity, along with axial diffusivity were found to be increased in ASD+/LI when compared to TD. Intermediate values were obtained in ASD-/LI. These findings might reflect reported microstructural abnormalities of the brain, thought to be related to immature white matter development.

2060. Asymmetric Interhemispheric Fiber Tracts in Patients with Hemimegalencephaly on Diffusion Tensor MRI

Noriko Sato¹, Tomoyuki Takahashi, Miho Ota, Nakata Yasuhiro, Masayuki Sasaki¹
¹National Center Hospital of Neurology and Psychiatry, Kodaira, Tokyo, Japan

Asymmetrical fiber tract distributions passing through the corpus callosum in hemimegalencephaly patients.

2061. Diffusion Tensor Imaging of Rostral Brain Areas in Patients with Congenital Central Hypoventilation Syndrome

Rajesh Kumar¹, Paul M. Macey²,³, Mary A. Woo², Ronald M. Harper¹,³
¹Neurobiology, David Geffen School of Medicine at UCLA, Los Angeles, CA, United States; ²School of Nursing, UCLA; Los Angeles, CA, United States; ³Brain Research Institute, UCLA, Los Angeles, CA, United States

Congenital central hypoventilation syndrome (CCHS) patients show respiratory and autonomic deficits likely resulting from PHOX2B mutations affecting autonomic development, or from hypoxic injury. We evaluated axial- and radial-diffusivity, indicating axonal and myelin deficits, respectively, in rostral brain of CCHS. Increased radial-diffusivity emerged in the corona-radiata, internal-capsule, and corpus-callosum, suggesting myelin injury. Axial-diffusivity changes appeared in the thalamus, internal-capsule, corona-radiate, occipital, and temporal lobes, suggesting axonal deficits. Increased axial- and radial-diffusivity appeared in basal forebrain, limbic, occipital, and temporal areas, indicating myelin and axonal deficits. The mechanisms of brain injury are unknown, but likely include both hypoxic and genetic processes.

2062. Surface Deformation-Based Analysis of Regional Shape Variations of Hippocampus in Children with FAS

Jesu Christopher Joseph¹, Anton Eicher², Christopher Warton¹, Sandra W Jacobson¹, Joseph L Jacobson¹, Christopher D Molteno, Patrick Marais², Ernesta M Meintjes¹
¹Human Biology, University of Cape Town, Cape Town, Western Cape, South Africa; ²Computer Science, University of Cape Town, Cape Town, Western Cape, South Africa; ³Psychiatry and Behavioral Neurosciences, Wayne State University, Detroit, United States

The main objective of this work is to assess the shape variations of the hippocampus structure between control and FAS affected children. For this High-resolution structural MRI images were acquired of 12 children aged 9-12 years on a 3T Siemens Allegra Scanner (6 controls and 6 FAS). Hippocampi were manually delineated. The entire structure of the hippocampus was divided into three regions, namely head, body and tail. A point distribution model, which represents the mean geometry of a shape using landmark points, was used to capture the true geometry of the hippocampus. Approximately 2366 landmark points were used. Principal Component Analysis (PCA) was used to study correlations of movement between groups of landmark points among the control children who were used as the training set and to assess the geometric variations between the healthy and exposed subjects.
2063. **A Realistic Model of Brain Tissue in Case of Hydrocephalus: Application of MRI, DTI and MRE**

Kamal Shahim¹, Ralph Sinkus², Jean-Marie Drezel¹, Shaham Momjian³, Jean-Francois Molinari⁴

¹LSMX, Ecole Polytechnique Fédérale de Lausanne, Lausanne, Vaud, Switzerland; ²Laboratoire Ondes et Acoustique, ESPCI, Paris, France; ³University Hospitals of Geneva and University of Geneva, Switzerland; ⁴LSMS, Ecole Polytechnique Fédérale de Lausanne, Lausanne, Vaud, Switzerland

Hydrocephalus is a cerebral disease wherein the brain ventricles dilate and the parenchyma is stressed. In order to study this condition, a finite element model is built using the geometries of the ventricles and the skull measured by MRI. DTI is used to establish the fiber direction and the local frame. Indeed, elasticity data based on MRE is incorporated into the constitutive equation. The brain parenchyma is modeled as a porous medium. Under an applied pressure gradient, isotropic and transverse isotropic models are tested and compared together. The transmission of the applied pressure is substantially influenced by the anisotropy and inhomogeneity of brain parenchyma.

**2064. Abnormal Brain Tissue Sodium Metabolism on MRI After Cardiac Arrest in Children**

Ericka L. Fink¹,², Patrick M. Kochanek¹,², Ashok Panigrahy³, Fernando E. Boada⁴,⁵

¹Critical Care Medicine, Children's Hospital of Pittsburgh of UPMC, Pittsburgh, PA, United States; ²Safar Center for Resuscitation Research, Pittsburgh, PA, United States; ³Radiology, Children's Hospital of Pittsburgh of UPMC, Pittsburgh, PA, United States; ⁴Radiology, UPMC, Pittsburgh, PA, United States; ⁵Magnetic Resonance Research Center, Pittsburgh, PA, United States

In two children with cardiac arrest, tissue sodium concentration was increased in regions of the brain that are most vulnerable to hypoxia-ischemia and reperfusion (basal ganglia and occipitoparietal cortex), representing prolonged or delayed deranged brain tissue Na metabolism.

**2065. Diffusional Kurtosis Imaging Assessment of Tuberous Sclerosis Complex**

Vitria Adisetiyo¹, Sarah S. Milla², Howard Weiner³, Caixia Hu³, Ali Tabesh³, Jens H. Jensen¹,², Joseph A. Helpern¹,²

¹Neuroscience and Physiology, New York University School of Medicine, New York, NY, United States; ²Radiology, New York University School of Medicine, New York, NY, United States; ³Neurosurgery, New York University School of Medicine, New York, NY, United States

Tuberous Sclerosis Complex (TSC) is a rare genetic disease that manifests in the CNS as cortical/subcortical tuber lesions consisting of abnormal dysplastic neurons. Tumors are presumed to contribute to epileptogenesis and to developmental delays in TSC. Given several reports of “silent” tubers with active surrounding perilesion tissue, we applied Diffusional Kurtosis Imaging (DKI) to quantitatively characterize the microstructure of tubers as compared to surrounding perilesion and normal appearing contralateral tissue in TSC patients aged 2-10 years and age-matched controls. Region of interest analysis found that only tubers are associated with significant increase in diffusivity and substantial decrease in microstructural heterogeneity.

**2066. Fetal Brain During a Binge Drinking Episode. a Dynamic Susceptibility Contrast Fetal Brain Perfusion Study.**

Peter Kochunov¹, Carlos Castro², Gerald Schattner³, David Purdy⁴, Hsiao-Ying Wey⁴, Duff Davis⁵

¹Research Imaging Institute, UTHSCSA, san antonio, TX, United States; ²Ob / Gyn and Reproductive Sciences, University of Pittsburgh School of Medicine, Pittsburgh, PA, United States; ³Pittsburgh Development Center, University of Pittsburgh School of Medicine, Pittsburgh, PA, United States; ⁴Siemens Healthcare USA, Malvern, PA, United States

While the teratogenic properties of alcohol are well known, the mechanisms by which alcohol-induced damage is produced in the CNS are still largely unknown. We present findings of changes in dynamic susceptibility contrast (DSC) in fetal brain of a non-human primate (baboon) during a protocol designed to approximate a binge drinking episode. Signal changes in the brain and uterus/placenta were compared using a pulse sequence protocol with high temporal and spatial resolution, showing that gadodiamide entered fetal cerebral circulation following alcohol administration.
Multiple Sclerosis

Hall B Monday 14:00-16:00

2067. 7 Tesla 3D-FLAIR and 3D-DIR: High Sensitivity in Cortical Regions in Multiple Sclerosis

Wolter L. de Graaf¹, F. Visser²,³, M. P. Wattjes⁴, J. Geurts⁴, P. Pouwels⁵, C. H. Polman⁶, F. Barkhof¹, P. R. Luijten¹, J. A. Castelijns¹
¹Radiology, VU University Medical Center, Amsterdam, Netherlands; ²Image Science Institute, University Medical Center Utrecht, Utrecht, Netherlands; ³PHILIPS Healthcare; ⁴Pathology, VU University Medical Center, Amsterdam, Netherlands; ⁵Physics and Medical Technology, VU University Medical Center, Amsterdam, Netherlands; ⁶Neurology, VU University Medical Center, Amsterdam, Netherlands

MR diagnostics in Multiple Sclerosis have benefited from sequences like fluid attenuated inversion recovery (FLAIR) and double inversion recovery (DIR), that increase sensitivity especially in cortical regions. We demonstrate use of 3D (isotropic) FLAIR, DIR and T1-weighted clinically feasible imaging at 7 Tesla. Images were read for the number of lesions visible in the regular classifications for the several sequences. Results were also compared with images obtained from the same patients at 3 Tesla. A large sensitivity increase especially in cortical regions was found at 7 Tesla for all 3D sequences. 3D-FLAIR however, proved to be the most sensitive.

2068. 3D Magnetization Prepared Double Inversion Recovery (3D MP-DIR) at 7 Tesla

Frederik Visser¹,², Jaco J M Zwanenburg¹, Wolter L. de Graaf¹, J A. Castelijns¹, Peter R. Luijten¹
¹UMC, Utrecht, Netherlands; ²PHILIPS Healthcare; ³VU UMC Amsterdam

Dedicated magnetization preparation pre-pulses (MP) have been designed to acquire high resolution 3D DIR images covering the whole brain at 7-Tesla. The ability to detect sub-millimeter cortical and/or sub cortical lesions has great potential for future clinical studies.

2069. Cortical Lesions in MS: Assessment at 7T

Kathrine T. Bluestein¹, Cherian Renil Zachariah¹, Steffen Sammet¹, Devin Elizabeth Prior¹, David Pitt¹, Aaron Boster¹, Amir Abduljalil¹, Michael V. Knopp¹, Petra Schmalbrock¹
¹Department of Radiology, The Ohio State University, Columbus, OH, United States; ²Department of Neurology, The Ohio State University, Columbus, OH, United States

Assessment of cortical lesions in MS is of significant interest, because correlation of conventional MRI with clinical findings is limited. However, detection of cortical lesions has been hampered by their small size and low contrast. In this study, we assessed cortical lesion detection in 7 MS patients and healthy controls at 7T using high resolution 3D T2* weighted, white matter attenuated (WHAT) turbo field echo and T1-weighted IR-TFE imaging. Cortical lesions were best seen with the WHAT sequence, and there was little reader variability.

2070. High Resolution Magnetization Transfer Imaging at 7T: Detection of Cortical Lesions in MS Patient

Olivier E. Mougin¹, Jennifer Dixon¹, Ian Donaldson², Emma Tallantyre², Nikos Evangelou¹, Penny A. Gowland¹
¹Sir Peter Mansfield Magnetic Resonance Centre, School of Physics & Astronomy, University of Nottingham, Nottingham, Nottinghamshire, United Kingdom; ²Institute of Neuroscience, Nottingham, Nottinghamshire, United Kingdom

This study aims to detect cortical lesions in MS patients. High resolution MTR scans (0.5mm isotropic, as well as 0.35mm in plane resolution) have been acquired at 7T using a novel imaging sequence. The MTR contrast has been compared between white matter and grey matter, showing a greater grey matter (GM) / white matter (WM) contrast to noise ratio at 7T, providing a good delineation of WM and GM lesions at high resolution with the MTR contrast. The sequence is being used to study changes in the cortex of MS patients.

2071. Surface-Based Analysis of Subpial T2* Signal Changes at 7T in Multiple Sclerosis

Julien Cohen-Adad¹,², Douglas Greve¹,², Thomas Benner¹,², Amy Radding¹,², R Philip Kinkel¹,², Bruce R. Rosen¹,², Bruce Fischl¹,², Caterina Mainiero¹,²
¹A. A. Martinos Center for Biomedical Imaging, Dept. of Radiology, MGH, Charlestown, MA, United States; ²Harvard Medical School, Boston, MA, United States; ³Beth Israel Deaconess Medical Center, Boston, MA, United States

The ability to detect and to classify in vivo gray matter (GM) lesions in multiple sclerosis (MS) is required to better understand pathological processes associated with disease progression and disability. In this paper we combined ultra high field MRI (7T) with surface-based analysis to achieve quantitative assessment of subtle and diffuse cortical changes in multiple sclerosis (MS). Results show a significant increase of the T2* signal in MS patients versus controls. This increase may reflect the diffuse subpial pathology that has been described in autopsy cases of MS. Surface-based analysis facilitates the characterization of cortical lesions in vivo.
What Does (Quantitative) MRI of the MS Cortical Gray Matter Measure? a Post Mortem Imaging Exploration.

Alexandra Marion Seewann1,2, Hugo Vrenken3,4, Evert-Jan Kooi5, Paul van der Valk5, Dirk Knol6, Chris Polman1, Petra Pouwels4, Frederik Barkhof3, Jeroen Geurts,3,5

1Neurology, VU University medical center, Amsterdam, Netherlands; 2Neurology, Medical University Graz, Graz, Austria; 3Radiology, VU University medical center, Amsterdam, Netherlands; 4Physics and Medical Technology, VU University medical center, Amsterdam, Netherlands; 5Pathology, VU University medical center, Amsterdam, Netherlands; 6Epidemiology and Biostatistics, VU University medical center, Amsterdam, Netherlands

Only few lesions in cortical gray matter (CGM) of multiple sclerosis (MS) patients can be visualized with conventional MRI. Quantitative MRI techniques are more sensitive to cortical damage, but the histopathological correlates of quantitative MRI changes in the MS CGM are unclear. We aimed to define the underlying pathology of cortical quantitative MRI changes, and to compare MRI visible and invisible lesions by histopathology. 16 brain slices from 10 chronic MS patients were imaged with qualitative and quantitative MRI at 1.5T. Regions of interests were correlated with histopathology.

Quantitative MRI measurements reflect the extent of cortical demyelination. Conspicuity of cortical GM lesions on conventional MRI is determined by lesional size.

Quantification of Formalin-Fixed MS Brain Tissue Parameters T1, T2*, PD and Phase at 7T and Comparison with Histopathology

Cherian Renil Zachariah1, David Pitt1, Peter Wassenaar1, Bradley D. Clymer1, Amir Abduljalil1, Michael V. Knopp1, Petra Schmalbrock1

1Radiology, The Ohio State University, Columbus, OH, United States; 2Neurology, The Ohio State University, Columbus, OH, United States

Depiction of cortical demyelination in MS is still hampered by low contrast, spatial resolution and specificity. This study applies T2*-gradient echo and inversion recovery turbo field echo (IR-TFE) sequences 7T to image formalin-fixed tissue specimen and measure T1, T2*, PD and phase differences. We notice that PD maps and phase maps may be promising for enhancing cortical lesion depiction. Following MRI, specimen were cut and labeled with anti-myelin basic protein antibodies to detect myelin and with anti-CD68 antibodies to detect activated macrophages/microglia. Scanned histology slides were scored for cortical lesions and compared to MRI

MRI Texture Correlates of Pathological Findings in Post-Mortem Multiple Sclerosis

Yunyan Zhang1,2, GR Wayne Moore1, Cornelia Laule1, Thorarin A. Bjarnason2, Piotr Kozlowski1, Alex L. Mackay1, Anthony L. Traboulsee1, David K. B. Li3

1University of British Columbia, Vancouver, BC, Canada; 2University of Calgary, Calgary, AB, Canada

Ten post-mortem brain samples from 3 MS subjects were imaged at 7T. Regions of interest were marked on histological sections staining for myelin and axon, then were matched on MR images including lesions (14), normal appearing white matter (NAWM, 12) and regions of reduced myelin and axon (rLrB). MRI texture analysis based on polar Stockwell Transform (PST) was performed. Texture was highest in lesions, intermediate in rLrB and lowest in NAWM (p < 0.01) providing evidence that texture abnormality associates with tissue pathology. PST analysis may be a potential tool to quantify tissue integrity in MS or other neurological disorders.

Evaluating MACC for Improved MS Rater Agreement

David S. Wack1, Michael G. Dwyer1, Niels Bergslund1, Sara Hussein1, Robert Zivadinov1

1University at Buffalo, Buffalo Neuroimaging Analysis Center, Buffalo, NY, United States

The software method of Minimum Area Contour Change (MACC) is evaluated for use to improve same scan inter-rater agreement for the delineation of T2 hyper-intense MS lesions; and for the application of ROIs to follow up time points. The MACC method improves inter-rater agreement, and performs about on par with another rater for the purpose of drawing lesion ROIs on a follow-up scan.

Lesion Recognition in Multiple Sclerosis: A Sequence Comparison and Quantification Study at 3T

Tobias Kober1,2, Cristina Granziera3,4, Delphine Ribes1,2, Patrick Browaeys5, Myriam Schluep6, Katrin Wohlfarth6, Reto Meuli5, Gunnar Krueger2

1Laboratory for functional and metabolic imaging, Ecole Polytechnique Fédérale de Lausanne, Lausanne, Switzerland; 2Advanced Clinical Imaging Technology, Siemens Suisse SA - CIBM, Lausanne, Switzerland; 3Department of Neurology, Hôpitaux Universitaires de Genève, Lausanne, Switzerland; 4Brain and Mind Institute, Ecole Polytechnique Fédérale de Lausanne, Lausanne, Switzerland; 5Department of Radiology, Centre Hospitalier Universitaire Vaudois, Lausanne, Switzerland; 6Department of Neurology, Centre Hospitalier Universitaire Vaudois, Lausanne, Switzerland; 7H IM MR PLM AW Neurology, Siemens AG, Erlangen, Germany

Detection and radiological characterisation of multiple sclerosis (MS) lesions is an essential part both of clinical diagnosis and MS research. Ten early-stage MS patients and ten controls were included in this study aiming at (i) comparing five different high-resolution imaging sequences (FLAIR, MP-RAGE, DIR, SPACE, MP2RAGE) and (ii) quantifying T1 relaxation times of lesions with
respect to their location in the brain. Results suggest that the DIR sequence is the most sensitive for total lesion count, followed by the MP2RAGE. Confirming previous studies, T1 relaxation times were found to be overall prolonged.

2077. Pre-Filling MS Lesions on T1 and T2-Weighted Images for Improved Tissue Segmentation
Jonathan S. Jackson1,2, Declan Chard1, Antonia Ceccarelli1, Elisa Dell'Oglio1, Ashish Arora1, Mohit Neema1, Rohit Bakshi1, David Miller1, Claudia Angela Michela Wheeler-Kingshott2
1Laboratory for Neuroimaging Research, Brigham & Women's Hospital, Harvard Medical School, Brookline, MA, United States; 2Department of Neuroinflammation, UCL Institute of Neurology, London, United Kingdom

Robust lesion in-painting has been demonstrated on T1 and T2-weighted images. Many automated algorithms rely on accurate histograms for segmentation; therefore this approach to lesion WM correction based on the global histogram is appropriate and strongly recommended as a pre-processing step for MS images.

2078. A New MRI Analysis Method for Lesional Heterogeneity Characterisation in Multiple Sclerosis as Demonstrated by Quantitative MRI.
Marios C. Yiannakas1, Daniel J. Tozer1, Declan T. Chard1, David H. Miller1, Claudia A.M Wheeler-Kingshott1
1UCL - Institute of Neurology, London, United Kingdom

In this work a new MR analysis method is presented which utilises conventional FSE dual echo data sets with the use of advanced images algebra (ADIMA) in order to enhance the dynamic range in the image with a consequent enhancement of lesional heterogeneity in MS lesions. It is found that the images show bright and dark lesions indicating heterogeneity of pathological process. Masks of these bright and dark lesions are applied to MRI parameter maps and it is found that the corresponding areas on MTR, T1 and T2 maps show different values, corresponding to the two lesion types.

2079. Characterization of Multiple Sclerosis Lesions Through a Quantitative Study of Perfusion Using a Gadolinium Contrast Agent
Ryan Griffin1, Adam Brandenberry1, Jiachao Liang1, Michael Knopp1, Steffen Sammet1
1Radiology, The Ohio State University, Columbus, OH, United States

The purpose of this study was to use Dynamic Contrast Enhanced MRI at 3T to quantitatively study the perfusion of MS lesions. Using Brix’s two compartment model, we found statistically significant differences in the mean extracted values of the pharmacokinetic values Amp and k_e of enhancing lesions with respect to those from normal appearing brain tissue, as well as a statistically significant difference in the mean extracted value of Amp from hypointense lesions with respect to normal appearing brain tissue. Rising enhancement after the initial uptake of gadolinium (indicated by a negative k_e value) was observed for every enhancing lesion.

2080. Altered Brain Perfusion and Tissue Injury in Early Multiple Sclerosis Assessed by ASL and MTR Statistical Mapping Analyses
Wafaa Zaaraoui1, Françoise Reuter1, Mathias Lemaire1, Audrey Rico1, Anthony Faivre1, Virginie Callot1, Irina Malikova1, Elisabeth Soulier1, Sylviane Confort-Gouyon1, Patrick J. Cozzone1, Jean Pelletier1, Bertrand Audoin1, Jean-Philippe Ranjeva1
1Faculté de Médecine, CRMHB UMR CNRS 6612, Marseille, France

Recent studies have evidenced the crucial role of perfusion alteration in multiple sclerosis (MS). However, little is known about the relationships between hemodynamical parameters and local tissue damage encountered at all stages of the disease, and especially at the early phase. To investigate the putative relationships between perfusion alterations and structural local white matter and grey matter impairments in early MS, we designed a MR protocol combining statistical mapping analyses of arterial spin labeling (ASL) data and magnetization transfer ratio (MTR) data obtained in 12 patients with clinically isolated syndromes (CIS) and 12 matched controls.

2081. Identifying the Start of Multiple Sclerosis Tissue Injury: A Longitudinal DTI Study
Robert J. Fox1, Daniel Ontaneda1, Xiofeng Wang1, Ken Sakaie2, Jian Lin3, Mark J. Lowe4, Michael D. Phillips5
1Mellen Center for MS, Cleveland Clinic, Cleveland, OH, United States; 2Quantitative Health Sciences, Cleveland Clinic, Cleveland, OH, United States; 3Radiology, Cleveland Clinic, Cleveland, OH, United States

We used HARDI DTI in a longitudinal study of multiple sclerosis patients to identify changes in brain tissue prior to the development of acute inflammation (gadolinium enhancement). We found significantly decreased fractional anisotropy (FA) up to 10 months prior to the development of gadolinium-enhancing lesions. Changes in FA were driven an increase in transverse diffusivity, while longitudinal diffusivity remained unchanged. This study provides evidence for impaired myelin integrity up to 10 months prior to development of gadolinium enhancement.
Corpus Callosum Atrophy and Diffusion Abnormalities in Clinically Isolated Syndrome Revealed by Diffusion Tensor Tractography

Fuchun Lin1, Chunshui Yu2, Yaou Liu2, Hao Lei1
1Wuhan Institute of Physics & Mathematics, The Chinese Academy of Sciences, Wuhan, Hubei, China; 2Department of Radiology, Xuanwu Hospital of Capital Medical University, Beijing, China

Diffusion tensor based group tractography was used to determine the corpus callosum (CC) integrity in clinically isolated syndrome (CIS). Compared to the healthy subjects, the CIS patients had significantly reduced midsagittal CC area, and significantly higher MD, \( \lambda_1, \lambda_2 \) and significantly lower FA in the entire CC. Moreover, the average FA of the normal-appearing CC of the CIS patients correlated negatively with the whole-brain lesion load while the other three diffusion indices correlated with the lesion load positively. These results suggested that both the morphology and the microstructure of the CC appear to be damaged at the stage of CIS.

Characterization of Early White Matter Damages in Multiple Sclerosis Patients with a Clinically Isolated Syndrome: A Tract Based Spatial Statistics Study

Salem Hannoun1,2, Françoise Durand-Dubief,3, Christian Confavreux7, Dominique Sappey-Marinier1,2
1CREATIS-LRMN, University of Lyon 1, Lyon, Rhone-Alpes, France; 2CERMEP-Imagerie du Vivant, Bron, Rhone-Alpes, France; 3Neurological Hospital, Lyon, Rhone-Alpes, France

This study aims to characterize early pathological processes occurring in twelve multiple sclerosis (MS) patients with a clinically isolated syndrome (CIS) compared to relapsing remitting (RR) patients and control subjects using tract-based spatial statistics (TBSS). Significant alterations of diffusivity including FA decrease, and axial (\( \hat{e}_a \)) and radial (\( \hat{e}_r \)) diffusivities increases, were found in extensive white matter regions of CIS patients, with \( \hat{e}_r \) being the most affected. If \( \hat{e}_r \) alterations may reflect the demyelinating processes occurring in MS, \( \hat{e}_a \) can be more evocative of late appearing axonal damage as confirmed by the increase of \( \hat{e}_a \) in RR compared to CIS patients.

Correlation of Clinical Parameters and DTI Imaging Features in Multiple Sclerosis

Carli Jessica Lehr1, Mustafa Okan Irfanoglu1, Firdaus Janoos, Steffen Sammet1, Michael V. Knopp1
1Department of Radiology, The Ohio State University, Columbus, OH, United States; 2Department of Radiology, OSU, Columbus, OH, United States

Diffusion Tensor Imaging plays an important role in the quantitative analysis of Multiple Sclerosis lesions. This study investigates the correlation between clinical parameters and DTI imaging features such as FA, ADC, lesion volumes, and tract connectivity. DTI derived features provide better correlations to clinical scores than conventional MRI-based characteristics. The strongest correlations were found when all DTI imaging features were analyzed together against clinical data values. This illustrates the usefulness of comprehensive DTI imaging features in analyzing clinical deficits in Multiple Sclerosis.

Effect of Gradient Resolution in Diffusion Tensor Imaging on the Appearance of Multiple Sclerosis Lesions at 3T

Mustafa Okan Irfanoglu1, Raghu Machiraju1, Michael V. Knopp1, Steffen Sammet1
1Department of Radiology, The Ohio State University, Columbus, OH, United States

Diffusion Tensor Imaging proved to be a useful modality for the diagnosis of Multiple Sclerosis. However, the quality of the DTI-derived scalar maps and tractography is directly dependent on experimental design. In clinical settings, scan time is a major constraint and not many diffusion weighted volumes can be acquired. In this work, we analyze the effects of gradient resolution on the appearance of multiple sclerosis regions. Results indicate that with increasing number of gradients, statistics based on lesion scalar map distributions becomes more stable and spending extra minutes might be beneficial if DTI is to be assessed for diagnosis.

Radial Diffusivity in Remote Optic Neuritis Discriminates Visual Outcomes

Junqian Xu1, Robert T. Naismith1, Nhial Tutlam1, Kathryn M. Trinkaus2, Sheng-Kwei Song1, Anne Cross1
1Neurology, Washington University in St. Louis, St. Louis, MO, United States; 2Biostatistics, Washington University in St. Louis, St. Louis, MO, United States; 3Radiology, Washington University in St. Louis, St. Louis, MO, United States

We studied 70 remote optic neuritis (ON) patients using the previously described high-resolution reduced field-of-view optic nerve diffusion tensor imaging protocol at 3 T. Radial diffusivity (RD) strongly correlated with visual functional assessments, retinal nerve fiber layer thickness, and visual evoked potential. RD also discriminated nerves with normal recovery from those with mild visual impairment, and those with mild impairment from profound visual loss. In addition, RD differentiated healthy controls from both the clinically affected nerves and unaffected fellow nerves after ON. RD differentiated all categories of 5% contrast sensitivity (CS) outcomes, and all categories of Pelli-Robson CS with the exception of normal recovery from mildly affected.
Low Contrast Visual Stimuli Yield Differential Volumes of Functional MRI Activation in Affected and Unaffected Eyes Following Recovery from Optic Neuritis

Robert A. Bermel1, Jeffrey A. Cohen1, Lael A. Stone1, Blessy Mathew2, Mark J. Lowe2, Michael D. Phillips2
1Neurological Institute, Cleveland Clinic, Cleveland, OH, United States; 2Imaging Institute, Cleveland Clinic, Cleveland, OH, United States

Optic neuritis (ON) is caused by inflammatory demyelination in the optic nerve, commonly as an early component of multiple sclerosis (MS). Recovery from ON is variable, facilitated by mechanisms which may include remyelination and cortical reorganization. We used visual fMRI with stimuli at three different contrast levels to investigate cortical activation following ON in 6 patients with MS and remote unilateral ON. Differences in cortical activation between affected and unaffected eyes were most apparent when utilizing the lower contrast visual stimulus. We conclude that low-contrast visual fMRI may be sensitive to detect cortical changes following ON.

Quantitative Fast T1 Mapping at 7 Tesla: Initial Results in Multiple Sclerosis

Wolter L. de Graaf1, J. M. Hoogduin1, F. Visser2,3, P. Pouwels1, H. Vrenken1, C. H. Polman1, F. Barkhof1, P. R. Luijten2, J. A. Castelijns1
1Radiology, VU University Medical Center, Amsterdam, Netherlands; 2Image Science Institute, University Medical Center Utrecht, Utrecht, Netherlands; 3PHILIPS Healthcare; 4Physics and Medical Technology, VU University Medical Center, Amsterdam, Netherlands; 5Neurology, VU University Medical Center, Amsterdam, Netherlands

In Multiple Sclerosis, T1 mapping has shown to be able to differentiate normal from normal appearing grey and white matter. At high field, T1 relaxation times increase and therefore it is expected that changes in brain tissue due to multiple sclerosis become more pronounced. A fast T1 mapping sequence of 4.5 minutes with an in-plane resolution of 1x1 mm2 and slice thickness of 1.5 mm is applied at 7 Tesla to assess the sensitivity of the method at high field. Patients as well as healthy controls are examined and whole brain histograms and analysis of specific brain regions are made.

In Vivo Quantitative Evaluation of Multiple Sclerosis Progression Using Gradient Echo Plural Contrast Imaging Technique

Jie Luo1, Pascal Sati2, Anne H. Cross1, Dmitriy A. Yaklonskiy2
1Chemistry, Washington University in St. Louis, St. Louis, MO, United States; 2Radiology, Washington University in St. Louis, St. Louis, MO, United States; 3Neurology, Washington University in St. Louis, St. Louis, MO, United States

One reason for the weak correlation between conventional MRI (based on T1/T2 weighted images) and clinical findings is the inability of conventional MRI to quantify the extent of tissue damage. In this study, we demonstrated that an efficient method based on GEPCI technique not only depicts MS lesions similar to conventional T1w and FLAIR images, but also allows quantitative evaluation of disease progression. Combining characteristics of main peak in R2* histograms and quantitative score assigned to MS lesions, allows the evaluation not only of the volume of cerebral MS lesions, but incorporates the degree of tissue damage as well.

Absolute Quantification of Myelin Related Volume in the Brain

J. B.M. Warntjes1, J. West1, A. M. Landtblom1,3, P. Lundberg2
1Center for Medical Imaging Science and Visualization (CMIV), Linköping, Sweden; 2Department of Medicine and Health, Division of radiation physics, Linköping, Sweden; 3Department of Clinical Neuroscience, Linköping, Sweden

A method is described to measure the myelin related volume fraction for each voxel for a complete brain within a scan time of 5 to 6 minutes, based on absolute quantification of the relaxation rates R1 and R2 and proton density. The absolute decrease of visible PD with a simultaneous increase of R1 and R2 corresponds to an increase of myelin. Myelin related volume is correlated with Fractional Anisotropy maps and conventional T1W, T2W and FLAIR images. Repeated measurements show a standard deviation of 1-2% in myelin volume for the whole brain.

Changes in Multiple Sclerosis Over 6 Months as Seen with T2 Relaxation and Diffusion Histograms

Irene Margaret Vavasour1, Shannon Heather Kolind2, Cornelia Laule1, Burkhard Maedler1, David K.B. Li3, Anthony L. Traboulsee1, Alex L. MacKay1,5
1Radiology, University of British Columbia, Vancouver, BC, Canada; 2FMRI Centre, University of Oxford, Oxford, United Kingdom; 3Physics and Astronomy, University of British Columbia; 4Medicine, University of British Columbia

Twelve multiple sclerosis subjects and 12 healthy age and gender matched controls were scanned twice at a 6 month interval to compare histograms derived from normal white matter (NWM), normal appearing white matter (NAWM) and multiple sclerosis lesions. Myelin water fraction (MWF), geometric mean T1 (GMT1), fractional anisotropy, mean diffusivity and the eigenvalues were measured. Mean MWF and GMT; histograms did not differ between the two time points although histograms from NWM, NAWM and lesions were different. Histograms from the diffusion metrics differed slightly between month 0 and 6. T1 relaxation and diffusion metrics give complementary information about MS tissue.
2092. **Myelin Water Fraction Reduction in Multiple Sclerosis Normal Appearing White Matter: Where Are All the Zeros?**

Cornelia Laule1,2, Shannon H. Kolind3, Irene M. Vavasour1, Burkhard Mädler2, Joel Oger4, Anthony L. Traboulsee6, Wayne Moore1, David KB Li1, Alex L. MacKay1

1Radiology, University of British Columbia, Vancouver, BC, Canada; 2Physics & Astronomy, University of British Columbia, Vancouver, BC, Canada; 3FMRIB Centre, University of Oxford, Oxford, United Kingdom; 4Medicine, University of British Columbia, Vancouver, BC, Canada; 5Pathology & Laboratory Medicine, University of British Columbia, Vancouver, BC, Canada

Using T2 relaxation it is possible to measure myelin water fraction in multiple sclerosis (MS) normal appearing white matter (NAWM). Previous work employing a region of interest based approach found reduced myelin water fraction (MWF) in MS NAWM relative to normal white matter in controls. Using an improved 3D T2 relaxation sequence at higher field strength, we also found reduced MWF in MS NAWM which correlated with EDSS. Voxels with lowest MWF values were not uniformly distributed throughout the NAWM, but rather tended to arise near grey/white matter interfaces in the periphery of the brain.

2093. **Individual Voxel Based Analysis of Brain Magnetization Transfer Maps Evidences High Variability of Grey Matter Injury in Patients at the First Stage of Multiple Sclerosis**

Lorena Jure1, Wafaa Zaaraoui1, Celia Rousseau1, Françoise Reuter1, Audrey Rico1, Irina Malikova1, Sylviane Confort-Gouny1, Patrick J. Cozzone1, Jean Pelletier1, Bertrand Audoin1, Jean-Philippe Ranjeva1

1CRMBM UMR CNRS 6612, Marseille, France

Various MR studies, based on group comparison have demonstrated a common pattern of grey matter (GM) injury in patients since the early stage of multiple sclerosis (MS). However, little is know about the potential variability of this early GM involvement which may determine the high variability of the functional prognosis. We propose an optimized method to obtain from statistical mapping analyses applied on MTR data, the GM MTR abnormalities of subjects at the individual level. Feasibility is demonstrated in early MS patients showing variable individual patterns of GM injury that could explain heterogeneity of clinical progression for this disease.

2094. **Definition of Regional Distribution of Gray Matter Loss in MS Patients with Fatigue: A Voxel-Based Morphometry Study**

Maria A. Rocca1, Gianna Riccitelli1, Cristina Forn1, Bruno Colombo2, Giancarlo Comi2, Massimo Filippi1

1Neuroimaging Research Unit, Institute of Experimental Neurology, Division of Neuroscience, Scientific Institute and University Hospital San Raffaele, Milan, Italy; 2Department of Neurology, Scientific Institute and University Hospital San Raffaele, Milan, Italy

Using voxel-based morphometry, we defined the topographical distribution of gray matter (GM) atrophy in multiple sclerosis (MS) patients with fatigue. Compared to healthy volunteers and to MS patients without fatigue, patients with fatigue had reduced GM volume in several areas of the left frontal lobe, including the middle frontal gyrus (MFG), the precentral gyrus, the superior and inferior frontal gyrus, and the cingulate gyrus. Fatigue severity was significantly correlated with atrophy of the precentral gyrus, suggesting that structural damage in areas that are part of the sensorimotor network might be among the mechanisms responsible for the presence of MS-related fatigue.

2095. **Evidence of Subcortical Grey Matter Atrophy and Surface Morphology Differences in Primary Progressive Multiple Sclerosis**

Rose Gelineau-Kattner1,2, Tarunya Arun1, Damian Jenkins1, Morgan Hough1, Jacqueline Palace3, Mark Jenkinson1

1FMRIB Centre, University of Oxford, Oxford, United Kingdom; 2Baylor College of Medicine, Houston, TX, United States; 3Clinical Neurology, Oxford University and Oxford Radcliffe Hospitals NHS Trust, United Kingdom

Grey matter damage is important in the pathology of Primary Progressive Multiple Sclerosis (PPMS). We scanned 22 patients and 7 controls at baseline, and 2, 50, and 52 weeks. FreeSurfer was used to segment subcortical grey matter and vertex analysis was performed with FSL’s FIRST to identify differences in surface morphology between groups. Significant atrophy and correlations with EDSS and/or disease duration were seen in some structures at baseline and all structures showed volume reduction over one year. Surface morphology differences were found in the thalamus and pallidum. Results highlight importance of subcortical atrophy and structural morphology differences in PPMS.
2096. **Regional Gray Matter Volumes Changes in Relapsing-Remitting and Secondary Progressive Multiple Sclerosis – a Longitudinal Comparative Voxel-Based Morphometry Study**

Kerstin Bendfeldt, Louis Hofstetter, Pascal Kuster, Stefan Traud, Nicole Müller-Lenke, Yvonne Naegelin, Ludwig Kappos, Achim Gass, Thomas E. Nichols, Frederik Barkhof, Stephan Roosendaal, Jeroen Geurts, Hugo Vrenken, Ernst-Wilhelm Radue, Stefan J. Borgwardt

1University Hospital Basel, Basel, Basel-Stadt, Switzerland; 2University of Warwick; 3University of Amsterdam; 4Medical Image Analysis Centre, University Hospital Basel, Basel, Basel-Stadt, Switzerland

We used optimized voxel-based morphometry to study similarities and differences of regional gray matter volume development in relapsing remitting and secondary progressive MS. Although regional gray matter volume measures reveal areas of significant gray matter volume loss in RRMS, the results from this study suggest, that there is no marked acceleration in the progressive phase of the disease. This implies that the more pronounced impact of gray matter pathology in the secondary progressive phase is a result of longer linear accrual of such damage, rather than a phase-specific acceleration.

2097. **Gender Effects on Atrophy in MS: Cognitive Implications**

Menno M. Schoonheim, Doriana Landi, Jeroen JG Geurts, Hugo Vrenken, Ernesto J. Sanz-Arigita, Linda Douw, Chris H. Polman, Frederik Barkhof

1Radiology, VU University Medical Center, Amsterdam, Noord Holland, Netherlands; 2Pathology, VU University Medical Center, Amsterdam, Noord Holland, Netherlands; 3Physics & Medical Technology, VU University Medical Center, Amsterdam, Noord Holland, Netherlands; 4Neurology, VU University Medical Center, Amsterdam, Noord Holland, Netherlands

Multiple sclerosis displays clear gender effects in female predisposition, as well as male negative clinical prognosis. To investigate gender effects of atrophy and cognition in MS, we acquired brain volumes and neuropsychological assessments in 32 RRMS patients (14 male, 17 female) and 22 healthy controls (10 male, 12 female). Atrophy and cognitive impairment were present in male patients only. An interaction between group and gender was present for whole-brain volume and verbal memory. These were correlated in the patient group only. This underlines the need for future research to investigate gender effects in MS more thoroughly, with possible therapeutic implications.

2098. **Memory Impairment in MS Correlates to Hemodynamic Response in Event-Related FMRI of Episodic Memory**

Katherine A. Koenig, Blessy Mathew, Jian Lin, Lael Stone, Stephen Rao, Michael Phillips, Mark J. Lowe

1Imaging Institute, The Cleveland Clinic, Cleveland, OH, United States; 2Mellen Center, The Cleveland Clinic, Cleveland, OH, United States; 3Schey Center, The Cleveland Clinic, Cleveland, OH, United States

Nineteen patients with MS performed a verbal incidental encoding task, followed by a word recognition task (WR). Stimuli from the WR task were split into “encoded” and “non-encoded” based on performance of each subject. The encoded stimuli of the five highest performers were used to create an average t-map to select regions of interest for a correlation analysis. Areas involved in semantic encoding, including the DLPFC and the inferior frontal gyrus, showed a significant positive correlation between the fit hemodynamic response amplitude during encoded stimuli on the WR task and a test of verbal memory.

2099. **Corpus Callosum Fractional Anisotropy Predicts Clinical Progression and Cognitive Dysfunction in Early Primary-Progressive MS: A 5 Year Follow-Up Study**

Benedetta Bodini, Mara Cerignani, Zhaleh Khaleeli, Sophie Penny, Maria Ron, David H. Miller, Alan J. Thompson, Olga Ciccarelli

1NMR Unit, Department of Brain Repair and Rehabilitation, UCL Institute of Neurology, London, United Kingdom; 2Neuroimaging Laboratory, IRCCS Santa Lucia Foundation, Rome, Italy; 3NMR Unit, Department of Neuroinflammation, UCL Institute of Neurology, London, United Kingdom; 4Department of Psychology, National Hospital for Neurology and Neurosurgery, London, United Kingdom; 5NMR Unit, Department of Neuroinflammation, UCL Institute of Neurology, London, United Kingdom

The aim of this study was to identify which brain area predicts the development of disability over five years and cognitive dysfunction after five years in 32 patients with early primary-progressive multiple sclerosis. Employing tract-based spatial statistics and voxel-based morphometry, we found that lower fractional anisotropy in the corpus callosum at study entry predicted a greater progression of disability, as measured by the EDSS, over the follow-up, and worse verbal memory, attention and speed of information processing, and executive functions, after five years. Our findings highlight the importance of damage to the inter-hemispheric callosal pathways in determining disability in MS.
A Voxel Based Diffusion Tensor Image Analysis on Cognitive Decline in Mildly and Moderately Impaired Multiple Sclerosis Patients

Wim Van Hecke1, Jan Sijbers2, Alexander Leemans3, Guy Nagels4, Evert Vandervliet1, Paul M. Parizel1
1Department of Radiology, Antwerp University Hospital, Antwerp, Belgium; 2VisionLab, University of Antwerp, Antwerp, Belgium; 3Image Sciences Institute, Utrecht, Netherlands; 4MS centrum, Melsbroek, Belgium

The aim of this study was to examine the relationship between the Paced Auditory Serial Addition Test and the diffusion properties that are related to microstructural white matter breakdown in patients with mild and moderate Multiple Sclerosis.

Early Compensatory Changes Within the Memory Network of Multiple Sclerosis

Hanneke E. Hulst1, Stefan D. Roosendaal1, Menno M. Schoonheim1, Lizanne J. Schweren1, Ysbrand D. van der Werf2, Chris H. Polman3, Frederik Barkhof4, Jeroen J. Geurts3,4
1Radiology, VU University Medical Center, Amsterdam, Noord-Holland, Netherlands; 2Clinical Neurophysiology, VU University Medical Center, Amsterdam, Noord-Holland, Netherlands; 3Neurology, VU University Medical Center, Amsterdam, Noord-Holland, Netherlands; 4Pathology, VU University Medical Center, Amsterdam, Noord-Holland, Netherlands

Cognitive decline is frequently seen in multiple sclerosis (MS). This study investigates the changes in hippocampal activation patterns in MS. Functional MRI, an encoding- and retrieval paradigm, was acquired of 24 cognitively preserved (CP) and 10 cognitively impaired (CI) MS patients and 15 healthy controls (HC). Where CP patients only showed increased brain activation in the dorsal streams of the memory system, CI patients showed reduced brain activation in the (para)hippocampal areas and the ventral stream of the memory system. Our findings indicate that functional reorganization takes place early in the disease course and is a finite phenomenon in MS.

Memory Impairment in MS Correlates to Hemodynamic Response in Event-Related FMRI of Incidental Encoding

Katherine A. Koenig1, Blessy Mathew1, Jian Lin1, Lael Stone2, Stephen Rao3, Michael Phillips3, Mark J. Lowe1
1Imaging Institute, The Cleveland Clinic, Cleveland, OH, United States; 2Mellen Center, The Cleveland Clinic, Cleveland, OH, United States; 3Schey Center, The Cleveland Clinic, Cleveland, OH, United States

Eighteen patients with MS performed a verbal incidental encoding task, followed by a word recognition task. Performance on the WR task was used to split incidental encoding stimuli into “encoded” and “non-encoded” maps. The fit hemodynamic response amplitude during encoded and non-encoded stimuli on the encoding task was correlated with a test of verbal memory. Against expectation, the non-encoded words showed only positive correlations, while the encoded words showed only negative correlations with verbal memory performance. It is unclear if this result is due to disease processes in MS, or due to compensatory strategies.

Cognitive Impairment in Early Multiple Sclerosis Related to Metabolic Impairment in Cerebellum

Wafaa Zaaraoui1, Françoise Reuter1, Audrey Rico1, Iriana Malikova1, Elisabeth Soulier1, Patrick Viou1, Yann Le Fur1, Sylvaine Confort-Gouny1, Patrick J. Cozzone1, Jean Pelletier1, Jean-Philippe Ranjeva1, Bertrand Audoin1
1Faculté de Médecine, CRMBM UMR CNRS 6612, Marseille, France

While metabolic changes and cognitive impairment are known to be present in multiple sclerosis (MS) from the earliest stage of the disease, no exhaustive examinations have been performed to assess potential relationships between metabolite levels and cognitive status. Our study aimed to investigate whether magnetic resonance spectroscopic markers in normal appearing brain tissues are related to cognitive status in multiple sclerosis.

Is Myelin Water Fraction a Clinically Viable Biomarker of Disease in Primary Progressive Multiple Sclerosis?

Shannon Kolind1,2, Lucy Matthews1,3, Heidi Johansen-Berg1, Rose Gelineau-Kattner1,4, M Isabel Leite5, Jacqueline Palace6, Sean Deoni3
1FMRIB Centre, University of Oxford, Oxford, United Kingdom; 2Centre for Neuroimaging Sciences, King's College London, London, United Kingdom; 3Clinical Neurology, Oxford University and Oxford Radcliffe Hospitals NHS Trust, Oxford, United Kingdom; 4Baylor College of Medicine, Houston, TX, United States

Critical need exists for a sensitive and specific biomarker in primary progressive multiple sclerosis (PPMS), which features diffuse neuronal and myelin damage. This study explored estimates of myelin water fraction (MWF) as such a biomarker. Sixteen PPMS patients were imaged using the mcDESPOT multi-component relaxometry technique, and correlations between MWF estimates and clinical disability scores were investigated. We found significant negative correlation between MWF and EDSS scores across diffuse brain regions. Correlations between MWF and specific scores of bladder/bowel, mental and sensory functions were found in appropriate brain regions. Findings support the emerging relevance of MWF changes to clinical manifestations.
2105. Preparation for Multi-Site Myelin Water Relaxation Studies: Inter and Intra-Site Reproducibility in Normal Controls

Cornelia Laule1, Irene M. Vavasour1, Burkhard Mädler2, Trudy Harris3, David KB Li1, Anthony L. Trabousee4, Alex L. MacKay1,2

1Radiology, University of British Columbia, Vancouver, BC, Canada; 2Physics & Astronomy, University of British Columbia, Vancouver, BC, Canada; 3UBC MRI Research Centre, University of British Columbia, Vancouver, BC, Canada; 4Medicine, University of British Columbia, Vancouver, BC, Canada

Quantitative assessment of T1 and T2 relaxation has the potential to provide important in-vivo markers for disease progression and treatment efficacy in pharmaceutical trials. The present study examine cross-site reproducibility of mean T1, geometric mean T2 (GMT2) and myelin water fraction (MWF) measured on the same 5 people at 6 sites. Average percent differences of inter and intra-site reproducibility was <1% for GMT2, ~3% for T1; and ~6% for MWF. While mean T1 and GMT2 have slightly better reproducibility, MWF provides a specific measure of brain myelin content, and is hence ideal for assessing neuroprotective and remyelination strategies.

2106. 1H-MRS and Water Proton T1 Investigations of New Lesions in Relapse Remitting Multiple Sclerosis

Madeleine Hodgson1, Cornelia Laule1,2, Irene Vavasour1,2, Burkhard Mädler1, Alex MacKay1,2

1Physics, University of British Columbia, Vancouver, British Columbia, Canada; 2Radiology, University of British Columbia, Vancouver, British Columbia, Canada

Little is known about the pathological evolution of acute MS lesions. Using 1H-MRS one can measure changes in metabolites such as n-acetyl-aspartate (NAA), which may become altered in MS. We used 1H-MRS and water proton T1 measurements to investigate the time-course of biochemical changes occurring in new MS lesions. Multi-voxel 1H-MRS data was acquired monthly from 20 Relapsing-Remitting MS subjects. Metabolite and water proton T1 changes for the same volume were investigated. Lesions exhibited a significant decrease in NAA and a significant increase in mean T1, compared to normal appearing white matter, 2 months before lesion appearance on conventional imaging.

2107. 1H-MRS Study of Secondary Progressive MS Patients Followed Over 2 Years in the Dirucotide (MBP8298) Placebo Controlled Study

Madeleine Hodgson1, Cornelia Laule1,2, Irene Vavasour1,2, David Li2, Yinshan Zhao3, Tony Trabousee1, Joel Oger1, Alex MacKay1,2

1Physics, University of British Columbia, Vancouver, British Columbia, Canada; 2Radiology, University of British Columbia, Vancouver, British Columbia, Canada; 3Medicine, University of British Columbia, Vancouver, British Columbia, Canada

1H-MRS is a useful technique for evaluating demyelination and axonal integrity and thus can be used to monitor disease progression in Multiple Sclerosis (MS). Dirucotide (MBP8298) has exhibited potential as a treatment for Secondary Progressive MS (SPMS) to slow disease progression. The effects of Dirucotide were investigated using 1H-MRS in a single centre, double-blinded MRI substudy with a placebo control. There is no change observed in important metabolites in either of the cohorts over a two-year period, which is perhaps not surprising given that Dirucotide did not meet primary endpoints in the MAESTRO-01 Phase III trial.

2108. In Vivo Measurement of Glutathione (GSH) in the Human Brain with Secondary Progressive Multiple Sclerosis Using Selective Multiple Quantum Chemical Shift Imaging of GSH

In-Young Choi1,2, Sang-Pil Lee1,3, Sharon G. Lynch4

1Hoglund Brain Imaging Center, University of Kansas Medical Center, Kansas City, KS, United States; 2Department of Neurology, Molecular & Integrative Physiology, University of Kansas Medical Center, Kansas City, KS, United States; 3Department of Molecular & Integrative Physiology, University of Kansas Medical Center, Kansas City, KS, United States; 4Department of Neurology, University of Kansas Medical Center, Kansas City, KS, United States

Oxidative stress has been implicated in multiple sclerosis (MS), a chronic inflammatory disease with the presence of a neurodegenerative process particularly in progressive MS. However, the effects of oxidative stress in MS have not been well described in the living human brain. In this study, we measured the cerebral GSH levels in the patients with secondary progressive MS (SPMS) using doubly selective multiple quantum GSH CSI. The GSH levels were significantly lower in the SPMS patients compared with those in the age- and gender-matched healthy controls, indicating the presence of increased oxidative stress in the absence of measurable inflammation.

2109. Quantitative Venous Vasculature Assessment on Susceptibility-Weighted Imaging Reflects Presence of Severe Chronic Venous Insufficiency in the Brain Parenchyma of Multiple Sclerosis Patients, a Case-Control Study

Guy U. Poloni1, Paola Zamboni2, E. Mark Haacke3, Stefano Bastianello4, Michael G. Dwyer1, Niels Bergsland5, Claudia V. Schirida1, David Wack1, Christopher R. Magnano1, Bianca Weinstock-Guttman6, Fabrizio Salvi7, David Hojnacki8, Robert Zivadinov3

1University at Buffalo, Buffalo Neuroimaging Analysis Center, Buffalo, NY, United States; 2University of Ferrara- Bellaria Neurosciences, Vascular Diseases Center, Ferrera, Italy; 3Radiology, Wayne State University, Detroit, MI, United States; 4Instituto Neurologico Casimiro Mondino, Neuroradiology Unit, Pavia, Italy; 5Department of Radiology, University of British Columbia, Vancouver, British Columbia, Canada; 6Department of Neurology, University of Buffalo, Buffalo, NY, United States; 7Institute of Neurology, Free University of Brussels, Brussels, Belgium; 8Department of Neurology, University of Turin, Turin, Italy

Quantitative assessment of T1 and T2 relaxation has the potential to provide important in-vivo markers for disease progression and treatment efficacy in pharmaceutical trials. The present study examine cross-site reproducibility of mean T1, geometric mean T2 (GMT2) and myelin water fraction (MWF) measured on the same 5 people at 6 sites. Average percent differences of inter and intra-site reproducibility was <1% for GMT2, ~3% for T1; and ~6% for MWF. While mean T1 and GMT2 have slightly better reproducibility, MWF provides a specific measure of brain myelin content, and is hence ideal for assessing neuroprotective and remyelination strategies.

2106. 1H-MRS and Water Proton T1 Investigations of New Lesions in Relapse Remitting Multiple Sclerosis

Madeleine Hodgson1, Cornelia Laule1,2, Irene Vavasour1,2, Burkhard Mädler1, Alex MacKay1,2

1Physics, University of British Columbia, Vancouver, British Columbia, Canada; 2Radiology, University of British Columbia, Vancouver, British Columbia, Canada

Little is known about the pathological evolution of acute MS lesions. Using 1H-MRS one can measure changes in metabolites such as n-acetyl-aspartate (NAA), which may become altered in MS. We used 1H-MRS and water proton T1 measurements to investigate the time-course of biochemical changes occurring in new MS lesions. Multi-voxel 1H-MRS data was acquired monthly from 20 Relapsing-Remitting MS subjects. Metabolite and water proton T1 changes for the same volume were investigated. Lesions exhibited a significant decrease in NAA and a significant increase in mean T1, compared to normal appearing white matter, 2 months before lesion appearance on conventional imaging.

2107. 1H-MRS Study of Secondary Progressive MS Patients Followed Over 2 Years in the Dirucotide (MBP8298) Placebo Controlled Study

Madeleine Hodgson1, Cornelia Laule1,2, Irene Vavasour1,2, David Li2, Yinshan Zhao3, Tony Trabousee1, Joel Oger1, Alex MacKay1,2

1Physics, University of British Columbia, Vancouver, British Columbia, Canada; 2Radiology, University of British Columbia, Vancouver, British Columbia, Canada; 3Medicine, University of British Columbia, Vancouver, British Columbia, Canada

1H-MRS is a useful technique for evaluating demyelination and axonal integrity and thus can be used to monitor disease progression in Multiple Sclerosis (MS). Dirucotide (MBP8298) has exhibited potential as a treatment for Secondary Progressive MS (SPMS) to slow disease progression. The effects of Dirucotide were investigated using 1H-MRS in a single centre, double-blinded MRI substudy with a placebo control. There is no change observed in important metabolites in either of the cohorts over a two-year period, which is perhaps not surprising given that Dirucotide did not meet primary endpoints in the MAESTRO-01 Phase III trial.

2108. In Vivo Measurement of Glutathione (GSH) in the Human Brain with Secondary Progressive Multiple Sclerosis Using Selective Multiple Quantum Chemical Shift Imaging of GSH

In-Young Choi1,2, Sang-Pil Lee1,3, Sharon G. Lynch4

1Hoglund Brain Imaging Center, University of Kansas Medical Center, Kansas City, KS, United States; 2Department of Neurology, Molecular & Integrative Physiology, University of Kansas Medical Center, Kansas City, KS, United States; 3Department of Molecular & Integrative Physiology, University of Kansas Medical Center, Kansas City, KS, United States; 4Department of Neurology, University of Kansas Medical Center, Kansas City, KS, United States

Oxidative stress has been implicated in multiple sclerosis (MS), a chronic inflammatory disease with the presence of a neurodegenerative process particularly in progressive MS. However, the effects of oxidative stress in MS have not been well described in the living human brain. In this study, we measured the cerebral GSH levels in the patients with secondary progressive MS (SPMS) using doubly selective multiple quantum GSH CSI. The GSH levels were significantly lower in the SPMS patients compared with those in the age- and gender-matched healthy controls, indicating the presence of increased oxidative stress in the absence of measurable inflammation.

2109. Quantitative Venous Vasculature Assessment on Susceptibility-Weighted Imaging Reflects Presence of Severe Chronic Venous Insufficiency in the Brain Parenchyma of Multiple Sclerosis Patients, a Case-Control Study

Guy U. Poloni1, Paola Zamboni2, E. Mark Haacke3, Stefano Bastianello4, Michael G. Dwyer1, Niels Bergsland5, Claudia V. Schirida1, David Wack1, Christopher R. Magnano1, Bianca Weinstock-Guttman6, Fabrizio Salvi7, David Hojnacki8, Robert Zivadinov3

1University at Buffalo, Buffalo Neuroimaging Analysis Center, Buffalo, NY, United States; 2University of Ferrara- Bellaria Neurosciences, Vascular Diseases Center, Ferrera, Italy; 3Radiology, Wayne State University, Detroit, MI, United States; 4Instituto Neurologico Casimiro Mondino, Neuroradiology Unit, Pavia, Italy; 5Department of Radiology, University of British Columbia, Vancouver, British Columbia, Canada; 6Department of Neurology, University of Buffalo, Buffalo, NY, United States; 7Institute of Neurology, Free University of Brussels, Brussels, Belgium; 8Department of Neurology, University of Turin, Turin, Italy

Quantitative assessment of T1 and T2 relaxation has the potential to provide important in-vivo markers for disease progression and treatment efficacy in pharmaceutical trials. The present study examine cross-site reproducibility of mean T1, geometric mean T2 (GMT2) and myelin water fraction (MWF) measured on the same 5 people at 6 sites. Average percent differences of inter and intra-site reproducibility was <1% for GMT2, ~3% for T1; and ~6% for MWF. While mean T1 and GMT2 have slightly better reproducibility, MWF provides a specific measure of brain myelin content, and is hence ideal for assessing neuroprotective and remyelination strategies.
To develop an objective method for quantifying venous vasculature in brain parenchyma on susceptibility-weighted imaging (SWI).

To apply this technique in multiple sclerosis (MS) patients and in healthy controls (HC).

2110. A Semi-Automated Analysis Pipeline for Reproducible SWI Analysis of Multiple Sclerosis Pathology

Michael G. Dwyer1, Niels Bergsland2, Claudiu Schirda2, Mari Heininen-Brown, Ellen Carl, David Wack, Guy U. Poloni, Robert Zivadinov3

1Buffalo Neuroimaging Analysis Center; 2University at Buffalo, Buffalo Neuroimaging Analysis Center, Buffalo, NY, United States; 3Neurology, Buffalo Neuroimaging Analysis Center, Buffalo, NY, United States

Susceptibility-weighted imaging (SWI) has gained much interest recently as a sensitive means for detecting iron deposition in a variety of diseases, including multiple sclerosis (SM). We propose a fast and reproducible analysis pipeline to extract detailed quantitative SWI data and to combine it with other established indicators of disease state (including magnetization transfer and perfusion imaging).

2111. Chronic Cerebrospinal Venous Insufficiency and Iron Deposition on Susceptibility-Weighted Imaging in Patients with Multiple Sclerosis

Robert Zivadinov1, Paolo Zamboni2, E. Mark Haacke3, Erica Menegatti4, Bianca Weinstock-Guttman3, Claudiu Schirda4, Anna M. Malagoni5, David Hojnacki5, Cheryl Kennedy5, Ellen Carl5, Niels Bergsland4, Sara Hussein4, Mari Heininen-Brown4, Ilaria Bartolomei6, Fabrizio Salvit7, Michael G. Dwyer1

1University at Buffalo, Buffalo Neuroimaging Analysis Center, Buffalo, NY, United States; 2University of Ferrara-Bellaria Neurosciences, Vascular Diseases Center, Ferrara, Italy; 3MR Research Facility, Wayne State University, Detroit, MI, United States; 4University of Ferrara-Bellaria Neurosciences, Vascular Diseases Center, Buffalo, NY, United States; 5University at Buffalo, The Jacobs Neurological Institute, Buffalo, NY, United States; 6University of Ferrara-Bellaria Neurosciences, Vascular Diseases Center, Ferrara, NY, United States

Chronic cerebrospinal venous insufficiency (CCSVI) is a vascular picture in multiple sclerosis patients characterized by stenoses affecting the main extracranial venous outflow pathways and by a high rate of cerebral venous reflux that may lead to increased iron deposition in the brain. We explored relationship between venous hemodynamic (VH) parameters and disability and iron concentration in deep-gray matter (DGM) structures and lesions on susceptibility-weighted imaging. There was a significant association between higher number of VH criteria and higher iron concentration in T2 and T1 lesion volumes. Higher iron concentration in DGM structures was strongly associated with higher disability status.

2112. Cine Cerebrospinal Fluid Imaging in Multiple Sclerosis. a Case-Control Study

Robert Zivadinov1, Christopher Magnano2, Bianca Weinstock-Guttman1, David Wack2, Eric Lindzen3, David Hojnacki3, Niels Bergsland2, Cheryl Kennedy2, Justine Reuther1, Michael G. Dwyer2, Claudiu Schirda1

1Neurology, Buffalo Neuroimaging Analysis Center, Buffalo, NY, United States; 2University at Buffalo, Buffalo Neuroimaging Analysis Center, Buffalo, NY, United States; 3University at Buffalo, The Jacobs Neurological Institute, Buffalo, NY, United States

To investigate the cerebrospinal fluid (CSF) dynamics in Sylvius aqueduct in multiple sclerosis (MS) patients versus healthy controls (HC) and to define correlates with other specific disease metrics.

2113. An Objective Quantification Technique of the Cerebrospinal Fluid (CSF) Flow in the Cerebral Aqueduct, in Patients with Multiple Sclerosis

Claudiu Schirda1, Paolo Zamboni1, Christopher Magnano1, Eric Lindzen1, David Wack1, Bianca Weinstock-Guttman1, Deepa Ramasamy1, Ellen Carl1, David Hojnacki1, Cheryl Kennedy1, Michael Dwyer1, Niels Bergsland1, Jennifer Cox1, Fabrizio Salvit1, Robert Zivadinov1,3

1Buffalo Neuroimaging Analysis Center, University at Buffalo, Buffalo, NY, United States; 2University of Ferrara, Ferrara, Italy; 3The Jacobs Neurological Institute, University at Buffalo, Buffalo, NY, United States

When compared to white matter or gray matter, the involvement of the cerebrospinal fluid (CSF) in the Multiple Sclerosis (MS) disease has scarcely been explored until now and typically a lumbar puncture is required. We investigate the flow properties of the CSF in the aqueduct of Sylvius and how they relate to other MS disease metrics, by using non-invasive MRI in a pilot study with MS patients and healthy controls. An objective flow quantification technique using automatic segmentation of the aqueduct was developed and was validated on a flow phantom and scan-rescanning 4 subjects within a week.
Effects of Temporal Resolution on Blood-Brain Barrier Permeability Measurement with Dynamic Contrast Enhanced MRI in Multiple Sclerosis Enhancing Lesions

Ileana Ozana Jelescu, Ilana Ruth Leppert, Sridar Narayanan, Douglas L. Arnold, G. Bruce Pike

Montreal Neurological Institute, McGill University, Montreal, Quebec, Canada

Accurate and reproducible measurements of blood-brain barrier permeability in MS enhancing lesions would benefit follow-ups of lesion activity and comparison of detection sensitivity between different Gd-enhanced protocols. We propose a Dynamic Contrast Enhanced MRI protocol that allows sampling of the arterial input function with high temporal resolution in the first minute post-injection, followed by a lower temporal resolution but high spatial resolution acquisition of enhancement in lesions. This “dual temporal resolution” method was tested experimentally and through simulations and, compared to previous methods, has proven to yield more accurate and precise estimates over a wide range of permeability values.

Relative Recirculation (RR): A Potential Tool for Monitoring Blood-Brain Barrier Disruption in Secondary Progressive Multiple Sclerosis

Andrea Kassner, Igor Sitartchouk, Rebecca E. Thornhill, Timothy J. Carroll, Chaitali Mulay, Richard Avivi

Medical Imaging, University of Toronto, Toronto, Ontario, Canada; Physiology and Experimental Medicine, Hospital for Sick Children, Toronto, Ontario, Canada; Radiology, Northwestern University, Chicago, IL, United States; Neuroradiology, Sunnybrook Health Sciences Centre, Toronto, Ontario, Canada

Multiple sclerosis (MS) is an inflammatory demyelinating disease of the central nervous system. While blood-brain barrier (BBB) disruption associated with relapsing-remitting MS is readily identified using gadolinium-enhanced T1-weighted MRI, these MRI markers lack the sensitivity required for monitoring secondary progressive MS. Relative recirculation (rR), a parameter extracted from dynamic susceptibility contrast (DSC) data, can delineate BBB disruption in patients with acute ischemic stroke. Relative recirculation was measured from DSC perfusion data obtained from 19 patients with secondary progressive MS. The average lesion rR was significantly greater than in normal appearing white matter and shows potential for monitoring secondary progressive MS.

A Three-Dimensional Multi-Scale Line Filter Algorithm for Segmentation of Vein Vessels in Susceptibility Weighted Images

Guy U. Poloni, Michael G. Dwyer, Niels Bergsland, Claudia V. Schirda, Stefano Bastianello, Robert Zivadinov

Buffalo Neuroimaging Analysis Center, Buffalo, NY, United States; Neuroradiology Unit, Fondazione “Istituto Neurologico Casimiro Mondino” IRCCS, Pavia, Italy; Buffalo Neuroimaging Analysis Center, Buffalo, NY, United States; The Jacobs Neurological Institute, University at Buffalo, Buffalo, NY, United States

SWI is a MRI application that can directly image cerebral veins through the use of phase information to enhance local susceptibility. The present work introduces an algorithm, based on a 3-dimensional linear filter, for segmenting and measuring vein vessels in the brain and for classifying vessels according to their diameter. The resultant multi-scale line-filtered images provide significantly improved segmentation and visualization of curvilinear structures, in particular with respect to small vessels, contributing to the quantitative investigation of vascular impairment in the pathologies of the central nervous system.

White Matter Diseases

MR Relaxometry and Diffusion Tensor Imaging of Normal Appearing White Matter in Mild Traumatic Brain Injury

Christopher James Andrew Cowie, Benjamin S. Aribisala, Jiabao He, Joshua Wood, Alexander David Mendelow, Patrick Mitchell, Andrew M. Blamire

Newcastle Magnetic Resonance Centre, Newcastle University, Newcastle upon Tyne, Tyne & Wear, United Kingdom; Department of Neurosurgery, Newcastle General Hospital, Newcastle upon Tyne, Tyne & Wear, United Kingdom

Mild traumatic brain injury (mTBI) is associated with long-term cognitive and affective symptoms. Findings on conventional MRI often do not account for the duration and severity of these symptoms. The aim of this study was to ascertain whether MR relaxometry and diffusion tensor imaging would reveal abnormalities in normal appearing white matter (NAWM) in patients with mTBI. Whole group analysis showed no significant differences, but after grouping the patients according to the side of the visible lesion, a significant increase in the mean diffusivity (MD) of ipsilateral frontal lobe NAWM was demonstrated.
**2118. Quantification of DTT Metrics in Various Fiber Bundle in Patients with Frontal Lobe Injury and Its Correlation with Neuropsychological Tests**

Manoj Kumar, Deepa Pal, Ram KS Rathore, Bal K. Ojha, Anil Chandra, Raj Kumar, Rakesh Kumar Gupta

1Radiodiagnosis, Sanjay Gandhi Post Graduate Institute of Medical Sciences, Lucknow, Uttar Pradesh, India; 2Mathematics and Statistics, Indian Institute of Technology, Kanpur, Uttar Pradesh, India; 3Neurosurgery, Chhatrapati Shahaji Maharaj Medical University, Lucknow, Uttar Pradesh, India

Diffusion tensor imaging (DTI) was performed within 7 days and after 6 months of injury in 21 traumatic brain injury (TBI) patients with frontal lobe injury and 21 age/sex matched controls. Diffusion tensor tractography (DTT) was proposed for quantification of various white matter (WM) tracts in patients with frontal lobe injury to assess diffuse axonal injury (DAI) and to look for correlation of these fiber bundles measures with various neuropsychological tests (NPT). We found reduced fractional anisotropy (FA) and increased mean diffusivity (MD) values in all WM tracts in TBI patients compared to controls, NPT scores were found to be significantly impaired in follow-up patients compare to controls and some of these tests showed significant correlation with DTT indices with different WM tracts. WM tracts which show significant difference on DTT were also correlated with those NPT which are associated with main function of frontal lobe such as memory, attention, visual and motor function. It appears more realistic methods for DAI quantification in TBI patients and provides information about structural integrity and connectivity of whole fiber tracts.

**2119. White Matter Degradation in Fornix After Mild Traumatic Brain Injury: Cross-Sectional and Longitudinal MRI Investigations**

Wang Zhan, Grant Gauger, Lauren Boreta, Gary Abrams, Karl Young, Yu Zhang, Marzieh Nezamzadeh, Norbert Schuff, Michael W. Weiner

1Radiology and Medical Imaging, University of California, San Francisco, San Francisco, CA, United States; 2VA Medical Center, San Francisco

Fornix is one of the primary white matter structures of the limbic system, and its damage in mild traumatic brain injury (TBI) may explain the memory and learning dysfunctions in the post-concussion syndrome. N=24 TBI patients were longitudinally studied in two time points using T1 anatomical imaging and diffusion tensor imaging (DTI) to measure the fornix-to-brain ratio (FBR) and WM integrity of fornix, and compared with matched healthy controls. Our data show that the WM degradation in fornix onset in the acute stage after mild TBI, and that this degradation continued during the following 6-month period of recovery.

**2120. Detection of Tissue Changes in Traumatic Brain Injury Patients Using Automatic Regional Analysis of Quantitative MR Scans**

Benjamin Segun Aribisala, Christopher J.A. Cowie, Jiabao He, Joshua Wood, David A. Mendelow, Andrew M. Blamire

1Institute of Cellular Medicine, Newcastle Magnetic Resonance Centre, Newcastle University, Newcastle upon Tyne, England, United Kingdom; 2Department of Neurosurgery, Newcastle General Hospital, Newcastle University, Newcastle upon Tyne, England, United Kingdom

Traumatic head injury is one of the major causes of neurological morbidity and mortality in the UK with more than 0.1 million admissions per year with primary diagnosis of head injury. This constitutes a huge drain on medical resources. Majority of these patients have ongoing symptoms which do not correlate with MRI or CT findings. Here we investigated a cohort of patients with mild TBI using multi-parametric real space analysis. Our results show that a fully automatic real space method of analysing quantitative MR parameters can be used to detect changes in normal appearing tissues in patients suffering mild TBI.

**2121. Using Jacobean Determinants to Map Within-Subject Serial Changes in Brain Volume in Difficult Contexts: Implementation in Traumatic Brain Injury with Decompressive Craniectomy**

Steve Sawiak, Virginia FJ Newcombe, M G. Abate, Jo G. Outtrim, John D. Pickard, T A. Carpenter, Guy B. Williams, David K. Menon

1Wolfson Brain Imaging Centre, University of Cambridge, Cambridge, Cambridgeshire, United Kingdom; 2Division of Anaesthesia, University of Cambridge, Cambridge, Cambridgeshire, United Kingdom

Atrophy is common post traumatic brain injury (TBI) and may correlate with outcome. We hypothesised that quantification of Jacobian determinants could assess progressive changes in brain volume in within subject analyses, even in contexts that produce major problems with comparative analyses. We show implementation of the approach in a single TBI subject with serial scans before and up to 12 months after decompressive craniectomy, compared to results from healthy controls. The results indicate it is possible to monitor the changes in brain volume over time post TBI in an individual.
The Relationship of White Matter Lesion and Contrast Enhanced Lesion Development Courses in Radiation Induced Brain Injury: An MRI Based Study
H Huang1,2, M Deng, S F. Leung, Y L. Chan1, D K. Yeung, H C. Chan1, A T. Ahuja1, Y X. Wang1
1Department of Diagnostic Radiology and Organ Imaging, The Chinese University of Hong Kong, Prince of Wales Hospital, Shatin, NT, Hong Kong; 2Department of Radiology, The Shenzhen Third People’s Hospital, Shenzhen, China; 3Department of Clinical Oncology, The Chinese University of Hong Kong, Prince of Wales Hospital

The natural course of radiation induced brain injury still remains poorly understood. Among the abnormalities white matter edema-like lesions (WML) and contrast enhanced necrotic lesions (CEL) have been most commonly reported. It was recently reported that radiation induced brain injury was not always an irreversible and progressive process, but one that could show regression and resolution. In total 22 nasopharyngeal carcinoma patients with 36 lobes displaying WML and CEL were analysed in this study. The preliminary results of this study suggest the development of WML and CEL tend to follow the same pattern, and not develop in the opposite direction.

Dynamic Susceptibility Contrast Mr Perfusion Imaging of the Brain in X-Linked Adrenoleukodystrophy
Otto Rapalino1, Mara Kunst1, Patricia Musolino2, Florian Eichler2,3
1Radiology, Massachusetts General Hospital, Boston, MA, United States; 2Neurology, Massachusetts General Hospital, Boston, MA, United States; 3Martinos Center for Biomedical Imaging, Charlestown, MA, United States

Dynamic Susceptibility Contrast (DSC) MR perfusion was used to characterize the perfusion abnormalities in patients with adrenoleukodystrophy and adrenomyeloneuropathy. This study demonstrates that the combination of conventional MR and DSC perfusion MR techniques allows the definition of five different zones with characteristic profiles of abnormal signal and perfusion in patients with adrenoleukodystrophy that correspond to the zonal anatomy previously described on pathological studies. These findings can be helpful in predicting disease progression, selecting patients for therapeutic interventions and elucidating the pathophysiology of this disorder.

Diffusion Tensor Imaging Detects Abnormalities in the Corticospinal Tract of the Brain in Patients with Adrenomyeloneuropathy
Aliya Gifford1, Anna Binstock2, Joseph Wang3, Kathy Zackowski1,4, Jonathan Farrell5,6, Peter C.M. van Zijl6,6, Seth Smith7,8
1Department of Neurogenetics, Kennedy Krieger Institute, Baltimore, MD, United States; 2University of Maryland School of Medicine, Baltimore, MD; 3Motion Analysis Laboratory, Kennedy Krieger Institute, Baltimore, MD; 4Department of Neurology, Johns Hopkins University School of Medicine, Baltimore, MD; 5Department of Radiology, Johns Hopkins University School of Medicine, Baltimore, MD; 6F.M. Kirby Research Center for Functional Brain Imaging, Kennedy Krieger Institute, Baltimore, MD; 7Vanderbilt University Institute of Imaging Science, United States; 8Department of Radiology, Vanderbilt University, Nashville, TN

Adrenomyeloneuropathy (AMN) is characterized by primary distal axonopathy with secondary demyelination. In this study we performed diffusion tensor imaging (DTI) at 1.5T on 29 healthy volunteers and 39 AMN patients. Tractography of the left and right corticospinal tracts (CST) were performed and diffusion anisotropy and diffusivity were computed. A significant change in FA and perpendicular diffusivity was found from the pons to mid-brain (p<0.01) and mid-brain to thalamus (p<0.001) regions in AMN patients. This suggests that DTI can quantify the pathway-specific abnormalities in AMN, and results are in corroboration with knowledge that cerebral damage is present in AMN.

A Seven Years Quantitative MRI and MRS Follow-Up Study on Successful Bone Marrow Transplantation for Presymptomatic Juvenile Metachromatic Leukodystrophy
Xiao-Qi Ding, Annette Bley, Alfred Kohlschütter, Jens Fiehler, Heinrich Lanfermann
1Institute of Diagnostic and Interventional Neuroradiology, Hannover Medical School, Hannover, Germany; 2Department of Paediatrics, University Medical Centre Hamburg-Eppendorf, Hamburg, Germany; 3Department of Neuroradiology, University Medical Centre Hamburg-Eppendorf, Hamburg, Germany

Bone marrow transplantation (BMT) has been advocated as treatment of juvenile metachromatic leukodystrophy (MLD). The effectiveness of this high-risk treatment is still questionable due to the rarity of follow-up reports. We carried out a 7 years MRI follow-up on a boy with juvenile MLD who had received BMT treatment in the presymptomatic phase and remained free of MLD symptoms during the observation. Conventional morphological MRI showed minor stable white matter lesions while quantitative T2-mapping and MR spectroscopy evidenced a stagnancy of the demyelination process and an ongoing maturation of the brain.
Voxelwise Analysis of Pelizaeus-Merzbacher Disease in 17 Genetically Proven Cases

Using Diffusion Tensor Imaging

Onur Ozyurt1, Alp Dincer2, Zuhal Yapici3, Cengiz Yalcinkaya4, Mefkure Eraksoy3, Cengizhan Ozturk1

1Bogazici University, Biomedical Engineering Institute, Istanbul, Turkey; 2Acibadem University, School of Medicine, Department of Radiology; 3Istanbul University, Istanbul Faculty of Medicine, Department of Neurology; 4Istanbul University, Cerrahpasa Medical Faculty, Department of Neurology

In this study, tract based spatial statistics (TBSS) approach is used for the investigation of Pelizaeus-Merzbacher Disease (PMD), which is a rare X-linked disease characterized by defective central nervous system myelination due to a mutation in the proteolipid protein 1 gene.

In Vivo Proton MR Spectroscopy Findings Specific for Adenylosuccinate Lyase Deficiency

Steffi Dreha-Kulaczewski1, Marco Henneke1, Knut Brockmann1, Marinette van der Graaf1, Michel Willemen1, Udo Engkel2, Peter Dechent3, Arend Heerschap1, Gunther Helms2, Ron Wevers3, Jutta Gaertner1

1Department of Pediatrics and Pediatric Neurology, Georg August University, Goettingen, Germany; 2Clinical Physics Laboratory in the Department of Pediatrics, Radboud University Nijmegen Medical Center, Nijmegen, Netherlands; 3Department of Radiology, Radboud University Nijmegen Medical Center, Nijmegen, Netherlands; 4Department of Pediatric Neurology, Radboud University Nijmegen Medical Center, Nijmegen, Netherlands; 5Laboratory of Genetic, Endocrine and Metabolic Diseases, Department of Laboratory Medicine, Radboud University Nijmegen Medical Center, Nijmegen, Netherlands; 6MR-Research in Neurology and Psychiatry, Georg August University, Goettingen, Germany

Adenylosuccinate lyase (ADSL) deficiency is an inherited metabolic disorder and characterized by the accumulation of succinylaminomimidazolecarboxamide riboside and succinyladenosine (S-Ado) in tissue and body fluids. In three children, presenting with psychomotor delay, autistic features, and white matter changes on brain MRI, screening for inborn errors of metabolism included in vitro proton MRS. It revealed resonances at 8.27 and 8.29ppm that correspond to S-Ado. In vivo proton MRS showed a signal at 8.3ppm in gray and white matter brain regions of all three patients, which was undetectable in controls. In vivo proton MRS provides a conclusive finding in ADSL deficiency.

Cerebral Accumulation of 3-Hydroxyisovaleric Acid in Adults Until Recently Unaware of Having 3-Methylcrotonyl-CoA Carboxylase (MCC) Deficiency

Marinette van der Graaf1,2, Udo F.H. Engelke3, Eva Morava4, Mirian C.H. Janssen5, Maaike C. de Vries4, Bozena Goraj1, Arend Heerschap1, Ron A. Wevers3

1Radiology, Radboud University Nijmegen Medical Centre, Nijmegen, Netherlands; 2Clinical Physics Laboratory, Radboud University Nijmegen Medical Centre, Nijmegen, Netherlands; 3Laboratory of Genetic, Endocrine and Metabolic Diseases, Radboud University Nijmegen Medical Centre, Nijmegen, Netherlands; 4Pediatrics, Radboud University Nijmegen Medical Centre, Nijmegen, Netherlands; 5General Internal Medicine, Radboud University Nijmegen Medical Centre, Nijmegen, Netherlands

Recently, our group showed for the first time cerebral accumulation of 3-hydroxyisovaleric acid (3HIVA) in a pediatric patient with 3-Methylcrotonyl-CoA carboxylase deficiency (MCCD). 3HIVA has been considered to have neurotoxic effects, but this is under debate. The present study reports on cerebral accumulation of 3HIVA detected by 3T proton MRS in two adult women with MCCD, whom deficiency was discovered by a positive neonatal screening of their healthy new-born babies. As the women had not been aware of having this disorder before and they have no or limited complaints, 3HIVA is postulated to have no or minor neurotoxic effect.

White Matter Lesion Load in Type 2 Diabetes - A VBM Study

Lars Eric Forsberg1,2, Sigurdur Sigurdsson1, Thor Aspelund1,4, Jesper Fredriksson3, Smári Kristinsson1, Ólafur Kjartansson1, Bryndís Öskarsdóttir1, Pálmi V. Jónsson1,4, Guðný Eiríksdóttir1, Tamara B. Harris5, Mark A. van Buchem3, Alex Zijdenbos4, Lenore J. Launer5, Vilmundur Guðnadson1,4

1Department of Neuroscience, Karolinska Institutet, Stockholm, Sweden; 2Rafórninn ehf, Reykjavík, Iceland; 3Icelandic Heart Association, Kopavogur, Iceland; 4The University of Iceland, Reykjavík, Iceland; 5Laboratory of Epidemiology, Demography, and Biometry, National Institute of Aging, Bethesda, MD, United States; 6Department of Radiology, Leiden University Medical Center, Leiden, Netherlands; 7Bioskopic Inc., Montreal, Canada

Type 2 diabetes (DM2) is a known risk factor for white matter lesions (WML) in elderly subjects. In this study, we used voxel-based morphometry (VBM) to analyse the common distribution of WML in 215 subjects with DM2 (average age 76.1 years) compared to 1675 non-diabetic controls (average age 75.8 years). Our main finding is that DM2 subjects have commonly large WML areas in the brain that extend from the frontal lobe to the parietal lobe.
Preliminary results indicate reduced 13C glutamate turnover in successfully treated HIV. Glutamate turnover by infusion of 2-13C glucose followed by low-power nOe 13C MRS in HIV and normal control subjects. This study develops the necessary frontal lobe assay of neuronal and axonal glutamate concentration in white matter of HIV-affected individuals requires independent 13C MRS measurement of glutamate turnover neurotransmitter rates in neurons and glia. Despite successful treatment of HIV and AIDS, neuroimaging and neurospectroscopy abnormalities persist suggesting residual viral effects or unwanted neurological side effects of effective therapies. Elucidation of the recently described reduction in frontal lobe glutamate concentration in white matter of HIV-affected individuals requires independent 13C MRS measurement of glutamate turnover neurotransmitter rates in neurons and glia. This study develops the necessary frontal lobe assay of neuronal and axonal glutamate turnover by infusion of 2-13C glucose followed by low-power nOe 13C MRS in HIV and normal control subjects. Preliminary results indicate reduced 13C glutamate turnover in successfully treated HIV.

Abnormal metabolite levels were found in 3/3 patients with a diagnosis a post Lyme disease syndrome using 1H-MRS.

Animal Models of White Matter Disease

Hall B Wednesday 13:30-15:30

Vascular Endothelial Growth Factor - A Novel Player in SCI Pain
Laura Sundberg1, Juan Herrera1, Olivera Nesc1, Ponnada Narayana1
1Diagnostic and Interventional Imaging, The University of Texas Medical School, Houston, TX, United States; 2Biochemistry and Molecular Biology, University of Texas Medical Branch, Galveston, TX, United States

Vascular endothelial growth factor (VEGF) has been investigated as a potential treatment for spinal cord injury (SCI) due to its vascular-promoting and neuroprotective effects; however, studies have provided conflicting information about the post-SCI effects of VEGF. In this study, VEGF was delivered immediately after SCI and longitudinal MRI and behavioral studies were performed into the chronic phase of injury. It was found that VEGF treatment results in tissue sparing and increased markers of neurofilament, but many animals also displayed a higher incidence of mechanical allodynia. VEGF may spare tissue, but may also encourage non-specific sprouting of axons into pain pathways.

Viscoelastic Properties Change at an Early Stage of Cuprizone Induced Affection of Oligodendrocytes in the Corpus Callosum of C57/black6 Mice
Katharina Schregel1, Eva Wuerfel1, Jens Wuerfel1, Dirk Petersen1, Ralph Sinkus2
1University of Luebeck, Luebeck, Germany; 2Institut Langevin, ESPCI, Paris, France

MRE is an innovative imaging technique developed to non-invasively map and quantify the viscoelastic properties of tissue in vivo. As pathological alterations cause changes in elasticity and viscosity, MRE might be applied to characterize the structural integrity of given tissues and could be employed for diagnosis and clinical monitoring of neurodegenerative diseases such as multiple sclerosis. Therefore it appears to be essential to evaluate the effect of pathological processes occurring in multiple sclerosis on the viscoelastic properties of cerebral tissue with the help of experimental rodent models. We introduced the cuprizone mouse-model (C57/black6) which depicts key features of multiple sclerosis.
2135. Hybrid Diffusion Imaging in a Spinal Cord Model of Dysmyelination
1Medical Physics, University of Wisconsin-Madison, Madison, WI, United States; 2Medical Sciences, University of Wisconsin-Madison; 3Radiology, University of Wisconsin-Madison; 4Dartmouth College

The shaking pup (shp) is a canine mutant model of dysmyelination, and suffers from severe myelin deficiency. In a previous study of shp brain, Po was shown to differentiate between a control and diseased pup with respect to myelin content. In this study, WM integrity is examined in the spinal cord of shp using both DTI and DSI measurements acquired from a HYDI approach. Standard DTI measures and Po are compared to see if one or both are sensitive to changes in myelin content between shp and control, as well as to more subtle differences between two diseased pups.

2136. Ex Vivo Visualization of Cortical Lesions in Non-Human Primates with MS Using Inversion Recovery Experiments
Erwin Lambert Blezer, Yolanda S. Kap, Jan Bauer, Bert L. ‘t Hart
1Image Sciences Institute, University Medical Center Utrecht, Utrecht, Netherlands; 2Department of Immunobiology, Biomedical Primate Research Center, Rijswijk, Netherlands; 3Brain Research Institute, University of Vienna, Vienna, Austria

Cortical pathology is an important feature of MS. However visualization with MRI is poor although sensitivity is increased using FLAIR and Double Inversion Recovery (suppression of CSF and white matter) experiments. Various inversion recovery experiments were tested ex vivo on brains of marmoset with MS, which develop cortical lesions, in their ability to improve cortical lesion detection. Experiments included settings of inversion times in which CSF, white or grey matter was suppressed and a DIR experiment in which both white and grey matter was suppressed. Cortical lesions were best visualized after suppression of white matter or in the DIR experiment.

2137. Increasing Diffusion Time Improves in Vivo DTI Sensitivity to White Matter Degeneration
Ying-Jr Chen, Joong Hee Kim, Jian Wang, Tsang-Wei Tu, Sheng-Kwei Song
1Radiology, Washington University in St. Louis, Saint Louis, MO, United States; 2Mechanical, Aerospace and Structural Engineering, Washington University in St. Louis, Saint Louis, MO, United States

The sensitivities of detecting white matter injury using 6 ms and 38 ms diffusion time were examined in the present study. We demonstrated that increased diffusion time in diffusion tensor imaging measurements improves the sensitivity of detecting axonal injury and myelin damage in cuprizone treated mice. In the cuprizone model of demyelination, axonal injury was seen as significantly decreased axial diffusivity at both 6 and 38 ms diffusion time with more significantly decreased axial diffusivity observed at longer diffusion time.

2138. The Effect of Systemic Depletion of Natural Killer Cells in an EAE Mouse Model of Multiple Sclerosis Examined by Magnetic Resonance Imaging and Bioluminescence Imaging
Gregory Harrison Turner, Junwei Hao, Ruolan Liu, Wenhua Piao, Timothy L. Vollmer, Rong Xiang, Antonio La Cava, Denise I. Campbellino, Luc Van Kaer, Fu-Dong Shi
1Keller Center for Imaging Innovation, Barrow Neurological Institute, Phoenix, AZ, United States; 2Neurology, Barrow Neurological Institute, Phoenix, AZ, United States; 3Neurology, University of Colorado Denver School of Medicine, Aurora, CO, United States; 4Medicine, Nankai University, Tianjin, China; 5Medicine, University of California Los Angeles, Los Angeles, CA, United States; 6Microbiology and Immunology, Vanderbilt University School of Medicine, Nashville, TN, United States

Natural killer (NK) cells of the innate immune system can profoundly impact the development of adaptive immune responses against foreign invaders, as well as self-antigens. In this study a combination of in vivo MRI and bioluminescence imaging was used to investigate effects of systemic depletion of NK cells on lesion development in an experimental autoimmune encephalomyelitis (EAE) mouse model of multiple sclerosis. The results of this study suggest organ-specific activity of NK cells on the magnitude of CNS inflammation.
2139. Glutamate, Glutamine, NAA, and GABA Levels in Hippocampus in Schizophrenia as Measured by 1H-MRS at 3T
Ana Stan¹, Perry Mihalakos², Deborah Douglas³, Stephanie Morris², Changho Choi³, Carol Tamminga²
¹Western Psychiatric Institute and Clinic, University of Pittsburgh Medical Center, Pittsburgh, PA, United States; ²Psychiatry, University of Texas Southwestern Medical Center, Dallas, TX, United States; ³Advanced Imaging Research Center, University of Texas Southwestern Medical Center, Dallas, TX, United States

We report a result of a 3T 1H-MRS study in schizophrenia. The concentrations of glutamate (Glu), glutamine (Gln), and N-acetylaspartate (NAA) in hippocampus (voxel 50x15x15 mm) were measured using a triple refocusing sequence. GABA was measured with a difference editing method. MRS scans were conducted on 13 schizophrenia volunteers (10 on medication (SV-ON) and 3 off-medication (SV-OFF)) and 14 normal volunteers (NV). LCModel fitting was used for spectral analysis. \([\text{Glu}]/[\text{Cr}]\) was observed to be similar between NV and SV-ON (p = 0.4). However, \([\text{Glu}]/[\text{Cr}]\) in SV-OFF was significantly lower (~30%) than in both NV and SV-ON (p = 0.02 and 0.04, respectively). For Gln, the concentrations were about the same between the three groups (p > 0.2). Compared to NV, \([\text{NAA}]/[\text{Cr}]\) was reduced (by 10%) in SV-ON (p = 0.006), but not in SV-OFF (p = 0.55). The GABA data showed difference between SV-OFF and SV-ON (p = 0.05).

2140. Asymmetry Patterns of Association Fibers in Schizophrenia: Preliminary Results Using Diffusion Spectrum Imaging Tractography
Yu-Chun Lo¹, Su-Chun Huang², Hai-Gwo Hwu³, Chih-Min Liu³, Chen-Chung Liu³, Wen-Yih Isaac Tseng²,4
¹Institute of Biomedical Engineering, National Taiwan University, Taipei, Taiwan, Taiwan; ²Institute of Biomedical Engineering, National Taiwan University, Taipei, Taiwan, Taiwan; ³Department of Psychiatry, National Taiwan University Hospital, Taipei, Taiwan; 4Center for Optoelectronic Biomedicine, National Taiwan University College of Medicine, Taipei, Taiwan

Three association fibers connecting the frontal and temporal lobes and three commissural fibers connecting the bilateral orbitofrontal lobes, inferior frontal gyri, and superior temporal gyri related to the social and language functions that might serve the neuropsychopathology of patients with schizophrenia inferred from diffusion spectrum imaging tractography. In neurotypical participants, a consistent leftward asymmetry in the three pairs of association fibers was found. However, adults with schizophrenia did not demonstrate such asymmetry. Lack of leftward asymmetry in schizophrenia may imply a disruption in the normal pattern of structural and functional connectivity in frontal-temporal brain regions.

Christine Rodriguez-Régent¹, Sabine Mouchet-Mages², Sebastian Rodrigo, Marie-Odile Krebs², Catherine Oppenheim, Jean-François Meder²
¹Department of Morphologic and Functional Imaging, University Paris Descartes, Sainte Anne Hospital, PARIS, France; ²Pathophysiology of Psychiatric Diseases, University Paris Descartes, Sainte Anne Hospital, PARIS, France

Schizophrenic patients often present with neurological soft signs (NSS) but the cerebral changes underlying these signs are poorly understood. This study examines the microstructural changes associated with NSS using Diffusion Tensor Imaging. Forty-five patients with first-episode schizophrenia underwent DTI and a neurological examination. Fractional anisotropy (FA), calculated using a voxel based analysis, was analyzed with NSS scores. FA was negatively correlated with NSS scores in the white matter of the right prefrontal, left occipital and right parietal areas. Thus, this is the first study which confirms that microstructural changes of white matter are associated with NSS in schizophrenia.

2142. Interaction of Hippocampal Volume and N-Acetylaspartate Concentration Deficits in Schizophrenia: A Combined MRI and 1H-MRS Study at 3 T
Florian Schubert¹, Andreas Klaer¹, Martina Ballmaier², Karolina Leopold², Ines Haeke², Martin Schaefer¹, Ruediger Bruehl², Juergen Gallinat²
¹Physikalisch-Technische Bundesanstalt, Berlin, Germany; ²Charite University Medicine, Berlin, Germany; ³Kliniken Essen, Essen, Germany

We used single voxel 1H-MRS at 3 Tesla to measure absolute NAA concentrations and, as a gold standard of CNS volumetry, a validated delineation protocol for the hippocampus to study the interaction between hippocampal NAA reduction and volume deficits in 29 schizophrenic patients and 44 controls. The hippocampus of the patients exhibited a significantly smaller volume and lower NAA concentration than that of healthy controls. For schizophrenic patients a significant negative correlation between hippocampal NAA concentration and volume was observed. The results argue for a coexistent neurochemical and structural deficit in the hippocampus of schizophrenic patients.
2143. An MRI Study of the Caudate Nucleus in Euthymic Bipolar I Disorder  
Louise Emsell, Camilla Langan, Sarah Hehir, Helen Casey, Wil van der Putten, Peter McCarthy, Rachel Skinner, Dara M. Cannon, Colm McDonald  
1NUI Galway, Galway, Ireland  
Bipolar disorder is a complex illness characterised by extremes of mood. It is likely that subtle changes in neuroanatomy contribute to the underlying aetiology of the disorder. This study sought to identify differences in the volume of the caudate nucleus in a prospectively confirmed sample of 59 remitted patients compared to 59 individually age and gender matched healthy controls to identify trait related anatomical changes. We did not find a main effect of diagnosis. However, we did detect gender differences in caudate volume (F>M), age-related volumetric decrease across the study population and a main effect of family history in patients.

2144. Brain Matter Corrected Quantification of Phosphomono- and Phosphodiesters in the Brain of Patients with Schizophrenia  
Wolfgang Weber-Fahr, Mathias Zink, Andreas Meyer-Lindenberg, Monika Uhrig, Nuran Tunç-Sarka, Mareen Hoerst, Helga Welzel-marquez, Alexander Sartorius, Gabriele Ende  
1Neuroimaging, Central Institute of Mental Health, Mannheim, NA, Germany; 2Dept. Psychiatry, Central Institute of Mental Health, Mannheim, NA, Germany  
A 3D-whole head RINEPT sequence was used together with point-spread function corrected tissue segmentation for robust absolute quantification of spectral edited Phosphomono- and –diester-signals in the brains of schizophrenic patients and controls. The corrected metabolite concentrations show a significant reduction of Phosphocholine and Glycerophosphocholine (GPC) in the basal ganglia and thalamus of schizophrenic patients compared to controls. GPC was also significantly lower in the cerebellum while Phosphorylethanolamine showed a trend for lower concentration in patients in the frontal region.

2145. Altered Fiber Radial Diffusivity in Schizophrenia Revealed by HARDI  
Xin Hong, Lori R. Arlinghaus, Herbert Y. Meltzer, Sohee Park, Adam W. Anderson,  
1Institute of Imaging Science, Vanderbilt University, Nashville, TN, United States; 2Department of Biomedical Engineering, Vanderbilt University, Nashville, TN, United States; 3Institute of Imaging Science, Vanderbilt University, Nashville, TN, United States; 4Department of Psychiatry, Vanderbilt University, Nashville, TN, United States; 5Department of Psychology, Vanderbilt University, Nashville, TN, United States  
We performed a group comparison of the diffusion properties and intravoxel fiber coherence estimated by FORECAST analysis. Significantly higher FA is found in schizophrenia patients compared to healthy controls in the left superior longitudinal fasciculus and bilateral internal capsules. In all three regions, strong negative correlation between FA and radial diffusivity is found at both voxel and cluster levels, even after controlling for coherence variation. Significantly lower coherence is found between the two groups at the cluster level, but not voxel level. Our results suggest the altered FA was mainly due to structural rather than organizational changes in these regions.

2146. Comparison of Different CSF Correction Methods in a MRS Study of Depressed Psychiatric Patients  
John DeWitt Port, Ileana Hancu, Heidi Alyssa Edmonson, Zhonghao Bao, Mark A. Frye  
1Radiology, Mayo Clinic, Rochester, MN, United States; 2GE Global Research Center, Niskayuna, NY, United States; 3Information Services, Mayo Clinic, Rochester, MN, United States; 4Psychiatry, Mayo Clinic, Rochester, MN, United States  
Various methods have been used to correct for the amount of CSF within spectroscopic voxels. However, it remains unclear which method is best. We performed CSF correction on an MRS dataset comparing depressed psychiatric patients to normal controls, using the ratio to creatine as well as two anatomically-based CSF correction methods. All three CSF correction methods yielded significant results for most statistical comparisons; ROC analysis demonstrated no single CSF correction technique to be better than the others. If the metabolite value used in the denominator is stable, ratios may actually improve statistical sensitivity relative to anatomically-based CSF correction methods.

2147. fMRI and Connectivity Effects of Electro-Convulsive Therapy (ECT) in Depressed Patients  
Erik B. Beall, Mark J. Lowe, Michael D. Phillips, Steve Jones, Pallab K. Bhattacharyya, David Muzina  
1Radiology, Cleveland Clinic, Cleveland, OH, United States; 2Psychiatry, Cleveland Clinic, Cleveland, OH, United States  
ECT is a safe and effective treatment for depression. However, its mechanisms have not been studied with the BOLD effect in a pre- and post-ECT fMRI and connectivity study. We present preliminary results that show reduced activation and connectivity in response to working memory and affective tasks.
2148. Decreased Anterior Cingulate Cortex GABA in Depressed Adolescents Measured by Proton MRS at 3T

Vilma Gabbay1, Xiangling Mao2, Yisrael Katz3, Aviva Pazner1, James S. Babb1, Dikoma C. Shungu

1NYU Child Study Center, NYU School of Medicine, New York, NY, United States; 2Radiology, Weill Cornell Medical College, New York, NY, United States

Adolescent major depressive disorder (MDD) is a serious public health concern as it often leads to suicide. However, limited research has been conducted to date in this clinical population. This is the first study to examine in vivo γ-aminobutyric acid (GABA) in adolescents with MDD. Using proton MRS, levels of GABA were measured in the anterior cingulate cortex of adolescents with MDD and found to be decreased compared to matched healthy control subjects. This finding supports the notion that GABA abnormalities may be involved early in the etiology of MDD.

2149. Reduced Functional Connectivity in Major Depression: A Whole Brain Study of Multiple Resting-State Networks

Ilya M. Veer1,2, Christian F. Beckmann3,4, Evelinda Baerends1,2, Marie J. van Tol4,5, Luca Ferrarini6, Julien R. Milles6, Dick J. Veltman7, Andre Aleman8, Mark A. van Buchem1,2, Nic J. van der Wee1,5, Serge A. Rombouts1,2

1Leiden Institute for Brain and Cognition (LIBC), Leiden, Netherlands; 2Department of Radiology, Leiden University Medical Center (LUMC), Leiden, Netherlands; 3FMRIB, University of Oxford, Oxford, United Kingdom; 4Department of Clinical Neuroscience, Imperial College London, London, United Kingdom; 5Department of Psychiatry, Leiden University Medical Center (LUMC), Leiden, Netherlands; 6Department of Radiology, Division of Image Processing, Leiden University Medical Center (LUMC), Leiden, Netherlands; 7Department of Psychiatry, Free University Medical Center (VUMC), Amsterdam, Netherlands; 8BCN Neuroimaging Center, University of Groningen, Groningen, Netherlands

Major depression is associated with abnormal function of a large-scale mood processing and regulating brain circuit of interconnected regions. Therefore, resting-state (RS) functional connectivity networks were investigated in a group of 19 medication-free patients diagnosed with major depressive disorder without comorbidity, and 19 age- and gender-matched healthy controls. Using independent component, 13 relevant RS networks were found for the entire group. Adopting a dual regression method, subject specific maps were calculated and subsequently used for permutation analysis. We found decreased functional connectivity in three networks, which may relate to the affective and cognitive symptoms in major depression.

2150. Investigating Transverse Relaxation Time Abnormalities in Autism

Yann Gagnon1,2, N Rajakumar3, Neil Gelman1,2, Peter Williamson1, Dick Drost1,2, Jean Théberge1,2, Rob Nicolson3

1Imaging, Lawson Health Research Institute, London, Ontario, Canada; 2Medical Biophysics, University of Western Ontario, London, Ontario, Canada; 3Psychiatry, University of Western Ontario

Quantitative transverse relaxation time (T2) imaging offers a unique opportunity to evaluate the neurobiology of brain tissue. In the current study, we further localize our previously reported overall white matter T2 increase in a sample of children with autism to developmentally relevant neuroanatomic white matter regions.

2151. Aberrant Neurodevelopment of the Social Cognition Network During Adolescence in Autism Spectrum Disorders

Chun-Wei Lan1, Kun-Hsien Chou2, I-Yun Chen3, Ya-wei Cheng3, Jean Decety4, Yang-Teng Fan1, Ching-Po Lin1,3

1Institute of Biomedical Imaging and Radiological Sciences, National Yang Ming University, Taipei, Taiwan; 2Institute of Biomedical Engineering, National Yang Ming University, Taipei, Taiwan; 3Institute of Neuroscience, National Yang Ming University, Taipei, Taiwan; 4Departments of Psychology and Psychiatry, The University of Chicago, Chicago, United States

The autism spectrum disorders (ASD), during childhood, undergoes precocious growth, followed by maturation deceleration. But how the ASD brain changed during adolescence is unclear. We enrolled 25 male adolescents with ASD and 25 controls for voxel-based morphometric analysis. Global brain volume enlargement of ASD did not persist into adolescence. The right inferior parietal lobule and posterior cingulate cortex, a role in social cognition, had a significant interaction of age by group as indicated by an accelerated age-related loss in the adolescents with ASD but an age-related gain in the controls. The findings provided evidence of aberrant neurodevelopment in ASD.

2152. White Matter Abnormalities in Boys with Autism Spectrum Disorders: Preliminary Evidence from Diffusion Tensor Imaging

Sung-Yeon Park1, Se-Hong Oh1, Hyo-Woon Yoon1, Young-Bo Kim1, Zang-Hee Cho1, Keun-Ah Cheon1

1Neuroscience Research Institute, Gachon University of Medicine and Science, Incheon, Korea, Republic of; 2Division of child and Adolescent Psychiatry, Department of Psychiatry, Kwandong University College of Medicine, Kyunggi-Do, Korea, Republic of

Autism spectrum disorders (ASD) are characterized by qualitative impairments of reciprocal social interaction and deficits in communication, and stereotyped or repetitive pattern of behavior. A few reports have shown the abnormalities of white matter in
autism using diffusion tensor imaging (DTI), however there is still lack of evidence showing strong relation to abnormalities in white matter structural integrity with autism. We enrolled thirty four male subjects (17 ASD, 17 healthy controls, matched on age, IQ, handedness). Our preliminary findings which showed significant reduction of FA in white matter structure related social cognition in ASD subjects compared control subjects support previous findings that social brain structure may be disrupted in ASD. These findings will help on understanding of more advanced neurobiological basis underlying the social deficits in ASD.

**2153. Imaging Myelin in Autism**

*Janneke Zinkstok*, *Eileen Daly*, *Christine Ecker*, *Patrick Johnston*, *Shannon Kolind*, *Declan Murphy*, *Sean Deoni*

1Section of Brain Maturation, Institute of Psychiatry, London, United Kingdom; 2Centre of Neuroimaging Sciences, Institute of Psychiatry, London, United Kingdom

Using the novel Multi-Component Driven Equilibrium Single Pulsed Observation of T1 and T2 (mcDESPOT) method, we quantitatively compared myelin content between individuals with autism and healthy controls. We found significantly reduced myelin content in adults with autism in brain regions previously implicated in autism, including the body of the corpus callosum, and in frontal, temporal, parietal and occipital regions; and in white matter tracts including the left and right uncinate, the left inferior occipitofrontal tract, the left inferior cerebellar peduncle, the left arcuate, the right anterior segment, the left inferior and superior longitudinal fasciculus, and the posterior segments bilaterally.

**2154. Inter-Subject Comparison of Fractional Anisotropy in Attention-Deficit/hyperactivity Disorder**

*Tzu-Chao Chuang*, *Sheng-Po Huang*, *Pinchen Yang*, *Ming-Ting Wu*

1Electrical Engineering, National Sun Yat-Sen University, Kaohsiung, Taiwan, Taiwan; 2Psychiatry, Kaohsiung Medical University Hospital, Kaohsiung, Taiwan, Taiwan; 3School of Medicine, National Yang-Ming University, Taipei, Taiwan, Taiwan; 4Radiology, Kaohsiung Veteran General Hospital, Kaohsiung, Taiwan, Taiwan

In this study, white matter abnormalities of attention-deficit hyperactivity disorder were investigated using diffusion tensor imaging. Two different algorithms, including the well-known voxel-based morphometry (VBM) method and recently proposed tract-based spatial statistics (TBSS), were applied for inter-subject comparison. 26 male adolescents (12 ADHD patients and 14 age-matching control subjects) were recruited in this study. Significant decrease of FA was observed on white matter tracts widespread in a scattering pattern by the use of both methods in patients compared to the control group.

**2155. MRS Measurement of GABA and Glutamate-Glutamine in Frontal Cortex in Obsessive-Compulsive Disorder**

*Lawrence Steven Kegeles*, *H. Blair Simpson*, *Xiangling Mao*, *Rena Staub*, *Dikoma C. Shungu*

1Psychiatry, Columbia University, New York, NY, United States; 2Radiology, Columbia University, New York, NY, United States; 3Radiology, Weill Cornell Medical Center, New York, NY, United States

This MRS study addressed GABA and glutamate-glutamine levels in a hypothesized abnormal neurochemical circuit in obsessive-compulsive disorder (OCD). Recent animal and human studies have implicated the glutamate system in OCD in these abnormalities. We used the J edited spin echo difference method to evaluate glutamate-glutamine and GABA in two frontal cortical regions, the anterior cingulate and dorsolateral prefrontal cortex in OCD. We found no differences between OCD subjects and controls in either measure in either brain region, suggesting that further studies are needed to fully characterize the neurochemistry of the hypothesized abnormal circuitry in OCD.

**2156. Impaired Default-Mode Networks of Affective Disorders: Evidences of Image-Guided Proton MRS**

*Tzu-chen Yeh*, *Chih-Ying Lin*, *Cheng-Wen Ko*, *Ton-Ping Su*, *Wan-Yuo Guo*, *Jen-Chuen Hsieh*, *Low-Ton Ho*

1Department of Medical Research and Education, Taipei Veterans General Hospital, Taipei, Taiwan, Taiwan; 2Institute of Brain Science, National Yang-Ming University, Taipei, Taiwan, Taiwan; 3Department of Computer Science and Engineering, National Sun Yat-sen University, Kaohsiung, Taiwan, Taiwan; 4Department of Psychiatry, Taipei Veterans General Hospital, Taipei, Taiwan, Taiwan; 5Department of Radiology, Taipei Veterans General Hospital, Taipei, Taiwan, Taiwan

The spatial template of default-mode network (DMN) has been constructed and shown precuneus/posterior cingulate areas (PC, Brodmann area 31) with highest reproducibility in 60 normal subjects. High resting metabolic rate of DMN was implied by previous deoxy-glucose positron emission tomography. In this study of affective disorders (bipolar and major depressive disorders), bioenergetics of Brodmann area 24 and DMN was probed by total creatine using real-time localized image-guided proton magnetic resonance spectroscopy (ig-HMRS) and LCModel quantification. As compared to affective disorders, higher metabolism of PC (representing DMN) in normal subjects was supported by higher total creatine concentration.
2157. **Glutamate Levels in the Anterior Cingulate Cortex Correlate with Self-Reported Impulsivity in Patients with Borderline Personality Disorder and Healthy Controls**

Mareen Hoerst$^1$, Wolfgang Weber-Fahr$^1$, Nuran Tunç-Skarca$^1$, Matthias Ruy$^1$, Martin Bohus$^2$, Christian Schmaier$^1$, Gabriele Ende$^1$

$^1$Department of Neuroimaging, Central Institute of Mental Health, Mannheim, Germany; $^2$Department of Psychosomatic Medicine and Psychotherapy, Central Institute of Mental Health, Mannheim, Germany

Dysfunction and deficits in the structure of the anterior cingulate cortex (ACC) have been reported in borderline personality disorder (BPD). Impulsivity belongs to the key features of BPD and can be related to ACC function. In this study we found significantly increased self-reported impulsivity and higher levels of glutamate in the anterior cingulate cortex in subjects with BPD as compared to healthy controls. In both groups the ACC glutamate concentrations were positively correlated with self-reported impulsivity.

2158. **Grey Matter Abnormalities in Adult Attention Deficit/Hyperactivity Disorder as Measured with Structural MRI**

Natalia del Campo$^1$,$^2$, Julio Acosta-Cabrero$^3$,$^4$, Samuel R. Chamberlain, Dowson Jonathan$^3$, Tim D. Fryer$^4$, Trevor W. Robbins, Barbara J. Sahakian$^5$, Ulrich Muller

$^1$Psychiatry, University of Cambridge, Cambridge, Cambs, United Kingdom; $^2$2Behavioural and Clinical Neuroscience Institute, Cambridge, Cambs, United Kingdom; $^3$Department of Clinical Neurosciences, University of Cambridge, Cambridge, United Kingdom; $^4$Wolfson Brain Imaging Centre; $^5$Department of Psychiatry

Attention deficit/hyperactivity disorder (ADHD) is the most prevalent psychiatric disorder in children. To date, little is known about the persistence and stability of anatomical changes in ADHD across the lifespan. 16 adult ADHD patients and 17 healthy controls undertook structural magnetic resonance imaging. Using cluster-based permutation analysis we found that ADHD patients had reduced grey matter density in distributed circuitries including the right inferior and middle frontal cortex, as well as bilateral putamen, hippocampus, amygdala and cerebellum. These findings add to a growing body of evidence implicating abnormalities in fronto-striatal, fronto-cerebellar and limbic circuitries in ADHD.

2159. **A Systematic Analysis of Association Fiber Tracts in Chronic Alcoholics Found Significant Deficit of White Matter Integrity in Superior Longitudinal Fasciculus Using Diffusion Spectrum Imaging Tractography**

Cheng-Liang Liu$^1$, I-Chao Liu$^2$, Wen-Yang Chiang$^3$, Fang-Cheng Yeh$^4$, Li-Wei Kuo$^1$, Wen-Yih Isaac Tseng$^1$,$^5$

$^1$Center for Optoelectronic Biomedicine, National Taiwan University College of Medicine, Taipei, Taiwan; $^2$School of Medicine, Fu Jen Catholic University, Taipei, Taiwan; $^3$The Methodist Hospital Research Institute, Weil Medical College of Cornell University, Houston, TX, United States; $^4$Department of Biomedical Engineering, Carnegie Mellon University, Pittsburgh, PA, United States; $^5$Department of Medical Imaging, National Taiwan University Hospital, Taipei, Taiwan

In this study, we investigated the relationship between the effect of alcoholic use and the microstructural alteration of seven association fiber tracts using diffusion spectrum imaging tractography and tract-specific analysis. The metric of generalized fractional anisotropy (GFA) was used to identify the difference between control and alcoholic groups. Among all the association fiber tracts, a significant GFA deficit was found in bilateral superior longitudinal fasciculus for chronic alcoholics. A future study to analyze the segmented parts of the tract is needed to further reveal the subtle change of microstructural alteration of association fiber tracts in alcoholism.

2160. **Frontal White Matter Choline-Containing Compounds Increase with Alcohol Consumption and Glutamate Decreases with Increasing Addiction Criteria**

Gabriele Ende$^1$, Derik Hermann$^1$, Mareen Hoerst$^1$, Nuran Tunç-Skarca$^1$, Gunilla Oberthuer$^1$, Svenja Wichert$^1$, Juri Rabenstein$^2$, Wolfgang Weber-Fahr$^1$, Karl Mann$^2$, Sabine Vollstädt-Klein$^1$

$^1$Neuroimaging, Central Institute of Mental Health, Mannheim, Germany; $^2$Addiction Medicine, Central Institute of Mental Health, Mannheim, Germany

With this 1H MRS study we aimed to investigate correlations between frontal white matter choline-containing compounds and glutamate with alcohol consumption and addictions scores in heavy drinking as well as in non-abstinent alcohol dependent patients. A positive correlation of choline-containing compounds and alcohol consumption could be replicated but the high variance could not be explained by addiction criteria (ODCS, ICD-10 and DSM IV). However, measures of addiction showed significant negative correlations with glutamate in the heavy drinking groups.
2161. **Test and Retest of the Emotional Responses in Adolescents Prenatally Exposed to Cocaine**

Zhihao Li¹, Priya Santhanam¹, Claire D. Coles², Mary Ellen Lynch², Stephan Hamann³, Xiaoping Hu¹

¹Biomedical Engineering, Emory Univ. & Georgia Tech., Atlanta, GA, United States; ²Psychiatry and behavioral Science, Emory Univ., Atlanta, GA, United States; ³Psychology, Emory Univ., Atlanta, GA, United States

The present fMRI study examined the interaction effect of prenatal cocaine exposure (PCE) and development on brain activations associated with emotional arousal, in adolescents. Comparing age 17 to 15, cortical responses elicited by negative emotional stimuli are reduced in the controls but remain roughly the same in the PCE adolescents. The present results suggest a long-term and stable PCE effect on emotional arousal regulation.

2162. **Altered Cortical Thickness in Young Cannabis Abusers**

Deborah Yurgelun-Todd¹, Piotr Bogorodzki³, Melissa Lopez-Larson¹,², Robert Kurjata³, John Churchwell¹, Jadwiga Rogowska⁴

¹Brain Institute, University of Utah, Salt Lake City, UT, United States; ²VISN 19 MIRECC, Salt Lake City, UT, United States; ³Institute of Radioelectronics, Warsaw Technical University, Warsaw, Poland; ⁴Brain Imaging Center, McLean Hospital/Harvard Medical School, Belmont, MA, United States

It is unknown whether altered cortical thickness during adolescence is associated with marijuana (MJ) use. This investigation used cortical-surface based techniques to compare MJ using adolescents and healthy controls (HC). Eighteen adolescents with DSM-IV MJ Dependence and 18 HCs had an MRI scans using a 3T Siemens Trio scanner. Cortical reconstruction and volumetric segmentation was performed with the Freesurfer image analysis suite. Compared to HCs, MJ users had decreased cortical thickness in bilateral superior frontal cortex and bilateral and left insula. Furthermore, the average thickness of the right insula was found to negatively correlate with age of first MJ use.

2163. **Perfusion Deficit to Cholinergic Challenge in Veterans with Gulf War Illness**

Peiying Liu Wang¹, Sina Aslan¹, Xiufeng Li², David Buhner³, Richard Briggs³, Robert Haley³, Hanzhang Lu¹

¹Advanced Imaging Research Center, University of Texas Southwestern Medical Center, Dallas, TX, United States; ²Department of Radiology, University of Texas Southwestern Medical Center, Dallas, TX, United States; ³Department of Internal Medicine, University of Texas Southwestern Medical Center, Dallas, TX, United States

A highly plausible etiology for the Gulf War Illness (GWI) is that the neural damage and cognitive deficits are associated with excessive exposure to cholinesterase-inhibiting cholinergic stimulants. Our previous SPECT study provided strong indication that cerebral blood flow of veterans with Syndrome 2 GWI has reduced responses to cholinergic challenge, compared to unaffected control veterans. The present study confirmed and extended previous findings that patients with Gulf War Illness have abnormal response to an inhibitory cholinergic challenge, physostigmine infusion, when compared to age-gender-education matched control veterans. This new technique may provide a cost-effective biomarker for characterization of Gulf war illness.

2164. **Cortical GABA and Glutamate Changes in Posttraumatic Stress Disorder**

Anderson Mon¹,², Thomas Neylan³, Dieter Meyerhoff¹,⁴

¹Radiology, University of California, San Francisco, San Francisco, CA, United States; ²Center for Imaging of Neurodegenerative Diseases, Veteran Administration Medical Center, San Francisco, CA; ³Psychiatry, University of California, San Francisco, San Francisco, CA, United States; ⁴Center for Imaging of Neurodegenerative Diseases, Veteran Administration Medical Center, San Francisco, CA, United States

We studied NAA, Glu and GABA levels in post traumatic stress disorder using magnetic resonance spectroscopy. We found lower NAA in the anterior cingulate, lower GABA in the posterior occipital cortex, and lower GABA and higher Glu in the medial temporal lobe as compared to control subjects. Metabolite levels related to PTSD symptomatology and suggest neuronal injury, perhaps associated with excitatory and inhibitory processes in cortical brain

Clinical Brain Tumor Imaging: Anatomic, MT, SWI & Perfusion MRI

Hall B Monday 14:00-16:00
Concern that infiltrating tumor may be missed, and may therefore escape optimal treatment. We provide preliminary evidence in two cases that quantitative magnetisation transfer (qMT) imaging can detect changes in white matter adjacent to glioblastoma which appear otherwise normal on conventional MR imaging.

2166. Perfusion MRI Fractional Tumor Bulk Mapping: Correlation with Multiple Stereotactic Biopsies in Recurrent GBM
Leland S. Hu1,2, Seban Liu1, Dilini S. Pinnaduvasge1, Kris A. Smith5, Peter Nakaji5, Amylou C. Dueck6, Todd Jensen1, Jennifer M. Eschbacher3, Joseph E. Heiserman7, John P. Karis4, Josef Debbins1, Burt G. Feuerstein9, Kathleen M. Schmainda10, Leslie C. Baxter9

1Radiology, Mayo Clinic, Arizona, Scottsdale, AZ, United States; 2Radiology, Neuroradiology Section, St. Joseph's Hospital - Barrow Neurological Institute, Phoenix, AZ, United States; 3Keller Center for Imaging Innovation, St. Joseph's Hospital - Barrow Neurological Institute, Phoenix, AZ, United States; 4Radiation Oncology, University of California - San Francisco, San Francisco, CA, United States; 5Neurosurgery, St. Joseph's Hospital - Barrow Neurological Institute, Phoenix, AZ, United States; 6Biostatistics, Mayo Clinic, Arizona, Scottsdale, AZ, United States; 7Imaging Biometrics, LLC; 8Neuropathology, St. Joseph's Hospital - Barrow Neurological Institute, Phoenix, AZ, United States; 9Neuro-Oncology, St. Joseph's Hospital - Barrow Neurological Institute, Phoenix, AZ, United States; 10Radiology, Medical College of Wisconsin, Milwaukee, WI, United States

We present methods to calculate ‘Perfusion MRI (pMRI) fractional tumor bulk,’ which quantifies and spatially localizes areas of tumor recurrence within non-specific contrast enhanced (CE) MRI lesions. We correlate these measures with the percentage, or fraction, of tissue samples histopathologically diagnosed as tumor, in a group of recurrent Glioblastoma Multiforme (GBM) patients undergoing multiple stereotactic biopsies.


Slim Fellah1, Yann Lefur1, Elisabeth Soulter1, Céline Boucard1, Sylviane Confort-Gouny1, Olivier Chinor2, Patrick J. Cozzone1, Jean-Philippe Ranjeva1, Virginie Callot1

1Centre de Résonance Magnétique Biologique et Médicale (CRMBM), CNRS UMR 6612, Faculté de Médecine, Marseille, France; 2Unité de Neuro-Oncologie, CHU Timone, Marseille, France

Anti-angiogenics have become part of Glioblastoma therapeutic protocol. However pseudo-response followed by a critical recurrence may be observed. Non-responders thus need to be prematurely identified. However current imaging criteria are insufficient or late, new MR markers should therefore be investigated. In this preliminary study, we used a multimodal protocol including particularly ASL and SWI, which provide vascular information. A few weeks after the beginning of the treatment, FLAIR and post-contrast T1-WI showed partial response whereas perfusion MRI and SWI demonstrated hyperperfusion and vascularization increase. The parameters derived from such sequences should thus be considered as early indicators of tumor evolution.


Kyrre E. Emblem1,2, Paulina Due-Tonnessen3,4, Inge A. Rasmussen Jr1, Ate Bjørnerud3,4

1The Interventional Centre, Rikshospitalet, Oslo University Hospital, Oslo, Norway; 2Department of Medical Physics, Rikshospitalet, Oslo University Hospital, Oslo, Norway; 3Clinic for Imaging- and Intervention, Rikshospitalet, Oslo University Hospital, Oslo, Norway; 4Department of Physics, University of Oslo, Oslo, Norway

In this study, a fully-automatic method for longitudinal monitoring of low-grade glioma transformation by quantitative dynamic susceptibility contrast (DSC) MRI was evaluated and compared to conventional criteria for malignant glioma progression. Thirteen patients were imaged at least three times, with an average time between two consecutive MR exams of 283 days. Our results suggest that the fully-automatic method provides a sensitive marker for tumor progression at an early stage compared to conventional imaging criteria. Also, the quantitative tumor analysis and monitoring of baseline perfusion values in unaffected brain tissue, allows inter- and intra-patient comparisons across MR machines and institutions.

2169. Can Susceptibility-Weighted Imaging Determine Response to Combined Anti-Angiogenic, Cytotoxic, and Radiation Therapy in GBM Patients?

Janine M. Lupo1, Soonmee Cha1, Emma Essock-Burns1,2, Nicholas Butowski3, Sarah J. Nelson1,2

1Department of Radiology and Biomedical Imaging, University of California, San Francisco, San Francisco, CA, United States; 2Department of Bioengineering and Therapeutic Sciences, University of California, San Francisco, San Francisco, CA, United States; 3Department of Neurosurgery, University of California, San Francisco, San Francisco, CA, United States

This study investigated whether the unique contrast provided by SWI, which highlights heterogeneity within the post-gadolinium contrast enhancing brain tumor lesion, can predict response to treatment. Nineteen patients with newly-diagnosed GBM were imaged prior to beginning anti-angiogenic, cytotoxic, and radiation therapy and followed until progression. The volume of SWI hypointense
signal within the contrast-enhancing lesion was dramatically higher in patients who progressed after 1 year post-therapy compared to patients who progressed within 6 months of initiating treatment. These findings suggest that SWI could be advantageous for determining which patients would be the best candidates for adjuvant anti-angiogenic therapeutic strategies.

2170. Comparison of DSC-Derived Perfusion Parameters in Response to Conventional Therapy or Adjuvant Anti-Angiogenic Therapy in Patients Newly-Diagnosed with GBM

Emma Essock-Burns¹,², Yan Li¹, Janine M. Lupo¹, Mei-Yin Polley³, Nicholas Butowski³, Susan M. Chang³, Soonmee Cha,¹,³, Sarah J. Nelson¹,⁴
¹Department of Radiology and Biomedical Imaging, UC San Francisco, San Francisco, CA, United States; ²Joint Graduate Group in Bioengineering, UC San Francisco/UC Berkeley, San Francisco, CA, United States; ³Department of Neurological Surgery, UC San Francisco, San Francisco, CA, United States; ⁴Department of Bioengineering and Therapeutic Sciences, UC San Francisco, San Francisco, CA, United States

Adjuvant anti-angiogenic therapy may alter the presentation of contrast enhancement creating a clinical need for new methods of evaluating response. Dynamic susceptibility contrast enhanced imaging was used to assess vascular changes of patients newly diagnosed with GBM in response to either conventional (XRT+cytotoxic) or adjuvant anti-angiogenic therapy. A decrease in vascularization was observed early in adjuvant anti-angiogenic therapy. Progression-free survival status of patients receiving anti-angiogenic therapy may be dominated by an initial change in leakage, while PFS of patients receiving conventional therapy is not. This work highlights the need for further functional imaging techniques for the evaluation of response.

2171. Parametric Response Map as an Imaging Biomarker to Distinguish Progression from Pseudoprogression in High Grade Gliomas

Christina Tsien¹, Craig J. Galban¹, Thomas L. Chenevert¹, Timothy D. Johnson¹, Daniel A. Hamstra¹, Pia C. Sundgren¹, Larry Junck¹, Charles R. Meyer¹, Alnawaz Rehemtulla¹, Theodore Lawrence¹, Brian D. Ross¹
¹University of Michigan, Ann Arbor, MI, United States

We have developed a reliable method for distinguishing true progression from pseudoprogression by quantifying on a voxel-wise basis therapeutic-associated hemodynamic alterations in patients with high grade glioma. The parametric response map of rCBV (PRMrCBV) at week 3 during chemoradiation is shown to be a potential early imaging biomarker of response that may be helpful in distinguishing pseudoprogression from true progression in patients with high grade glioma.

2172. Quantitative Metrics Derived from DCE MRI as a Biomarker for Early Response to Radiation Therapy in Brain Metastases

Yue Cao¹, Felix Y. Feng, Diana Gomez-Hassan², James A. Hayman, Theodore S. Lawrence, Christina I. Tsien
¹Radiology and Radiation Oncology, University of Michigan, Ann Arbor, MI, United States; ²Radiology, University of Michigan, Ann Arbor, MI, United States

The response of metastatic lesions to whole brain radiation therapy (WBRT) is highly heterogeneous. In this study, we evaluated quantitative metrics derived from DCE MRI for early assessment of response of brain metastatic lesions to WBRT. We found that changes in vascular volume and perfusion at the completion of WBRT differentiated responsive lesions from non-responsive ones. These DCE metrics have the potential for early prediction of treatment response in brain metastases. This requires further validation, but may provide a means for individualizing therapy in patients with brain metastases by selecting patients requiring treatment intensification with stereotactic RT.

2173. Dynamic Contrast Enhanced and Susceptibility Based CBV Measurements Perform Equally in Grading of Cerebral Gliomas

Mufthah Ahmed Manita¹, Paul Morgan², Keith Robson³, Timothy Jaspan³, Dorothee P. Auer³
¹Academic Radiology, University of Nottingham, Nottingham, United Kingdom; ²Radiology & Radiological Science, Medical University of South Carolina, United States; ³Nottingham University Hospital, United Kingdom

Perfusion MRI DSC (T2*) has shown added values in glioma tumour differentiation with rCBVmax is the best performing metrics obtained from dynamic susceptibility contrast technique (DSC). However, this technique is susceptible to blood leak that results in rCBV overestimation. T1 MRI perfusion (DCE) is not susceptible to vascular disruption. Nineteen patients with low and high grade glioma underwent MR perfusion (T1 and T2*) was analysed with Java image software. Significant difference (P=0.000) with excellent correlation (0.81) between the two tumour grades in both techniques with accuracy of 100%. T1 based DCE is robust technique to follow postoperative cases.
This study describes the relationship between the DCE-MRI derived measure, Enhancing Fraction, and overall survival in patients with Glioblastoma Multiforme, with the findings of increased survival in association with elevated Enhancing Fraction.

Imaging of Brain Tumors: Techniques & Contrast Media
Hall B Tuesday 13:30-15:30

2175. Delta T1 Method: An Automatic Post-Contrast ROI Selection Technique for Brain Tumors
Devyan Bedekar1, Todd Jensen1, Scott Rand4, Mark Malkin, Jennifer Connelly, Kathleen Schmainda, Devyan Bedekar1, Todd Jensen1, Scott Rand4, Mark Malkin, Jennifer Connelly, Kathleen Schmainda
1Radiology, Medical College of Wisconsin, Milwaukee, WI, United States; 2Translational Brain Tumor Research Program, Medical College of Wisconsin, Milwaukee, WI, United States; 3Imaging Biometrics, Milwaukee, WI, United States; 4Translational Brain Tumor Research Program, Medical College of Wisconsin, Milwaukee, WI, United States; 5Neurology, Medical College of Wisconsin, Milwaukee, WI, United States; 6Radiology & Biophysics, Medical College of Wisconsin, Milwaukee, WI, United States

The primary approach to monitoring patients with brain tumors is to obtain pre and post-contrast T1-weighted images. Bright areas on the pre-contrast images are suggestive of blood products, which may be a result or treatment, and are therefore not to be considered as enhancing lesions on the post-contrast images. However, the difference between the brightness that exists on both the post and pre-contrast images can be quite subtle, a condition that is occurring more frequently now with the increasing use of anti-angiogenic agents. Therefore it is becoming increasingly difficult to monitor patients with brain tumors simply by visually comparing differences in enhancement. As a solution in this report we propose an automatic method, the delta T1 method (dTM), which is capable of detecting even subtle enhancing tumor free of blood products, thereby enabling the automatic creation of ROIs in a fast and reliable manner that avoids subjective variability.

2176. Analysis of Brain Tumors and Metastases by Quantitative MT Imaging with BSSFP: Initial Experiences
Meritxell Garcia1, Monika Gloor2, Christoph Stippich1, Felix Jax1, Klaus Scheffler2, Oliver Bieri2
1Department of Neuroradiology, University of Basel Hospital, Basel, Switzerland; 2Radiological Physics, University of Basel Hospital, Basel, Switzerland

The efficacy of quantitative MT (qMT) imaging for characterization of benign and malignant brain lesions is analyzed with balanced steady-state free precession. Eleven patients with 3 different lesions (4 glioblastoma multiforme, 4 meningiomas and 3 metastases) were investigated on a clinical 1.5T MR-scanner. MT-effects are described in terms of MTR, relaxation times (T1, T2), MT exchange rate (kf) and the macromolecular content (F). Marked divergences between contrast-enhancing regions, edema and normal-appearing brain were found within and between the different lesions, which might be attributed to differences in edema, cell infiltration and myelin properties. Thus, qMT-imaging might play a major role in adding information for diagnostic tumor characterization.

2177. Magnetic Resonance Imaging Contrast of Brain Tumors at 7 Tesla Compared to 3 Tesla
Iris-Melanie Noebauer-Huhmann1, Pavol Szomolanyi1, Claudia Kronnerwetter1, Siegfried Trautzig1, Iris-Melanie Noebauer-Huhmann1, Pavol Szomolanyi1, Claudia Kronnerwetter1, Siegfried Trautzig1
1MR Centre - High field MR, Department of Radiology, Medical University of Vienna, Vienna, Austria; 2Department of Imaging Methods, Institute of Measurement Science, Slovak Academy of Sciences, Bratislava, Slovakia

It is well known that the effect of MR contrast agents is influenced by the magnetic field strength. The aim of the study was to compare the diagnostic efficacy of a Gadolinium-based MRI contrast agent (gadobenate dimeglumine) in primary brain tumors at 7Tesla versus 3Tesla. Post contrast MP-RAGE sequences were evaluated by region of interest measurements. At 7Tesla, the tumor-to-brain-contrast after gadolinium administration was significantly higher (91.4) than at 3Tesla (37.3). Further studies will show if the higher tumor-to-brain-contrast post gadolinium administration at 7Tesla may be beneficial for tumors with minor contrast agent accumulation, or allow for a dose reduction.
During sodium MRI tumor cells to facilitate in the development of anisotropic treatment margins. In this study we have shown that the affinity of cancer often occur at the boundary of the treatment margin. We developed a random walk model to determine the microscopic spread of 

demonstrate the use of UHF for evaluating the microvascular structure of brain tumors and the improvements in signal quantification during sodium MRI

We demonstrated the clinical feasibility of combined $^1$H and $^3$P MRSI with sensitivity enhancement by polarisation transfer of $^1$H to $^3$P spins of human brain tumors at 3T to uncover the composition of (phosphorylated)choline and phosphorylated ethanolamine compounds in the membrane. Preliminary results from 4 patients with different tumour types show potentially important differences among tumours. This opens a window on a detailed view of the levels of some key metabolites in membrane phospholipid metabolism of human tumours.

Echo time dependence of coupled-spin metabolites following point-resolved spectroscopy (PRESS) at 3T has been investigated with computer simulations. Three pairs of PRESS subecho times, (TE1, TE2) = (32, 22), (32, 80), and (32, 214) ms, were selected for optimum selectivity of glutamate and glutamine, and used for in vivo measurements of metabolites in brain tumors. We present preliminary in vivo results that show pronounced abnormalities of metabolic profiles, including elevated glutamine and glycine in glioblastoma multiforme and differentiation between lipids and lactate in low- and high-grade gliomas.

Neural stem cells (NSC) have been recognized as cellular vehicles for treatment of invasive brain tumors. MRI is a unique non-invasive tool to monitor the migration of stem cells labeled with MR contrast agents, such as superparamagnetic iron oxide (SPIO) particles. Pervious studies have confirmed that magnetosonoporation (MSP) can instantly labeled SPIO into stem cells. The aim of this study was to validate the feasibility of MRI of MSP-labeled NSC migration to gliomas in vivo.

The current methods for determining the treatment margin for stereotactic radiotherapy of gliomas are inadequate as recurrences often occur at the boundary of the treatment margin. We developed a random walk model to determine the microscopic spread of tumor cells to fibers in the brain can be modeled better by the spread in the direction of migration about the Principal Diffusion Direction determined using DTI than by using a variable step-size in the random walk of cancer cells.

The current methods for determining the treatment margins for stereotactic radiotherapy of gliomas is inadequate as the tumor often recurs at the boundary of the treatment margin. The areas of high normalized cell migration predicted by our random walk model
coincide with the direction along which the tumor recurs. Here we have established that there is a statistically significant correlation between the model predictions and the recurrence site and the average normalized cell concentration in the recurrence site is higher than the normalized cell concentration in 78% of the voxels on a surface equidistant from the primary tumor surface.

2184. Decreased Cerebral Oxygen Extraction Fraction (OEF) Measured by MR qBOLD Following Stereotactic Radiosurgery (SRS) in Patients with Metastatic Brain Tumors
Parinaz Massoumazdeh1, Xiang He1, Sarah Jost1, Keith Rich1, Dmitriy Yablonskiy1, Tammie Benzinger1  
1Mallinckrodt Institute of Radiology, Washington University in Saint Louis; 2Swedish Hospital, Seattle, WA, United States; 3Neurosurgery, Washington University in Saint Louis; 4Mallinckrodt Institute of Radiology, Washington University in Saint Louis, St. Louis, MO, United States

There is growing evidence that solid organ tumors with ability to grow in hypoxic conditions demonstrate resistance to conventional chemotherapy and radiation therapy. Here, we used MR qBOLD technique to measure the OEF of metastatic brain tumors before and after SRS. In this population, OEF of both the tumors and peritumoral edema prior to SRS was elevated. Following SRS, OEF decreased in the areas of lesions. This suggests that qBOLD OEF may provide a new method to monitor brain tumor response to therapy.

2185. A Comparison of Signal Intensity & DCE-MRI Based Methods for Assessing Enhancing Fraction
Samantha Jane Mills1,2, Gerard Thompson1, Giovanni Buonacorri1, Geoff James Parker1, Alan Jackson1,2  
1Imaging Science and Biomedical Engineering, University of Manchester, Manchester, United Kingdom; 2Department of Neuroradiology, Salford Royal Foundation Trust Hospital, Salford, Greater Manchester, United Kingdom

The established technique for measuring Enhancing Fraction utilises the initial area under the concentration curve derived from a DCE-MRI acquisition. This can be time consuming and requires complex post processing analysis. This study examines the feasibility of obtaining an measure of Enhancing Fraction from conventional, pre and post contrast T1-weighted imaging and compares this to the established DCE-MRI derived technique. The two methods show good correlation but are not directly interchangeable methods of measuring Enhancing Fraction.

2186. Simultaneous Resting State FMRI and FET-PET
Irene Neuner1,2, Joachim Bernhard Maria Kaffanke1, Cornelius Werner1,2, Martina Reske1,3, Karl-Joseph Langen1, Hans Herzog1, N. Jon Shah1,2  
1Institute of Neurosciences and Medicine 4, Medical Imaging Physics, Forschungszentrum Jülich GmbH, 52425 Juelich, Germany; 2Faculty of Medicine, Department of Neurology, RWTH Aachen University, 52074 Aachen, Germany; 3Department of Psychiatry, University of California San Diego, San Diego, CA, United States

For the planning of surgical intervention in human brain tumour cases, it is important to know if critical brain areas might be affected by the surgical process itself. PET imaging using radiolabelled amino acids is a valuable technique for the diagnosis of cerebral gliomas. O-(2-[18F]Fluorethyl)-L-Tyrosin (FET) is a well established amino acid tracer that delivers information about tumour extent, the optimal biopsy site and detection of tumour recurrences. In this study, FET-PET and BOLD-MRI data were acquired simultaneously; data from a representative human brain tumour case are presented. In contrast to task-based functional studies, resting state fMRI offers the opportunity to detect a variety of cortical networks in a single experiment.

2187. Multi-Layer Appearance of Abscess Capsule on Post-Gd SWI Images: Effects of Filtering and Phase Mask
Ping-Hong Lai1,2, Hing-Chiu Chang3,4, Hsiao-Wen Chung4  
1Department of Radiology, Kaohsiung Veterans General Hospital, Kaohsiung, Taiwan; 2School of Medicine, National Yang-Ming University, Taipei, Taiwan; 3Applied Science Laboratory, GE Healthcare Taiwan, Taipei, Taiwan; 4Institute of Biomedical Electronics and Bioinformatics, National Taiwan University, Taipei, Taiwan

SWI is a novel MR technique that exploits the magnetic susceptibility differences of various tissues, such as venous structure and iron deposition. When SWI was applied to patients with abscess, we found that, compared with homogeneous rim-enhancement on post-contrast magnitude images, the capsular portion of pyogenic brain abscess on post-contrast SWI images showed a multi-layer appearance. In this work, in order to clarify whether this multi-layer characteristic is physiological or technical in its origin, we investigate the causes of this multi-layer appearance, and use a theoretical model to simulate the multi-layer appearance upon the use of different SWI processing parameters.

2188. When Does Brain Motion Interfere with the Accuracy of Stereotactic Radiosurgery?
Investigation of Brain Motion in the Presence of Stereotactic Frame.
Dee H. Wu1, Jesse Hatfield2, Jignesh Modi1, Genu Mathew1  
1Radiological Sciences, University of Oklahoma Health Sciences Center, Oklahoma City, OK, United States

The aim of stereotactic radiosurgery is to provide accurate placement of radiation localized to targeted diseased tissues while minimizing placement of large doses of radiation into sensitive normal tissues (such as motor strip, brain stem, internal capsule, optic nerve, and other major nerve bundles). It is well known that the brain moves during the cardiac cycle in which the action of pulsatile blood flow produces brain expansion and contraction. Such movement provides a potential conflict with the objective of providing millimeter to submillimeter localization accuracy of radiation treatment. This has led to recommendations for the use of electronic
gating of radiosurgery placement. While brain motion was extensively studied in the early 1990s(1, 2), and has been a source of debate for more recent studies for the degree of head fixation required for patients for presurgical planning with IMRI (3). Such brain motion has been cited to be on the order of 0.5 mm for controlled studies over a short period of time (minutes), to 1-3 millimeters over the course of an IMRI experiment when standard to minimal head fixation is used (4). None of these studies were performed with such stringent fixation as that provided during radiotherapy. The frames such that include head fixation with the insertion of metal pins attached to the patient skull with metallic frames.

2189. Image-Guided Tissue Validation of Combined Preload Dosing and Mathematical Modeling Correction of Perfusion MRI Measures

Leland S. Hu1,2, Leslie C. Baxter3, Dilini S. Pinnaduwage3, Todd Jensen4, Amylou C. Dueck5, Jennifer M. Eschbach6, Joseph E. Heiserman7, John P. Karis3, Josef Debbins1, Jonathan Placencia Placencia8, Seban Liu3, Burt G. Feuerstein9, Kathleen M. Schmainda10

1Radiology, Mayo Clinic, Arizona, Scottsdale, AZ, United States; 2Radiology, Neuroradiology Section, St. Joseph’s Hospital - Barrow Neurological Institute, Phoenix, AZ, United States; 3Keller Center for Imaging Innovation, St. Joseph’s Hospital - Barrow Neurological Institute, Phoenix, AZ, United States; 4Radiation Oncology, University of California - San Francisco, San Francisco, CA, United States; 5Imaging Biometrics, LLC; 6Biosciences, Mayo Clinic, Arizona, Scottsdale, AZ, United States; 7Neuropathology, St. Joseph’s Hospital - Barrow Neurological Institute, Phoenix, AZ, United States; 8Biomedical Engineering, Arizona State University, Tempe, AZ, United States; 9Neuro-Oncology, St. Joseph’s Hospital - Barrow Neurological Institute, Phoenix, AZ, United States; 10Radiology, Medical College of Wisconsin, Milwaukee, WI, United States

We validate mathematical modeling correction of relative cerebral blood volume (rCBV) in regards to effectiveness of 1) minimizing T1W leakage and 2) correcting T2/T2*W residual effects, by correlating localized measures with image-guided tissue histopathology and microvascular density from stereotactic biopsies in post-treatment high-grade gliomas.

2190. Automatic Segmentation of Optic Pathway Gliomas Using Multimparametric MRI

Methods
Liat Ben Sira1, Lior Weizman1, Leo Joskowicz2, Ronit Precel1, Shlomi Constantini3,4, Dafna Ben Bashat5

1Department of Radiology, Tel Aviv Sourasky Medical Center, Tel-Aviv, Israel; 2School of Eng and Computer Science, The Hebrew University of Jerusalem, Jerusalem, Israel; 3The Paediatric Neurosurgery Department, Tel Aviv Sourasky Medical Center, Tel-Aviv, Israel; 4Sackler Faculty of Medicine, Tel Aviv University, Tel-Aviv, Israel; 5The Wohl Institute for Advanced Imaging, Brain Imaging Center, Tel Aviv Sourasky Medical Center, Tel-Aviv, Israel

Accurate and consistent volumetric measurements of optic pathway gliomas (OPG), the most common tumor in the brain in patients with Neurofibromatosis, are clinically crucial. In this study we present an automatic method for segmentation of OPGs from multispectral MRI datasets. The method effectively incorporates prior location of the OPG, its shape and intensity and accurately identifies the boundaries in a consistent and repeatable manner. The method was tested on 15 data sets, the optimal threshold was derived from a receiver operating characteristic curve, and a significant correlation was obtained between the volume calculated using this method compared to manual measurements.

2191. Translational Methods for Retrospective Long Term Evaluation of Cancer with MRS

Dee H. Wu1, Levi Garrett1, Jignesh Modi1, Bowei Han1, Hans Cao1

1Radiological Center, University of Oklahoma Health Sciences Center, Edmond, OK, United States

We have created a procedure for retrospective review of digitized MRS images that permits fundamental baseline removal and frequency bracketing with the target of creating a user-friendly tool. This newly created clinical workflow will improve long term care for patients who may require important decisions pertaining to whether the status of a tumor has changed (such as tumor reoccurrence or remission). A central concept is that we have also conducted tolerance testing in which common confounds to artifacts that arise from shimming, electronic noise, field inhomogeneity, coil sensitivities, relaxation.

2192. MR Biomarkers of Tyrosine Kinase Inhibition in Mouse Gliomas

Paul A. Schornack1, Jia-Jean Yin, Bo Hu, Raghvendra S. Sengar, Ken-Wei Liu, Haizhong Feng, Frank S. Lieberman, Jann N. Sarkaria2, Erik Wiener, Hsin-I Ma3, Shiyuan Cheng

1Radiology, University of Pittsburgh, Pittsburgh, PA, United States; 2Mayo Clinic; 3Taiwan National Defense Medical Center

We present a comparison of MR techniques sensitive to T2, T2*, & ADC to measure mouse gliomas & correlate with histology. We compare untreated mice with mice treated with an anti-angiogenic agent, ZD6474 (Zactima, vandetanib), a dual inhibitor of VEGFR2 & EG. ZD6474 significantly inhibited growth & angiogenesis of gliomas expressing EGFRvIII by specifically blocking signaling transducers in brain, which suggests a potential application in treatments for gliomas that overexpress this factor. Our results indicate that susceptibility/T2* weighted MR along with ADC and T2 measurements can be used as a means of non-invasively quantifying the efficacy of such treatment protocols.
Brain neoplasms are typically characterized by contrast enhanced T1 imaging. Depending on the course of treatment, tumor reoccurrence remains a possibility, and can be difficult to distinguish from other enhancing areas, for example post-treatment radiation effects (PTRE), typically necrosis [1]. Further, detailed information about the tumor heterogeneity as detected by standard MR methods is not generally available, but can play a significant role in characterizing and grading the tumor. In this work, a simple multi-b-value DWI sequence has been developed to better understand the heterogeneity and diffusion characteristics of different types of tumors, encountered during routine clinical scanning. The signal decay is fitted with two recently developed diffusion models: a stretched exponential ($\xi$-DWI) [2] and a cumulant expansion (DKI) [3] model, where fitted parameters $\xi$ and $K$ were shown to correlate the diffusion heterogeneity. We expected to see differences in alpha and $K$ when the multi-b-value DWI sequence directed to the anatomy of interest, primarily due the heterogeneity of the more advanced tumors.

Regarding nephrogenic systemic fibrosis (NSF), the injected dose level becomes very important, since NSF is reported to be related to gadolinium chelate injection in patients with an impaired renal function, depending upon chelate stability and dose. With gadobenate dimeglumine, a chelate with transient protein binding and a higher $r_1$ relaxivity became available. Combining a high relaxivity chelate and 3 T offers multiple opportunities for dose reduction without loss in image quality. This was proven in a rat brain glioma model at 1.5 and 3 T, comparing half dose gadobenate dimeglumine vs full dose gadopentetate dimeglumine, a standard extracellular gadolinium chelate.
Brain Tumor Imaging: Diffusion, MRS & High-Field Imaging
Hall B Wednesday 13:30-15:30

2197. Assessment of Invasion and Recurrence in Glioblastoma Multiforme Using Diffusion Weighted MRI Edge Characteristics of Contrast Enhancing Tumor

Peter Sherman LaViolette1,2, Benjamin M. Ellingson,2,3, Jennifer M. Connelly,2,4, Mark G. Malkin,2,4, Scott D. Rand,2,3, Kathleen M. Schmainda1,2

1Biophysics, Medical College of Wisconsin, Milwaukee, WI, United States; 2Translational Brain Tumor Program, Medical College of Wisconsin, Milwaukee, WI, United States; 3Radiology, Medical College of Wisconsin, Milwaukee, WI, United States; 4Neurology, Medical College of Wisconsin, Milwaukee, WI, United States

Traditionally, brain tumor recurrence is defined as new MRI contrast enhancement apparent in follow-up imaging. This study shows that diffusion weighted MRI edge characteristics of contrast enhancing tumors show measurable differences indicative of tumor invasion prior to contrast enhancing recurrence.

2198. Determination of Structural Differences Between Glioblastomas and Metastases by Diffusion Kurtosis Imaging

Peter Raab1,2, Elke Hattingen2, Kea Franz3, Friedhelm E. Zanella2, Heinrich Lanfermann1,2

1Neuroradiology, Hannover Medical School, Hannover, Germany; 2Neuroradiology, JW Goethe University, Frankfurt/Main, Germany; 3Neurosurgery, JW Goethe University, Frankfurt/Main, Germany

Diffusion kurtosis imaging evaluates the non-Gaussian diffusion pattern of water and indicates tissue structure complexity. In this diffusion study we found differences between glioblastomas and cerebral metastases, that indicate more directed diffusion in glioblastomas and a higher structural complexity in metastases.

2199. Fiber Density Mapping in Patients with Gliomas: Histopathologic Evaluation of a Novel Approach for Post-Processing of DTI Data

Andreas Stadlbauer1,2, Michael Buchfelder1, Oliver Ganslandt2

1MR Physics Group, Department of Radiology, Landesklinikum St. Poelten, St. Poelten, Austria; 2Department of Neurosurgery, University of Erlangen-Nuremberg, Erlangen, Germany

To histopathological evaluate fiber density mapping (FDM) in glioma patients for assessment of the extent of destruction of white matter structures in the center, the transition zone and the border zone of gliomas. We correlated FDM-data and histopathological findings from 78 stereotactic biopsies of 20 glioma patients. We found a negative logarithmic correlation of fiber-density with both, % tumor infiltration and tumor cell number. For a tumor infiltration of >60% no fibers are remaining. In tumor regions with <16% tumor cells functional important fiber structures may still exists. Our histopathology-fiber-density-model may be helpful for preoperative-planning to prevent post-therapeutic neurologic deficits.

2200. Graded Functional Diffusion Maps (FDMs) Applied to the Whole Brain: A Sensitive Imaging Biomarker for Monitoring Brain Tumor Growth and Invasion

Benjamin M. Ellingson1,*, Mark G. Malkin4, Scott D. Rand3, Jennifer M. Connelly1,4, Pete S. LaViolette2,3, Devyani P. Bedekar1,2, Kathleen M. Schmainda1,2

1Translational Brain Tumor Program, Medical College of Wisconsin, Milwaukee, WI, United States; 2Dept. of Radiology, Medical College of Wisconsin, Milwaukee, WI, United States; 3Dept. of Neurology and Neurosurgery, Medical College of Wisconsin, Milwaukee, WI, United States; 4Dept. of Neurology, Medical College of Wisconsin, Milwaukee, WI, United States

Diffusion weighted imaging (DWI) measures of apparent diffusion coefficient (ADC) is believed to reflect the level of tumor cellularity in malignant gliomas. Functional diffusion maps (fDMs) were developed to examine voxel-wise changes in ADC, then stratify voxels as either increasing ADC (indicative of necrosis or "hypocellularity"), decreasing ADC (indicative of growing tumor or "hypercellularity"), or not changing within regions of contrast-enhancement or FLAIR signal abnormality. Because the particular threshold used for voxel classification dictates the sensitivity and specificity to changes in tumor cell density, we hypothesize that a graded fDM technique that stratifies voxels into varying degrees of change, applied to the whole brain, may be useful for visualizing invading and proliferating tumor with both high sensitivity and specificity. In the current study we examine graded fDMs in 120 patients and discuss how graded fDMs can be used to detect and monitor brain tumor growth and invasion beyond the traditional malignant boundary.
Difficulties can arise in clinical practice in differentiating between primary malignant glioma and brain metastasis owing to their similar appearances on conventional MRI sequences. Although previous studies have identified differences in diffusion parameters between the tumour types, the diagnostic role of diffusion tensor imaging (DTI) has yet to be fully elucidated. We propose an application of a novel whole brain DTI segmentation algorithm in generating regions of interest (tumour and oedema) from Diffusion Colour Maps (DCMs) created using our technique. We identify differences in diffusion between tumour types, compare our method with conventional manually drawn regions of interest and propose potential clinical applications for our method.

**Assessment of Diffusion Parameters in Scans Prior to Progression in GBM Patients Following Anti-Angiogenic Therapy**

_Laleh Jalilian^1, Emma Essco-Burns^1,2_, Susan M. Chang^3_, Soonmee Cha^1,4_, Sarah J. Nelson^1,4_

^1Surbeck Laboratory of Advanced Imaging, Department of Radiology, University of California, San Francisco, San Francisco, CA, United States; ^2UCSF/UCB Graduate Group in Bioengineering, University of California, San Francisco, San Francisco, CA, United States; ^3Department of Neurological Surgery, University of California, San Francisco, San Francisco, CA, United States; ^4Department of Radiology, University of California, San Francisco, San Francisco, CA, United States

Diffusion-weighted Imaging (DWI) is an important adjunct to standard imaging in the management of GBM patients receiving anti-angiogenic treatments. In this study, ADC values were obtained for a) areas on preprogression scans that ultimately progressed to new contrast-enhancement on progression scans (NEW_CEL), and b) new FLAIR abnormality on preprogression scans with exclusion of areas of contrast enhancement and areas that progress to new contrast-enhancement on progression scans (T2ALL_M). Results demonstrated increasing ADC values in NEW_CEL but no change in T2ALL_M in scans prior to progression. Clinical implications include interpreting new FLAIR abnormality as a consequence of anti-angiogenic treatment alone.

**Comparison of Glioma Sub-Populations Using In-Vivo ADC Values and Ex-Vivo 1H HR-MAS Spectroscopy**

_Adam Elkhaled^1_, llewellyn Jalbert^1_, Hikari Yoshihara^1_, Gaby Bourne^1_, Colleen Cloyd^1,2_, Joanna Phillips^3_, Soonmee Cha^1_, Susan M. Chang^4_, John Kurhanewicz^2,5_, Radhika Srinivasan^1_, Sarah J. Nelson^1,4_

^1Department of Radiology and Biomedical Imaging, University of California, San Francisco, San Francisco, CA, United States; ^2School of Pharmacy, University of California, San Francisco, United States; ^3Department of Pathology, University of California, San Francisco, San Francisco, CA, United States; ^4Department of Neurological Surgery, University of California, San Francisco; ^5Department of Bioengineering and Therapeutic Sciences, University of California, San Francisco, United States

Characterization of glioma recurrence and grade transformation has remained elusive. Image-guided biopsies from glioma patients were evaluated using pathology, in-vivo ADC, and ex-vivo proton HR-MAS spectroscopy. Newly diagnosed and recurrent grade IV tissue samples were found indistinguishable from one another. A comparison of recurrent grade IV to recurrent low-grade glioma revealed a significant difference in [myo-inositol] and [creatinine]; recurrent low-grades which had upgraded displayed higher total choline compared to non-upgraded and high-grade glioma; the [myo-I]/[total choline] ratio differentiated non-upgraded low-grades from all other cohorts. ADC values demonstrated an inverse relationship with tumor grade and negative correlation with glutathione.

**Finding Early Prognostic Marker from 3D ¹H-MRSI and Diffusion Tensor Imaging for Newly-Diagnosed GBM Patients Receiving Radiation, Temozolomide and PKC Inhibitor**

_Ilwoo Park^1,2_, Adam Elkhaled^1_, Achuta Kadambi^1_, Inas Khayal^2_, Nicholas Butowski^3_, Susan M. Chang^2_, Sarah J. Nelson^1,2_

^1Joint Graduate group in Bioengineering, University of California San Francisco/Berkeley, San Francisco, CA, United States; ^2Surbeck Laboratory of Advanced Imaging, Department of Radiology and Biomedical Imaging, University of California San Francisco, San Francisco, CA, United States; ^3Department of Neurological Surgery, University of California San Francisco, San Francisco, CA, United States

The purpose of this study was to use 3D ¹H MR Spectroscopic Imaging (MRSI) and diffusion tensor imaging (DTI) to develop early prognostic markers for GBM patients undergoing radiation, temozolomide and PKC inhibitor. Twenty-nine patients with newly diagnosed GBM were examined using a 3T MR scanner. Conventional anatomical imaging parameters could not distinguish between progression groups at baseline or 1 month. Parameters derived from MRSI and DTI provided information at baseline and early follow-up examinations that may be valuable in predicting the time-to-progression for patients with GBM.
Glioblastoma Multiforme (GBM) is the most common and malignant type of primary brain tumor, resulting in a median survival of approximately one year. Our study of 18 patients with GBM indicated that metabolic abnormalities more accurately reflect the underlying tumor burden. We found that the Cho to NAA index (CNI) values in the contrast-enhancing lesion (CEL) are elevated at 2 months prior to progression while having less changes in CEL volume at that time. Patients who have a CEL volume with high CNI values are more likely to progress compared with those who have with smaller CEL volume and lower CNI values. We also observed that the regions with high CNI values outside the CEL region could subsequently become enhancing.

Gliomatosis Treated with Temodal, Radiotherapy and Antiangiogenic Therapy.

2209.

5 Year Longitudinal MRI Follow-Up and 1H Single Voxel MRS in 13 Patients with Gliomatosis Treated with Temodal, Radiotherapy and Antiangiogenic Therapy.

Jean-Marc Constats1, François Kauffmann2, Gabriela Hossu3, Weiwei Dou4, Jean-Michel Derlon4, Emmanuel Lechapt-Zalcmann4, Samuel Valable4, Jean-Sebastien Guillame5,6

1MR Unit, CHU de CAEN, CAEN, Normandy, France; 2CEROXy, Cyeceron- CI-NAPS- CNRS , CAEN, Normandy, France; 3LMNO- UMR 6139, CNRS, CAEN, France; 4UMR 947, CIC-IT et INSERM, Nancy, France; 5Electronic, Tsinghua University, Beijing, China; 6C Departamento de Medicina Nuclear, Hospital Universitario Wright, NL

MRS with Cho/Cr, ml/Cr and NAA/Cr ratios, could be more sensitive than MRI and could, in some cases, be predictive of worsening in gliomatosis follow-up. These spectroscopic changes occurred well before clinical deterioration. There is a large variability, but repetition and modelling of spectroscopic measurements during longitudinal follow-up could allow us to diminish it and to improve gliomatosis prognostic evaluation.

Studying the relationship between MRS features, methionine PET, segmentation and perfusion parameters could lead to better understanding of therapeutic response, especially with regard to chemotheraphy and antiangiogenic molecules and in the future hypoxia modulators.
Prominent Citrate Predicts Malignant Progression of Low-Grade Astrocytomas in Children

Arabhi C. Nagasunder1, Mikhail Laskov2, Albert Joseph2, Ashok Panigrahy1,2, Girish Dhall1, Jonathan L. Finlay2, Ignacio Gonzalez-Gomez2, Mark D. Krieger2, Marvin D. Nelson3, Stefan Blum1,6
1Department of Radiology, Childrens Hospital Los Angeles, Los Angeles, CA, United States; 2Childrens Center for Cancer and Blood Diseases, Childrens Hospital Los Angeles, Los Angeles, CA, United States; 3Department of Radiology, Childrens Hospital of Pittsburgh of UPMC, Pittsburgh, PA, United States; 4Department of Neuropathology, Childrens Hospital Los Angeles, Los Angeles, CA, United States; 5Department of Neurosurgery, Childrens Hospital Los Angeles, Los Angeles, CA, United States; 6Radiology Institute, Santa Barbara, CA, United States

Pediatric low-grade gliomas can either progress to a high-grade lesion or remain dormant for long periods of time. Currently, there is a need to identify markers that would allow pediatric neuro-oncologists to predict tumor progression. Our goal was to determine whether aggressive pediatric low-grade II astrocytoma have metabolic features that distinguishes them from stable grade II astrocytoma using in vivo MR Spectroscopy. We found that elevated citrate and low NAA may predict malignant progression of low-grade astrocytomas.

Brain MR Imaging and 1H-MR Spectroscopy Changes in Patients with Extrahepatic Portal Vein Obstruction from Early Childhood to Adulthood

Santosh Kumar Yadav1, Sona Saxena1, Anshu Srivastava1, Arti Srivastava1, Vivek A. Saraswat1, Michael A. Thomas1, Ram Kishore S. Rathore1, Rakesh K. Gupta2
1Radiodiagnosis, Sanjay Gandhi Post Graduate Institute of Medical Sciences, Lucknow, Uttar Pradesh, India; 2Pediatric gastroenterology, Sanjay Gandhi Post Graduate Institute of Medical Sciences, Lucknow, Uttar Pradesh, India

Sixty-three patients with EHPVO having different age groups with 47 age/sex matched controls were studied. Neuropsychological tests, MR imaging, 1H-MR Spectroscopy and blood-ammonia estimation were performed in all subjects. 40% EHPVO patients had MHE who showed significantly increased Mean diffusivity, Glx/Cr, blood-ammonia and GP T1 H in all age groups; however, mlns/Cr was significantly lower only in adults when compared to controls. Mean diffusivity positively correlated with blood-ammonia and Glx/Cr in all age groups. A significant positive correlation was observed between Glx/Cr and blood-ammonia. Increases in Mean diffusivity, Glx/Cr, blood-ammonia and GP T1 H and decrease in mlns/Cr are associated with pathogenesis of MHE in adults with EHPVO. No change of cho/Cr in EHPVO may serve as a diagnostic marker for its differentiation from cirrhosis induced MHE. A significant positive correlation among blood ammonia, Glx/Cr and mean diffusivity indicates that hyperammonia contributes to the generalized low grade cerebral edema.

Repeatability of Measured Lactate and Other Metabolites in Patients with Astrocytoma

Mary McLean1, Amy Sun2, Radha Raiikar2, Andrea Schaeffer2, Haifying Liu2, Rose-ann Blemman-Abange2, Ilse Joubert3, Stephen Price3, Charlotte Hodgkin3, John Griffiths3
1Cambridge Research Institute, Cancer Research UK, Cambridge, England, United Kingdom; 2Merck & Co Inc, West Point, PA, United States; 3Addenbrooke’s Hospital, Cambridge, United Kingdom

We implemented lactate editing at 3T using BASING pulses and assessed its repeatability in phantoms and in human brain tumours in vivo to estimate the level of lactate and other metabolites. In phantoms, a coefficient of variation of 11% was achieved for lactate with SNR similar to in vivo. In tumours, lactate was detected, and there was a non-significant trend of lower metabolite concentrations in scan 2 than scan 1. Lactate editing may provide a useful means of simultaneously monitoring lactate, choline and lipids in vivo, all of which are of interest in tumour progression and response to treatment.

Differentiation Between Low and High Grade in Non-Enhancing Cerebral Gliomas and Neuronal- Glial Tumors

Xiang Liu1, Wei Tian1, Sven Ekholm1
1Department of Imaging Science, University of Rochester Medical Center, Rochester, NY, United States

Grading of non-enhancing supratentorial gliomas and neuronal-glia1 tumors (NEGGNT) is a diagnostic dilemma on conventional MR imaging as 45% of these tumors could be malignant. We retrospectively compared diffusion tensor imaging (DTI), MR perfusion weighted imaging (PWI) and MR spectroscopic imaging in preoperative grading of 50 patients with histology confirmed non-enhancing supratentorial gliomas and neuronal-glia1 tumors. The imaging parameters, included mean FA, mean FA ratio, maximal FA, minimal ADC, maximal rCBV, Cho/Cr and Cho/NAA which all were evaluated for both tumor groups. There were significant differences of mean FA, mean FA ratio and maximal FA between low and high grade NEGGNT(p<0.05), but no significance was found for the other parameters. ROC analysis showed that the maximal FA value had a higher sensitivity and specificity than the other parameters to differentiate between low and high grade NEGGNT. This result indicates that maximal FA may be the best adjuvant tool to help differentiating between low and high grade in non-enhancing supratentorial gliomas and neuronal-glia1 tumors.
2214. MR Biomarker Profile for Infiltrative Tumor Region in Malignant Glioma

Radhika Srinivasan1, Joanna J. Phillips1, Gabriela Bourne1, Alvin Au1, Soonmee Cha1, Susan Chang1, Sarah J. Nelson1

1University of California, San Francisco, San Francisco, CA, United States

This study addresses the inability of conventional imaging to delineate infiltrative tumor regions, which causes the tumor to recur within the treatment volume. These regions have normal cellularity due to diffusely infiltrating cells and cannot be located based on increased cellularity with choline and ADC. To define an MR profile of an infiltrative tumor region HR-MAS spectroscopy of image-guided biopsies in newly diagnosed and recurrent GBM were analyzed and evaluated relative their spatial location within the tumor, pathological measures of its paired sample and diffusion measures derived from the biopsy location. These results will be presented and discussed.

2215. Assessment of Vascularity in Malignant Glioma: Development of an Imaging Protocol at 7 T

Lars Gerigk1, Armin Nagel2, Armin Biller1, Julien Dinkel1, Lydia Schuster1, Thomas Hauser1, Michael Puderbach1, Marco Essig1, Stefan Delorme1, Michael Bock2

1Radiology, German Cancer Research Institute, Heidelberg, Baden-Württemberg, Germany; 2Medical Physics in Radiology, German Cancer Research Institute, Heidelberg, Baden-Württemberg, Germany

Malignant gliomas are highly vascularized, which makes them a target for new anti-angiogenic agents. MRI therapy monitoring will require more sophisticated methods than measuring the extent of contrast enhancement, because these agents change the blood-brain-barrier. Using the advantage of 7 T, direct imaging of the tumor vasculature becomes feasible. In our newly developed clinical imaging protocol, high-resolution T2w and T1w images show the internal morphology of the lesion, whereas TOF-MRA and SWI visualize the arterial and venous intratumoral vasculature. Automatic co-registration of MRA and morphology proved to be a simple, fast and reliable method to evaluate tumor vascularization.

2216. Initial Experience with Ferumoxytol Dynamic Susceptibility MRI in Human Brain at 3T and 7T

Jeffrey Moses Njus1, Edit Dosa2, Seymur Gahramanov2, John W. Grinstead3, Xin Li1, Charles S. Springer, Jr.1, Edward A. Neuwelt2, William D. Rooney1

1Advanced Imaging Research Center, Oregon Health & Science University, Portland, OR, United States; 2Department of Neurology, Oregon Health & Science University, Portland, OR, United States; 3Siemens Medical Solutions, Portland, OR, United States

MRI DSC techniques offer an efficient way to characterize brain perfusion properties. However, the use of low-molecular weight gadolinium based contrast agents (Gd) can introduce a significant confound into standard DSC analysis if extravasation is extensive; as often is the case for brain tumors. The purpose of this study was to investigate the use of an ultra-small paramagnetic iron oxide (USPIO) compound to estimate brain tumor blood volume in human subjects. To accomplish this goal, DSC acquisitions were performed using both Gd and USPIO based contrast agents in eleven human subjects at 3T and 7T.

Clinical Stroke Imaging: DWI DKI, MTC MRS & Plaque Imaging

Hall B Thursday 13:30-15:30

2217. Identification of Early Onset Strokes Using Multiparametric MRI as a Witness

Ona Wu1, Lee H. Schwamm2, Priya Garg1, Muhammed A. Pervez2, Albert J. Yoo3, Aurauma Chutinet2, Robert Irie4, William D. Rooney4, Ramon A. Bittencourt1, Aneesh B. Singhal5, Karen L. Furie1, Alma Gregory Sorensen1

1Athinoula A. Martinos Center for Biomedical Imaging, Massachusetts General Hospital, Charlestown, MA, United States; 2Department of Neurology, Massachusetts General Hospital; 3Department of Radiology, Massachusetts General Hospital

Approximately 25% of ischemic stroke patients have un-witnessed strokes and therefore ineligible for on-label thrombolytic therapy. We investigated whether multiparametric MRI can be used for identifying patients who have early stage strokes (<=4.5 h). Acute DWI, PWI and FLAIR images from acute stroke patients imaged within 12 h since last known to be well (N=175) were analyzed. In regions that were DWI abnormal, there were significant difference in relative T2WI and FLAIR between patients seen within 4.5 h and those seen later. Multivariate logistic regression showed that T2WI, ADC, and CBV were predictive of patients with early onsets.

2218. Evolution of Fractional Anisotropy in Hyperacute Ischemic Stroke

Ashley D. Harris1,2, Linda B. Andersen,2,3, Robert K. Kostor,2,4, Henry Chen,2,5, Marina Salluzzi,2,4, Randall B. Stafford,2,3, Bradley G. Goodyear,2,3, Richard Frayne,2,3

1School of Psychology, CUBRIC, Cardiff University, Cardiff, United Kingdom; 2Seaman Family MR Research Centre, Foothills Medical Centre, Calgary, Alberta, Canada; 3Clinical Neurosciences and Radiology, University of Calgary, Calgary, Alberta, Canada; 4Biomedical Engineering, University of Calgary, Calgary, Alberta, Canada; 5Physics, University of Calgary, Calgary, Alberta, Canada

Diffusion-weighted images and apparent diffusion coefficient maps are widely used in ischemic stroke detection; however, additional information may be available from diffusion imaging in the assessment of hyperacute ischemic stroke. In this study, fractional
anisotropy was examined during hyperacute ischemic stroke (0–6h from onset) in a canine model. White matter shows a biphasic FA response; an initial increase followed by a decrease. Grey matter showed FA increases. The timing and magnitude of these FA changes appears to be related to stroke severity. With thorough understanding of these changes, FA may be useful in treatment decisions for stroke patients.

**2219. Apparent Kurtosis and Fractional Anisotropy Potentially Predicts Tissue Outcome in Sub-Acute Stroke**

Danielle van Westen1,2, Markus Nilsson3, Håkan Sjunnesson1,2, Freddy Ståhlberg,2,3, Sara Brockstedt4, Ronnie Wiestam5, Jimmy Lätt1,3

1Center for Medical Imaging and Physiology, Lund University Hospital, Lund, Sweden; 2Department of Diagnostic Radiology, Lund University, Lund, Sweden; 3Department of Medical Radiation Physics, Lund University, Lund, Sweden; 4Radiation Physics, Lund University Hospital, Lund, Sweden

Diffusion measurements were performed 2, 9 and 90 days after stroke onset, estimating the mean diffusivity (MD), the apparent diffusion kurtosis (ADK) and the fractional anisotropy (FA). Tissue outcome at day 90 was dependent on tissue type, i.e. white- or grey matter, as well as location. For instance, deep white matter developed gliosis, while subcortical U-fibres pseudonormalized. FA and ADK obtained at day 2 predicted the tissue outcome at day 90 in white matter.

**2220. Diffusion Weighted Imaging of Carotid Atherosclerotic Plaque in Symptomatic Patients at 3-Tesla: Correlation with MRI, CT & Histopathological Predictors of Plaque Vulnerability**

N. Jane Taylor1, Vicky J. Goh1, J James Stirling1, Ian Simcock1, Matthew Orton2, David J. Collins1, Ralph Strecker3, Leon Menezes3, Raymond Endozo1, Justin J. Cross1, Richard Harvey1, Carl W. Kotze1, Syed W. Yusuf2, Ashley Groves2

1Paul Strickland Scanner Centre, Mount Vernon Hospital, Northwood, Middlesex HA6 2RN, United Kingdom; 2CRUK-EPSRC Cancer Imaging Centre, Institute of Cancer Research & Royal Marsden Hospital, Sutton, Surrey, SM2 5PT, United Kingdom; 3Healthcare Sector, Siemens AG, 91052 Erlangen, Germany; 4University College Hospital, London, United Kingdom; 5Addenbrookes Hospital, Cambridge, United Kingdom; 6Brighton and Sussex University Hospitals, Brighton, Sussex, United Kingdom

Accurate identification of vulnerable carotid plaque influences patient treatment. Diffusion weighted imaging at 3T may potentially contribute to the identification of active plaques. This feasibility study in 14 patients with symptomatic disease assesses the correlation between plaque apparent diffusion coefficient (ADC) and imaging/histopathological features of vulnerability (thin cap, lipid core, haemorrhage, angiogenesis (CD105 or VEGF) & inflammation (CD68)). Mean (SD) plaque ADC was 1.30 X10-3(0.29) mm2/s. There was no difference in ADC between patients with and without MRI features of plaque vulnerability. There was a positive trend between ADC & CD105/VEGF, markers of angiogenesis meriting further investigation.

**2221. Differing Fractional Anisotropy Changes in Grey Matter and White Matter in Early Ischemic Stroke**

Mohamed Mustafa Hirji1,2, Ashley D. Harris,2,3, Robert K. Kosior,2,4, Cheryl R. McCready,2,5, Richard Frayne2,5

1University of Calgary, Calgary, Alberta, Canada; 2Seaman Family MR Research Centre, Alberta Health Services, Calgary, Alberta, Canada; 3School of Psychology & Cardiff University Brain Research Imaging Centre, Cardiff University, Cardiff, Wales, United Kingdom; 4Biomedical Engineering, University of Calgary, Calgary, Alberta, Canada; 5Radiology & Clinical Neurosciences, University of Calgary, Calgary, Alberta, Canada

We characterise the fractional anisotropy (FA) changes in ischemic stroke. Diffusion tensor images of 13 patients were obtained within 26 hours of stroke (acutely) and ~21 days later (follow-up). FA and eigenvalues were measured in freehand regions of interest (ROIs); anatomically-matched contralateral ROIs were used for control. Acutely, FA increased in grey matter (GM) but not in white matter (WM); the eigenvalue reductions were unbalanced in GM, but balanced in WM. At follow-up, FA decreased in both GM and WM with the eigenvalue changes similar in both GM and WM. Our results give insight into microstructural changes in stroke.

**2222. Intensive Blood Pressure Lowering Increases Cerebral Blood Flow in Older Subjects with Hypertension**

Jiabao He1, Dinesh Tryambake1, Michael J. Firbank2, John T. O’Brien2, Gary A. Ford1, Andrew M. Blamire1

1Institute of Cellular Medicine, Newcastle University, Newcastle upon Tyne, Tyne and Wear, United Kingdom; 2Institute for Ageing and Health, Newcastle University, Newcastle upon Tyne, Tyne and Wear, United Kingdom

CBF determines brain tissue metabolic supply and is compromised in chronic hypertension which alters autoregulatory function. Blood pressure (BP) lowering therapy has clear clinical benefit but may risk inducing hypoperfusion. Optimal target BP in older subjects with hypertension is unclear, although guidelines recommend target BP of <130/85 mmHg and ~140/80 mmHg for patients with and without previous vascular events respectively. We used ASL to determine the effect of usual (~140/85 mmHg) and intensive (~130/80 mmHg) BP lowering on CBF in older hypertensive subjects and demonstrate that intensive BP lowering increases CBF compared to usual BP lowering therapy.
2223. Correlation Study of Cerebral Blood Flow and EEG Feature Based on CO2 Stimulation

Jing Wang1, Liu Chen1, Bing Wu1, Xiaoping Hu2, Xiaoying Wang1, Jue Zhang1,4, Jing Fang1,4

1Academy for Advanced Interdisciplinary Studies, Peking University, Beijing, China; 2Dept. of Radiology, Peking University First Hospital, Beijing, China; 3Dept. of Biomedical Engineering, Georgia Institute of Technology / Emory University, Atlanta, United States; 4College of Engineering, Peking University, Beijing, China

The MR based evaluation of cerebral blood flow (CBF) plays an important role in assessment of post-stroke rehabilitation, but limits by its inconvenient and high costs. In this study, the weighted average accuracy index (WAAI), as a novel electroencephalogram (EEG) feature related index was introduced to estimate effectively the change of EEG pattern with the gradual CBF improvement due to the increase of CO2 concentration. Group results of healthy subjects showed that there existed a strong relationship between WAAI and CBF, indicating that the proposed WAAI index could be helpful to evaluate the extent of brain perfusion recovery.

2224. MRI Study of ASL, MRS and BOLD in Patients with Left Symptomatic Internal Carotid Artery

Jie Lu1, KunCheng Li1, Miao Zhang, XiaoYi Wang

1Xuanwu Hospital, Capital Medical University, Beijing, China

Arterial Spin Labeling (ASL) can quantitatively measure perfusion without the need of contrast material. 1H spectroscopy (1H-MRS) can identify cerebral abnormal metabolism. Patients with symptomatic occlusion of the internal carotid artery (ICA) with compromised cerebral blood flow (CBF) and decrease N-acetyl aspartate (NAA) are at risk for future ischemic infarcts. These patients can have different degree of cognitive impairment, especially working memory impairment2. Blood oxygenation level dependent (BOLD) is best used for studying processes that can be rapidly turned on and off like memory. In this study, we characterized CBF, MRS and BOLD changes in patients with symptomatic ICA occlusion.

2225. Is There a Relationship Between M1 Cortex Activation and Upper Extremity Motor Characteristics During Acute Stage After Stroke?

Urska Puh1, Andrej Vovk2, Igor Serša3, Dusan Suput4

1University of Ljubljana, Faculty of Health Sciences, Ljubljana, Slovenia; 2Pathophysiology, Univ. of Ljubljana Faculty of Medicine, Ljubljana, Slovenia; 3Institut Jozef Stefan, Slovenia; 4Pathophysiology, Univ. of Ljubljana Faculty of Medicine, Slovenia

12 patients with partially impaired function of one upper extremity 2-8 days after first ischemic stroke participated in the study. A 1.5 T scanner was used for brain fMRI during upper extremity functional tasks in the first and third week and 3 months after the stroke. Muscle strength and dexterity of the HPE were measured concomitantly. Spearman correlation coefficient was calculated to compare the M1 activation of each brain hemisphere and the motor characteristics of the HPE. Recovery of HPE function correlated well with the intensity and/or area of M1 cortex activation mainly in the ipsilesional hemisphere.

2226. Varied Vasomotor Responses Among Brain Territories in Unilateral ICA Stenosis Patients Studied Using Breath-Hold BOLD MRI

Wan Chun Kuan1, Ting Yu Chang2, Keh Shih Chuang1, Ho Fai Wong3, Tsong Hai Lee3, Ho Ling Liu4,5

1Dept. of Biomedical Engineering and Environmental Sciences, National Tsing Hua Univ., Hsinchu, Taiwan; 2Stroke Center, Department of Neurology, Chang Gung Memorial Hospital; 3Department of Neuroradiology, Chang Gung Memorial Hospital; 4Dept. of Medical Imaging and Radiological Sciences, Chang Gung Univ.; 5Dept. of Medical Imaging and Intervention, Chang Gung Memorial Hospital

Impaired cerebral vasoreactivity could be one of the predictors for hyperperfusion after carotid interventions for patients with internal carotid artery (ICA) stenosis. This study aimed to evaluate the differences of hemodynamic responses among blood-supply territories, induced by vasodilatation following a breath-holding task, in patients with unilateral ICA stenosis using BOLD MRI. The temporal correlation between bilateral vasomotor responses in the MCA territories was utilized as an index. The results showed significantly impaired responses of the lesion side as compared to the normal side (p<0.05) for patients exhibited hyperperfusion after the stenting (sensitivity = 100%, specificity = 92.3%).

2227. Quantitative Magnetization Transfer Imaging in Acute Stroke: A Follow Up Study Correlating Quantitative MRI with Respect of Severity of Stroke

Felix Jax1, Monika Gloo2, Oliver Bieri3, Meritxell Garcia4, Stefan Engelter5, Felix Fluri1, Klaus Scheffler2, E.-W. Radue1, SG Wetzel1

1Department of Neuroradiology, University of Basel Hospital, Basel, Switzerland; 2Department of Radiological Physics, University of Basel Hospital, Basel, Switzerland; 3Department of Neurology, University of Basel Hospital, Basel, Switzerland

Magnetisation transfer (MT) imaging can potentially serve as a marker for loss of tissue integrity. Moreover increased pathologic specificity is expected from quantitative MT (qMT) as compared to the assessment of the semi-quantitative MT ratio (MTR) images only. Here, we present an evaluation of qMTI data over three consecutive MRIs within the first 10 days for patients suffering from...
middle cerebral artery stroke with different progression of symptoms. Results seem to be superior to simple MTR measurements and possibly allow for early statement of prognosis and efficacy of therapeutic methods.

**2228. The Assessment of Vessel Size Index and Its Application in Patients with Ischemic Stroke**

Chao Xu1, Wolf Schmidt1, Peter Brunecker1, Valerij Kiselev2, Peter Goll3, Nils Bodammer4, Jochen Fiebach1

1Center for Stroke Research Berlin (CSB), Charité - Universitätsmedizin Berlin, Berlin, Germany; 2Medical Physics, Department of Diagnostic Radiology, University Hospital Freiburg, Freiburg, Germany; 3Max Planck Institute for Human Development, Berlin, Germany

This study aims at implementation and evaluation of vessel size imaging (VSI) in patients with ischemic stroke. Stable values of vessel diameter have been observed in healthy volunteers in a good agreement with anatomic knowledge. VSI measurement is shown to be feasible for the clinical examination in stroke patients. Given the limitations of small number of patients, hypointensities on VSI maps in acute and chronic stage have been observed in areas of the final infarction. The recovered tissue showed normal VSI in the acute phase.

**2229. Regional Delta-Diffusion Analysis of the Brain During Cardiac Cycle in Idiopathic Normal Pressure Hydrocephalus**

Naoki Ohno1,2, Tosiaki Miyati2, Mitsuhito Mase3, Hirohito Kan2, Harumasa Kasai2, Masaki Harai2, Yuta Shimamoto4, Kazuo Yamada4, Akifumi Kitanaka4, Tomoyuki Yamamoto1

1Department of Radiological Technology, Kanazawa University Hospital, Kanazawa, Japan; 2Faculty of Health Sciences, Institute of Medical, Pharmaceutical and Health Sciences, Kanazawa University, Kanazawa, Japan; 3Department of Neurosurgery and Restorative Neuroscience, Graduate School of Medical Sciences, Nagoya City University, Nagoya, Japan; 4Department of Radiology, Nagoya City University Hospital, Nagoya, Japan

There have been many unsolved problems with this syndrome in terms of the diagnostic criteria and selection of appropriate patients for shunt surgery. To evaluate the intracranial condition of the brain in idiopathic normal-pressure hydrocephalus (I-NPH), we determined the change in the apparent diffusion coefficient of the brain during the cardiac cycle (delta-ADC). Delta-ADC analysis makes it possible to noninvasively obtain new and more detailed information on the intracranial condition in I-NPH and thereby assist in the diagnosis.

**Stroke: Animal Models**

Hall B Monday 14:00-16:00

**2230. Enhanced Functional and Structural Connectivity in the Contralesional Hemisphere After Unilateral Stroke in Rats: A Combined Resting-State fMRI and MEMRI Study**

Maurits P.A. van Meer1,2, Wim M. Otte1,3, Kajo van der Marel1, Jan W. Berkelbach van der Spreken1, Rick M. Dijkhuizen1

1Biomedical MR Imaging and Spectroscopy group, Image Sciences Institute, Utrecht, Netherlands; 2Department of Neurosurgery, Rudolf Magnus Institute of Neuroscience, Utrecht, Netherlands; 3Department of Neurology, Rudolf Magnus Institute of Neuroscience, Utrecht, Netherlands

Reorganization of neuronal networks may effectively constitute spontaneous functional recovery after stroke. However, the association between structural and functional remodelling in post-stroke brain remains unclear. In this study we combined resting-state fMRI with manganese-enhanced MRI to elucidate the relationship between functional and structural brain connectivity in presumably reorganized contralesional brain tissue in rats that have recovered from experimental unilateral stroke. We detected increased uptake of the neuroanatomical tracer manganese in the contralesional sensorimotor cortex that was significantly correlated with enhanced functional connectivity within this region. Our data suggest that improved neuroanatomical connectivity underlies enhancement of functional connectivity in reorganizing neuronal networks after stroke.

**2231. Evolution of Functional Connectivity After Transient Stroke in Rats**

Woo Shim1,2, Kwangyeol Yeol Baek1,2, Jeong Kon Kim3, Guangping Dai1, Jaeseong Jeong2, Bruce Rosen1, Young Ro Kim1

1Radiology, Athinoula A. Martinos Center for Biomedical Imaging, Charlestown, MA, United States; 2Bio and brain engineering, KAIST, Yuseong-gu, Daejeon, Korea, Republic of; 3Radiology, Asan Medical Center, Seoul, Korea, Republic of

We monitored changes of resting-states functional connectivity using cross-correlation technique over a period of 30 days after transient cerebral ischemic damage. Averaged correlation strengths among some ROIs in stroke rats monotonically increased within the contralesional hemisphere over time, eventually matching those in control group. Despite the slight recovery, cross-correlation values measured within ipsilesional hemisphere and between bilateral hemispheres show severely impaired functional connectivity over 30 days after stroke. Although highly speculative, the data demonstrated that the initial limb dysfunction is related to the loss of brain connectivity in both ipsi- and contra-lesional brain regions and that the restoration of function may be associated more with the increase of functional connectivity within the contralesional than the ipsilesional hemisphere.
The investigation of rt-PA therapy after MCAo in mice by means of MRI requires adequate resolution for the brain size of about 1 x 1 cm², in measurement times acceptable for follow-up studies. We present a protocol including t2-weighted imaging, diffusion weighted imaging and a TOF angiography using a 1H surface cryo coil at 9.4T. The results demonstrate that rt-PA therapy leads to reperfusion of the MCA and significantly reduces the extension of ischemia. The short measurement time makes the protocol suitable for both, detection of the MCAo success immediately after the surgery and temporal evolution studies after rt-PA therapy.

In vivo 31P chemical shift imaging allows direct measurements of the high energy phosphates. 31P NMR has proven useful for investigating the bioenergetics in normal brain. However, the low SNR, long scan time and low spatial resolution of 31P NMR have prevented its widespread use, particularly in the study of acute stroke. This study implemented and optimized 31P CSI on rat brain with high spatio-temporal resolution at 11.7T. This approach, along with 1H diffusion, perfusion and T2 MRI, was used to investigate changes of high energy phosphates in stroke rats at 1, 3 and 24 hrs after onset.

Diffusion tensor imaging allowed accurately measuring ADC, which is very essential for stroke studies. We sought to establish feasibilities of EPI-version DTI of mouse brain after brief ischemia at 14T. The nearly artifact free DTI images allowed accurately measuring ADC maps and help localizing ischemic core more precisely when no abnormal T2 contrast expressed.

Strong hyperperfusion was observed in transient ischemic tissue 48-72 h after middle cerebral artery occlusion (MCAO). To investigate a physiological reason for the phenomena, we have performed experiments for revealing cerebral blood flow (CBF) autoregulation in transient ischemic tissue using a lower body negative pressure method. Using the lower body negative pressure method, we can avoid an estimation error in CASL from a blood oxygen dependent signal change. The results show CBF in ischemic tissue is higher than normal in all blood pressure range and it should indicate the autoregulatory failure of small pial artery in the ischemic tissue.

Acute diffusion data has been used to predict ischemic tissue fate on a pixel-by-pixel basis. Previous predictions however were made based on acute MRI data from a single time point. This study proposes a novel approach to incorporate the temporal characteristics of acute ADC (apparent diffusion coefficient) changes to characterize tissue fate based on a pixel-by-pixel basis. This approach was tested on rat stroke models subjected to permanent and 60-min middle cerebral artery occlusion (MCAO). We concluded that there were distinct temporal patterns that determined tissue salvageability.
Tissue plasminogen activator (tPA) has been frequently used for treating acute ischemic stroke based on re-canalization, reopening of occluded vessels for the reinstitution of regional blood perfusion. Despite the promising clinical outcomes, exogenous tPA may worsen the ischemia-induced blood brain-barrier disruption, elevate risks of intracranial hemorrhage, and in part consequently reduces the therapeutic time window. Therefore, it is critically important to understand the overall effects of tPA treatment on cerebrohemodynamics. In this study, we investigated the vasoreactivity in response to intravenously administered tPA and to systemic hypercapnia before and after tPA using a permanent focal stroke rat model.

Validation of T2* Weight Signal Change of Oxygen Challenge as a Potential Better Penumbra Estimation
Fang Du1, Shiliang Huang1, Qiang Shen1, Timothy Q. Duong1
1Research Imaging Institute, University of Texas Health Science Center at San Antonio, San Antonio, TX, United States
Mismatch of diffusion/perfusion by MRI has been used as an estimate of the ischemic penumbra, but there are large parts of the mismatch region appear not to at risk and it was also reported that some of the apparent diffusion coefficient reduction area can be salvaged by early reperfusion. It was proposed that T2* weight signal change of oxygen challenge could be a better penumbra estimation. This study applied OC technique to a group of transient ischemia rats and proved this hypothesis.

MRI of Emboli Localization and Lysis in an Embolic Model of Rat Middle Cerebral Artery Occlusion
Ronn Philip Walvick1, Bernt Torre Bratane2, James Bouley2, Nills Henninger2, Mitchell Albert1, Marc Fisher1
1Radiology, University of Massachusetts Medical School, Worcester, MA, United States; 2Neurology, University of Massachusetts Medical School, Worcester, MA, United States
We present a novel technique to localize and observe the dynamics of clot lysis during tissue Plasminogen Activator (tPA). Prior to fabrication of clots, blood was doped with Magnevist (Bayer, Wayne, NJ). Clots were withdrawn tubing and injected into the left common carotid artery at the base of the skull causing a middle cerebral artery occlusion. MRI consisted of diffusion, perfusion, and T1 weighted imaging for clot localization, and MR angiography. During tPA administration, serial T1 weighted and perfusion imaging was performed. Our results demonstrate the ability of this method to detect clots in a preclinical model of embolic stroke.

Magnetic Resonance Imaging as an In-Vivo Tool for Evaluating Efficacy of Brain Edema Prevention Therapy in a Rat Stroke Model
Denise C. Welsh1, Andrew Danziger2, Theodore Detwiler2, Hillary Regan2, Joseph J. Lynch2, Christopher P. Regan2, Donald S. Williams1, Alexandre Coimbra1
1Imaging, Merck, West Point, Pa, United States; 2Central Pharmacology, Merck, West Point, Pa, United States
While numerous studies have used MRI techniques for studying stroke pathology, there has been limited use of MR parameters as in vivo markers of novel treatment efficacy. Here, Gd-enhanced T1-w and T2-w MR data were used to verify the efficacy of pre- and post-infarct treatment with a novel KDR kinase inhibitor (KDRi) known to reduce vascular permeability and therefore, BBB leakage. In line with previously published ex-vivo data (1), in-vivo MRI results suggest efficacy of KDRi treatment in reducing BBB leakage and edema formation, as indicated by tissue water content.

Longitudinal Assessment of Brain Damage in Hypertension Rats Using Diffusion Tensor Imaging
Chien-Yuan Lin1, Cheng-Di Chiu2,3, Ming-Huang Lin1, Wai-Mui Cheung1, Teng-Nan Lin1, Chen Chang1
1Institute of Biomedical Sciences, Academia Sinica, Taipei, Taiwan; 2Graduate Institute of Medical Sciences, National Defense Medical Center, Taipei, Taiwan; 3Department of Neurosurgery, Chang-Hua Hospital, Chang-Hua, Taiwan
The elevated blood pressure is considered to be the main risk factor of stroke and is highly associated with white matter lesions. This study aimed to investigate the change of white matter microstructure under various levels of blood pressures.
MRI Monitoring of Endogenous Stem Cell Therapies in Animal Models of Stroke
Voytek Gretka1, Lisa Di Diodato1, Amy Hoyles2, Nancy J. Lobaugh3, Cindi Morshead2, Greg J. Stanisz1
1Department of Medical Biophysics, University of Toronto, Toronto, ON, Canada; 2Department of Surgery, University of Toronto, Toronto, ON, Canada; 3Cognitive Neurology, Sunnybrook Health Sciences Centre, Toronto, ON, Canada

In animal models of stroke, endogenous neural precursor cells can be activated with growth factors such as epidermal growth factor (EGF) and erythropoietin (EPO) leading to increased neurogenesis and behavioural recovery. We demonstrated the feasibility of using MR to distinguish between regenerating and pathological tissues when using endogenous stem cell therapies in rats. Tissue growth in the lesion site has MR characteristics (T1 and T2) similar to that of normal brain tissue, and differs distinctly from the cavity present when animals are untreated. MRI is able to predict the outcome of the treatment as early as 2 weeks post stroke.

Identifying the Ischaemic Penumbra by Probing Tissue Metabolism and Imaging
William Matthew Holmes1, Maria Rosario Lopez Gonzalez2, Lindsay Gallagher1, Graeme A. Deuchar1, I M. Macrae1, Celestine Santosh3
1GEMRIC, Wellcome Surgical Institute, University of Glasgow, Glasgow, United Kingdom; 2SINAPSE, Clinical Physics, University of Glasgow, Glasgow, United Kingdom; 3Institute of Neurological Sciences, Southern General Hospital, Glasgow, United Kingdom

One of the most important considerations when treating acute stroke patients is to establish whether potentially salvageable (penumbral) tissue is still present within the brain. Currently perfusion-diffusion mismatch MRI is used, which is an indirect measure lacking precision. Here we propose a new MRI method for imaging the ischaemic penumbra based on the brain’s capacity to use lactate as a metabolic substrate. Spectroscopic imaging is used to map the changes in tissue lactate induced by giving a challenge of 100% oxygen.

Estimation of the Onset Time of Cerebral Ischemia in Rats Using T1ρ MRI
Kimmo T. Jokivarsi1, Yrjö Hiltunen2, Heidi I. Gröhn3, Olli H. Gröhn1, Risto A. Kauppinen3
1Department of Neurobiology, A.I.Virtanen -Institute, Kuopio, Finland; 2Department of Environmental Science, University of Kuopio, Kuopio, Finland; 3Department of Clinical Physiology, Nuclear Medicine and Neurophysiology, North Karelia Central Hospital, Joensuu, Finland; 4Department of Radiology, Dartmouth Medical School, Hanover, NH, United States

MRI parameters can be used to acquire information about stroke and its progression. We investigated the prediction potential of absolute T1ρ in cerebral ischemia in a rat stroke model. Our results show that 3T1ρ can give an accurate estimate of ischemia time. Clinically this method provides an easy and fast MR method for ischemia time estimation that can be used in the absence of a priori knowledge or as an additional confirmation for the clinical estimate of stroke onset.

Artificial Neural-Network Prediction of Ischemic Tissue Fate in Acute Stroke Imaging
Shiliang Huang1, Qiang Shen1,2, Timothy Q. Duong1,2
1Research Imaging Institute, University of Texas Health Science Center at San Antonio, San Antonio, TX, United States; 2Department of Ophthalmology/Radiology, University of Texas Health Science Center at San Antonio, San Antonio, TX, United States

A flexible artificial neural network (ANN) algorithm was developed and applied to predict ischemic tissue fate on three stroke groups: 30-min, 60-min and permanent MCAO in rats. CBF, ADC and T2 were acquired during the acute phase up to 3hrs and again at 24hrs followed by histology. Infarct was predicted pixel-by-pixel using only acute (30-min) stroke data. Receiver-operating-characteristic analysis was used to quantify prediction accuracy. It was concluded that the ANN predictive model has the potential to serve as promising metrics for diagnosis, prognosis and therapeutic evaluation of acute stroke.

Prolonged Post-Ischemic Hyperperfusion: A Systematic Multimodal MRI Study
Qiang Shen1,2, Fang Du1, Shiliang Huang1, Timothy Q. Duong1,2
1Research Imaging Institute, University of Texas Health Science Center at San Antonio, San Antonio, TX, United States; 2Ophthalmology/Radiology, University of Texas Health Science Center at San Antonio, San Antonio, TX, United States

Regional hyperperfusion after stroke is a frequent, yet poorly understood, phenomenon. In this study, multimodal MRI (diffusion, perfusion, T2, T1, pH-weighted and dynamic contrast-enhanced imaging, and MRA) were acquired in a 30-min transient MCAO in rat. Significant hyperperfusion was observed 24hrs post-occlusion and peaked at 48hrs. Hyperperfusion areas were consistent with regions with T1 and T2 decreases, and early-phase pH decrease, and late-phase permeability changes. MRA showed significant vasodilatation of distal small arteries. We conclude that hyperperfusion does not appear to salvage tissue. Multimodality MRI investigation helps to gain significant insights into the underlying physiological changes associated with hyperperfusion.
Magnetic Resonance Angiography of the Mouse Cerebrovascular System at 17.6 T
Firat Kara1, Ali Alia1
1Leiden Institute of Chemistry, Leiden University, Leiden, Netherlands

As magnetic field strength increases toward higher fields, it allows significant improvements in MRI techniques by enhancing contrast to noise and signal to noise ratio. The use of magnetic resonance angiography (MRA) in ultra-high magnetic field to visualize cerebrovascular structure of animals, promotes development of early diagnosis and treatment of human neurodegenerative diseases. In this study, an improved contrast-to-noise ratio at 17.6 T imaging contribute to visualization the smaller vessels of the mouse brain. Branches of anterior cerebral artery (ACA) are better depicted on maximum intensity projections (MIP) with 17.6 T imaging than MIPs obtained with 9.4.

Time of Flight Magnetic Resonance Angiography of the Canine Brain at 3T and at 7T - A Quantitative Comparison
Steffen Sammet1, Paula Martin-Vaquero2, Rita E. Echandi2, Ronaldo C. da Costa2, Christina L. Tosti1, Michael V. Knopp3
1Department of Radiology, The Ohio State University, Columbus, OH, United States; 2Veterinary Hospital, The Ohio State University, Columbus, OH, United States; 3Department of Radiology, The Ohio State University, Columbus, OH, United States

The purpose of this study was to evaluate the ability of 2D ToF-MRA to depict cerebral arteries in the canine brain and to compare the results obtained from a high field magnet (3T) with an ultrahigh field magnet (7T). ToF-MRA at high and ultra-high magnetic fields should be included in MRI imaging protocol of dogs suspected of having cerebrovascular disease. 7T field ToF-MRA allows a better delineation of small vessels in the canine brain than 3T ToF-MRA.

Blood Contrast Agent Concentration Measured by Dynamic MRI in Intra- And Extracranial Mouse Vessels at 9.4 Tesla Using a Novel Cryogenic Probe
Melanie Heilmann1, Hanne Boll2, Sebastian J. Schambach2, Christoph Groden2, Marc A. Brockmann2, Lothar R. Schad3
1Computer-Assisted Clinical Medicine, Heidelberg University, Mannheim, Germany; 2Neuroradiology, University Medicine Mannheim, Germany

Quantitative dynamic MRI requires knowledge of contrast agent (CA) concentration in blood. Due to the small size of murine vessels, so far an arterial input function (AIF) has only been measured in mouse hearts. Using a novel cryogenic probe at 9.4 T, we measured CA kinetics in intra- and extracranial vessels. Although high inter-individual variations were observed, in average, kinetics of the superficial temporal vein provided good estimates for blood CA concentration. Smaller vessels suffered from partial volume effects but were less prone to inter-individual variations. Whether mouse perfusion studies benefit from vessel-based AIFs, remains to be studied in future.

Cerebral Blood Flow Change in One Hear Beat by CO2 Concentration Using Retrospective PC MRI Measurements
Yi-Jui Liu1, Chun-Jung Juan2, Teng-Yi Huang4, Hsiao-Wen Chung5, Cheng-Yu Chen5
1Department of Automatic Control, Feng Chia University, Taichung, Taiwan; 2Master's Program in Biomedical Informatics and Biomedical Engineering, Feng Chia University, Taichung, Taiwan; 3Department of Radiology, Tri-Service General Hospital and National Defense Medical Center, Taipei, Taiwan; 4Department of Electrical Engineering, National Taiwan University of Science and Technology, Taipei, Taiwan; 5Department of Electrical Engineering, National Taiwan University, Taipei, Taiwan

The purpose of this study was to evaluate the cerebral blood change in one cardiac cycle in different concentration of carbon dioxide inhalation. Using retrospectively gated 2D phase contrast MRI is suitable method for measuring the velocity of cerebral arteries and veins during one heart beat. It is noninvasive modality to quantify the blood flow and blood volume in one heart cycle with high spatial and temporal resolution. By this MR method, we proceeded the experiment that observe the blood flow change during the CO2 concentration change.

Quantification of Carotid Artery Blood Flow Before and After the Acetazolamide Challenge
Josephine Mary Reeve1, Dinesh Selvarajah1, Nyssa Craig1, Paul David Griffiths1, Solomon Tesfaye2, Iain D. Wilkinson1
1Academic Radiology, University of Sheffield, Sheffield, S Yorkshire, United Kingdom; 2Diabetes, Royal Hallamshire Hospital, Sheffield, S Yorkshire, United Kingdom

Cerebrovascular reserve or the ability to vasodilate under stress may be a crucial physiological mechanism, providing increased arterial flux when necessary. This study quantified flow within the internal carotid artery (ICA) in 14 normal young adults before and after administration of a carbonic anhydrase inhibitor (acetazolamide). Quantitative flow assessment was based on a single-slice, multi-phase, fast-field echo sequence. Data was extracted via ROI analysis. Significant increases in velocity, flux, apparent vessel...
Utility of Susceptibility Weighted Imaging for the Detection of Arteriovenous Shunting in Vascular Malformations of the Brain

Qianna Jin1, Tomoyuki Noguchi1, Hiroyuki Irie1, Masashi Nishihara1, Tetsuyoshi Hirai1, Masatou Kawashima2, Toshio Matsushima2, Sho Kudo1

1Neuroradiology, Washington University School of Medicine, St Louis, MO, United States; 2Neurosurgery, Saga University Hospital, Saga, Japan

We retrospectively evaluated the utility of susceptibility weighted imaging (SWI) in the detection of arterio-venous shunting (AVS) in 47 patients with 66 brain vascular malformations (BVM) identified on digital subtraction angiography (DSA). AVS was considered to be present if there was hyperintensity in a vein adjacent to the BVM. Overall, SWI had a sensitivity of 93%, specificity of 100% and accuracy of 97% for the detection of AVS. In the 13 BVMs associated with hemorrhage, SWI had sensitivity and specificity of 100%.

Comparative Study of 3.0- and 1.5-T MR in the Follow-Up of Moyamoya Disease

To retrospectively compare 3.0- and 1.5-T magnetic resonance (MR) findings in patients with moyamoya disease (MMD), and assess the relationship and difference between those two modalities in the follow-up of MMD. 60 (120 sides) MMD patients (15 male and 45 female) were included in the study. The patients were divided into two groups: group A (3.0-T MRI) and group B (1.5-T MRI). The examinations were performed at 3 and 18 months after the initial diagnosis.

High Resolution 3D Intracranial Imaging at 3.0T

Yiu-Cho Chung1, Steven Shea2, Ye Quao1, Orlando P. Simonetti3, Bruce Wasserman3

1Siemens Medical Solutions USA, Inc., Columbus, OH, United States; 2Siemens Corporate Research, United States; 3Johns Hopkins University, United States

Intracranial artery imaging is usually done by 2D TSE. However, the technique has long scan time, and has very limited anatomical coverage. We propose here the use of T1w-SPACE, a variant of TSE, for 3D imaging of the intracranial vessels. Using a 32 channel head coil at 3T, the technique achieves a spatial resolution of (0.5mm)3, comparable to CT, in less than 11 minutes. The technique can cover both sides of the tortuous ICA and MCA in one scan. SNR comparison found that the 3D technique has consistently higher SNR than 2DTSE.
female patients, age range: 5 to 60 years, post/pre-operative patients: 44/16) were included. We got different upgrading rate among one-year interval follow-up with 1.5- and 3.0-T MR in different orders. Regardless of disease progressing, we should be careful about 1.5-T MR in evaluating steno-occlusive severity of intracranial vessels in MMD for its higher overestimating rate compared with 3.0-T MR.

2258. Temporal Stability of Blood Flow Patterns in Cerebral Aneurysms Quantified with 2D Phase Contrast Magnetic Resonance Imaging In-Vivo

Christof Karmoukin1, Yi J. Zhang2, Orlando Diaz2, Richard Klucznik3, David Purdy3, Robert G. Grossman1
1Neurosurgery, The Methodist Hospital Neurological Institute, Houston, TX, United States; 2Radiology, The Methodist Hospital Neurological Institute, Houston, TX, United States; 3Siemens Healthcare, Malvern, PA, United States

Complex flow patterns in cerebral aneurysms have been identified by computational fluid dynamics (CFD) studies to potentially be predictive of aneurysm rupture. Here, we quantified the stability of blood flow patterns in cerebral aneurysms in vivo based on flow features in 2D pcMRI images in seven aneurysms. A stability index (SI) defined as the area fraction (in percent) exhibiting sign changes of the through-plane velocity was calculated. Average SI range was 1.3%-20.6%. Average SI and aneurysm size were linearly correlated (R=0.796). Further studies are warranted to explore the potential of the average SI as a marker for aneurysm rupture.


Elan J. Grossman1, Yulin Ge2, Matilde Inglese1, Ke Zhang1, Jing An2, Ding Xia3, Jian Xu4, Niels Oesingmann1, Kelly A. Mcgorty1, Joseph Reaume1, Robert I. Grossman1, Qun Chen4
1Center for Biomedical Imaging, Department of Radiology, NYU School of Medicine, New York, United States; 2Siemens Medical Solutions, Beijing, China; 3Siemens Medical Solutions, Malvern, PA, United States

Conventional imaging fails to reveal evidence of damage in mild traumatic brain injury (MTBI) that accounts for its disabling impairments. The purpose of the current study is to examine if perfusion changes in thalamus and basal ganglia can be a possible indicator of pathology in acute MTBI. We have employed segmented True-FISP ASL, which we recently developed to measure perfusion in deep gray matter at high spatial resolution. Results indicate there are significant differences between patients and controls in thalamus and caudate. This suggests these regions may exhibit hypoperfusion in acute MTBI and could be biomarkers of persistent post-concussive syndrome.

2260. Complex Flow Patterns in a Real-Size Intracranial Aneurysm Phantom: A PC-MRI Study Compared with PIV

Pim van Ooij1, Annetje Guédon2, Christian Poelma1, Joppe J. Schneiders4, Charles B. Majoie1, Jenny Dankei1, Ed vanBavel1, Aart J. Nederveen1
1Biomedical Engineering & Physics, Academic Medical Center, Amsterdam, Noord-Holland, Netherlands; 2Biomechanical Engineering, Delft University of Technology, Delft, Netherlands; 3Laboratory for Aero and Hydrodynamics, Delft University of Technology, Delft, Netherlands; 4Radiology, Academic Medical Center

To validate 4D blood flow velocity measurements in intracranial aneurysms using phase contrast MRI, a real-size glass phantom of an intracranial aneurysm was created and used for blood flow velocity measurements using PC-MRI and PIV. Resolution of PC-MRI was 0.5x0.5x0.5 mm and took 70 minutes to scan. Both steady and pulsatile flow measurements in MRI and PIV produced similar flow patterns of similar magnitude, although more noise was found in the MR results. Velocity to noise ratio will improve with more accurate velocity encoding settings. More importantly, to be able to apply the PC-MRI scan in patients, scan time needs to be shortened severely, for example by acceleration techniques.

2261. Distribution of Cerebral Blood Flow in the Nucleus Caudatus, Nucleus Lentiformis, and Thalamus in Patients with a Carotid Artery Stenosis

Nolan S. Hartkamp6, Reinoud P.H. Bokkers6, H. B. van der Worp7, L. J. Kappelle2, M. P.J. van Osch7, Willem P.T.M. Mali1, Jeroen Hendrikse1
1Department of Radiology, University Medical Center Utrecht, Utrecht, Netherlands; 2Department of Neurology, University Medical Center Utrecht, Utrecht, Netherlands; 3Department of Radiology, Leids University Medical Center, Leiden, Netherlands

For patients with a symptomatic internal carotid artery (ICA) stenosis, it is often difficult to identify the symptomatic artery for treatment due to the variability in perfusion territories of the major cerebral arteries. For the basal ganglia, this imposes an even greater difficulty. Using selective arterial spin-labeling MRI, this study found the nucleus caudatus in patients with a symptomatic ICA stenosis was more often fed by the contralateral ICA compared to healthy control subjects (p=0.03). This was accompanied by reversed blood flow through the ipsilateral anterior part of the circle of Willis (p<0.01).

2262. Value of Three-Dimensional Contrasted-Enhanced MR Angiography Combined with MRI in Diagnosis and Treatment of Cerebral Arteriovenous Malformations

Qi Liu1, Ping jian Lu1, Fei Wang1, li Wang2
1Radiology, Changzhai Hospital, Second Military Medical University, Shanghai, China

Cerebral arteriovenous malformations are congenital vascular lesions with dilated feeding arteries and draining veins without an intervening capillary bed. Treatment is recommended for most patients because of the risk of hemorrhage, which largely dependent on
the imaging information available before treatment. Three-dimensional contrasted-enhanced MR angiography combined with MRI, as a noninvasive technique with the advantages of arterial angiography, can depict the feeding arteries, venous drainage pattern, nidus, and provide more accurate localization of the nidus, adjacent brain anatomy. These data are important for the planning of surgical resection, endovascular embolization and radiotherapy.

### 2263. Flow-Sensitive Black Blood Imaging: Clinical Intracranial Applications

_Vijay Sawlani¹, J Spark², Faiza Admira-Behloul²_

¹Radiology, Morriston and Singleton hospitals ABM university NHS trust, Swansea, United Kingdom; ²Morriston and Singleton hospitals ABM university NHS trust, Swansea, United Kingdom

Susceptibility-weighted imaging (SWI) is sensitive to venous vasculature and is a powerful tool for evaluating vascular malformations such as venous angiomas. To enhance the visibility of small vascular structures, especially at 1.5T systems, a flow-sensitive black-blood (FS-BB) has been recently developed. The purpose of this study is to evaluate the utility of the FS-BB sequence in various intracranial lesions apart from vascular malformations.

### 2264. Characterization of Carotid Plaque in Vivo and ex Vivo Using MRI, CTA and Histology

_Maria Rosario Lopez Gonzalez¹, William Matthew Holmes², William Stewart³, Keith W. Muir³, Barrie Condon, George Welch³, Kirsten Forbes_

¹SINAPSE, Clinical Physics, University of Glasgow, Glasgow, United Kingdom; ²GEMRIC, Wellcome Surgical Institute, Faculty of Medicine, University of Glasgow, Glasgow, United Kingdom; ³Department of Neuropathology, Institute of Neurological Sciences, Southern General Hospital, Glasgow, United Kingdom

In-vivo 3T MR and CTA images were acquired of symptomatic stroke patients. These images show that most of the patients presented high degrees of atherosclerotic carotid plaque. To help to identify unstable and vulnerable plaques, segmentation of the different plaque components was carried out by using a semi-automatic thresholding method. Half of the patients underwent surgical excision of the carotid plaque. The specimens obtained were imaged in a 7T scanner. The specimens were sectioned and stained with hematoxylin-eosin and Elastin van Gieson. Correlation of the MRI datasets and Histology was carried out.

### 2265. Supraaortic MRA and Vessel Wall Enhancement with a Blood Pool Contrast Agent at 3.0T: Preliminary Results in Carotid Artery Disease and Intravascular Comparison with Gd-DTPA

_Dariusch Reza Hadizadeh¹, Guido Matthias Kukul¹, Jürgen Gieseke¹, Arne Koscielny³, Frauke Verrel², Jack Boschewitz², Ute Fahlenkamp², Hans Heinz Schild³, Winfried Albert Willinek²_

¹Radiology, University of Bonn, Bonn, NRW, Germany; ²Vascular surgery, University of Bonn, Bonn, NRW, Germany; ³Vascular surgery, University of Bonn, Bonn, NRW, Germany

Vessel wall enhancement may serve as a potential marker for identification of high-risk atherosclerotic plaques. 3D-MRA and plaque enhancement at the level of the carotid bifurcation were assessed after application of the blood pool contrast agent gadofosveset trisodium and Gd-DTPA at 3.0 Tesla. 24h after injection of Gd-DTPA, no remaining vessel wall enhancement was observed, whereas remaining vessel wall enhancement (10% in atherosclerotic plaque and 2% in non-diseased vessel walls) was observed after injection of Gadofosveset Trisodium. Residual vessel wall enhancement 24h after injection of gadofosveset trisodium may reflect neo-vascular density and be a predictor for future ischemic events.


_Yoko Saito¹, Minoru Osanai¹, Kauzhiro Oyu², Ketto Hamada², Hiraku Yodono³_

¹Graduate School of Health Sciences, Hirosaki University, Hirosaki, Aomori, Japan; ²Radiology, Narumi Hospital, Hirosaki, Aomori, Japan; ³Radiology, University of Miami, Miami, FL, United States

We evaluated the stenotic degree of arteries at the skull base level which are demonstrated on both 3D-TOF MRA and CE-MRA in 139 cases (659 vessels). The discrepancy between these two technique in grading stenotic degree occurred in 80 arteries. The stenotic grading were more severely estimated with CE MRA than with TOF MRA. We also performed phantom study. TOF-MRA tended to demonstrate the phantom more accurately than CE-MRA. On TOF- MRA with 1.6mm slice thickness, diameters were most accurately demonstrated. In CE-MRA, diameters of the tube were significantly more accurate with parallel imaging than with ZIP.

### 2267. Direct Visualization and Quantitation of CSF Flow in Shunts

_Noam Alperin¹, Sang H. Lee¹, Leonardo Macedo², Daniele Rigamonti², Ari Blitz²_

¹University of Miami, Miami, FL, United States; ²Radiology, University of Miami, United States

Diversion of excessive CSF from hydrocephalic brains by shunting is, in many cases, a life saving procedure. The down side of shunting is high failure rate. Consequently, about 40% of the shunting procedures performed annually in the US are for shunt replacement. The decision for shunt replacement is challenging as there is no reliable noninvasive test for shunt function. We present the first direct visualization and quantitation of CSF flow in ventricular shunts using high temporal and spatial resolution cine phase.
contrast MR and automated flow quantitation technique. Volumetric flow rate through in patent shunts were on the order of the CSF production rate.

**Manganese - Enhanced MRI**

**Hall B Wednesday 13:30-15:30**

---

**2268. Using Manganese-Enhanced MRI (MEMRI) to Detect the Order of Neuronal Connections in the Olfactory Pathway at the Level of Specific Layers**

*Der-Yow Chen*, Stephen J. Dodd, Daniel R. Glen, Ziad S. Saad, Alan P. Koretsky

1NINDS, National Institutes of Health, Bethesda, MD, United States

MEMRI can be used for neuronal tracing in the brain. Here it is demonstrated that MEMRI identifies the laminar connections of the olfactory system and traces layer-specific inputs to olfactory cortices. MnCl₂ was injected into nostrils or the olfactory bulb of rats, and they were imaged with this MRI technique at several time points. The dynamic changes of Mn²⁺ enhancement could be characterized by the arrival latency into each specific region. The olfactory pathway from olfactory bulb to higher-order cortex was labeled in proper, known laminar order. Mn²⁺ enhancement into the orbitofrontal cortex predicts that connections from olfactory cortex innervate superficial layer of the orbitofrontal cortex. This is a connection that has not been previously mapped. Therefore, MEMRI neural tracing is specific at the level of cortical layers in the olfactory pathway.

---

**2269. Evaluation of the Applicability of Manganese-Enhanced and Dynamic Gadolinium-Enhanced Imaging to Study the Role of Caveolin-1 in Blood-Retinal Barrier Integrity**

*Philippe Garteiser*, Bruce A. Berkowitz, Debbie Saunders, Rebecca Cranford, Rheal A. Towner, Michael H. Elliott

1Advanced Magnetic Resonance Center, Oklahoma Medical Research Foundation, Oklahoma City, OK, United States; 2Department of Anatomy and Cell Biology, Wayne State University, Detroit, MI, United States; 3Department of Ophthalmology, Wayne State University, Detroit, MI, United States; 4Department of Ophthalmology, Dean A McGee Eye Institute, University of Oklahoma Health Sciences Center, Oklahoma City, OK, United States

Mn-enhanced MRI (MEMRI) has recently emerged as an important tool in retinal function studies. Caveolin-1 (Cav-1), the principal protein member of caveolar membrane domains, is believed to be essential to blood-retinal barrier integrity and ion homeostasis of the retina. Here, we evaluate how MEMRI and other MRI techniques may detect functional disruptions induced by cell type-specific knockout of the Cav-1 gene in mice. The MEMRI signature of light and dark adaptation and the dynamic gadolinium-enhanced signal behavior of iodate-induced retinal impairments indicate that both methods have sufficient sensitivity to warrant their application to cell-type specific Cav-1 ko mice.

---

**2270. Layer-Specific Anatomical MRI of the Retina with Balanced Steady State Free Precession with and Without Manganese Enhancement**

*Eric Raymond Muir*, Bryan H. De La Garza, Sung-Hong Park, Timothy Q. Duong

1Biomedical Engineering, Georgia Institute of Technology, Atlanta, GA, United States; 2Research Imaging Institute, Ophthalmology/Radiology, UT Health Science Center San Antonio, San Antonio, TX, United States; 3Research Imaging Institute, Radiology, UT Health Science Center San Antonio, San Antonio, TX, United States

Anatomical MRI of the retina has previously reported 3-4 layers in the rodent retina using conventional gradient echo (GE) and spin echo MRI. Following intraretinal injection of manganese, seven layers were detected previously. This study explored balanced steady state free precession (bSSFP) MRI to image the mouse retina at 35x35x200 µm. Moreover, we compared GE and bSSFP with and without intraretinal manganese injection. We demonstrated that bSSFP can reveal 7 layers without using contrast agent. Layers detected by bSSFP without manganese were consistent with those of manganese-enhanced MRI and histology.

---

**2271. Assessing in Vivo Axonal Transport Rates from Deep Brain Structures in Mouse Models of Human Disease**

*Taeko Inoue*, Robia G. Pautler

1Dept. of Molecular Physiology & Biophysics, Baylor College of Medicine, Houston, TX, United States

Axonal transport is an important cellular mechanism necessary for the normal function and viability of a neuron. As a result, deficits in axonal transport have become associated with the development and progression of human diseases such as diabetes and neurodegenerative diseases such as Alzheimer’s disease. Here we demonstrate the potential of Manganese Enhanced MRI (MEMRI) for measuring in vivo deficits of axonal transport in two mouse models of human disease.
Peripheral administration of monosodium glutamate (MSG) stimulates feeding in rodents. This may be due to the direct activation of glutamate receptors expressed in the arcuate nucleus (ARC) of the hypothalamus. We have used manganese enhanced MRI (MEMRI) to demonstrate that intraperitoneal administration of MSG dose dependently increases Mn²⁺ influx into the ARC and that this can be suppressed with a glutamate receptor subtype specific receptor antagonist. These results reveal that MEMRI is a sufficiently sensitive tool to detect glutamatergic signalling in vivo with high temporal and spatial resolution.

Manganese enhanced MRI (MEMRI) allows in-vivo mapping of functional neuronal connections in the brain. The method was used to investigate the olfactory system in mice with experimental neuropsychiatric lupus (NPSLE), induced by intra-cerebro-ventricular injection of anti-ribosomal-P antibodies. MEMRI scans were performed before and 40 hours after intranasal MnCl₂ administration. NPSLE induction resulted in a depression-like behavior accompanied with a significant deficit in olfactory function. MEMRI demonstrated impaired olfactory neuronal function expressed as a significant reduction in normalized manganese enhancement and flow throughout of the olfactory pathway, compared to healthy mice. Our results propose that autoimmune-CNS conditions may influence olfactory function.

Manganese-enhanced magnetic resonance imaging (MEMRI) is a potentially powerful diagnostic method for identifying neural regions of pain processing for image-guided interventions. Manganese can enter nerves via voltage-gated calcium channels, which are selectively upregulated in pain. We gave manganese by oral gavage to two rat groups: one with spared injury of their sciatic nerves and a sham-operated group. We found that rats with spared nerve injury have increased manganese ion uptake and retention in their nerves compared to the nerves of sham-operated rats as shown by increased MR signal and nerve concentrations. Therefore, manganese can specifically enhance nerves associated with nociception.

The ability of in vivo diffusion tensor imaging to detect axonal plasticity in dentate gyrus sub region of hippocampus was studied in rats after kainic acid induced status epilepticus. Our results show that fractional anisotropy of dorsal dentate gyrus is increased 17 months after the brain injury when compared to healthy control animals. Histological evaluation showed significant increase in the density of mossy fiber sprouting and myelinated axons the kainic acid treated animals, consistent with the DTI results. The results of this study suggest that axonal plasticity can be detected using in vivo DTI.

Plasticity in the adult brain following learning procedure is commonly attributed to functional plasticity and restricted to the hippocampus. This study we utilize Magnetic diffusion tensor imaging (DTI) in order to characterize microstructural plasticity induced by short-term learning paradigm. Analyses were done by ADC and FA parameters in order to characterize both white and gray matter changes. Rats were scanned before and one day after a one-day version of the Morris water maze task. Paired t-test comparisons demonstrate FA increase in the cingulum bundle and FA and ADC decrease in striatum-related gray matter, motor and sesorimotor cortex.
2277. Investigation of Tissue Plasticity Following Low-Dose Amphetamine Treatment in Transient Ischemic Rat Stroke Model Using Diffusion Tensor Imaging
Hua-Shan Liu1, Hui Shen1, Hanbing Lu1, Jenny Chou1, April P. Zhu1, William Rea1, Yun Wang1, Yihong Yang1
1National Institute on Drug Abuse, Baltimore, MD, United States

There is considerable evidence to suggest that amphetamine can improve functional outcome in animal model of stroke, which is involved in the mechanisms of induced axonal growth and reinnervation of brain tissues. In this study we used DTI to assess changes in perilesional tissue integrity after amphetamine treatment in a rat stroke model. We found that FA showed a significantly higher increase under the influence of amphetamine after 25 days.

2278. Learning Is Necessary for Training Induced Brain Plasticity
Jason Philipp Lerch1, Amanpreet Badhwar2,3, Edith Hamel2, John G. Sled1
1Mouse Imaging Centre, Hospital for Sick Children, Toronto, Ontario, Canada; 2McGill University, Montreal, Quebec, Canada; 3contributed equally to this abstract

Here we used a mouse model of Alzheimer’s Disease (AD) with impaired spatial learning to test whether a capacity to learn is necessary for training induced MRI detectable volume changes to occur. Mice were trained on two different versions of the Morris Water Maze, fixation perfused and scanned overnight at 32 µm isotropic resolution. As hypothesized, hippocampal based spatial learning was impaired in AD mice, whereas striatum dependent non-spatial learning was equivalent between AD and wild-type mice. The data presented herein thus indicates that learning is a requirement for MRI detectable plasticity.

fMRI in Brain Diseases
Hall B Monday 14:00-16:00

2279. Functional Asymmetry of Hippocampal Subfields in Temporal Lobe Epilepsy: An Application of Postmortem Atlas
Sandhitsu R. Das1, Dawn Mechanic-Hamilton2, Marc Korczykowski2, John Pluta2, John A. Detre2, Paul A. Yushkevich1
1Department of Radiology, University of Pennsylvania, Philadelphia, PA, United States; 2Department of Neurology, University of Pennsylvania, Philadelphia, PA, United States

We present preliminary data demonstrating the use of postmortem hippocampus atlas to study activation asymmetry in patients with unilateral temporal lobe epilepsy

2280. Spatiotemporal Network Alterations in Experimental Focal Cortical Epilepsy: MRI-Based Longitudinal Functional Connectivity and Weighted Graph Analysis
Willem M. Otte1,2, Rick M. Dijkhuizen1, Cornelis J. Stam1, Kajo van der Marel2, Maurits P.A. van Meer1,2, Max A. Viergever2, Kees P.J. Braun1
1Rudolf Magnus Institute of Neuroscience, University Medical Center Utrecht, Utrecht, Netherlands; 2Image Sciences Institute, University Medical Center Utrecht, Utrecht, Netherlands; 3Department of Clinical Neurophysiology, VU University Medical Center, Amsterdam, Netherlands

There is increasing evidence that the topology of brain networks may be changed in epilepsy. In particular, a random topology has been suggested as an explanation for lower seizure thresholds. To test this hypothesis, we assessed focal epileptic and healthy networks over time using resting state functional MRI and weighted graph theoretical analysis in a rat model. Brain networks in focal epilepsy were globally affected, toward a more ordered network topology. Networks largely normalized at ten weeks after epilepsy induction. Graph analysis provides a promising method to explore dynamical network alterations in epilepsy.

2281. Role of Resting State Functional Connectivity Mri in Presurgical Investigation of Mesial Temporal Lobe Epilepsy
Gaëlle Bettus1,2, Fabrice Bartolomei3, Sylviane Confort-Gouny1, Eric Guedj1, Patrick Chauvel1, Patrick Cozzone1, Jean-Philippe Ranjeva1, Maxime Guye1
1CNRS UMR6612 CRBM-CEMEREM, Marseille, France; 2INSERM U751 Epilepsie et Cognition, Marseille, France

We aimed at determining the ability of resting-state functional connectivity MRI (fcMRI) to lateralize/localize the epileptogenic zone in mesial temporal lobe epilepsy (MTLE) at the individual level. Basal functional connectivity (BFC) was evaluated in 22 MTLE patients compared to 36 controls using a single shot GE-EPI sequence at rest. In patients, BFC was characterized by bilateral decreases predominant in the epileptic side, and unilateral increases almost exclusively observed in the contralateral (non-epileptic) side. We suggest that fcMRI is a useful technique that could be added to the presurgical assessment of drug-resistant partial epilepsies.
In this study we applied two different methods to analyze fMRI data, acquired simultaneously with EEG, coming from experiments involving patients with Idiopathic Generalized Epilepsy or with Cryptogenic Partial Epilepsy. We used first the data driven ICA (Independent Components Analysis) on fMRI data, while in the second approach we applied the GLM (General Linear Model) on the same data, but exploiting the EEG recording to compute the regressor. ICA and GLM analysis detected either activation areas located in agreement with presumed electroclinical hypothesis and the BOLD patterns of activation in response to synchronized ictal activity.

Functional MRI (fMRI) has the potential for non-invasively localizing interictal epileptic activity more accurately than other clinical methods. Currently the gold standard for detecting the timing of interictal activity during the fMRI scan is simultaneous electroencephalography (EEG). The objective of this work is to compare a data-driven method, 2dTCA, to EEG/fMRI in temporal lobe epilepsy. Overall, there was good qualitative agreement between the two methods with the 2dTCA maps showing more mesial activation in patients with Idiopathic Generalized Epilepsy or with Cryptogenic Partial Epilepsy. We used first the data driven ICA, then the data driven GLM (General Linear Model) analysis detected either activation areas located in agreement with presumed electroclinical hypothesis and the BOLD patterns of activation in response to synchronized ictal activity.

In this study we applied two different methods to analyze fMRI data, acquired simultaneously with EEG, coming from experiments involving patients with Idiopathic Generalized Epilepsy or with Cryptogenic Partial Epilepsy. We used first the data driven ICA (Independent Components Analysis) on fMRI data, while in the second approach we applied the GLM (General Linear Model) on the same data, but exploiting the EEG recording to compute the regressor. ICA and GLM analysis detected either activation areas located in agreement with presumed electroclinical hypothesis and the BOLD patterns of activation in response to synchronized ictal activity.

Functional MRI (fMRI) has the potential for non-invasively localizing interictal epileptic activity more accurately than other clinical methods. Currently the gold standard for detecting the timing of interictal activity during the fMRI scan is simultaneous electroencephalography (EEG). The objective of this work is to compare a data-driven method, 2dTCA, to EEG/fMRI in temporal lobe epilepsy. Overall, there was good qualitative agreement between the two methods with the 2dTCA maps showing more mesial temporal activation concurring with the presumed epileptogenic region in these patients, without the need for the additional hardware, software, analyses and scalp EEG spikes required for EEG/fMRI.

Language fMRI in aphasic patients is exceptionally challenging. The patients often have latency in responding to cognitive tasks. Using a data-driven approach for analysis might enable extraction of language networks even if the task is not performed at the intended pacing. In this study, five patients with chronic aphasia were examined. Conventional analysis did not result in language activation in most patients. When using a data-driven approach, four out of five patients elicited language related networks. It was concluded that language areas in patients with aphasia could be extracted using data driven analysis even if the conventional fMRI analysis fails.

In this study, single subject net hemodynamic responses to paired stimuli from patients with migraine without aura and controls are fitted using inverse logit functions and compared. We demonstrate that patients with migraine without aura do not show a decrease in amplitude of their interictal hemodynamic response to a second stimulus in a pair with 1 second interstimulus interval, whereas the control group shows hemodynamic refractory effects when looking at repetitive stimuli. The finding in this patient group may be the neurovascular correlate of the absence of electrophysiological habituation.

The objective of this study is to evaluate the alterations in the whole-brain functional connectivity after fronto-occipital impact mild traumatic brain injury (MTBI). We used the resting state fMRI to relate the cognitive deficits occurring after fronto-occipital impact MTBI to the disruptions in functional connectivity. We found the disintegration of prefrontal, temporal and parietal regions in resting-state networks of MTBI patients and showed that the disconnection between prefrontal regions underlies the decline in the rate of information processing.
2287. fMRI Study of Response to Semantic Cuing During Verbal Learning in TBI

Rebecca Jo Chambers¹, William M. Brooks¹, JoAnn Lierman¹, Laura E. Martin¹, Amanda Bruce¹,², Brenda A. Kirchhoff¹, Monica Kurylo, Linda Ladesich, George Varghese, Cary R. Savage¹

¹Hoglund Brain Imaging Center, University of Kansas Medical Center, Kansas City, KS, United States; ²University of Missouri - Kansas City; ³University of Missouri - St. Louis

Following TBI, memory functioning is frequently disrupted, and patients may not benefit from cognitive rehabilitation therapy. In an fMRI study, participants’ responses were measured during a verbal learning task of semantically related or unrelated word lists. They were asked to first remember the words with no further instruction, and then were cued to the semantic nature of the task. Both groups benefitted from semantic cueing, but showed differential brain responses in left DLPFC, a region implicated in working memory. This finding may suggest that after TBI, patients must compensate with additional neural processing in DLPFC to benefit from semantic cueing.

2288. Adaptive Changes in Response Inhibition BOLD Responses Following Antidepressant Treatment

Darragh Downey¹, Karen Elizabeth Davies¹, Shane McKie², Gabriella Juhasz², Ian Muir Anderson¹, John Francis William Deakin², Stephen Ross Williams¹

¹Imaging Science and Biomedical Engineering, University of Manchester, Manchester, Lancashire, United Kingdom; ²Neuroscience and Psychiatry Unit, University of Manchester, Manchester, Lancashire, United Kingdom

We investigated adaptive changes in 5-HT signalling following sub-chronic antidepressant treatment in healthy controls performing a response inhibition paradigm. 24 healthy volunteers were provided with 20mg citalopram or placebo for 11 days and tested with a behavioural inhibition task after 14 days following a 3 day drug washout. Citalopram pre-treatment compared to placebo was associated with a reduced response bilaterally in the inferior frontal gyrus and BOLD increases in the right middle frontal gyrus, mid cingulate, precuneus and posterior cingulate when inhibiting responses. These findings suggest that chronic antidepressant treatment modifies 5-HT pathways involved in cognitive flexibility and inhibitory control.

2289. A Novel FMRI Task to Visualize Frontal Lobe Circuitry Associated with Transient Sadness

Leslie Baxter¹, Ryan Smith¹, Richard Fadok¹, Michael Purcell¹, Seban Liu¹, Josef Debbins¹

¹Neuroimaging, Barrow Neurological Institute, Phoenix, AZ, United States

We developed a novel functional magnetic resonance imaging (fMRI) method designed to activate the subgenual anterior cingulate cortex (sACC) and other frontal regions during transient sadness. We sought to develop a task that would show sufficient and specific activation in individuals to be useful as a potential target for deep brain stimulation treatment (DBS).

2290. Trait Anxiety and Serotonin Transporter Polymorphism Influence Amygdala Activation as Measured with FMRI During Fear Extinction at 3 T

Harald Kugel¹, Christina Sehlmeyer²,³, Udo Dannlowski²,³, Sonja Schoening²,³, Martin Pyka²,³, Astrid Veronika Rauch²,³, Katharina Domschke², Bettina Pfleiderer³, Pienie Zwiterlood¹, Walter Heindel¹, Volker Arolf¹, Carsten Konrad³,⁴

¹Dept. of Clinical Radiology, University of Muenster, Muenster, NRW, Germany; ²Dept. of Psychiatry, University of Muenster, Muenster, NRW, Germany; ³Research Group 4, Interdisciplinary Center for Clinical Research (IZKF), University of Muenster, Muenster, NRW, Germany; ⁴Dept. of Psychiatry, University of Muenster, Muenster, NRW, Germany; ⁵Dept. of Psychiatry, University of Marburg, Marburg, HE, Germany

The effect of the serotonin transporter polymorphism 5-HTTLPR and trait anxiety on amygdala activation during fear conditioning and extinction was investigated with fMRI. 32 volunteers were tested with a fear-conditioning paradigm, presenting neutral faces combined with an acoustic startle. Individual trait anxiety was determined with the State Trait Anxiety Inventory (STAI). Evaluation showed that trait anxiety and 5-HTTLPR polymorphism did not affect acquisition, but fear extinction. Trait anxious volunteers and carriers of the short s-allele showed less deactivation of the amygdala during extinction, demonstrating that they react strongly to fear stimuli, and they can extinct fear reactions less easily.
Functional Differences in Mental Rotation Between Men and Transsexual Patients Before and During Hormone Therapy Studied with FMRI at 3 T

Harald Kugel1, Sonja Schoening2, Almut Engelien1, Anette Kersting2, Cornelia Roestel3, Pienie Zwitserlood3, Wolfgang Lehmann3, Walter Heindel4, Volker Arolt5, Carsten Konrad6,7

1Dept. of Clinical Radiology, University of Muenster, Muenster, NRW, Germany; 2Dept. of Psychiatry, University of Muenster, Muenster, NRW, Germany; 3Research Group 4, Interdisciplinary Center for Clinical Research (IZKF), University of Muenster, Muenster, NRW, Germany; 4Dept. of Psychology, University of Muenster, Muenster, NRW, Germany; 5Dept. of Psychology, University of Magdeburg, Magdeburg, ST, Germany; 6Research Group 4, Interdisciplinary Center for Clinical Research (IZKF), University of Muenster, Muenster, NRW, Germany; 7Dept. of Psychiatry, University of Marburg, Marburg, HE, Germany

In order to investigate differences in neurobiological processes in patients with gender identity disorder, 11 male-to-female transsexual patients before, 11 patients during cross-sex hormone therapy, and 11 control males underwent fMRI while performing a sexually dimorph mental rotation paradigm. The transsexual subjects showed less activation in the left parietal cortex (BA 40). Activation patterns different from controls, i.e. distinct from their biological sex, did not change during hormonal treatment.

Temporal Modulation in Connectivity Within the Salience Network in Autism

Juha Nikkinen1, Jukka Rahko2, Tuomo Starck1, Jukka Remes1, Ahmed Abou Elseoud1, Irma Moilanen2, Osmo Tervonen1, Vesa Kiviniemi1

1Department of Diagnostic Radiology, Oulu University Hospital, Oulu, Finland; 2Department of Child Psychiatry, Oulu University Hospital, Oulu, Finland

Temporal modulation in connectivity within the salience network (SN) has been investigated in autism spectrum disorder (ASD) utilizing group independent component analysis (ICA). Using the ICA mixing matrix time courses, connectivity between the components including SN structures, anterior insula (AI) and anterior cingulate cortex (ACC), was investigated. One IC was found to be focused at AI and ACC structure was shown to be detectable in two ICs, ventral ACC and dorsal ACC. As a result we show that the temporal modulation in connectivity is altered in ASD between the AI and ventral ACC components.

Attachment Model Affects Brain Responses in Areas Related to Empathy and Maternal Behaviour

Delia Lenzi1,2, Cristina Trentini3, Patrizia Pantano1, Emiliano Macaluso3, Gian Luigi Lenzi1,4, Massimo Ammaniti

1Dipartimento di Scienze Neurologiche, Università di Roma "Sapienza", Roma, Italy; 2Neuroimaging Laboratory, Fondazione Santa Lucia, Roma, Italy; 3Department of Dynamic and Clinical Psychology, Università di Roma "Sapienza", Roma, Italy; 4Centro per le Scienze della Salute e della Mente dell'Uomo, Università di Roma "Sapienza", Rome, Italy

Within the Attachment theory, Securely attached people tend to have positive views of themselves and their relationships. They feel comfortable with intimacy and independence, balancing the two in their relationships. Dismissive-avoidant adults tend to suppress and hide their feelings, dealing with rejection by distancing themselves from partners. Using fMRI we show that Dismissive subjects during the observation of stimuli activating attachment and maternal feelings have a overall greater reaction when compared to Secure subjects, i.e. greatly activate areas related to empathy and emotions (mirror neuron and limbic system) and inhibit areas related to maternal behaviour (anterior cingulated cortex).

Differences of Functional Activation Patterns Between Subjects with Mild Cognitive Impairment and Normal Subjects

Mingwu Jin1, Victoria Pelak2, Tim Curran3, Marie Banich3, Rajesh Nandy4, Dietmar Cordes5

1C-TRIC and Radiology, University of Colorado Denver, Aurora, CO, United States; 2Neurology, University of Colorado Denver, Aurora, CO, United States; 3Institute of Cognitive Science, University of Colorado at Boulder, Boulder, CO, United States; 4Biostatistics and Psychology, UCLA, Los Angeles, CA, United States

Functional MRI (fMRI) is an important imaging modality to reveal altered function in neurodegenerative diseases. We hypothesize that functional changes in activation occur earlier and can be measured before structural degeneration is obvious. fMRI can potentially lead to an imaging marker for the early diagnosis of mild cognitive impairment (MCI) and furthermore may predict the development of Alzheimer’s disease (AD). In this work, we present fMRI results of 8 MCI and 8 normal subjects using different memory paradigms.
2295. Functional Connectivity in Resting State CBF Mapping in Postherpetic Neuralgia

Jing Liu1, Yue Zhang2, Xiaoying Wang1, Mingyi Du1, Jue Zhang3
1Department of Radiology, Peking University First Hospital, Beijing, China; 2College of Engineering, Peking University, Beijing, China; 3Department of Radiology, Peking University First Hospital, Beijing, China

Given the poor specificity and reproducibility of blood oxygenation level dependent (BOLD), we use cerebral blood flow for the first time to build resting-state networks of default mode both in patients suffering from postherpetic neuralgia and healthy subjects, and compare the two groups. The results of functional connectivity in healthy subjects showed that the areas activating were the same with the parts previously described in the literatures using BOLD. The results between-groups comparison showed that some parts were in strengthened correlation of posterior cingulate cortex in patients, such as anterior cingulated cortex and insula which are related to pain.

2296. Identification of Hyperactive Intrinsic Amygdala Network Associated with Impulsivity in Abstinent Heroin Addicts

Chunming Xie1, Liping Fu1, Lin Ma1, Wenjun Li1, Alex Cohen1, Zheng Yang2, Shi-Jiang Li1
1Medical College of Wisconsin, Milwaukee, WI, United States; 2Beijing Institute of Basic Medical Science, Beijing, China; 3Department of Radiology, The PLA General Hospital, Beijing, China

The purpose of this study was to investigate the neurophysiological underpinnings of impulsive network on abstinent heroin addicts using resting-state functional connectivity method. Heroin subjects showed the higher impulsive scores and abnormal amygdala networks activity. The altered amygdala network strengths significantly correlated with impulsivity, and different correlation patterns were fund in heroin subjects relative to control subjects. This finding indicated the neural constructs of impulsive network was different in these two group subjects and altered amygdala network activity in heroin subjects makes a critical contribution to the impulsive dysfunction and represents the pathological damage underlying the impulsive control.

2297. Changes in Glutamate Levels After an FMRI Experiment

Paul G. Mullins1, Niklas Ihssen2, David Linden1, Miles Cox1
1Psychology, Bangor University, Bangor, Gwynedd, United Kingdom

MRS measures of brain chemistry are often considered static snapshots. We present MRS data showing an increase in Glutamate levels in the anterior cingulate cortex from baseline after a cognitive fMRI task. The biologic and methodologic implications of these findings are discussed.

2298. Development of a 17.6T Ultra-High Field BOLD-FMRI Method for Amygdala

Markus Friedrich Hildenbrand1, Stephan Nauroth2, Xavier Helluy1, Philipp Moerchel3, Angelika Schmitt4, Klaus-Peter Lesch5
1Research Center Magnetic Resonance Bavaria (MRB), Wuerzburg, Germany; 2Department of Psychiatry, University of Wuerzburg, Germany; 3Department of Experimental Physics 5, University of Wuerzburg, Germany

For psychiatric disorders being a worldwide strain to individuals and the health care systems and still being without comprehensive therapies, the mouse as model organism is a very promising research approach. Based on the development of a 17.6T ultra-high field BOLD-fMRI method for targeting the amygdala in the mouse brain, an access to serotonin mediated psychiatric diseases has been accomplished. By the usage of predator odor the activation of the amygdala shows a high sensitivity and specificity which yields a very good observation of the location and time devolution of the stimulus in the amygdala over a specified time period.

2299. Short-Long Functional Polymorphism of Serotonin Transporter Gene Modulates the Acute Citalopram Challenge PhMRI Response

Darragh Downey1, Gabriella Jukasz2, Shane McKie2, Karen Elizabeth Davies1, Emma Jane Thomas1, Diana Chase2, Rebecca Elliot2, John Francis William Deakin1, Ian Mair Anderson2, Stephen Ross Williams1
1Imaging Science and Biomedical Engineering, University of Manchester, Manchester, Lancashire, United Kingdom; 2Neuroscience and Psychiatry Unit, University of Manchester, Manchester, Lancashire, United Kingdom

We investigated whether citalopram-challenge phMRI, as a probe of serotonin transporter function, would detect functional variants of the serotonin transporter gene and how this may influence normal serotonergic function. 42 normal volunteers underwent phMRI with intravenous 7.5mg citalopram. Homozygous Short/Short allele carriers had reduced BOLD responses bilaterally in the caudate, mid-cingulate gyrus and parietal cortex and increases in the superior frontal gyrus compared with the Long/Long carriers. The results offer the first direct evidence that the short and long variants of the 5HTT promoter region indeed influence synaptic 5HT function in the living human brain.

2300. Occupational Solvent Exposure and Working Memory Function

David Matthew Carpenter1, Emily L. Eaves1, Cheuk Ying Tang1, Gudrun Lange1,3, Johnny Ng1, Nancy L. Fiedler2
1Radiology, Mount Sinai School of Medicine, New York, United States; 2Psychiatry, UMDNJ-New Jersey Medical School, Newark, NJ; 3Radiology, UMDNJ-New Jersey Medical School, West Orange, NJ, United States
In this report, BOLD fMRI was used to investigate the functional deficits of subjects with long-term occupational solvent exposure. Subjects underwent fMRI while performing a Sternberg task and N-back working memory task. We used an exploratory voxel-wise and ROI analysis to test the hypothesis that the occupationally exposed subjects show hypo-activation in regions associated with working memory when compared to a carefully matched control group. The results suggest that prolonged occupational solvent exposure is related to a decreased activation in regions associated with working memory.

### 2301. Can Resting State Measurements Supplement Task Based FMRI for Presurgical Motor Cortex Mapping? a Test-Retest Reliability Study

**Peter Mannfolk¹, Markus Nilsson¹, Ronnie Wirestam¹, Freddy Ståhlberg¹,², Peter Fransson⁴, Andreas Weibull⁴, Johan Olsrud¹,³**

¹Dept. of Medical Radiation Physics, Lund University, Lund, Sweden; ²Dept. of Diagnostic Radiology, Lund University Hospital, Lund, Sweden; ³Department of Clinical Neuroscience, Stockholm Brain Institute, Karolinska Institute, Stockholm, Sweden; ⁴Dept. of Medical Radiation Physics, Lund University, Malmö, Sweden; ⁵Center for Medical Imaging and Physiology, Lund University Hospital, Lund, Sweden

Clinical BOLD fMRI of children or in patients showing severe disease-related impairment can be difficult as active participation is required. Therefore, the possibility of using resting state data would be of great value. The aim of this study was to evaluate the test-retest reliability in detecting the intrinsic motor network from resting state data as compared to activation maps based on a bilateral finger tapping task. The test-retest reliability of resting state data was found to be comparable to what is seen for a typical task based fMRI experiment within a subject. However, large differences between subjects were also found.

### 2302. Correcting for EPI Distortion at Very High Field Using the Fieldmap Method with Multi-Channel Coils: Effectiveness in Presurgical Planning FMRI at 7 T

**Simon Robinson¹, Alexander Geissler², Siegfried Trattnig¹, Roland Beisteiner²**

¹High Field MR Centre, Department of Radiology, Medical University of Vienna, Vienna, Austria; ²Clinical fMRI Study Group, Departments of Neurology, Neurosurgery, and Radiology, Medical University of Vienna, Austria

We assess the effectiveness of a fast MGE sequence and postprocessing steps for fieldmapping with multichannel coils in correcting for EPI distortions in presurgical planning fMRI at 7T. Complex conjugate phase combination, unwrapping, denoising and fieldmap thresholding (for maximum achievable remapping) are described. Four patients underwent multiple runs of motor area localisation. Without distortion correction, primary foci for hand activation were mislocalised by 5-7mm, which could give rise to serious postoperative impairment of function. No residual distortions were observed after distortion correction, allowing fMRI results to be reliably registered to structural images and imported into neurosurgical planning systems.

### 2303. An Objective Approach to FMRI Assessment of Language Lateralization

**David F. Abbott¹,², Anthony B. Waites¹,², Graeme D. Jackson¹,³**

¹Brain Research Institute, Florey Neuroscience Institutes (Austin), Melbourne, Victoria, Australia; ²Department of Medicine, The University of Melbourne, Melbourne, Victoria, Australia; ³Departments of Medicine & Radiology, The University of Melbourne, Melbourne, Victoria, Australia

Language lateralization based on fMRI is often used in clinical neurological settings. With most conventional methods, the laterality determined can be dependent on the quality of a particular study and chosen statistical threshold. We present an objective threshold-independent method of assessing when individual patients have statistically atypical language lateralization. We illustrate the method using fMRI of verbal fluency in 34 healthy controls. One could also apply the method to other paradigms or regional assessments; for example the assessment of lateralisation of a different task, or to the assessment of anterior-posterior distribution rather than laterality.

### High Resolution Brain Imaging

**Hall B Tuesday 13:30-15:30**

### 2304. Patch Structure in White Matter Detected by Microscopic MRI at High Field Strength

**Tie-Qiang Li¹, M. Fukunaga², K Shmueli², S Dodd², J H. Duyn³**

¹Department of Medical Physics, Karolinska University Hospital, S-141 86, Stockholm, Sweden; ²Laboratory of Functional and Molecular Imaging, National Institute of Neurological Disorders and Stroke, National Institutes of Health, United States

T2*-weighted MRI at high magnetic field strength has recently been used to reveal cortical layer structures and white matter heterogeneity in vivo. Magnetic susceptibility differences have been widely thought to give rise to most of the contrast but the precise mechanisms underlying the contrast is still poorly understood. Here, we report an interesting finding from microscopic MRI and histological studies of white matter specimens of the human brain, which may provide further clues for better understanding of the mechanisms underlying the T2*-weighted contrast.
2305. MR Contrast in Post-Mortem Brain Remains After 6 Decades of Storage: Imaging in Cerebellar Agenesis

Stephen J. Sawiak, Guy B. Williams, T Adrian Carpenter, S A. Edgley

1Wolfson Brain Imaging Centre, University of Cambridge, Cambridge, United Kingdom; 2Behavioural and Clinical Neurosciences Institute, University of Cambridge, Cambridge, United Kingdom; 3Department of Physiology, Development and Neuroscience, University of Cambridge, Cambridge, United Kingdom

Cerebellar agenesis is a condition where the cerebellum fails to develop normally. Here we present data from two individuals acquired post-mortem from brains extracted in the 1940s showing high resolution anatomical and structural data with MPRAGE and DTI sequences.

2306. Measuring Cortical Thickness of the Human Brain Using Ultra High Resolution Data

Falk Lüsebrink, Astrid Wollrab

1RheinAhrCampus, Remagen, Germany; 2Biomedical Magnetic Resonance, Otto-von-Guericke-Universität, Magdeburg, Germany

The analysis of the human cerebral cortex and the measurement of its thickness based on MRI data provide insight into normal brain development and neurodegenerative disorders. Accurate and reproducible results of the cortical thickness measurement are desired. In addition to data processing tools, the quality (i.e. resolution) of the imaging data is evaluated. We thus compare ultra high resolution data acquired at 7T with 3T data for measuring the cortical thickness of the human brain.

2307. Effect of Head Motion on the MRI Visibility of Cortical Layers in Human Primary Visual Cortex

Jessica Schulz, Miriam Wähnert, Robert Trampel, Robert Turner

1Max-Planck-Institute for Human Cognitive and Brain Sciences, Leipzig, Germany

There is increased interest in using ultra-high-field brain MRI to map intracortical structures. We simulated the effect on layer structure of small in-plane motions during data sampling, using 200 micron resolution ex vivo brain images. Such motions can easily introduce illusory structures, shown in images and cortical intensity profiles of human primary visual cortex, without and with motion corruption. Our simulations emphasize the crucial importance of appropriate motion correction of high resolution brain data.

2308. Sub-Millimeter Isotropic Ocular-Dominance Mapping at 7T Using 3D EPI

Natalia Petridou, Ben M. Harvey, Serge O. Dumoulin, S F.W. Neggers, Tjerk Gutteling, Peter Luijten, Hans Hoogduin

1UMC Utrecht, Utrecht, Netherlands; 2Psychology, Utrecht University, Utrecht, Netherlands; 3Rudolf Magnus Institute for Neuroscience, UMC Utrecht, Utrecht, Netherlands

The advent of high fields has made it possible to reconstruct the functional organization of ocular-dominance columns in the human cortex with sub-millimeter in-plane (2D) resolution. However, 2D-based imaging techniques necessarily use anisotropic spatial resolution and are restricted to subjects that have relatively flat regions of cortex. Using 3D EPI with sub-millimeter isotropic resolution at 7T and a differential ocular stimulation we found alternating activation patterns in V1 which may relate to the expected ocular-dominance column distribution. This suggests that at 7T, 3D EPI can offer an avenue for sub-millimeter isotropic mapping not limited by the underlying anatomy.

2309. Optic Nerve Characterisation by Isotropic High-Resolution MRI

Sandro Romanzetti, Petra Stoerig, Ana Maria Oros-Peusquens, N. Jon Shah

1Institute of Neuroscience and Medicine 4, Medical Imaging Physics, Forschungszentrum Juelich, Juelich, Germany; 2Institut für Experimentelle Psychologie, Heinrich-Heine-Universität, Düsseldorf, Germany; 3Faculty of Medicine, Department of Neurology, RWTH Aachen, Aachen, Germany

Many ophthalmological and neurological pathologies affect the optic nerve which provides the brain with retinal information. Revealing their manifestations with isotropic, high-resolution imaging of the optic nerve, the orbit and the chiasm may allow early and direct diagnosis of diseases that result in loss of visual function, partial or complete blindness. In this pilot study, we present isotropic, high-resolution optic nerve images which may be suitable for clinical applications.

2310. Detection of Cortical Layers Via Magnetization Transfer Imaging at 7T

Olivier E. Mougin, Alain Pitiot, Penny A. Gowland

1Sir Peter Mansfield Magnetic Resonance Centre, School of Physics & Astronomy, University of Nottingham, Nottingham, Nottinghamshire, United Kingdom; 2School of Psychology, Institute of Neuroscience, Nottingham, Nottinghamshire, United Kingdom

Variations in magnetization transfer (MT) ratio across the cortex have been detected using high resolution MT scans at 7T and are assumed to correspond to variations in myelination, and variations in MT corresponding to the stria of Gennari have been detected on MT maps.
2311. Improved Direct Localization of the Human Pedunculopontine Nucleus (PPN) by 3D FLASH MRI at Sub-Millimeter Resolution

Tobias M. Lindig1,2, Sorin Breit1, Ludger Schöls1, Thomas Nägele, Uwe Klose3, Gunther Helms3

1Department of Neurology and Hertie-Institute for Clinical Brain Research, University Hospital Tuebingen, Tuebingen, Germany; 2Section of experimental MR of the CNS, Department of Diagnostic and Interventional Neuroradiology, University Hospital Tuebingen, Tuebingen, Germany; 3MR-Research in Neurology and Psychiatry, University Medical Center Goettingen, Goettingen, Germany

The pedunculopontine nucleus (PPN) is a potential target for deep brain stimulation to address symptoms of gait freezing and postural instability in Parkinson’s disease. Proton density-weighted (PD-w) MRI has been recommended to locate its position. Contrast and delineation of the PPN area in healthy subjects were improved by multi-echo 3D MRI at an increased resolution of 0.8 mm3, and by using signal amplitude maps S0. These were calculated from a dual-angle FLASH protocol, thus eliminating the residual influence of T1 from the PD-w images. Usefulness for stereotactic planning was verified on two patients at 3T using a protocol of 4x4minutes.

2312. Ammon’s Horn Sclerosis Detected in Temporal Lobe Epilepsy with 7 T MRI

Thomas R. Henry1, Marie Chupin*, Stéphane Lehêricy1, Kamil Ugurbil4, Frederick Ot4, Zhiyi Sha1, Pierre-Francois Van de Moortele5

1Neurology, University of Minnesota, Minneapolis, MN, United States; 2Universite Pierre et Marie Curie-Paris, Paris, France; 3Neuroradiology, Universite Pierre et Marie Curie-Paris, Paris, France; 4Center for Magnetic Resonance Research, University of Minnesota, Minneapolis, MN, United States; 5Radiology, University of Minnesota, Minneapolis, MN, United States

Increased contrast and spatial resolution at 7 T permitted the reliable detection of internal architecture of the hippocampal formation. Submillimetric T2w images at 7 T consistently resolved the continuous white matter band, which separates deep portions of CA1-3 from CA4 and the dentate hilus. The resulting accuracy permitted intrahippocampal (subregional) volumetry. These preliminary results strongly support expectations that brain imaging at very high magnetic field may allow for a more accurate patient classification based on qualitative and quantitative information that is difficult or impossible to collect reliably at lower field.

2313. In Vivo Imaging of Human Hippocampal Subfields at 7 Tesla

Caitlin Judith Hardy1, Vasthie Prudent, Songtao Liu, Graham Wiggins, Dolores Malaspina*, Oded Gonen

1Radiology, NYU School of Medicine, New York, NY, United States; 2Psychiatry, NYU School of Medicine

Using a combination of 7 T field, B0-shim, high count receive-coil arrays and heavy T2* weighting we were able to depict hippocampal subfields down to 100 micron in 10/10 young adults in a clinically acceptable time of 14 minutes.

2314. Delineation of Human Primary Auditory Cortex on the Basis of a Combined T1 and T2 Weighted MR Contrast

Christian Wasserthal1, Karin Engel1, Jörg Stadler1, Bruce Fish4,5, Patricia Morosan5, Andre Brechmann1

1Special-Lab Non-Invasive Brain Imaging, Leibniz-Institute for Neurobiology, Magdeburg, Germany; 2Department of Simulation and Graphics, Otto-von-Guericke University of Magdeburg, Germany; 3Department of Radiology, Harvard Medical School, Charlestown, MA, United States; 4Computer Science and AI Lab, Massachusetts Institute of Technology, Cambridge, MA, United States; 5Institute of Medicine, Research Center Jülich, Germany

In the visual system the primary cortex area can robustly be identified by retinotopic mapping. In the auditory modality, a routine method to delineate the primary auditory cortex (PAC) area in individual human subjects is not available. We developed a method to anatomically identify the PAC area on the basis of myelin content in single subjects by creating an artificial contrast using conventional T1 and T2 weighted imaging at 3 Tesla. Results show a region on the medial two thirds of Heschl’s gyrus that is very consistent to the probability map of the PAC defined in post-mortem brains.

2315. Differences in the Proportional Volume of Different Brain Regions Relative to the Whole Brain Size

Marcus Belke1, David H. Salat2, Enno Wehrmann1, Katija Menzler1, Ulrike Lengler3, Wolfgang H. Oertel1, Felix Rasenov1, Karsten Krakow3, Susanne Knake1

1Department of Neurology, Philippus-University Marburg, Marburg, Germany; 2Athinoula A. Martinos Center for Biomedical Imaging, Harvard Medical School, Boston, MA, United States; 3Brain Imaging Center Frankfurt, University of Frankfurt, Frankfurt, Germany

We investigated association between total intracranial volume (TIV) and the volume of several cortical, subcortical and white matter regions. After an automated parcellation of the brain, a slope was calculated, representing the proportional volume of each structure relative to the TIV. Cortical regions were particularly associated with TIV. The greatest slope of the subcortical regions was found for the brainstem. In a second test gender differences were investigated. Large differences were found between men and women when uncorrected volumes were compared. After correction for the influence of the TIV, no gender differences were found in any of the investigated regions.
Trigeminal autonomic cephalalgias include cluster headache, paroxysmal hemicrania and SUNCT. An earlier voxel-based morphometry (VBM) study pointed at the posterior inferior hypothalamus to be involved in CH, but results were never reproduced. In the current study we used state of the art whole-brain and regional VBM, and manual segmentation of the hypothalamus, in analyzing the brains of 151 subjects with TACs (n=70), migraine patients (n=33) and controls (n=48). We found the anterior part (but not the posterior part) of the hypothalamus, including the suprachiasmatic nucleus (“the biological clock”), to be larger in TACs compared to migraineurs and controls. Our results seem to be specific for TACs, and question the validity and/or relevance of the earlier finding, including its role in deep brain stimulation as treatment for intractable cluster headaches.

Clinically-Driven Fast and High-Resolution Mapping of T1, M0, and B1 with Whole Brain Coverage

Quantitative MR techniques, such as accurate mapping of the longitudinal relaxation time and water content, have become more important in neurological research. The current T1 mapping methods are generally lengthy and not adequate in a clinical environment. Also, further acquisitions are usually required to obtain the brain tissue water content. Several factors, including RF field inhomogeneities and low SNR impair the accuracy of these methods. In this study, we present a modified two-acquisition SPGR method for simultaneous B1, T1, and M0 mapping with a 1-mm isotropic spatial resolution that covers the entire human brain in a clinically acceptable time.

Orientation Selectivity of Individual Voxels in Early Visual Areas Using 7 Tesla

Using 1.5 mm isotropic GE imaging of BOLD activation to a continuously rotating stimulus, we find individual voxels with significant orientation selectivity in human visual areas V1, V2, and V3.

Layer-Specific MRI of the Rat Retina with Intraocular Injection of Gadolinium-DTPA

The retina can be divided into seven cellular and synaptic layers. It has been shown that intraocular injection of manganese enhances contrast in the rat retina, revealing 7 layers with MRI. Gadolinium-DTPA is a T1 shortening contrast agent like manganese, but the localization of the two within in a tissue could be expected to be to differ, potentially leading to different layer-specific enhancement. In this study we used intraocular injection of gadolinium to provide unique layer enhancement in the rat retina. Gadolinium-enhanced MRI clearly resolved six retinal layers at 25x25 µm.

Contrast at Ultra-High Field: Relaxation Times in the Rat Brain at 16.4 T

Knowledge of the relaxation times is not only necessary for sequence optimization; it may also be decisive to judge the advantages for ultra-high field MRI. Here, $T_1$, $T_2$, and $T_2^*$ in the rat brain were measured at 16.4 T with a spatial resolution of 180 µm inplane. The relaxation times were quantified with high accuracy for 20 anatomical structures and maps were generated to display the spatial distribution of the relaxation times over the brain.

New Approaches to the Study of Comparative Neuroanatomy in Marine Vertebrates Using MRI: The Whale Shark, Rhincodon Typus, as a Case Study

The study of species with unique behavioral and morphological specializations is critical when teasing apart evolutionary trends, yet becomes difficult, as often these species are extremely rare and invasive methodologies are impractical. This paper examines the use of MRI to obtain high-resolution image data in an important but damaged brain specimen of the whale shark, Rhincodon typus, wherein digital reconstruction allowed for non-invasive quantification of its brain organization. We will discuss the effectiveness of MRI as investigative tool for non-invasive visualization and quantification of the internal anatomy of fishes.
Detection of Amyloid-Beta Plaques Using Phase Imaging at 9.4 Tesla

Wen-Tung Wang\textsuperscript{1}, In-Young Choi\textsuperscript{1,2}, Jieun Kim\textsuperscript{1}, Sang-Pil Lee\textsuperscript{1}

\textsuperscript{1}Hoglund Brain Imaging Center, University of Kansas Medical Center, Kansas City, KS, United States; \textsuperscript{2}Neurology, Molecular & Integrative Physiology, University of Kansas Medical Center, Kansas City, KS, United States

Magnetic resonance imaging is the only modality that can provide sufficient spatial resolution and image contrast to visualize Alzheimer’s amyloid plaques noninvasively. Previously Alzheimer’s amyloid plaques have been visualized in images acquired using spin-echo and gradient echo sequences at 7 T and 9.4 T. At high fields, it has been reported that the increased susceptibility-related contrast resulted in additional anatomical information, such as delineation of veins and iron-rich regions in human brain. In this study, we show that the susceptibility-induced contrast in gradient-echo phase images can improve detection of amyloid plaques.

Automatic Detection of Amyloid Plaques on Ex Vivo APP/PS1 Mouse Brain Using a Zoom T2-Weighted Spin Echo Sequence

Benjamin Marty\textsuperscript{1}, Céline Giraudc\textsuperscript{1}, Julien Flamenc\textsuperscript{1}, Sidi Mohamed Ahmed Ghal\textsuperscript{1}, Franck Lethimonnier\textsuperscript{1}, Fawzi Boumezbeur\textsuperscript{1}, Julien Valette\textsuperscript{1}, Sébastien Mériaux\textsuperscript{1}

\textsuperscript{1}CEA/DSV/I2BM/Neurospin, Gif-Sur-Yvette, France

Amyloid plaques are a marker of Alzheimer’s disease which are traditionally detected as hypointense signals on T2*-weighted images due to the presence of iron. This study proposes a comparison between the images of an ex vivo APP/PS1 mouse brain obtained using a conventional T2* gradient echo sequence and a zoom adiabatic T2 spin echo sequence. This comparison, based on the ability of both sequences to allow successful plaques detection using an automatic home-made procedure, reveals that T2 contrast allows resolving amyloid plaques with a better specificity than T2* contrast, which is disturbed by the hypointense signals coming from blood vessels.

Anatomical Phenotyping of Rett Syndrome in the Mouse

Jacob Ellegood\textsuperscript{1}, Jason P. Lerch\textsuperscript{1}, R Mark Henkelman\textsuperscript{1}

\textsuperscript{1}Mouse Imaging Centre, Hospital for Sick Children, Toronto, Ontario, Canada

Rett Syndrome is an X-linked disorder, which primarily affects females, and is caused by mutations to the Mecp2 gene. A commonly used mouse model of Rett involves a truncation of the Mecp2 gene at codon 308. The purpose of this study was to examine the volume changes in the Mecp2\textsuperscript{308} Rett syndrome mouse model with high resolution MRI. Volume changes were found in many regions, for example, significant decreases were found in the cerebral cortex as well as increases in the cerebellar cortex and ventricles.

A Transversal and Longitudinal MRI Study in Patients with Cervical Dystonia Using VBM Analysis.

Porzia Totaro\textsuperscript{1}, Eytan Raz, Gian Marco Contessa, Francesca Tona, Giovanni Fabbrini, Alfredo Berardelli, Carlo Colosimo, Luigi Bizzar, patrizia pantano\textsuperscript{7}

\textsuperscript{1}Department of Neurological Sciences, Sapienza University of Rome, Rome, Italy; \textsuperscript{7}Sapienza University of Rome, Rome, Italy, Italy

A transversal and longitudinal MRI study in patients with cervical dystonia using voxel-wise comparison of the local Gray Matter concentration.

MRI of the Lumbar Spine at 7 Tesla in Healthy Volunteers and a Patient with Spina Bifida

Astrid Ellen Grams\textsuperscript{1,2}, Oliver Kraff\textsuperscript{1,2}, Lale Umutlu\textsuperscript{1,2}, Stefan Maderwald\textsuperscript{1,2}, Philipp Dammann\textsuperscript{1,2}, Mark E. Ladd\textsuperscript{1,2}, Elke Ruth Gizewski\textsuperscript{1,2}

\textsuperscript{1}Department of Diagnostic and Interventional Radiology and Neuroradiology, University Hospital Essen, Essen, NRW, Germany; \textsuperscript{2}Erwin L. Hahn Institute for Magnetic Resonance Imaging, University Hospital Essen, Essen, NRW, Germany

In the present study the feasibility of imaging of the lumbar spine and its adjacent structures under healthy and under pathological conditions at 7 Tesla was investigated. A combination of a 3D-CISS and a 3D-VIBE sequence comprehended imaging of the vertebrae, the intervertebral discs, the bony neural foramina, the facet joints, the dural sac and the intraspinal portions of the spinal nerves.

Voxel-Based Morphometric Analysis of Gray and White Matter in Perinatally HIV-Infected Youth

Manoj Kumar Sarma\textsuperscript{1}, Rajakumar Nagarajan\textsuperscript{1}, Michael Albert Thomas\textsuperscript{1}, Judy Hayes\textsuperscript{2}, Jaime Deville\textsuperscript{1}, Karin Niels\textsuperscript{1}, David Michalik\textsuperscript{2}, Whitney B. Pope\textsuperscript{1}, Margaret A. Keller\textsuperscript{2}

\textsuperscript{1}Radiological Sciences, UCLA, Los Angeles, CA, United States; \textsuperscript{2}Pediatrics, Harbor-UCLA Medical Center, Torrance, CA, United States; \textsuperscript{3}Pediatrics, UCLA, Los Angeles, CA, United States; \textsuperscript{4}Miller’s Children’s Hospital, Long Beach, CA, United States

Voxel-based morphometry was used to compare both gray and white matter volume in perinatally human immunodeficiency virus (HIV)-infected youth versus healthy controls. HIV patients had reduced gray matter volume in the bilateral caudate nucleus, left parietal lobe, but an increase of gray matter volume in the frontal lobe, posterior temporal lobe, and parietal lobe. Striking white matter volume reductions were found in the temporal lobe, pons, right pre-frontal area, corpus callosum and the junction of the
thalamus and mid brain. These findings suggest the sensitivity of VBM in evaluating GM and WM abnormalities in perinatally HIV-infected youth.

2328. **The Effects of Voxel Size and Image Smoothing on R2* Measurements of the Human Brain**

Christian Denk, Alexander Rauscher

UBC MRI Research Centre, University of British Columbia, Vancouver, BC, Canada

Quantitative imaging of the R2* relaxation rate employing multiple echoes can be used to assess blood oxygenation and iron content in neural structures. However, R2* is not a strictly intrinsic tissue property, as it also depends on the spatial relationship between voxel geometry and background field inhomogeneities. These background field inhomogeneities cause additional signal decay. To investigate the influence of spatial resolution and smoothing on R2* values, we acquired images with high spatial resolution and applied spatial smoothing to the complex data, which simulates acquisition at lower spatial resolution, and to the magnitude data. We found that both changes in spatial resolution and spatial smoothing of magnitude of high resolution data leads to strong changes in R2*, which suggests that R2* values should be interpreted in the light of data acquisition parameters as well as data smoothing.

2329. **Direct Visualization of Surgical DBS Targets Using High-Field (7T) MRI**

Noam Harel, Essa Yacoub, Kamil Ugurbil, Aviva Abosch

Radiology, University of Minnesota, Minneapolis, MN, United States; Neurosurgery, University of Minnesota, Minneapolis, MN, United States

Deep brain stimulation (DBS), a surgical treatment involving the implantation of an electrode in the brain, is used for the treatment of patients with movement disorders. The success of this surgical technique is critically dependent on precise placement of the DBS electrode into the target structure. However, current clinical imaging methods lack the sensitivity for resolving and visualizing of the DBS target. Here, using a combination of high magnetic field (7T) with susceptibility-weighted contrast resulted in a dramatically improved ability to identify and delineate anatomical architecture of deep brain structures that are FDA-approved DBS targets.

2330. **Human T2* and Phase Imaging at 9.4 T**

Juliane Sabine Budde, Gunamony Shajan, Jens Hoffmann, Frank Muehlbauer, Kamil Ugurbil, Rolf Pohmann

Max Planck Institute for Biological Cybernetics, Tuebingen, Germany; Center for Magnetic Resonance Research, University of Minnesota, Minneapolis, United States

Ultra-high static magnetic field causes higher susceptibility effects which yield shorter T2* values and larger variations of the image phase. In this work, we acquired highly detailed T2* maps showing internal structures. Mean T2* values for GM were estimated as 28ms±6ms and 20ms±4ms for WM. Phase images were post-processed to yield images with high tissue contrast between grey and white matter throughout the brain at a resolution of 200µm x 200µm x 1mm. Signal gain at ultra-high field allows for high resolution surface phase images of 130µm x 130µm in-plane resolution. In these, differences within grey matter are visible.

2331. **Ultra-High Field MRI at 7.0 Tesla in Patients with Ischemic or Hemorrhagic Stroke: A Preliminary Study**

Anja Gwendolyn van der Kolk, Jaco JM Zwanenburg, Geert Jan Biessels, Fredy Visser, Peter R. Luijten, Jeroen Hendrikse

Department of Radiology, University Medical Center, Utrecht, Netherlands; Department of Neurology, University Medical Center, Utrecht, Netherlands; Philips Healthcare, Best, Netherlands

Seven patients with clinically and standard imaging-based proven ischemic or hemorrhagic stroke were scanned with magnetization prepared 3D FLAIR, combined time-of-flight inflow and multi-echo fast field echo (meFFE), T1 3D TFE, and DTI. 7.0 Tesla results were comparable to results of similar 1.5 Tesla sequences, but with better resolution and – in 3 out of 7 patients – additional information regarding underlying pathology. Furthermore, meFFE with 3 echoes was valuable in identification of microbleeds, microinfarcts and thrombus.

**General Brain Imaging: Technique Development**

**Hall B Wednesday 13:30-15:30**

2332. **Multicontrast 3D Structural Imaging to Improve Automatic Brain Extraction and Segmentation**

Bradley P. Sutton, Anh Tu Van

Bioengineering, University of Illinois, Urbana, IL, United States; Beckman Institute, University of Illinois, Urbana, IL, United States; Electrical and Computer Engineering, University of Illinois, Urbana, IL, United States

Currently many structural neuroimaging studies rely only on a T1-weighted image for brain extraction. Additional image contrast like T2 may improve the performance of the automatic brain extraction procedure. In this work, a previously proposed multiparametric 3D structural imaging sequence that provides several volumes with varying contrast in a multi-echo acquisition is used to assist in automatic brain segmentation. Two 3D volumes (one T1-weighted and one T2-weighted) with 1.2 mm isotropic resolution and a low
A novel parallel imaging technique for PROPELLER that utilizes external calibration data as well as a small amount of internal calibration data per blade is demonstrated for T1 FLAIR imaging. Short echo trains, which are optimal for T1 imaging, are maintained while the effective blade width is increased by reducing the number of internal calibration lines. Wider blades enable motion to be detected and corrected more reliably, improving robustness in uncooperative patients. The method is validated in studies of volunteers instructed to move their head during the acquisition.

The MR flow quantification of the vessels can be used to evaluate the response of the vessel-related surgeries. However, for the previously implemented automatic ROI selection method were proposed to reduce the inter-scan variation. Furthermore, GPU-degrade the accuracy of evaluation. In our study, in order to solve this problem, an automatic slice positioning method combined with we developed a spin echo two-point Dixon technique for fat-suppressed T1-weighted imaging. In comparison to the conventional spin echo with FS pulses, we demonstrated in vivo that the new technique was 40% more efficient and had much better image contrast, calibration data per blade is demonstrated for T1 FLAIR imaging. Short echo trains, which are optimal for T1 imaging, are maintained while the effective blade width is increased by reducing the number of internal calibration lines. Wider blades enable motion to be detected and corrected more reliably, improving robustness in uncooperative patients. The method is validated in studies of volunteers instructed to move their head during the acquisition.

The human brain is extremely sensitive and vulnerable to even small alterations in oxygen supply, making a measure for assessing global cerebral metabolic rate of oxygen consumption (CMRO2) very important. We propose a method for estimating CMRO2 by simultaneous quantification of oxygen saturation by MR oximetry and cerebral blood flow by phase-contrast MRI in the major vessels draining (superior sagittal sinus) and feeding the brain (internal carotid and vertebral arteries), respectively. Our results demonstrate that the proposed technique is robust and reproducible, yielding temporally stable measurements at a temporal resolution 30 seconds.

Inclusion of fat suppress (FS) pulses in a spin echo acquisition substantially reduces scan efficiency. At 3 Tesla, the incidental magnetization transfer and dielectric effects from the FS pulses also degrade the image contrast and image uniformity. In this study, we developed a spin echo two-point Dixon technique for fat-suppressed T1-weighted imaging. In comparison to the conventional spin echo with FS pulses, we demonstrated in vivo that the new technique was 40% more efficient and had much better image contrast, better FS and overall image uniformity for fat-suppressed T1-weighted imaging of head & neck at 3 Tesla.

We aimed to design a head holder for calculation the susceptibility through multiple orientation sampling (COSMOS). Different brain tissues with different susceptibility result in the changes of focal magnetic fields. Quantitative susceptibility imaging of brain are obtained by measurement of the focal magnetic field changes. It is a promising approach for exploring various brain pathological conditions. For clinical application, the challenging problem is to rotate the head of patient along the Y axis only and fix the head in the degree through the MR scan. Our results show great control of the rotation in three axes with the facilitation of head holder.

**2333. PROPELLER Using Parallel Imaging with Across Blade Calibration for T1 FLAIR**

James H. Holmes¹, Philip J. Beatty², Howard A. Rowley¹,², Zhiqiang Li³, Ajeetkumar Gaddipati¹, Xiaoli Zhao⁴, Reed F. Busse¹, Jean H. Brittain¹

¹Applied Science Laboratory, GE Healthcare, Madison, WI, United States; ²Applied Science Laboratory, GE Healthcare, Menlo Park, CA; ³Radiology, University of Wisconsin-Madison, Madison, WI, United States; ⁴Neurological Surgery, University of Wisconsin-Madison, Madison, WI, United States; ⁵GE Healthcare, Phoenix, AZ; ⁶GE Healthcare, Waukesha, WI, United States

**2334. The Inter-Scan Variations of Flow Quantifications on Human Basilar Artery: A Study Controlled the Scan Conditions with Automatic Slice Positioning and the Automatic Lumen-Area Segmentation.**

Shiu-Ying Ju¹, Yu-Wei Tang¹, Teng-Yi Huang¹, Hsu-Hsia Peng²

¹Department of Electrical Engineering, National Taiwan University of Science and Technology, Taipei, Taiwan; ²Department of Biomedical Engineering and Environmental Sciences, National Tsing Hua University, Hsinchu, Taiwan

**2335. MRI Estimation of Global Brain Oxygen Consumption Rate**

Varsha Jain¹, Michael Langham¹, Felix Wehrli¹

¹University of Pennsylvania, Philadelphia, PA, United States

**2336. Improved Image Contrast and Scan Efficiency for Fat Suppressed T1-Weighted Imaging at 3T with a Spin Echo Two-Point Dixon Technique**

Jingfei Ma¹, Ken-Pin Huang², Ashok Kumar³, Lawrence Ginsberg³

¹Department of Imaging Physics, University of Texas MD Anderson Cancer Center, Houston, TX, United States; ²Applied Science Lab, GE Healthcare Technologies, Houston, TX, United States; ³Department of Diagnostic Radiology, University of Texas MD Anderson Cancer Center, Houston, TX, United States

**2337. A Design of Head Holder for Calculation of Susceptibility Through Multiple Orientation Sampling (COSMOS)**

Hsiao-Wei Peng¹, Chao-Chun Lin²,³, Yi-Jui Liu¹,⁴, Chien-Kuo Chen¹, Kuo-Fang Shao⁴, Wu-Chung Shen⁵, Ting-Chiu Chang⁶,⁷

¹Department of Automatic Control Engineering, Feng Chia University, Taichung, Taiwan, Taiwan; ²Department of Radiology, China Medical University Hospital, Taichung, Taiwan; ³Graduate Institute of Biomedical Electronics and Bioinformatics, National Taiwan University, Taipei, Taiwan; ⁴Master's Program in Biomedical Informatics and Biomedical Engineering, Feng Chia University, Taichung, Taiwan; ⁵School of Medicine, China Medical University, Taichung, Taiwan; ⁶Applied Science Laboratory, GE Healthcare Taiwan, Taipei, Taiwan; ⁷Institute of Biomedical Electronics & Bioinformatics, National Taiwan University

We aimed to design a head holder for calculation the susceptibility through multiple orientation sampling (COSMOS). Different brain tissues with different susceptibility result in the changes of focal magnetic fields. Quantitative susceptibility imaging of brain are obtained by measurement of the focal magnetic field changes. It is a promising approach for exploring various brain pathological conditions. For clinical application, the challenging problem is to rotate the head of patient along the Y axis only and fix the head in the degree through the MR scan. Our results show great control of the rotation in three axes with the facilitation of head holder.
2338. A Study Specific Brain Template in MNI Space for an Aged Population with Aortic Stenosis

Ping Wang¹, Elizabeth Strambrook², Thomas Floyd³

¹Radiology, University of Pennsylvania, Philadelphia, PA, United States; ♻Anesthesiology & Critical Care, University of Pennsylvania, Philadelphia, PA, United States; ♻Anesthesiology & Critical Care, and Neurology, University of Pennsylvania, Philadelphia, PA, United States

The MNI standard template is ideal for healthy subjects. To improve the accuracy of normalization and the further analysis (such as statistical analysis), we created a study specific template in MNI space for an aged population with mild to critical aortic stenosis. This study specific template is approximately in MNI template space, but accommodates some characteristics of this particular study population, especially incorporating the increased ventricular volume.

2339. Use of Opposed Shim Currents for Infold Reduction on a UHF MRI System with Head Gradient

Christopher John Wiggins¹, Marion Caillat¹, Denis Le Bihan¹, Franz Schmitt², Eva Eberlein²

¹CEA/NeuroSpin, Gif-Sur-Yvette cedex, France; ♻Siemens AG, Healthcare Sector Imaging & IT Division, Magnetic Resonance, Erlangen, Germany

The use of a head gradient set within a wholebody magnet can lead to significant artifacts. Signal arising from the shoulders is encoded in such a way that it aliases into the main image. Such artifacts are particularly pronounced at higher field, where B1 effects cause the sensitive region of volume coils to extend out into the chest and shoulder region. Previous approaches have tried to diminish the RF penetration in this area (through the use of RF shielding materials) or to disrupt the local field through using ferromagnetic material shown into a jacket that the subject wears. This study shows that with the use of both the wholebody and head gradient shim sets the signal from the shoulders could be dephased without affecting the signal from the head itself.

2340. A Qualitative Comparison of Magnetic Resonance Images of Brain Acquired Using Phased-Array Head Coils with 32 and 12 Array Elements at 1.5 Tesla

Pankit Parikh¹, Gurpreet Singh Sandhu¹², Kristine A. Blackham¹, Michael D. Coffey¹, Daniel P. Hsu¹, John A. Jesberger², Kecheng Liu³, Mark A. Griswold⁴, Jeffrey L. Sunshine¹²

¹Radiology, University Hospitals of Cleveland, Case Western Reserve University, Cleveland, OH, United States; ²Case Center for Imaging Research, Case Western Reserve University, Cleveland, OH, United States; ³Siemens Healthcare, Malvern, PA, United States; ⁴Biomedical Engineering, Case Western Reserve University, Cleveland, OH, United States

Phased-array coils with increasing number of array elements have been developed and employed for clinical MR imaging. A phased-array head coil with 32 array elements provides quantitatively better brain images as compared to commercially available head coil with lower number of array elements. In this study, we investigate if application of this coil would improve the anatomic and pathologic analysis from the resultant brain images by qualitatively comparing MR images obtained using this coil with those obtained using a commercially available phased-array head coil with 12 array elements.

2341. Looking at Magnetization Exchange in Human White Matter Structures in Vivo

Saeed Kalantari¹, Cornelia Laule², Thorarin Bjarnason³, Alex MacKay¹²

¹Department of Physics and Astronomy, University of British Columbia Hospital, Vancouver, BC, Canada; ²Department of Radiology, University of British Columbia Hospital, Vancouver, BC, Canada; ³Department of Electrical and Computer Engineering, University of Calgary

The objective of this study was to measure the cross relaxation exchange time between the myelin water and intra/extracellular water pools in healthy human white matter in vivo. Five different white matter structures were investigated. Bloch equations were solved analytically and cross relaxation exchange times were extracted. Due to the ambiguity in the literature on spin-lattice relaxation times in white matter, three T1 scenarios were developed. The extracted cross relaxation times were then used to estimate the exchange corrections for myelin water fraction (MWF) measurements. The choice of T1 scenario had a significant effect on cross relaxation times and consequently on MWF corrections.

2342. A Head Mimicking Phantom for 7T, Matched for Tissue Parameters, B1+ Behavior, and Coil Loading Effects

Andrew T. Curtis¹², Lauren E. Villemaire², Kyle M. Gilbert³, Ravi S. Menon¹²

¹Centre for Functional and Metabolic Mapping, Roberts Research Institute, London, Ontario, Canada; ²Medical Biophysics, The University of Western Ontario, London, Ontario, Canada

An agarose gel and saline solution phantom was developed to mimic properties of the human brain at 7T. This design provides many parameters matched to the behaviour seen in vivo including: grey matter/white matter contrast for sequence development, matched B1+ interference (RF wavelength) behaviour, and coil loading effects.
Simple and Efficient Image Processing Techniques to Improve the Registration Between the MR and Light Microscopy Images
Xi Li1, Ann Choe1, Yurui Gao2, Ivona Stepniewska3, Adam Anderson3,4
1Radiology, Vanderbilt University, Nashville, TN, United States; 2Institute of Imaging Science, Vanderbilt University, Nashville, TN, United States; 3Biomedical Engineering, Vanderbilt University; 4Institute of Imaging Science, Vanderbilt University, Nashville, TN, United States

The light microscopy images have a high spatial resolution and are usually co-registered to the corresponding MR images in order to make the comparison. However, there are artifacts, such as tearing, deformation, or disappearance of tissue fragments, in the stained slices. Those artifacts make the registration among MR, blockface, and light images more difficult. In this study, two image post-processing techniques are introduced, which can provide a better initialization to the nonrigid registration algorithm.

Inter-Reader Reproducibility for Carotid Territory Cerebral Vascular Infarcts: A 3.0T Magnetic Resonance Imaging Study
Wei Yu1, Li Dong,2, Lu Zhou2, Dan Hipper2, Marina Fergurson2, Guangrui Liu1, Dean Shibata3, Chun Yuan1, Zhaoqi Zhang1
1Beijing Anzhen Hospital, Capital Medical University, Beijing, China; 2University of Washington, Seattle, WA, United States

We determined the inter-reader reproducibility in the assessment of carotid territory brain lesions. In a carotid study, two reviewers reviewed brain images of 134 hemispheres from 67 subjects independently. The inter-reader agreement was substantial for the lesion presence (κ = 0.67; 0.54-0.80) and the lesion size (κ = 0.75; 0.60-0.92), and there was complete agreement (κ = 1.0) for age. Some disagreements on the presence or absence of lesions may be due to their location near the boundary of the carotid territory. It is important to point out small old lesions were the primary factor that reduced reproducibility.

Quantitative Measurements of Cerebral Oxygen Extraction Fraction for Rabbits with Carotid Occlusion Using MRI
Xiaodong Zhang1, Chao He2, Lihong Hui3, Xiaoying Wang,1,3, Sheng Xie3, Jiangxi Xiao3, Hongyu An4, Jue Zhang1,2, Jing Fang1,2
1Academy for Advanced Interdisciplinary Studies, Peking University, Beijing, China; 2College of Engineering, Peking University, Beijing, China; 3Dept.of Radiology, Peking University First Hospital, Beijing, China; 4Dept. of Radiology, University of North Carolina at Chapel Hill, Chapel Hill, NC, United States

Cerebral oxygen extraction factor (OEF) provides critically important information to assess the brain oxygen metabolism in both normal and disease states. It has been reported that the OEF could be evaluated for healthy human volunteers using MRI. In this study, a based gradient echo sampling of the spin echo (GESSE) sequence implemented on GE 3.0T scanner to evaluate the cerebral OEF distribution of rabbits before and after carotid artery occlusion operation. Our study demonstrated a consistent and significant increase of OEF in rabbits post carotid artery occlusion, suggesting that this MR based method can be utilized to detect pathophysiological changes in cerebral oxygenation.

Myelin Water Imaging of Children with Diverse Reading Ability
Eugene Yip1, Pauline Low2, Burkhard Mädler,1,3, Catherine Lebel1, Christian Beaulieu4, Linda Siegel2, Alex Mackay2
1Department of Physics and Astronomy, University of British Columbia, Vancouver, British Columbia, Canada; 2Department of Education and Counselling Psychology, and Special Education, University of British Columbia, Vancouver, British Columbia, Canada; 3Philips Medical Systems; 4Department of Biomedical Engineering, University of Alberta, Edmonton, Alberta, Canada

Magnetic resonance imaging provides a mean to non-invasively investigate the neurological cause of dyslexia, a learning disability that affects one’s ability to read despite adequate intelligence. Myelin water imaging, based on calculating the myelin water fraction from multi-echo T2 relaxation curves, can be used to quantitatively assess white matter. In this study, myelin water imaging and cognitive and reading assessments were performed on children with a wide range of reading ability in order to investigate the relationship between dyslexia and white matter development in the brain.

Improving Characterization of Traumatic Brain Injury by Synergistic Use of Multi-MRI Techniques
Zhifeng Kou1, Robin Hanks, Scott Millis, Randall Benson, Ramtilak Gattu, E Mark Haacke1
1Radiology, Wayne State University School of Medicine, Detroit, MI, United States

There is no treatment of TBI partially due to the current clinical classification system cannot effectively identify the pathoanatomical information of the brain. We propose that a synergistic use of multi-imaging techniques may capture much of the heterogeneity and complexity of brain injury in individual patients therefore result in improved accuracy and detail in prognostic models and improved
efficiency of clinical trials. In this study, we report our preliminary observations regarding the synergistic use of these three MRI techniques in an improved characterization of TBI.

2348. 4D Flow Measurement of Cerebrospinal Fluid Pulsation at the Cranio cervical Junction and Cervical Spine and Its Clinical Potential

Alexander Christian Bunck1, Wolfram Schwindt1, Jan-Robert Kröger1, Alena Jüttner1, Angela Bruntrup1, Barbara Fiedler2, Gerard Crelier2, Walter Heindel1, David Maintz1, Thomas Niederstadt2
1Department of Clinical Radiology, University hospital of Muenster, Muenster, Germany; 2Department of Neurosurgery, University hospital of Muenster, Muenster, Germany; 3Department of Paediatrics, University hospital of Muenster, Muenster, Germany; 4Institute for Biomedical Engineering, ETH Zurich, Zurich, Switzerland

Time resolved 3D-phase contrast imaging allows to assess cerebrospinal fluid pulsation at the cranio cervical junction and cervical spine. Using state-of-the-art visualization techniques it helps to identify and differentiate between pathological and physiological cerebrospinal fluid flow pattern. As such it may add valuable information for the analysis of pathologies associated with altered cerebrospinal fluid flow like in Chiari malformations and may promote a better understanding of the underlying pathophysiology of these diseases.

2349. Differentiating Haematoma with the R2* Relaxation Rate

Gopal Varma1, Prakash Saha2, Matt Waltham2, Stephen Keevil3, Alberto Smith2, Tobias Schaeffter1
1Imaging Sciences, King's College London, London, United Kingdom; 2Academic Department of Surgery, King's College London, London, United Kingdom; 3Medical Physics, Guy's and St Thomas' NHS Foundation Trust, London, United Kingdom

Subdural haematoma (SDH) is an emergency when acute, and management is often guided by imaging. Distinguishing between the different phases of SDH may be possible by the presence and position of methaemoglobin. In this study, we create an in vitro system of SDH and examine the relationship between intra- and extracellular methaemoglobin at various concentrations, using R2, R2* and R2â€™ parameters. R2â€™ relaxation rate appears to be the most sensitive marker of methaemoglobin concentration and can readily differentiate between when it is intra- or extracellular. This parameter could therefore be used to stage the phase of SDH.

2350. Hyperintense Carotid Plaque on T1-Weighted TFE MRI in Symptomatic Patients with Low Grade Carotid Stenosis and Carotid Occlusion

Anja Gwendolyn van der Kolk1, Gert Jan de Borst2, Anne G. den Hartog2, M Eline Kooi3, Willem PThM Mali1, Jeroen Hendrikse2
1Department of Radiology, University Medical Center, Utrecht, Netherlands; 2Department of Vascular Surgery, University Medical Center, Utrecht, Netherlands; 3Department of Radiology, University Medical Center, Maastricht, Netherlands

The carotid MR hyperintense (vulnerable) plaque is associated with a higher morbidity and mortality. We investigated the prevalence of this plaque and its clinical correlates on T1-weighted turbo-field echo (T1w-TFE) MRI in patients with ischemic symptoms and varying degrees of stenosis. 153 patients with TIA or ischemic infarct were retrospectively examined. 18% showed one or more hyperintense plaques. Half of all hyperintense plaques occurred in symptomatic patients with either 0-69% stenosis or occlusion; more than ⅓ of patients with 50-69% stenosis presented with this plaque. This subgroup of patients could in future possibly benefit from aggressive medicinal therapy or revascularization.


Karin Shmueli1, Ruth O’Gorman2,3, David Lythgoe4, Michael Samuel5, Richard Selway6, Keyoumars Ashkan6, Jozef Jarosz2
1Advanced MRI Section, Laboratory of Functional and Molecular Imaging, National Institute of Neurological Disorders and Stroke, National Institutes of Health, Bethesda, MD, United States; 2Department of Neuroradiology, King's College Hospital, London, United Kingdom; 3MR-Zentrum, University Children’s Hospital, Zurich, Switzerland; 4Centre for Neuroimaging Sciences, Institute of Psychiatry, King's College London, United Kingdom; 5Department of Neurology, King's College Hospital, London, United Kingdom; 6Department of Neurosurgery, King's College Hospital, London, United Kingdom

Susceptibility-Weighted Imaging (SWI) improves the visibility of target structures (globus pallidus (GP) and subthalamic nucleus (STN)) for deep brain stimulation (DBS). However, because phase contrast is non-local and orientation dependent, SWI contains artifacts that may result in targeting errors. Susceptibility maps, which have shown promise for overcoming such artifacts, were calculated from clinical 1.5-T phase data acquired at a single orientation. 2-mm shifts in the superior borders of the red nuclei and GP in the SWI relative to the susceptibility maps were observed in several volunteers and DBS patients showing that susceptibility mapping may help reduce SWI targeting errors.
Aqueductal cerebrospinal fluid flow, measured with motion sensitive phase contrast MRI, is subject to typical imperfections in flow imaging such as partial volume effects and difficulties in lumen delineation. In this study we abandoned graphically represented vessel delineations. Instead we used complex data generated by the PC-MRI in a method with the potential of objective and absolute measurement of CSF velocity and area, without restrictions by matrix resolution. We compared the complex value methodology with conventional manual segmentation for the determination of aqueduct CSF stroke volume in a group of 42 healthy elderly.

In this study high field MR and phase contrast (PCMR) data were used to construct a subject-specific model of flow in the vertebro-basilar system. Wall shear stress (WSS) data from the model yield insight into artery bypass graft design.

Apparent diffusion coefficient (ADC) is a widely used neuronal injury marker for early detection of various brain disorders. In the current study, we investigated the timing of decreased ADC vs. the detectable tissue swelling resulting from N-methyl-D-aspartate (NMDA) induced cytotoxic edema in mouse retina in vivo. Results suggest that decreased ADC is a biomarker of cytotoxic edema providing an early measure of retinal excitotoxic injury before detectable retinal swelling.

The present study reports on the acute and sub-chronic neuronal effects of the NMDA antagonist memantine on the rat brain measured as BOLD (blood oxygenation level dependent) contrast changes in a pharmacological magnetic resonance imaging (phMRI) study. Corroborative investigations include recording the spontaneous local field potential (LFP) activity in key brain regions (through electrophysiology) and the pharmacokinetics of acute and sub-chronic memantine treatment in blood plasma and the brain.

Type-I diabetes was induced in rats by a single injection of streptozotocin (STZ). Directional diffusion-weighted imaging on the optic nerves were performed at 4 weeks and 10 weeks on a 4.7 T scanner to monitor the early pathological changes induced by diabetes. Water diffusivities parallel and perpendicular to the axonal tracts were measured by the apparent diffusion coefficients ADC// and ADC( perpendicular), respectively. Compared to the control animals, the STZ-treated animals showed a trend of reduced ADC( perpendicular) in the optic nerves at 4 weeks, and significantly decreased ADC( perpendicular) at 10 weeks, but insignificant changes in ADC// at these time points.

In this study, diffusion tensor imaging and high resolution rapid-acquisition relaxation-enhancement (RARE) imaging were used to detect the morphological and structural changes in the brain of rats subjected to early bilateral enucleation at postnatal day 4. Profound atrophy was observed in the ON and OCH of the enucleated rats, likely a manifestation of transneuronal degeneration induced by
deafferentation. The optic tract of the enucleated rats did not appear to be atrophic, but exhibited water diffusion abnormalities resembling those found in Wallerian degeneration. The primary visual cortex of the enucleated rats showed no changes in water diffusivity.

2358. Developmental in Vivo 1H NMR Spectroscopy at 14.1 T in Mice with Genetic Redox Dysregulation: An Animal Model with Relevance to Schizophrenia

Joao MN Duarte1, Anita Kulak2, Kim Q. Do3, Rolf Gruetter1,2,3
1Center for Biomedical Imaging (CIBM), Lausanne, Vaud, Switzerland; 2Centre for Psychiatric Neuroscience, Lausanne Univ. Hosp., Lausanne, Switzerland; 3Department of Radiology, Universities of Lausane and Geneva, Lausanne, Switzerland

The present study reports alterations of the neurochemical profile in the cortex of a mouse model of redox deregulation induced by genetic reduction of glutathione synthesis. The observed metabolic alterations suggest impaired mitochondrial metabolism and eventually altered neurotransmission, both possibly triggering degeneration.

2359. An Automated Method to Optimize the Contrast of Small Structures

Ryan Chamberlain1, Thomas M. Wengenack2, Joseph F. Poduslo3, Clifford R. Jack3, Michael Garwood1
1Center for Magnetic Resonance Research, University of Minnesota, Minneapolis, MN, United States; 2Departments of Neurology, Neuroscience, and Biochemistry/Molecular Biology, Mayo Clinic College of Medicine, Rochester, MN, United States; 3Department of Radiology, Mayo Clinic College of Medicine, Rochester, MN, United States

Many MRI applications require visualizing structures on the order of a few pixels in size. In these applications the CNR ratio of the small structures is more important than the SNR of the image. The CNR can be affected dramatically by the image resolution relative to the size of the structure, but the exact relation of resolution and CNR depends on the specific structure and pulse sequence. This work describes an automated method to determine the acquired image resolution to optimize the CNR of small structures. It is demonstrated as applied to imaging amyloid plaques in transgenic mouse models of Alzheimer's disease.

2360. MR Elastography of the Brain in a Mouse Model of Alzheimer's Disease

Matthew C. Murphy1, Geoffrey L. Curran2, Kevin J. Glaser1, Phillip J. Rossman1, John Huston, III1, Joseph F. Poduslo2, Clifford R. Jack3, Joel P. Felmlee1, Richard L. Ehman1
1Department of Radiology, Mayo Clinic College of Medicine, Rochester, MN, United States; 2Department of Neuroscience, Mayo Clinic College of Medicine, Rochester, MN, United States; 3Department of Radiology, Mayo Clinic College of Medicine, Rochester, MN, United States

Magnetic resonance elastography was performed in 5 wild-type (WT) mice and 5 Alzheimer’s disease (AD) mice. The AD model is a double mutation in amyloid precursor protein and presenilin-1 (APP-PS1), which leads to the extracellular deposition of amyloid protein and the formation of plaques with age. The AD mice were found to have a significantly lower mean stiffness compared to age-matched WT mice with a p-value of less than 0.01. The decrease in stiffness may result from mechanical changes in the extracellular matrix following amyloid deposition.

2361. Cerebral Amyloid Angiopathy in Transgenic Mice Modelling Alzheimer’s Disease Studied Non-Invasively by MRI

Nicola Beckmann1, Catherine Canet1, Christelle Gerard1, Dorothee Abramowski2, Matthias Staufenbiel2
1Global Imaging Group, Novartis Institutes for BioMedical Research, Basel, BS, Switzerland; 2Nervous System Department, Novartis Institutes for BioMedical Research, Basel, BS, Switzerland

MRI detected effects of cerebral amyloid angiopathy (CAA) in several lines of Alzheimer’s mice differing by amyloid-beta-40 (Aβ40) contents. SPION was administered i.v. 24h before MRI. Signal attenuations became apparent in multiple foci throughout the brain cortex and in thalamic regions of APP23 mice displaying high Aβ40. At sites of MRI signal loss, iron was localized in microglia cells/macrophages in/or around damaged vessels. The small number of attenuated signal foci in the brains of APP24 and APP23xPS45 mice characterized by low Aβ40 is consistent with histology showing significantly less vascular amyloid compared to APP23 animals. These results agree with Aβ40 predominating in CAA-related vascular amyloid.

2362. MR Biomarkers of Neurodegeneration in a Transgenic Mouse Model of Alzheimer's Disease

Ryan Chamberlain1, Malgorzata Marjanska2, Gregory Preboske2, Linda Kotilinek2, Thomas M. Wengenack1, Joseph F. Poduslo2, Karen H. Ashe2, Michael Garwood1, Clifford R. Jack2
1Center for Magnetic Resonance Research, University of Minnesota, Minneapolis, MN, United States; 2Department of Radiology, Mayo Clinic, Rochester, MN, United States; 3Department of Neurology, University of Minnesota, Minneapolis, MN, United States; 4Department of Neurology, Neuroscience, and Biochemistry, Mayo Clinic, Rochester, MN, United States

The histological abnormalities that characterize Alzheimer’s disease are commonly divided into three major classes: amyloid plaques, neurofibrillary tangles and neurodegeneration. Much work has been done to image amyloid plaques using the APP/PS1 mouse model. However, the APP/PS1 model was developed to study amyloid plaques, and neurodegenerative changes are minimal in this model. The Tg4510 mouse model recapitulates neurodegeneration mediated through over expression of mutant human tau. In this work we
compare the ability of various MR techniques (volume, T1, T2, ADC, FA) to detect neurodegeneration in the Tg4510 mouse model compared to wild-type mice.

**2363. Regional Metabolic Alteration of Alzheimer’¡¯s Disease in the Mouse Brain**

**Expressed as Mutant Human APP-PS1 Using 1H HR-MAS**

Dong-Cheol Woo1, Sung-Ho Lee2, Do-Wan Lee2, Sang-Young Kim4, Goo-Young Kim4, Hyang-Shuk Rhim5, Chi-Bong Choi5, Hwi-Yool Kim5, Chang-Wook Lee5, Bo-Young Choe5

1The Catholic University of Korea, Seoul, Korea, Republic of; 2Konkuk University of Korea; 3Kyung-Hee University of Korea, Seoul, Korea, Republic of

This study was to investigate the regional neurochemical profile of APP-PS1 in the mouse brain of early-stage Alzheimer’¡¯s disease (AD) using 1H HR-MAS. Compared to the wild-type mice, the memory index (MI, behavioral test result) of the APP-PS1 mice at 18 weeks was not significantly different; however, the MI of the APP-PS1 mice at 35 weeks was significantly lower. The results of 1H HR-MAS showed that the [NAA+ Acet] level of the APP-PS1 mice decreased in the hippocampus and temporal cortex, mls and slns level was increased in the entire brain which are frontal, occipital, parietal cortex, hippocampus and thalamus.

**2364. Magnetic Resonance Microscopy and Micro Computed Tomography of Brain Phenotypes of Two FGFR2 Mouse Models for Apert Syndrome.**

Thomas Neuberger1, Kristina Aldridge2, Cheryl A. Hill3, Jordan A. Austin4, Timothy M. Ryan5, Christopher Percival5, Neus Martinez-Abadías5, Yingli Wang5, Ethylwin Wang6, Andrew G. Webb5,6, Joan T. Richtsmeier3

1The Huck Institutes of the Life Sciences, Pennsylvania State University, University Park, PA, United States; 2University of Missouri-School of Medicine; 3Department of Anthropology, Pennsylvania State University, University Park, PA, United States; 4Department of Genetics and Genomic Sciences, Mount Sinai School of Medicine; 5Department of Bioengineering, Pennsylvania State University, University Park, PA, United States; 6Department of Radiology, Leiden University Medical Centre, Leiden, Netherlands

Apert syndrome (AS) is one of at least nine disorders considered members of the FGFR-1,-2, and -3-related craniosynostosis syndromes. Nearly 100% of individuals diagnosed with AS have one of two neighboring mutations on Fgfr2. The cranial phenotype associated with these two mutations includes coronal suture synostosis. Brain dysmorphology associated with AS is thought to be secondary to cranial vault or base alterations, but the variation in brain phenotypes within Apert syndrome is unexplained. Here we present novel MRM and µ-CT 3D data on brain phenotypes of mice each carrying one of the two Fgfr2 mutations associated with AS. Our data suggest that the brain is primarily affected, rather than secondarily responding to skull dysmorphogenesis.

**2365. A Multimodal Imaging Approach for Phenotyping of Dynein Heavy Chain Mutant Mice Cra1 Using MRI and PET/CT**

Detlef Stiller1, Thomas Kaulisch1, Selina Bucher1, Julia Tillmanns1, David Kind1, Heiko G. Niessen1, Krisztina Rona-Vörös2, Kerstin E. Braunstein2, Hans-Peter Müller2, Luc Dupuis3, Albert C. Ludolph4

1In-Vivo Imaging, Dept. of Drug Discovery Support, Boehringer Ingelheim Pharma GmbH & Co. KG, Biberach, BW, Germany; 2Dept. of Neurology, University of Ulm, Ulm, BW, Germany; 3ISERM U692, Strasbourg, France

A mouse with a point mutation in the gene encoding the motorprotein dynein is characterized by abnormal reflexes and by progressive motor and behavioral abnormalities without motor neuron degeneration. Even though previous studies showed age-dependent striatal astrocytosis and dysfunction, no in-vivo characterization of the brain has been performed yet. To investigate structural and functional alterations in the mouse brain, longitudinal MRI and [18F]-Fallypride PET were performed. In mutant mice the striatum size was significantly decreased, that of the ventricles significantly increased. PET imaging revealed a significantly reduced striatal uptake of Fallypride, supporting the theory of cell loss in the structure.

**2366. Gliogenesis in Live Animals Using Targeted MRI: Detecting Neural Progenitor Cells in Vivo**

Philip K. Liu1, Christina H. Liu1

1Radiology, Mass General Hospital/Harvard Medical School, Charlestown, MA, United States

Recruitment of specific cells is associated with tissue repair. Cell typing especially at the level of the DNA or RNA, has long depended on tissue biopsy of affected organs or postmortem investigation. The ability to evaluate therapies that might overcome such perturbations by using genes or cells (gene or stem cell therapies) in a host has been significantly limited. We have developed probes for specific cell type detection using mRNA targeting antisense DNA and contrast-enhanced MRI in live animals. Examples of detecting neural progenitor cells during brain repair after cerebral ischemia using targeted MRI in vivo will be presented.

**2367. Metabolic Profiling to Characterise Brain Tissues from a New Animal Model of Neurodegeneration with Lewy Body Pathology**

Philippine Camilla Geiszler1,2,3, Lynn Bedford4, R John Mayer5, Dorothee P. Auer4, Clare A. Daykin5

1Division of Academic Radiology, School of Clinical Sciences, University of Nottingham, Nottingham, Nottinghamshire, United Kingdom; 2Division of Molecular and Cellular Sciences, School of Pharmacy,
This NMR spectroscopy-based metabolic profiling pilot study was conducted to examine the ability to characterise early effects of neurodegeneration in ubiquitin proteasome-depleted mice. In specific brain areas, these animals develop pyknotic nuclei preceding Lewy body-like neuronal inclusions and extensive neuronal loss. Cortices and hippocampi were extracted at the pyknotic nuclei stage. Liquid-state spectra, recorded at 400MHz, showed significant metabolic alterations (N-acetylaspartate, taurine, choline) in both areas indicative of substantial neuronal cell remodelling before neuronal death. The investigation demonstrated clearly the ability of NMR-based metabolic profiling techniques to aid in the characterisation of early neurodegeneration.

2368. Assessing Lysosomal Pathology Using Magnetic Resonance Imaging
Yuan Mei, Robia G. Pautler

There are many neurodegenerative diseases that cause lysosomal pathology including Alzheimer’s and Sandhoff disease. In these disorders, cellular irregularities disrupt the lysosomal membrane and cause the organelle to lose its internal acidity. Using a convertible T1 contrast agent sensitive to acidity, we hypothesize that magnetic resonance imaging (MRI) can be used to detect lysosome membrane permeabilization and loss of acidity in mouse models with lysosomal pathology. If successful, this methodology can potentially be applied in vivo and used as a tool to improve current diagnostic methods for neurological disorders such as Alzheimer’s disease.

2369. Tract-Based Spatial Statistics (TBSS) Analysis Reveals Novel Changes in Lateral Thalamic Nuclei of Kainic Acid Treated Rats - Comparison of DTI and Histology
Alejandra Sierra, Kimmo Lehtimäki, Teemu Laitinen, Lassi Rieppo, Asla Pitkänen, Olli Gröhn

Diffusion tensor imaging (DTI) in combination with tract-based spatial statistics (TBSS) analysis provides valuable anatomical information about changes in brain areas contributing to epileptogenic process. Lateral thalamic nuclei are one of the areas highlighted in TBSS showing increased FA 6 months after status epilepticus in rats. The present work is focused to characterize the interrelationship of histopathological changes and ex vivo DTI in combination with TBSS analysis using several histological stainings and polarized light microscopy.

2370. Brain Behavior Relationship in Wild-Type Mice and a Mouse Model of Huntington’s Disease
Jurgen Germann, Jeffrey B. Carroll, Christine Laliberte, R. M. Henkelman, Michael R. Hayden, Jason P. Lerch

We examined brain-behavior correlations in mice using MRI and 4 behavioural tests: Rotarod, Forced-Swim, Pre-pulse-Inhibition and Open Field test. Secondly, we investigated how these relationships are altered in a Huntington’s disease (HD) mouse model. Strong correlations were found in the wild-type mice identifying functional networks related to motor function, stress and anxiety, cortical gating and memory. The correlations are an expression of learning induced structural changes and provide insight into the study of brain networks controlling behavior; their absence in the HD mice could provide some insight into disease processes as they interfere with the changes normally induced by learning.

2371. Diffusion Kurtosis in a Symptomatic Rat Model of Huntington’s Disease: Selective Grey and White Matter Pathology
Ines Blocks, Marleen Verhoye, Dirk Poor, Johan Van Audekerke, Huu Phuc Nguyen, Stephan Von Hörsten, Jan Sijbers, Annemie Van der Linden

Diffusion Kurtosis Imaging (DKI) quantifies the well known non-gaussianity of the diffusion process in biological tissue and is therefore an indicator of microstructural complexity. HD is a progressive late-onset neurodegenerative disorder and is characterized by the formation of huntingtin aggregates and degeneration of the corticostriatal network. In the present study, we used the microstructural sensitivity of DKI to detect neurodegeneration in symptomatic tgHD rats at the age of 16 months. Region of interest analyses revealed significant differences of DT and DK parameters in grey (caudate putamen) and even in white matter (external capsule) structures.
Areas of Susceptibility of the Predisposed Immature Rat Brain to Hyperthermic Seizures and Resultant Neurodevelopment Delay: An MRI and PET Study

Olivier Clerk-Lamalice, Pierre Gravel, Luc Tremblay, Roger Lecomte, Lionel Carmant, Martin Lepage

1Centre d’imagerie moléculaire de Sherbrooke, Université de Sherbrooke, Sherbrooke, Quebec, Canada; 2Département de radiologie, Hôpital Notre-Dame du Centre Hospitalier de l’Université de Montréal, Montréal, Quebec, Canada; 3Centre de recherche de l’hôpital Sainte-Justine, Université de Montréal, Montréal, Quebec, Canada; 4Groupe de recherche sur le système nerveux central, Université de Montréal, Montréal, Quebec, Canada

A new animal model has been developed to study the relation between cortical dysplasia, hyperthermic seizure (HS) and temporal lobe epilepsy (TLE). In this study, volumetric MRI, T2-weighted signal intensity and PET were used to better understand the neurodevelopmental changes that occur after HS in a predisposed brain and a possible link with the development of TLE. Our results suggest a causal relationship between a T2-weighted signal change resulting from metabolism/vascularisation imbalance after HS and a consequent developmental delay of the hippocampus.

Cerebral Blood Volume Mapping of Macro- And Microvasculature in Mouse Brain with 3D Gradient Echo MRI

Valerio Zerbi, Diane Jansen, Andor Veltien, Amanda Kiliaan, Arend Heerschap

1Anatomy, UMC St. Radboud, Nijmegen, Netherlands; 2Radiology, UMC St. Radboud, Nijmegen, Netherlands

Impaired cerebral macro- and microvascular perfusion play an important role in the development of Alzheimer’s disease (AD). Here, a post-processing method is evaluated to distinguish and quantify cerebral blood volume (CBV) in macro- and microvasculature with contrast-enhanced MRI in a transgenic mouse model for AD. A comparison between steady-state CBV computations is presented, and histogram analysis is used to separate between vascular compartments. Results showed a decrease in hippocampal microvascular CBV as consequence of aging and genotyping that is not visible without separation of vascular compartments for macro- and microvasculature perfusion.

Correlation of Fractional Anisotropy and Mean Diffusivity in Rhesus Monkey with Age and Parkinson’s Disease

Megan P. Phillips, David K. Powell, Zhiming Zhang, Richard Grondin, Peter A. Hardy

1Center for Biomedical Engineering, University of Kentucky, Lexington, KY, United States; 2MRISC, University of Kentucky

Parkinson’s Disease (PD) is a common neurodegenerative disease characterized by loss of motor control. PD results from the loss of dopamine-producing neurons in the substantia nigra (SN). Depletion of the dopamine neurons in the SN affects white matter tracts connecting the SN to the putamen. Using diffusion tensor imaging (DTI), the goals of our research are first to identify the white matter tracts between the SN and putamen affected by the depletion of dopamine and second, identify the effects of age on white matter, specifically, fractional anisotropy (FA) and mean diffusivity (MD).

Evaluation of Inflammatory Process in Parkinson's Disease Model: Magnetization Transfer Image Histogram Parameter and 1H Magnetic Resonance Spectroscopy

Moon-Hyun Yoon, Hyun-Jin Kim, Jin-Yeung Jang, Bo-Young Choe

1Biomedical Engineering, Medical College, The Catholic Univ. of Korea, Seoul, Metro of Seoul, Korea, Republic of; 2Lee Gil Ya Cancer and Diabetes Institute, GACHON University of medicine and Science, Seoul, Korea, Republic of

We found that inflammatory process was significantly associated with the highest peak height value of MTR histogram in the striatum and the SN. A possible explanation for this could be the early phase of the influence of specific neurotransmitters on the mean MTR values. The higher peak height of the MTR histogram in the striatum and SN was significantly associated with higher Glx/Cr ratios after MPTP intoxication suggesting neuronal dysfunction. The pathological studies in PD model clearly demonstrate the presence of disseminated activated microglial-like inflammatory cells in the central nervous system.

Longitudinal Magnetic Resonance Spectroscopy and T2 Measurements in a Mouse Model of Niemann-Pick Type C Disease

John Totenhagen, Ivan Borbon, Eriko Yoshimaru, Christine Howison, Robert P. Erickson, Theodore P. Trouard

1Biomedical Engineering, University of Arizona, Tucson, AZ, United States; 2Pediatrics, University of Arizona, Tucson, AZ, United States; 3Arizona Research Laboratories, University of Arizona, Tucson, AZ, United States

Results are presented from a longitudinal study of T2 and MRS measurements in a mouse model of Niemann-Pick Type C (NPC) disease to examine T2 measurements and MRS as possible indicators of disease progression and response to therapy in NPC disease.
2377. **Sub-Type Specific Hippocampal Glutamate Levels in the Chronic Mild Stress Rat**

**Model for Depression**

Adriaan Campo¹, Ove Wiborg², Helene Benveniste³, Annemie Van Der Linden¹

¹Bio-Imaging Lab, University of Antwerp, Antwerp, Belgium; ²Center for psykiatrisk forskning, Århus Universitetshospital Risskov, Risskov, Århus, Denmark; ³Medical Department, Brookhaven National Laboratory, Upton, NY, United States

MR spectroscopy was used to assess neurochemical changes in the hippocampus of the CMS rat model for depression. Besides the well known anhedonic phenotype, and control animals, a third group of animals was included: so-called stress resilient animals. These animals show different symptoms when subjected to prolonged stress. We suppose that these different signs of depression are due to different modulation of the HPA axis, as assessed by glutamate levels in the hippocampus: normal stressed animals show higher glutamate concentration, while the abnormal subgroup shows similar glutamate concentration as the control animals.

2378. **Effects of Continuously High Levels of Corticosteroids on Mouse Hippocampus – a Longitudinal in Vivo MRI Study**

Dana Suciu¹, Alize E. H. Scheenstra², Jouke Dijkstra³, Melly Sylvana Otzi³, Louise van der Weerd¹, ², ³

¹Radiology, LUMC, Leiden, Netherlands; ²Radiology - Image processing, LUMC, Leiden, Netherlands; ³Medical Pharmacology, LACDR, Netherlands; ⁴Anatomy, LUMC, Leiden, Netherlands

We report a longitudinal MRI investigation on mice chronically exposed to stress hormones (hypercorticism) to investigate hippocampal morphology. The mice were implanted with a continuous corticosterone-releasing pellet (n=10) or a placebo cholesterol pellet (n=10). T2W MRI scans of the mouse brain were taken over several weeks. Volumetric analysis by manual delineation using SPSS analysis and quantitative group-wise comparison using deformation fields and a 3D Moore-Rayleigh test with Bonferroni correction were employed. Our study demonstrated that chronic hypercorticism in mice indeed leads to volume loss in the hippocampus, which is at least partially reversible after recovery.

2379. **Combined Vegf and Angiopoietin-1 Gene Transfer Using Aav Vectors After Spinal Cord Injury**

Juan Jose Herrera¹, Ponnada A. Narayana¹

¹Diagnostic and Interventional Imaging, The University of Texas Health Science Center at Houston, Houston, TX, United States

A consequence of spinal cord injury is the disruption of spinal vasculature, and it is this disruption that contributes to the initiation of cascade of biochemical events leading to secondary damage from the ischemic and inflammatory responses Using adenovirus-associated viral vectors engineered to express Ang-1 and or VEGF may stimulate angiogenesis and vessel maturation after spinal injury. Our study indicates that the synergistic effect of both agents reduces spinal vascular permeability and lesion volume determined by MRI leading to functional recovery.

2380. **Characterization of Inner Ear Inflammation in Rodents Using in Vivo Dynamic Contrast Enhanced Magnetic Resonance Imaging and Ex Vivo Light Microscopy**

Johann Le Floc'h¹, Beau Pontré², Winston Tan¹, Srdjan M. Vlajkovic¹, Peter R. Thorne¹

¹Physiology, The University of Auckland, Auckland, New Zealand; ²Centre for Advanced MRI, New Zealand

Inner ear inflammation is thought to be a major contributor to the development of hearing loss and balance disorders. We report the results of the in vivo characterization of cochlear tissues inflammation induced by noise exposure or injection of bacterial lipopolysaccharide in two rodent species. The anaesthetized animals were scanned using a 4.7T MRI system. The calculated signal enhancement due to the observed uptake of a contrast agent was greater on inflamed than normal cochleae. MR findings correlated well with immunohistochemistry. We suggest that increase in gadodiamide uptake occurred as a consequence of increased vascular permeability.

2381. **Cerebral Metabolite Assessment in Low and High Capacity Running Rats Using 1H-MRS**

Steven R. Roys¹, Anjaneyulu Murugundla¹, Su Xu¹, Aurora Anderson¹, Jiachen Zhuo¹, Mark Limson², J Choi³, Steve Britton¹, Krish Chandrasekaran³, Paul Yarovsky³, James Russell³, Rao P. Gullapalli¹, ², ³

¹Diagnostic Radiology & Nuclear Medicine, University of Maryland School of Medicine, Baltimore, MD, United States; ²Core for Translational Research in Imaging @ Maryland (C-TRIM); ³Neurology, University of Maryland School of Medicine, Baltimore, MD, United States; ³Neurology, University of Maryland School of Medicine, Baltimore, MD, United States; ³Anesthesiology, University of Michigan, Ann Arbor, MI; ²Experimental Therapeutics and Pharmacology, University of Maryland School of Medicine, Baltimore, MD, United States

Very little is understood regarding CNS changes that lead to various cognitive impairments among people with impaired glucose tolerance. Even less is understood regarding the differences between high performing diabetic patients versus the low performing diabetics. The purpose of this study was to examine the neurochemical profile differences between low capacity runner rats (LCR) and high capacity runner rats (HCR) using proton magnetic resonance spectroscopy at 7.0 Tesla. Findings suggest that LCR rats have elevated taurine, myo-inositol, glutamate and choline containing compounds compared to HCR rats consistent with similar findings in diabetic patients.
**2382. Effect of Lactate on FMRI Responses Under Hypoglycemia**

**Lihong Jiang**, Basavaraju G. Sanganahalli, Peter Herman, Raimund Herzog, Robert Sherwin, Fahmeed Hyder, Douglas Rothman, Kevin Behar

Yale University, New Haven, CT, United States

We investigated BOLD responses to forepaw stimulation under insulin-induced acute hypoglycemic condition, as well as effect of lactate infusion under hypoglycemic condition. All high field fMRI experiments were conducted in α-chloralose anesthetized rats. The magnitude of the BOLD response in primary somatosensory (S1FL) region decreased from euglycemic to hypoglycemic conditions. Upon lactate infusion, under hypoglycemic condition, transiently increased S1 activities, but also recruited regions beyond S1FL. These results will benefit the understanding of brain function and metabolism, as well as the role of alternative fuels under hypoglycemic condition.

**MRS of Animal Brain**

**Hall B Tuesday 13:30-15:30**

**2383. Simultaneous Detection of Metabolism of Different Substrates in the Carboxylic/amide Region Using in Vivo 13C MRS**

**Yun Xiang**, Jun Shen

National Institute of Mental Health, Bethesda, MD, United States

In the carboxylic/amide region, brain 13C signals can only have one one-bond 13C-13C homonuclear coupling. As such only doublets (with a 13C-13C coupling of ~50 Hz) and singlets exist in this region. The large one-bond 13C-13C J coupling and the lack of interference from other isotopomers provide a unique condition for simultaneous detection of metabolism of different substrates. Examples of co-infusion of [13C6]-D-glucose and [1-13C] acetate as well as co-infusion of [13C6]-D-glucose and [1,3-13C2] hydroxybutyrate are shown to demonstrate in vivo simultaneous detection of different metabolic pathways in the brain using 13C MRS of the carboxylic/amide region.

**2384. Alcohol as a Substitute for Acetate in 13 C MRS Study of Brain Metabolism**

**Yun Xiang**, Jun Shen

National Institute of Mental Health, Bethesda, MD, United States

Acetate is a glia-specific substrate and has been used to study brain metabolism. Potential risk in intravenously infusing sodium acetate to patients is unknown in many disorders. The effect of alcohol (ethanol) consumption is well understood. Alcohol is predominantly metabolized into acetate in the liver. In the present study, steady state 13C spectra of rat brain acquired after administration of [1-13C] ethanol were found to be highly similar to spectra obtained using [1-13C] acetate, suggesting that oral administration of [1-13C] alcohol could replace intravenous infusion of sodium [1-13C] acetate in certain studies when the direct effect of alcohol is unimportant for the subject of the study.

**2385. Neurochemical Profile of the Rat Lateral Septum Investigated with 1H-MRS**

**Nathalie Just**, Maria-Isabel Cordero Campana, Guillaume Poirier, Hongxia Lei, Carmen Sandi, Rolf Gruetter

LIFMET, CIBM, EPFL, Lausanne, Switzerland; Department of Radiology, UNIL, Lausanne, Switzerland; Laboratory of Behavioural Genetics, EPFL, Brain and Mind Institute, Lausanne, Switzerland; Department of Child and Adolescent Psychiatry, HUG, Geneve, Switzerland; Department of Radiology, UNIL and HUG, Lausanne and Geneva, Switzerland

The rat lateral septum has been shown to be involved in the expression of anxiety-behaviors such as those involved in conflict procedures. The neurochemical profile of the lateral septum has however never been characterized using proton magnetic resonance spectroscopy in the rat. In the present work, the neurochemical profile of the rat lateral septum was measured at 9.4T using 1H-MRS demonstrating significant changes compared to similar data measured in unspecific rat brain regions. It appears essential to characterize the metabolic profile of specific brain areas with accuracy using 1H MRS.

**2386. Lesions of Ventral Tegmental Area in the Mouse and Consequences on Glutamate, Gaba and Glutamine Levels Assessed Using Proton 1H MRS**

**Carine Chassain**, Guy Bielicki, Yildiz Zengin, Jean-Pierre Renou, Franck Durif

NMR plateform, INRA, Saint Genes Champanelle, France; EA 3845, University of Auvergne, Clermont-Ferrand, France; service Neurology, CHU Clermont-Ferrand, Clermont-Ferrand, France

Parkinson's disease, 1H MRS, Glutamate, Glutamine, GABA, nucleus accumbens

**2387. NMR Investigations of Excitatory and Inhibitory Neurotransmission in Mouse Brain**

**Anant Bahadur Patel**, Vivek Tiwari, A.L. Susmitha, K.S. Varadarajan

NMR Microimaging and Spectroscopy, Centre for Cellular and Molecular Biology, Hyderabad, Andhra Pradesh, India

Knowledge of neurotransmitter metabolism is very important for understanding the pathophysiology of neurological disorders. In the present study we have investigated neuronal TCA cycle and neurotransmitter cycle flux in different brain regions of C57BL6 mouse.
Mice were infused with \([1,6-^{13}C_2]\)glucose for different time ranging from 7 to 90 min or \([2-^{13}C]\)acetate for ~90 min. Brain metabolite levels and \(^{13}C\) labeling of amino acids were measured with \(^1H\-[^{13}C]\)-NMR spectroscopy at 14T NMR spectrometer. The metabolite levels were distinct in different regions of the brain. Glutamatergic rate was higher in cortex while GABAergic was more in cerebellum and olfactory bulb.

**2388. Regional Absolute Quantification in Neurochemical Profile of the Canine Brain:**

**Investigation by Proton Nuclear Magnetic Resonance Spectroscopy and Tissue Extraction**

Dong-Cheol Woo\(^1\), Chi-Bong Choi\(^2\), Sung-Ho Lee\(^3\), Eunjung Bang\(^4\), Sang-Soo Kim\(^5\), Hyang-Shuk Rhim\(^1\), Sang-Young Kim\(^6\), Bo-Young Choe\(^7\)

\(^1\)The Catholic University of Korea, Seoul, Korea, Republic of; \(^2\)Kyung-Hee University of Korea; \(^3\)Konkuk university of Korea; \(^4\)Korea Basic Science Institute

This study was to characterize the regional neurochemical profiles of canine brain using NMRS, tissue extraction, and external simulated phantom concentration quantification. The occipital, frontal, and temporal lobes, thalamus, cerebellar cortices, and spinal cords of adult beagles were obtained, and NMR samples were prepared using M/C extraction method. The metabolite concentrations in canine brain tissues were measured and compared with those found in human and rat brain. In addition, the cross peaks of brain metabolites were identified using 2D-COSY. This study demonstrated the absolute quantification of canine neuronal parts using MRS, with tissue extraction used to measure metabolite concentrations.

**2389. In Vivo Evidence for Ketamine-Induced Neurochemical Changes in Rat Prefrontal Cortex: An Animal Model of Schizophrenia**

Sang-Young Kim\(^1\), Hyun-Sung Lee\(^2\), Eunjung Bang\(^3\), Hyun-Ju Kim\(^4\), Sung-Ho Lee\(^5\), Do-Wan Lee\(^6\), Dong-Cheol Woo\(^7\), Chi-Bong Choi\(^8\), Bo-Young Choe\(^9\)

\(^1\)Department of Biomedical Engineering, The Catholic University of Korea, Seoul, Korea, Republic of; \(^2\)Korea Basic Science Institute, Korea, Republic of; \(^3\)Department of Veterinary Surgery, Konkuk University, Seoul, Korea, Republic of; \(^4\)Department of Radiology, Kyunghee University Medical Center, Seoul, Korea, Republic of

The ketamine, a NMDA receptor antagonist, impair prefrontal cortex (PFC) function in the rat and produce symptoms similar to schizophrenia. In this study, we used in vivo and in vitro \(^1H\)-NMR spectroscopy to examine the brain metabolism of rat treated with subanesthetic dose of ketamine. In vivo data for Glu/Gln abnormalities in ketamine-treated rats may support the hypotheses of glutamate dysfunction for schizophrenia. In addition lower metabolic level of NAA in rats treated with ketamine may indicate reduced neuronal viability. Therefore our findings suggest that the neurochemical alterations induced by ketamine may provide the foundation for pathophysiological models of schizophrenia.

**2390. In Vitro Proton MRS of Cerebral Metabolites in a Mouse Model of Alzheimer's Disease**

Duncan Forster\(^1\), Steve Williams\(^2\), Mike James\(^3\), Jill Richardson\(^3\)

\(^1\)University of Manchester, Manchester, United Kingdom; \(^2\)University Of Manchester; \(^3\)GlaxoSmithKline

An in vitro proton MRS study was carried out on mice ranging from 3 to 18 months in order to investigate cerebral metabolic differences between TASTPM Alzheimer's mice and their wild type base strain. An effect of genotype was observed for myo-inositol, with concentration being higher in TASTPM mice, myo-inositol may therefore be an Alzheimer's marker. Lower levels of succinate were observed in TASTPM mice, being an effect of both age and genotype. This may indicate impaired neuronal energy production or mitochondrial dysfunction. The results also call into question the use of creatine as a reference metabolite.

**2391. In Vivo \(^1H\) MRS Measurements of Acetate in Mouse Striatum After Permanent Focal Middle Cerebral Artery Occlusion**

Hongxia Lei\(^1\), Lijing Xin\(^1\), Carole Berther\(^2\), Lorenz Hirt\(^3\), Rolf Gruetter\(^4\)

\(^1\)LIFMET, Ecole Polytechnique Fédérale de Lausanne, Lausanne, Switzerland; \(^2\)Radiology, University of Lausanne, Lausanne, Switzerland; \(^3\)Neurology, Centre Hospitalier Universitaire Vaudois, Lausanne, Switzerland; \(^4\)Radiology, University of Geneva, Geneva, Switzerland

\(^1\)H MRS of permanent focal middle cerebral occlusion (pMCAO) in mice could be feasible at high magnetic field. However, one of hydrolytic metabolites of NAA, acetate (1.9ppm), was heavily overlapped by accumulated GABA (1.89ppm) after pMCAO. In this study, we demonstrated that short echo time \(^1H\) MRS of measuring acetate was feasible at ultra short echo time using LCModel analysis when comparing to the measurements with minimal GABA contributions at a moderate echo time.

**2392. In Vivo \(^1H\) MR Studies of Cortical Metabolic Response During Insulin-Induced Hypoglycemia**

Hongxia Lei\(^1\), Arthur W. Magill\(^1\), Vladimir Mlynarik\(^1\), Rolf Gruetter\(^1\)

\(^1\)LIFMET, Ecole Polytechnique Fédérale de Lausanne, Lausanne, Switzerland; \(^2\)Radiology, University of Lausanne, Lausanne, Switzerland; \(^3\)Neurology, Centre Hospitalier Universitaire Vaudois, Lausanne, Switzerland; \(^4\)Radiology, University of Geneva, Geneva, Switzerland

Understanding hypoglycemia became very essential for treating diabetes in clinical. We explored \(^1H\) MR studies, including cerebral blood flow and neurochemical profile of cortical tissue under insulin-induced hypoglycemia in rats.
Elevated Brain Lactate Measured by 1H-MRS Is an Early Phenotype Due to Mitochondrial Dysfunction in the Prematurely Ageing MtdNA Mutator Mouse

Jaime M. Ross1,2, Johana Öberg3, Stefan Brené4, Giuseppe Coppotelli4, Mügen Terzioglu4, Karin Pernold4, Rouslan Sitnikov7, Jan Kehr7, Alexandra Trifunovic6, Nils-Göran Larsson8, Barry J. Hoffer2, Lars Olson1

1Neuroscience, Karolinska Institutet, Stockholm, Sweden; 2National Institute on Drug Abuse, National Institutes of Health, Baltimore, MD, United States; 3Clinical Science, Intervention and Technology, Karolinska Institutet, Stockholm, Sweden; 4Neurobiology, Health Sciences and Society, Karolinska Institutet, Stockholm, Sweden; 5Cell and Molecular Biology, Karolinska Institutet, Stockholm, Sweden; 6Laboratory Medicine, Karolinska Institutet, Stockholm, Sweden; 7Physiology and Pharmacology, Karolinska Institutet, Stockholm, Sweden; 8Max Planck Institute for Biology of Ageing, Cologne, Germany

The prematurely ageing mtDNA mutator mouse was used to study mitochondrial dysfunction in the brain. 1H-MRS detected a 2-fold increase in cortical and striatal lactate levels as early as 6-9 weeks and continued throughout the lives of mtDNA mutator mice (average life span 45-48 weeks). Increased brain lactate levels were confirmed postmortem by high-performance liquid chromatography (HPLC). These methods revealed that abnormally high lactate levels in the CNS are an early phenotype of premature ageing in the mtDNA mutator mouse. Our data support the hypothesis of abnormal metabolism in ageing due to mitochondrial dysfunction.

Mouse Brain Structure and Metabolic Stability Follows Focused Beam Microwave Irradiation

Michael D. Boska1, Erin McIntyre1, Melissa Lynn Mellon1, Howard E. Gendelman2

1Radiology, University of Nebraska Medical Center, Omaha, NE, United States; 2Pharmacology and Experimental Neurosciences, University of Nebraska Medical Center, Omaha, NE, United States

Mouse brain structural and metabolic stability were determined by T1 and T2 mapping and DTI at 0.7 and 0.9 s of 4 kW FBMI and by quantitative single voxel PRESS, respectively. Measures were taken in-vivo before and repetitively, at 1.17 hour intervals, after FBMI. Analysis continued for a total duration of 16 hours at room temperature. The longer FBMI duration was best for maintaining metabolite levels in the mouse brain; whereas T1, T2, and DTI metrics were best maintained by shorter duration FBMI.

Coupling of Cerebral Phosphoethanolamine and Nucleotide Triphosphate Levels and Mitochondrial-Respiration Modulation During Perinatal "secondary Energy Failure"

Ernest Brunton Cady1, Osuke Iwata2, Alan Bainbridge1, John Wyatt2, Nikki Jayne Robertson2

1Medical Physics & Bioengineering, UCLH NHS Foundation Trust, London, United Kingdom; 2Institute for Women’s Health, University College London, London, United Kingdom

Phosphoethanolamine concentration ([PE]) is high in neonatal brain. [PE] reduction increases mitochondrial respiration. We aimed to elucidate PE’s metabolic role following hypoxia-ischaemia (HI). Thirty-three piglets were studied by 31P MRS (27 HI; 6 controls). For severe cerebral injury [PE]/[exchangeable phosphate pool] fell below controls but later recovered: however, [PE]/[nucleotide triphosphate (NTP; mainly ATP)] was almost constant suggesting strong PE to NTP coupling. In cells stressed after HI reduced [ATP] may inhibit ethanolamine phosphokinase resulting in [PE] reduction and stimulation of ATP generation by surviving mitochondria. High neonatal [PE] may be a factor evolved to counter mammalian cerebral birth trauma.

Protective Actions of L-Carnitine in Ammonia-Precipitated Hepatic Encephalopathy

Jane Missler1,2, Wenlei Jiang3, Dieter Leibfritz2, Claudia Zwingmann1

1Département de médecine, Centre de Recherche, Hôpital Saint-Luc, Université de Montréal, Montréal, Quebec, Canada; 2Department of Chemistry, University of Bremen, Bremen, Germany; 3Département de médecine, Centre de Recherche, Hôpital Saint-Luc, Université de Montréal, Montréal, Quebec, Canada

Hepatic Encephalopathy is associated with hyperammonemia and energetic changes in brain. In animal models and patients with mild HE, L-carnitine has been shown to be protective. In order to investigate the effect of L-carnitine on brain energy-metabolism, multinuclear NMR was used to measure metabolic pathways in brain following administration of [U-13C]glucose in ammonia-treated rats with PCA. In ammonia-precipitated encephalopathy, L-carnitine considerably delayed the time to coma, concomitantly to enhanced ammonia detoxification via astrocytic glutamine synthesis and attenuation of lactate accumulation. These results indicate to cell-specific actions of L-carnitine which might explain its therapeutic effect in ammonia-precipitated HE in cirrhotic patients.
Until recently, no data are available about the behavioral and simultaneous non-invasive measurements of neurochemical responses following antidepressant treatment in mice FST model. In this study, in vivo 1H-MRS at 9.4 T was used to examine the effects of desipramine (DMI) pretreatment on behavioral and regional neurochemical responses of C57BL/6 mice brain. We found significant behavioral changes as well as metabolic alterations of glutamate and myo-inositol by the DMI pretreatment. Our results suggest that glutamatergic activity and glial cell dysfunction contribute to pathophysiological mechanisms underlying depression and that modulation of synaptic neurotransmitter concentrations represent invaluable targets for antidepressant drug development.

Animal models for depression are indispensable tools in the search to identify new antidepressant drugs. The forced swimming test (FST) is the most widely used tool for assessing antidepressant activity in rodents. Few studies have been performed proton spectroscopy to assess antidepressant effects on brain metabolism of rat exposed to the FST. The in vivo proton spectra quantified by LCModel revealed that myo-inositol metabolic level in left dorsolateral prefrontal cortex of rat was significantly altered in both FST and desipramine treated group. Our findings suggest a possible role of myo-inositol within the left DLPFC of rat model for depression.
hypoglycemia to investigate the role of increased lactate transport and/or metabolism in the brain of a rat model with ketogenic diet-induced upregulation of MCT1.

2402. **Acute Flupirtine Administration Reduces Glutamate/glutamine Ratio in Rat Hippocampus**

*Renuka Sriram*¹, *Robert J. Mather*², *Serguei Liachenko*¹

¹BioImaging CoE, Pfizer Inc, Groton, CT, United States; ²Neuroscience, Pfizer Inc, Groton, CT, United States

Neurotransmitter levels of glutamate and glutamine are tightly coupled with modulation of one resulting in a corresponding opposing change in the other. Since glutamate is implicated in a variety of neurological disorders, the observation of an endogenous pool of glutamate (Glu) and glutamine (Gln) and/or its ratio can serve as a strong mechanistic biomarker and measure of efficacy. Flupirtine, a potassium channel opener, has been shown to cause decrease in Glu and a relative increase in Gln in the rat hippocampus.

2403. **1H MRS Profiling at 9.4T in Prefrontal Cortex and Hippocampus of Ethanol Dependent Rats During Intoxication, Withdrawal and Protracted Abstinence**

*Wolfgang Weber-Fahr*¹, *Gabriele Ende*¹, *Alexander Sartorius*¹, *Rainer Spanagel*², *Claudia Falchan-Melgoza*³, *Dirk Cleppien*¹, *Wolfgang H. Sommer*²

¹Neuroimaging, Central Institute of Mental Health, Mannheim, NA, Germany; ²Dept. Psychopharmacology, Central Institute of Mental Health, Mannheim, NA, Germany

Out of a group of 17 animals eight were made dependent by 7 weeks ethanol vapor exposure with peak levels up to 4 g/l blood alcohol concentration. We assessed metabolic profiles in two brain regions with functional importance for dependence, i.e. medial prefrontal cortex and hippocampus, using in vivo single-voxel 1H magnetic resonance spectroscopy at TE=10 ms on a 9.4T scanner. Animals were measured up to 5 times before during and after ethanol exposure. Reduced myoinositol and N-acetylaspartate levels as well as increased choline-containing compounds were found during intoxication. Raised glutamate levels were found during early withdrawal.

2404. **Brain Neurochemical Effects of Long-Term Sleep Fragmentation Investigated in Mice at 14.1T Using 1H-MRS**


¹LIFMET, CIBM, EPFL, Lausanne, Switzerland; ²Department of Radiology, UNIL, Lausanne, Switzerland; ³Laboratoire de neuroénergétique et dynamique cellulaire, EPFL, Lausanne, Switzerland; ⁴Brain and Mind Institute, Lausanne, Switzerland; ⁵Department of Radiology, UNIL and HUG, Lausanne and Geneva, Switzerland

The present study examined the effects of sleep fragmentation (SF) in the hippocampus and the cortex of mice using proton MR spectroscopy at 14.1T. Disruptions in brain sensory processing and cognitive performance were seen during sleep fragmentation. Moreover, there is evidence that SF negatively affects memory and learning. Here, significant decreases in GABA and Lactate concentrations were detected in the hippocampus of mice following sleep fragmentation indicating decreased synaptic function in the hippocampus.

2405. **Regional Variations of Metabolite Concentrations in the Rat Brain Assessed with in Vivo ¹H MR Spectroscopy at 16.4T**

*Sung-Tak Hong*¹, *Dávid Zsolt Balá*¹, *Gunamony Shajan*¹, *Changho Choi*², *Rolf Pohmann*¹

¹High-Field Magnetic Resonance Center, Max-Planck Institute for Biological Cybernetics, Tuebingen, Baden-Wuerttemberg, Germany; ²Advanced Imaging Research Center, University of Texas Southwestern Medical Center, Dallas, TX, United States

Regional differences of metabolites in the rat brain were investigated by using localized in vivo 1H MR spectroscopy at 16.4T. Three regions, thalamus, striatum and hippocampus, were investigated with an ultra-short TE STEAM sequence. The results demonstrated significant variations in all metabolites except aspartate and NAA. The remarkable variation of spectra was the substantially decreased level of the Tau methylene signal at 3.25 ppm in thalamus. The significant increase of the GABA methylene signal at 1.89 ppm was also observed in thalamus.

2406. **Measurement of the Effects of Different Anesthetics in the Rat Thalamus by in Vivo ¹H NMR Spectroscopy at 16.4T**

*Sung-Tak Hong*¹, *Chi-Bong Choi*², *Rolf Pohmann*¹

¹High-Field Magnetic Resonance Center, Max-Planck Institute for Biological Cybernetics, Tuebingen, Baden-Wuerttemberg, Germany; ²Department of Radiology, Kyung Hee University Medical Center, Hookidong, Seoul, Korea, Republic of

The effect of different anesthetic agents was investigated in the rat brain by using in vivo 1H NMR spectroscopy. A volume-of-interest was placed in thalamus under two different anesthesia, isoflurane and ketamine/xylazine. The significant increase of glucose was observed in a deep ketamine/xylazine anesthesia while additional metabolic variations on ascorbate, aspartate, glutathione and lactate were detected.
2407. Differential Neurochemical Responses in the Rat Striatum with Isoflurane or Ketamine/xylazine Anesthesia: In Vivo Proton MRS Study at 16.4 T
Chi-Bong Choi¹, Sung-Tak Hong¹, Sang-Young Kim¹, Dong-Cheol Woo³, Bo-Young Choe¹, Kyung-Nam Ryu¹, Eun-Hee Kang¹, Sung-Vin Yim¹, Do-Wan Lee³, Rolf Pohmann²
¹Kyung Hee University of Korea, Seoul, Korea, Republic of; ²Max Planck Institute for Biological Cybernetics; ³The Catholic University of Korea

This study was to evaluate alterations in striatum metabolites of rats between anesthetized with isoflurane and ketamine/xylazine in vivo 1H-MRS at 16.4T, and to investigate the appropriateness of anesthetic agents. The concentrations of Ala, Asc, Asp, GABA, Gly and PCr were significantly different between isoflurane and ketamine/xylazine induced groups at the striatum. We demonstrated that metabolites in specific brain region can be differentially influenced according to anesthetic agents. This study showed that the choice of anesthetic is significant in the setting of 1H-MRS. Appropriate anesthetic choice should be pursued to exclude the effect of anesthetic agents on the target area.

Head & Neck Imaging: Normal to Cancer
Hall B Wednesday 13:30-15:30

2408. Movement-Artefact-Free Measurement of $T_1$ in the Human Eye to Determine Oxygenation of the Vitreous Humour
Nicholas G. Dowell¹, Edward H. Hughes², Paul S. Tofts¹
¹Brighton and Sussex Medical School, Brighton, United Kingdom; ²Sussex Eye Hospital, Brighton, United Kingdom

Accurate and precise $T_1$ mapping of the eyeball is difficult due to eye movement and image distortions. An accurate measure of $T_1$ could provide a non-invasive determination of eye oxygenation since $T_1$ times are subtly increased by reduced partial pressure of oxygen (pO$_2$) of the vitreous humour in the eye. Poor oxygenation leads to retinopathy and, in patients with low pO$_2$ at the retina, a vitrectomy may be performed, where the vitreous humour is extracted and replaced by saline. However, there is no clear evidence that an increase in pO$_2$ is actually achieved by this procedure and MRI would provide an important validation for ophthalmologists. We have developed a technique, using a TrueFISP acquisition sequence, which provides eye images with no movement artefacts, no image distortion and good SNR. This permits the measurement of $T_1$ (and hence pO$_2$) from the vitreous humour of the human eye. Furthermore, we show that asking a subject to fixate on a single point can control eye movement but the need to blink limits fixation to < 5 s. Consequently, we will provide an audio/visual cue that warns the subject when they must fixate. This approach to eye imaging could dramatically improve imaging of the eye and retina.

2409. Ultrashort Echo Time Imaging of the Middle Ear Ossicle: A Pilot Study
Koji Yamashita¹, Takashi Yoshiura¹, Akio Hiwatashi¹, Hironori Kamano¹, Yukihisa Takayama¹, Eiki Nagao¹, Hiroshi Honda¹
¹Radiology, Kyushu university, Fukuoka, Japan

Our purpose was to assess the feasibility of ultrashort echo-time (uTE) imaging for visualization of middle ear ossicles in normal subjects. Twelve volunteers with normal hearing levels were scanned at a 3.0T clinical unit using a dual-echo uTE sequence at TE1/TE2 = 0.14 ms/1.8 ms. In all subjects, the middle ear ossicles were clearly visualized as a high signal intensity spot on short TE images bilaterally, while they were not visible in long TE images in any of the subjects. To our knowledge, this is the first report of MR visualization of middle ear ossicles.

2410. Automatic Segmentation of Laryngeal Cartilages Using Support Vector Machines
R. Reeve Ingle¹, Berhane H. Azage¹, Joëlle K. Barrat², Kie Tae Kwon¹, Edward G. Damrose², Nancy J. Fischbein, ²,³, Dwight G. Nishimura¹
¹Electrical Engineering, Stanford University, Stanford, CA, United States; ²Otolaryngology, Stanford University, Stanford, CA, United States; ³Radiology, Stanford University, Stanford, CA, United States

MR is critical in the staging of laryngeal cancer. However, the presence and extent of cartilage invasion is difficult to assess. In this work, automatic intensity correction is integrated in a support vector machine algorithm, which is used to segment the cartilages from high-resolution MR images of the larynx.

2411. Dynamic MRI of the Temporomandibular Joint at 3 Tesla Using a Gradient Echo Sequence
Yoon-Chul Kim¹, John L. Go², Sara Banerjee², Meng Law², Houchun Harry Hu¹, Krishna S. Nayak¹,²
¹Ming Hsieh Department of Electrical Engineering, University of Southern California, Los Angeles, CA, United States; ²Keck School of Medicine, University of Southern California, Los Angeles, CA, United States

Dynamic MRI may be useful for assessing temporomandibular joint (TMJ) dysfunction. This application requires sub-millimeter resolution and adequate contrast between the articular disc and surrounding tissue. A gradient echo sequence was optimized by first measuring the $T_2^*$ values and then calculating the parameters of flip angle, TE, and TR that maximize the CNR efficiency. The dynamics of the TMJ disc was visualized with a 3.2 second temporal resolution, 0.5 × 0.5 mm$^2$ in-plane spatial resolution using a 6-channel Carotid coil at 3 Tesla.
2412. Chemical Shift Imaging in the Head and Neck at 3T: Initial Results
David K W Yeung1, Devin K. Fong1, Queenie Chan1, Ann D. King2
1Diagnostic Radiology and Organ Imaging, The Chinese University of Hong Kong, Shatin, N.T., Hong Kong; 2MR, Philips Healthcare, Wanchai, Hong Kong

Proton MRS is useful to probe tissue metabolism in vivo and its application yields considerable information about tissue biochemistry. In the head and neck, the detection of choline peak using single voxel spectroscopy has been found useful in confirming malignancy and treatment response. CSI is desirable for the study of large heterogeneous lesions, but shimming a large volume in the head and neck is challenging due to large susceptibility differences. We employed an anti-susceptibility device to improve the local field homogeneity. We examined 13 patients using this technique and we showed that CSI is feasible in the head and neck.

2413. 3D Mapping of Vocal Fold Geometry During Articulatory Maneuvers Using Ultrashort Echo Time Imaging at 3.0 T
Tobias Frauenrath1, Andreas Goemmel2, Christoph Butenweg1, Mario Otten1, Thoralf Niendorf1,3
1Berlin Ultrahigh Field Facility, Max-Delbrueck Center for Molecular Medicine, Berlin, Germany; 2Chair of Structural Statics and Dynamics, RWTH, Aachen, Germany; 3Erich-Thienhaus-Institute, Hochschule für Musik, Detmold, Germany; 4Experimental and Clinical Research Center (ECRC), Charité Campus Buch, Humboldt-University, Berlin, Germany

Even if some spatial insight can be obtained by stereoscopy imaging from classical optical methods or ex-vivo experiments, real 3D in-vivo measurements of vocal fold geometry are still elusive. Magnetic resonance imaging (MRI) is conceptually appealing for the pursuit of 3D imaging since it affords sub-millimeter spatial resolution and versatile tissue/muscle/cartilage image contrast. However, MRI comes with the penalty that it requires relatively long scan times. Hence, imaging of moving organs requires consideration of physiological motion. For the phoning vocal folds, periodic oscillation is superimposed by breathing movements (abduction and adduction). While for the first, synchronization cannot be obtained yet, the second can be handled by a customized explicit synchronization technique. The imaging protocol consisted of segmented 3D gradient-echo imaging and segmented 3D ultra-short TE. In vivo imaging on male and female subjects was conducted using a 3.0T in modal and head register. 3D MRI data were included into segmentation to derive boundary conditions for finite-element models of vocal fold oscillation. Thereby, the segmented air volume of the larynx is transformed in splines at different positions in the anterior-posterior axis of the vocal folds.

2414. MR Elastography of the Ocular Vitreous Body
Daniel V. Litwiller1, Yogesh Mariappan1, Richard L. Ehman1
1Mayo Clinic, Rochester, MN, United States

The gradual liquefaction of the ocular vitreous body with age can lead to retinal detachment and loss of sight. Although retinal detachment is a simple condition to diagnose, historically, means to evaluate the mechanical properties of the vitreous body have been invasive and technically challenging. The development of a reliable, noninvasive measurement technique would improve our understanding of the underlying physiology of this condition, and aid in evaluating patients and potential treatments. The purpose of this work was to investigate the utility of MR elastography as a noninvasive means to quantify the viscoelastic properties of the vitreous body.

Cheng-Chieh Cheng1, Chun-Jung Juan2, Hsiao-Wen Chung2,3, Yee-Min Jen2, Su-Chin Chiu1, Hing-Chiu Chang1,4, Hsi-Chen Huang1,6, Cheng-Hsien Hsu2,7, Guo-Shu Huang2, Cheng-Yu Chen1
1Graduate Institute of Biomedical Electronics and Bioinformatics, National Taiwan University, Taipei, Taiwan; 2Department of Radiology, Tri-Service General Hospital, Taipei, Taiwan; 3Department of Electrical Engineering, National Taiwan University, Taipei, Taiwan; 4Applied Science Laboratory, GE Healthcare Taiwan, Taipei, Taiwan; 5Department of Nuclear Medicine, Tri-Service General Hospital, Taipei, Taiwan; 6EMBA in Global Chinese Management, Department of Business Administration, Tamkang University, Taipei, Taiwan; 7Division of Software Design, Notebook Unit 5, Quanta Computer Inc., Taipei, Taiwan

Parotid glands are highly radiosensitive, while the utilization of parotid sparing technique decreases the irradiation, and thus may reduce radiation therapy damage. In this study, we demonstrate a graded alteration in the perfusion characteristics of parotid glands, with the respect of parotid-sparing volume provided by the intensity modulated radiotherapy (IMRT) technique.

2416. High-Resolution Imaging of the Laryngeal Cartilages: Volunteer and Cancer
Patient Studies
Joëlle Karine Barral1, R. Reeve Ingle1, Edward J. Damrose2, Nancy J. Fischbein2,3, Dwight G. Nishimura1
1Electrical Engineering, Stanford University, Stanford, CA, United States; 2Otolaryngology, Stanford University, Stanford, CA, United States; 3Radiology, Stanford University, Stanford, CA, United States

Current staging of laryngeal cancer and choice of optimal treatment are hindered by the difficulty of accurately assessing cartilage invasion. The use of a dedicated three-channel array instead of the conventional eight-channel neuro-vascular array allows a reduction in voxel size by a factor of 20. A low-order polynomial fitting approach is used to compensate for the coil sensitivity profile. In healthy volunteers, the increased resolution makes visible the delineation of non-osified cartilage, otherwise indistinguishable from muscle. The dedicated array is also used in cancer patients, and improvement in image quality is demonstrated.
Brain Structural Changes Underlying Cognitive Disabilities in Patients with Obstructive Sleep Apnea Syndrome (OSAS): A VBM Study

Giovanni Giulietti1,2, Federico Torelli1,2, Marco Bozzali1, Girolamo Garreffa1,2, Nicola Moscufo1, Silvana Zannino1,3, Laura Serra1, Fabio Placidi1, Fabrizio Fasano1, Gisela Hagberg1, Bruno Maraviglia1,2, Ina Djonlagic6, Julian Saboisky6, Atul Malhotra6, Maria Grazia Marciani1,5, Charles Guttmann4

1IRCCS "Santa Lucia Foundation", Rome, Italy; 2"Enrico Fermi" Center, Rome, Italy; 3Center for Neurological Imaging, Brigham and Women's Hospital, Harvard Medical School, Boston, United States; 4Center for Neurological Imaging, Brigham and Women's Hospital, Harvard Medical School, Boston, United States; 5Department of Neuroscience, University "Tor Vergata", Rome, Italy; 6Division of Sleep Medicine, Brigham and Women's Hospital, Harvard Medical School, Boston, United States

This VBM study aims at investigating GM and WM changes which might account for clinical disabilities in patients with OSAS. Sixteen patients with OSAS (grouped in moderate and severe clinical stage) and 14 healthy controls were investigated. Neuropsychological assessment and MRI scanning were obtained from each subject. Patients reported a selective impairment of verbal memory. Subjects with severe OSAS showed a bilateral GM atrophy of the hippocampus and some volumetric reductions in the contiguous WM. These findings suggest that both regional GM atrophy and WM disconnection might, at least partially, explain cognitive deficits detectable in patients with OSAS.

Oral Tongue Squamous Cell Carcinoma Evaluated by PROPELLER and Echoplanar Diffusion-Weighted Imaging

Chun-Jung Juan1, Hing-Chiu Chang2,3, Cheng-Yu Chen1, Hung-Wen Kao1, Chun-Jen Hsu1, Chih-Wei Wang1, Cheng-Chieh Cheng1,3, Su-Chin Chiu1,3, Hsiao-Wen Chung1,3, Guo-Shu Huang1

1Department of Radiology, Tri-Service General Hospital, Taipei, Taiwan; 2Applied Science Laboratory, GE Healthcare Taiwan, Taipei, Taiwan; 3Institute of Biomedical Electronics and Bioinformatics, National Taiwan University, Taipei, Taiwan

In this study we aimed to verify the imaging quality of fast spin-echo PROPELLER diffusion weighted imaging (FSE-PROP-DWI) and echoplanar DWI (EP-DWI) in oral cavity and to investigate the apparent diffusion coefficient (ADC) of pathological proven oral tongue squamous cell carcinoma (OTSCC). Our results show that FSE-PROP-DWI is superior to EP-DWI with less imaging distortion and is satisfactory for measurement of ADC of OTSCC.

Improved Head and Neck Contrast Enhanced Imaging Using High Resolution Isotropic 3D T1 SPACE: A Feasibility Study

Magalie Viallon1, Karen Masterson1, Minerva Becker1

1Radiologie, Hôpital Universitaire de Genève, Geneva, Switzerland

Post Gadolinium MR head and neck examinations remain challenging due to the need for a large anatomic coverage in minimum acquisition time. For cranial nerves and skull base investigation, 3D acquisitions are very useful not only to better visualize and analyze the nerves but also to provide large head and neck coverage of often extended or multi focal pathology. Until recently, 3D acquisitions implemented to image the head and neck area were based on gradient echo imaging kernel (T1 3D Vibe FS, T1 MP-RAGE. Unfortunately, fast 3D T1w gradient echo imaging is limited by the presence of air-tissue interfaces and inherent susceptibility artefacts. Nevertheless, to study the whole course of nerves and localize focal or global contrast enhancement, a fat saturated spin-echo 3D T1 sequence seems more adequate. We investigate here the utility of 3D T1 FS SPACE (Sampling Perfection with Application optimized Contrasts using different flip angle Evolutions) for head and neck imaging at 3T and its clinical relevance in various pathologies of this region.

Tumor Metabolism and Perfusion in Head and Neck Squamous Cell Carcinoma: Pretreatment Multimodality Imaging with 1H-MRS, DCE-MRI and 18F-FDG PET: An Exploratory Study

Jacobus FA Jansen1, Heiko Schoder1, Nancy Lee1, Hilda Stambuk1, Ya Wang1, Matthew Fury1, Snehal Patel1, David Pfister1, Jatin Shah1, Jason Koutcher1, Amita Shukla-Dave1

1MSKCC, NY, United States

The study aims to correlate pretreatment multimodality (MM) imaging data obtained with 1H-MRS, DCE-MRI and 18F-FDG PET in patients with head and neck squamous cell carcinoma (HNSCC) with neck nodal metastases for more precise assessment of the tumor metabolism and perfusion. Additionally, pretreatment MM imaging data was evaluated for its efficacy in prediction of short term response to treatment. In 29 HNSCC patients, Cho/W, Ktrans, ve, kep, 18F-FDG SUV measures were correlated. It was found that pretreatment MM imaging is valuable for the precise assessment of tumor biology, and maybe a predictive marker for short term response.
MR Visualization of Ventral Thalamic Nuclei
Kei Yamada, Kentaro Akazawa, Sachiko Yuen, Mariko Goto, Shigenori Matsushima, Akiko Takahata, Tsunehiko Nishimura
1Radiology, Kyoto Prefectural University of Medicine, Kyoto, Japan
Ventrointermediate nucleus of the thalamus is located adjacent to and medial to the pyramidal tract and it can be identified on anisotropy maps of diffusion tensor imaging as well as inversion recovery sequences.

Distance Between Meyer’s Loop Anterior Tip and Temporal Pole in Southern Chinese Measured with Diffusion Tensor Tractography Using BrainLAB and Philips FiberTrak Software
Yi Xiang Wang, X L. Zhu, M Deng, Y W. Siu, C S. Leung, Q Chan, T M. Chan, W S. Poon
1Department of Diagnostic Radiology and Organ Imaging, The Chinese University of Hong Kong, Prince of Wales Hospital, Shatin, NT, Hong Kong; 2Division of Neurosurgery, Department of Surgery, The Chinese University of Hong Kong, Prince of Wales Hospital; 3Jockey Club Centre for Osteoporosis Care and Control, The Chinese University of Hong Kong, Prince of Wales Hospital; 4Philips Healthcare, Hong Kong SAR, China
Using Diffusion tensor tractography, the relationship of Meyer’s loop to temporal lobe was investigated in 16 Southern Chinese subjects. Operator A is a neurosurgeon and BrainLAB software (Feldkirchen, Germany) was used. Operator B is a radiologist and Philips FiberTrak Software (Best, The Netherlands) was used. The results demonstrated a neurosurgeon and a radiologist using different DTT tools reached similar results on Meyer’s loop to temporal pole (ML¨CTP) distance, suggesting BrainLAB and Philips FiberTrack software are able to provide comparable results. ML¨CTP distance from southern Chinese population was similar to literature data of Caucasian and Japanese population.

Diffusion Tensor Imaging Correlates of Cognitive Impairment and Fatigue in Multiple Sclerosis
Gunja P. Parikh, Maxim Bester, Mariana Lazar, James S. Babb, Hina Jaggi, Laura Miles, Robert Grossman, Matilde Iglezio
1Radiology, New York University, New York, NY, United States; 2Neuroradiology, Eppendorf-Hamburg University, Hamburg, Germany; 3Radiology, New York University, New York, NY, United States; 4Neurology, New York University, New York, NY, United States
Diffusion tensor tractography provides the possibility to reconstruct fiber bundles and to focus on regions that might play a major role in the development of clinical deficits in patients with multiple sclerosis (MS). We used tractography to determine whether tissue damage in the corpus callosum (CC) and in the anterior-thalamic tracts (AT) is associated with cognitive dysfunction and fatigue in patients with benign MS (BMS) and clinically isolated syndrome (CIS). Differences from controls were observed in the CC and AT tracts of BMS and CIS patients. A significant association was found between DTI metrics in the CC and cognitive deficits.

The Effects of HIV and Aging Using Diffusion Tensor Imaging
Huiling Peng, Joseph Mettenburg, Avi Snyder, David Clifford, Tammie Benzinger, Beau Ances
1Neurology, Washington University in St. Louis, St. Louis, MO, United States; 2Radiology, Washington University in St. Louis, St. Louis, MO, United States; 3Neurology, Washington University in St. Louis, St. Louis, MO, United States
HIV can lead to chronic inflammation. We investigated the relationship between aging and HIV status and white matter integrity using DTI in four groups of participants (HIV younger (20-25 years old) (n=8), HIV- older (50-65 years old) (n=12), HIV+ younger (20-25 years old) (n=9), and HIV+ older (50-65 years old) (n=9)). Regions-of-interest corresponding to the genu, middle, and splenium were selected. HIV- older subjects had significant decreases in mean diffusivity, axial diffusivity (AD), and radial diffusivity (RD) compared to other all groups. While HIV led to a reduction in DTI measures these decreases were not significant.

Differences in White Matter Fiber Orientation in Three Clinical Groups of Children: Reading Disability, NF-1 and Reading Disability, and Controls
Daniel Jon Peterson, Sheryl L. Rimrodt, Laurie E. Cutting
1Developmental Cognitive Neurology, The Kennedy Krieger Institute, Baltimore, MD, United States; 2Division of Developmental Medicine, Children’s Hospital at Vanderbilt, Nashville, TN, United States; 3Developmental Cognitive Neurology, Kennedy Krieger Institute, Baltimore, MD, United States; 4Kennedy Center for Research and Development, Vanderbilt University, Nashville, TN, United States
DTI was used to investigate differences in white matter fiber orientation between three groups: children with reading disability (RD), children with neurofibromatosis type 1 and reading disability (NF1+RD), and typically developing controls. A voxel-wise statistical test that detects differences in fiber orientation revealed bilateral differences in the anterior limb of the internal capsule. In this region, the fiber orientation of controls and RD subjects were similar, while those of the NF1+RD subjects clearly differed, with minimal overlap.
2426. Voxel-Based Morphometric Analysis of Brain Volumetry and Diffusivity in Hepatitis C

Manoj Kumar Sarma1, Rajakumar Nagarajan1, Charles H. Hinkin2, Steven A. Castellon2, Jason P. Smith, Homayoon Khanlou3, Laveeza Bhatti4, Jonathan Truong4, E Singer5, Jiah Jang6, Michelle Kim6, Gabe Waterman6, Rakesh Kumar Gupta7, Michael Albert Thomas1

1Radiological Sciences, UCLA, Los Angeles, CA, United States; 2Psychiatry and Biobehavioral Sciences, UCLA School of Medicine and VA Greater Los Angeles Healthcare System, Los Angeles, CA, United States; 3AIDS Healthcare Foundation, Los Angeles, CA, United States; 4Kaiser Permanente, Lancaster, CA, United States; 5Neurology, UCLA School of Medicine, Los Angeles, CA, United States; 6VA West Los Angeles Healthcare System, Los Angeles, CA, United States; 7Radiological Sciences, SGPGIMS, Lucknow, UP, India

We investigated mean diffusivity (MD) and fractional anisotropy (FA) value changes along with white matter and gray matter volume in patients with hepatitis C compared to healthy controls using voxel based morphometry (VBM). Extensive increased MD values were observed in bilateral frontal gray and white matter, bilateral external capsule, temporal white matter, and right occipital gray matter. FA values decreased in the corpus callosum, right frontal and occipital white matter. Widespread gray matter volume reduction was seen in the frontal, parietal and temporal regions. White matter volume decreases were observed in the right frontal, corpus callosum and mid brain.

2427. DTI Detects Progressive Neurodegeneration in the Brain and Cervical Spinal Cord in ALS

Govind Nair1, John D. Carew2,3, Longchuan Li1, Sharon Usher4, Xiaoping P. Hu1, Michael Benatar4,5

1Department of Biomedical Engineering, Emory University and Georgia Institute of Technology, Atlanta, GA, United States; 2Institute for Health Studies, Carolinas HealthCare System, Charlotte, NC, United States; 3School of Public Health, Emory University, Atlanta, GA, United States; 4Department of Neurology, Emory University, Atlanta, GA, United States; 5Department of Epidemiology, Emory University, Atlanta, GA, United States

Diffusion tensor imaging of the brain and spinal cord in patients with Amyotrophic Lateral Sclerosis and age-matched healthy control subjects revealed a significant decrease in fractional anisotropy, and increase in mean diffusivity and radial diffusivity along the corticospinal tract. The DTI parameters from ALS patients showed significant correlation with their average finger and foot tapping speed, a measure of upper motor neuron dysfunction. These findings suggest that DTI might represent useful imaging biomarkers of ALS disease progression.

2428. Comparison of Limbic Regions FA Using Tractography-Defined ROIs in AD and MCI

Darryl H. Hwang1, Sinchai Tsao1, Manbir Singh1

1Radiology and Biomedical Engineering, University of Southern California, Los Angeles, CA, United States

The limbic regions appear to be affected by mild cognitive impairment (MCI) and Alzheimer Disease (AD). We use normalized tractography to objectively isolate the fornix and cingulum in a common template space for a voxel-based analysis of FA changes among normal control, MCI, and AD populations. The results show FA change propagation from normals to MCI to AD with more changes in the right hemisphere, which is consistent with previous reports.

2429. Axial and Radial Diffusivity Measures Detect Brain Tissue Injury in Heart Failure

Rajesh Kumar1, Mary A. Woo2, Paul M. Macey2,3, Gregg C. Fonarow4, Michele A. Hamilton4, Ronald M. Harper1,3

1Neurobiology, David Geffen School of Medicine at UCLA, Los Angeles, CA, United States; 2School of Nursing, UCLA, Los Angeles, CA, United States; 3Brain Research Institute, UCLA, Los Angeles, CA, United States; 4Cardiology, UCLA, Los Angeles, CA, United States

Heart failure (HF) patients show injury in multiple brain sites, which may represent axonal or myelin injury, or both; however, the nature of the injury is unclear. We assessed axial and radial diffusivity measures in HF, which show axonal and myelin changes, respectively. Axonal injury with reduced axonal density or caliber appeared in internal capsule and cerebellar regions, and reduced myelin in temporal and frontal areas. Other brain sites, including internal capsule and dorsomedial medulla showed myelin and axonal injury. The processes contributing to tissue injury in different brain regions are unknown, but may include ischemic/hypoxic or inflammatory processes.
In this study, the connection between the bilateral STGs in normal controls (NC) and schizophrenics (SZ) is investigated using DTI measures, namely FA, mode and trace. The connection was obtained from whole-brain streamline tractography using STGs white matter as ROIs. By dividing the connection into three sub-regions (Left, Corpus Callosum and Right) and comparing the computed DTI measures of NC and SZ, we found statistically significant differences in mean FA and mode in the Right region, with NC having greater values. This study paves the way for further localization of the differences in STGs connection between NC and SZ.

Delineating frontostriatal network-related white matter tracts into dorsal/ventral pathways is of particular interest in obsessive-compulsive disorder (OCD) studies. Hence we aim to investigate fractional anisotropy (FA) of dorsal/ventral projections of callosal fibers in OCD on the basis of quantitative diffusion tractography analysis using Brodmann ROI approach and tract parameterization. We found significant FA decreases in callosal fibers of OCD in both DLPFC/OFC projections, benefitting from function/region-specific tractography analysis. Thus we validated well-known abnormalities in these networks of OCD. In particular, DLPFC-specific callosal fiber integrity was first revealed by the function/region-sensitivity of the present methods (not found by previous methods).

In this study we use quantitative tractography to explore potential associations between cognitive functions and cerebral white matter pathways. We support inferences made about relationships between working memory, processing speed, motor function, executive function, visual naming and white matter health not only through observed correlations, but also through the lack thereof, in functions

The connection between bilateral Heschl’s gyrus (HG) in normal controls (NC) and schizophrenics (SZ) is investigated using DTI here. Whole-brain tractography was first generated using filtered two-tensor tractography method, instead of conventional streamline tractography. The relevant connection was then extracted using the white matter of bilateral HGS as the ROIs. Measures for quantifying the connection are mean FA, mode, trace, parallel and perpendicular diffusivity. Statistically significant between-group differences in trace, parallel and perpendicular diffusivity were observed. Our findings are consistent with theories which suggest that SZ group has decreased WM pathology, particularly in regions associated with auditory and language processing.

Delineating frontostriatal network-related white matter tracts into dorsal/ventral pathways is of particular interest in obsessive-compulsive disorder (OCD) studies. Hence we aim to investigate fractional anisotropy (FA) of dorsal/ventral projections of callosal fibers in OCD on the basis of quantitative diffusion tractography analysis using Brodmann ROI approach and tract parameterization. We found significant FA decreases in callosal fibers of OCD in both DLPFC/OFC projections, benefitting from function/region-specific tractography analysis. Thus we validated well-known abnormalities in these networks of OCD. In particular, DLPFC-specific callosal fiber integrity was first revealed by the function/region-sensitivity of the present methods (not found by previous methods).
The development of diffusion tensor (DT) imaging and tractography affords the ability to account for the white matter fibers and has visualisation of the motor pathway in patients with high grade brain tumors. Track volume intersection (TVI) with independent fMRI and DTI eigenvectors (DTST). SDPROB was found to be significantly (p<0.01) superior to both SDST and DTST algorithms for identified eloquent cortex from SDPROB tractography was compared to traditional stream tracking algorithms based on CSD (SDST) mapping the motor pathway to the eloquent motor cortex.

We are investigating the use of HARDI, utilising whole-brain track-density maps to improve definition of brain tumour margins. Our hypothesis is that infiltrating tumour will reduce WM connectivity enabling improved depiction of tumour boundaries. To assist in the determination of tumour extent, the 3D visitation maps are anatomically fused to 18F-FDOPA – PET images. We report that infiltrating tumour delineated on 18F-FDOPA maps that is present outside of the tumour-enhancement boundary defined on CET1 images results in a reduction in WM connectivity or streamline density on corresponding whole-brain track density maps. This has significant implications for surgical and radiation treatment planning.

A virtual reality environment for integrating neuroanatomy was developed for clarify the relationship among tumor mass and peritumoral microstructures for facilitating neurosurgical trajectory design and optimizing therapeutic outcome. Brain tumor and edema were segmented manually and reconstructed into 3D display. Fiber tracking was carried out via the Fiber Assignment by Continuous Tracking algorithm with fractional anisotropy threshold of 0.2 and angular limitation of 60 degree. The 3D stereo image was projected on the non-depolarizing screen by two projectors with polarizing filter. Therefore, the viewpoints of the user’s right and left eyes would be slightly different and the stereo image would be produced from the user’s viewpoint with 3D glasses.

The aim of this study was to investigate whether a probabilistic tractography algorithm based on CSD (SDPROB) was superior for visualisation of the motor pathway in patients with high grade brain tumors. Track volume intersection (TVI) with independent fMRI identified eloquent cortex from SDPROB tractography was compared to traditional stream tracking algorithms based on CSD (SDST) and DTI eigenvectors (DTST). SDPROB was found to be significantly (p<0.01) superior to both SDST and DTST algorithms for mapping the motor pathway to the eloquent motor cortex.

The development of diffusion tensor (DT) imaging and tractography affords the ability to account for the white matter fibers and has the potential to be an important tool in neurosurgical navigation. In addition to the usual fiber tracking challenges related to small fibers that may make sharp turns and/or encounter crossing fibers, tractography in patients with brain tumors may be compromised by the tumor and/or the associated edema. In patients with brain tumors near the arcuate fasciculus, we hypothesize that tractography based on a probabilistic model will perform better than a standard deterministic model.
Mapping the Language Network in Grade II Gliomas: A Longitudinal Study with fMRI, MR Tractography and Neuropsychology

Alberto Bizzi1, Francesca Ferre2, GianMarco Castelli1, Maria Luisa Mandelli1, Sylvie Piacentini2, Francesca Ciaraia1, Domenico Aquino1, Carlo Marras2, Francesco Di Meco1, Giovanni Broggi1, Carlo Lazzaro Solero2

1Neuroradiology, Fondazione Istituto Neurologico Besta, Milan, Italy; 2Neurology, Fondazione Istituto Neurologico Besta, Milan, Italy; 3Neurosurgery, Fondazione Istituto Neurologico Besta, Milan, Italy

Fourteen patients with grade II glioma were evaluated longitudinally with fMRI and DTI-MR Tractography of the language network and Aachener Aphasie Test before surgery, at 3 and 12 months. Functional cortex and streamlines of the dorsal and ventral language pathways were mapped. Deficits in phonemic and semantic fluencies were prevalent in patients with glioma infiltrating the insula, temporal pole and stem and were associated with ventral pathway interruption. Left hemisphere dominance was preserved in most patients. These imaging data suggest that ipsilateral rather than contralateral mechanisms of functional reorganization of the language network are more common in grade II gliomas.

Role of Diffusion Tensor Imaging in Diagnosis of Medial Temporal Lobe Epilepsy

Heba Ali1, Mona Mohamed2, Yosra Abdullah, Ahmed Gaber, Yasser Abbas

1AIN SHAMS UNIVERSITY HOSPITALS, CAIRO, Egypt; 2JOHNS HOPKINS UNIVERSITY SCHOOL OF MEDICINE, BALTIMORE, MD, United States

Modern MR techniques are helpful in assessment of patients presenting with seizures and EEG changes suggestive of temporal lobe epilepsy, yet having normal conventional magnetic resonance imaging (MRI) epilepsy protocol. Here, we performed diffusion tensor imaging (DTI), with quantitative assessment of fractional anisotropy (FA) and apparent diffusion coefficient (ADC) combined with tractography for pertinent white matter tracts. Results revealed that DTI is helpful for more accurate assessment of patients with MTLE.

Impaired Structural Connectivity of Language and Memory Networks in Patients with Chronic Epilepsy

Maarten Vaessen1,2, Jaap Jansen3, Paul Hofman, Marielle Vlooswijk, Henriette Majoie, Mark de Krom, Albert Aldenkamp1,2, Walter Backes

1School for Mental Health and Neuroscience, Maastricht University Medical Centre, Maastricht, Limburg, Netherlands; 2Kempenhaeghe Epilepsy Institute, Heeze, Netherlands; 3Memorial Sloan-Kettering Cancer Center, New York, NY, United States

Patients with chronic epilepsy commonly develop cognitive co-morbidity. Previously, it was observed that their declined cognitive performance was associated with loss of functional connectivity derived from functional MRI of memory and language tasks. In this study we aimed to identify impaired structural connections, obtained with fibre tractography, between brain regions commonly associated with language and memory function. We found that fiber connections between the left and right frontal lobe were significantly reduced in these patients and were correlated with IQ.

Longitudinal Diffusion Tensor Imaging of Fornix Degeneration Following Epilepsy Surgery

Min Liu1, Donald Gross2, B.Matt Wheatley3, Christian Beaulieu1

1Biomedical Engineering, University of Alberta, Edmonton, Alberta, Canada; 2Neurology, University of Alberta, Edmonton, Alberta, Canada; 3Neurosurgery, University of Alberta, Edmonton, Alberta, Canada

Diffusion tensor imaging (DTI) may be a sensitive method of following the unique phases of Wallerian degeneration of injured white matter fibers in human brain. Longitudinal DTI tractography of the fimbria-fornix was performed at several time points on three patients with temporal lobe epilepsy before and after their anterior temporal resections (several times within the first week and 2-4 months post-surgery). The diffusion parameters of the ipsilateral fornices showed unique dynamic changes, notably a reduction of parallel diffusivity acutely, while perpendicular diffusion curiously showed a smaller reduction within the first week followed by the expected increase at chronic times.

FACT, Probability Maps and Gibbs Tracking for Preoperative Fiber Tracking in Epilepsy Surgery

Irina Mader1, Constantin Anastasopoulos1, Valerij G. Kiselev2, Andreas Schulze-Bonhage1, Marco Reisert1

1Clinic for Neuroradiology, University Hospital Freiburg, Freiburg, Germany; 2MR Physics, Department of Radiology, University Hospital Freiburg, Freiburg, Germany; 3Section for Pre-surgical Epilepsy Diagnostics, Clinic for Neurosurgery, University Hospital Freiburg, Freiburg, Germany

Problem: The protection of functional fiber bundles is essential in epilepsy surgery. The aim was to compare FACT, probability maps and Gibbs tracking in their relevance for the neurosurgeon. Methods: Ten patients received pre-operative fiber tracking (5 corticospinal tract, 5 optic radiation). Results: Probability maps and GIBBS tracking were successful for all fiber structures on the healthy and the pathologic side, whereas FACT was only successful in 5 cases on the pathological side and 6 on the healthy side. Conclusion: Probability maps and Gibbs tracking are superior to FACT. A higher specificity of Gibbs cannot be shown at the moment.
2444. Probability Maps Compared to FACT Algorithm in Human Gliomas

Irina Mader1, Thao Nguyen Thanh1, Susanne Schnell2, Thomas Reithmeier2, Valerij G. Kiselev3
1Clinic for Neuroradiology, University Hospital Freiburg, Freiburg, Germany; 2MR Physics, Department of Radiology, University Hospital Freiburg, Freiburg, Germany; 3Clinic for Stereotactic and Functional Neurosurgery, University Hospital Freiburg, Freiburg, Germany

Problem: The importance of FACT algorithm for surgical planning has been substantiated in the past. No clinical experience is available for probability maps. This work aimed to compare FACT and probability maps in human gliomas.

Methods: 10 patients with human gliomas (4 WHO°II, 6 WHO°III) received both fiber tracking methods of the motor fibers arising from fMRI derived seed points.

Results: Probability maps were successful in all cases. FACT failed in three cases with moderate to severe motor impairment.

Conclusion: Probability maps seem to be superior to FACT, especially in cases with strong fiber deviations and present oedema.

2445. Trimodal Imaging and Brain Plasticity: MR Diffusion Tensor Imaging Supplements Simultaneously Acquired FET-PET and MP-RAGE of Human Brain Tumour Imaging

N. Jon Shah1,2, Irene Neuner1,2, Joachim Bernhard Maria Kaffanke1, Yuliya Kupriyanova1, Karl-Joseph Langen1, Hans Herzog1
1Institute of Neurosciences and Medicine 4, Medical Imaging Physics, Forschungszentrum Jülich GmbH, 52425 Juelich, Germany; 2Faculty of Medicine, Department of Neurology, RWTH Aachen University, 52074 Aachen, Germany

PET imaging is well established for the diagnosis of brain tumours. Its metabolic specificity delivers valuable information about the malignancy and the extent of tumour tissue. Tumour growth forces the brain to reorganize itself to compensate for the lost areas. It has been shown that DTI is a valuable tool to demonstrate the plasticity of the brain and it therefore offers information about the reorganization caused by tumour growth as well as surgical intervention. The acquisition of trimodal PET, MP-RAGE and DTI data on an MR-PET hybrid scanner, capable of simultaneous MR and PET, to investigate plasticity and reorganisation in human brain tumours is demonstrated.

2446. Comparison of Electrophysiologic Connectivity with Imaging Connectivity from DWI and Resting State fMRI

Stephen Edward Jones1, Andreas Alexopolous, Erik Beall, Joanna Fong, Jorge Gonzalez-Martinez, Mark Lové, Blessy Mathew, Dileep Nair, Imad Najm, Michael Phillips, Kenneth Sakaie
1Neuroradiology, Cleveland Clinic, Cleveland, OH, United States

We present a comparison of in-vivo connectivity scores: one derived from electrophysiology (EP) signals in human brains monitored with parenchymal electrodes (for epilepsy workup); and the other from imaging connectivity methods such as HARDI and resting state fMRI. Assuming EP represent a gold standard of connectivity, this provides a validation of various connectivity scores derived from MRI.

2447. Pre-Surgical Mapping Using Magnetoencephalography and Diffusion Tensor Tractography Reveals a Case of Neuroplasticity

Nadia CF Scantlebury1, William Gaetz2, Elysa Widjaja, James Rutka3, Eric Bouffet4, Conrad Rockel1, Don Mabbott1
1Program in Neuroscience and Mental Health, The Hospital for Sick Children, Toronto, Ontario, Canada; 2Biomagnetic Imaging Laboratory, Children's Hospital of Philadelphia, Philadelphia, PA; 3Neurosurgery, The Hospital for Sick Children; 4Haematology/Oncology, The Hospital for Sick Children

We used combined magnetoencephalography (MEG) and Diffusion Tensor Imaging (DTI) tractography methods to delineate the cortico-spinal tracts (CSTs) of an 11-year old female who presented with an arteriovenous malformation (AVM). Concurrent MEG-DTI techniques revealed a case of cerebral plasticity, whereby motor function of the patient remained intact despite the contra-lateral displacement of her CST by the AVM. These data support the use of the functional activation as a seed for launching neural tracts during pre-surgical evaluation in children. Moreover, these findings demonstrate that using a concurrent MEG-DTI approach to delineate CSTs is invaluable when evaluating plasticity in the developing brain.

2448. Role of fMRI and DTI in Assessing the Efficacy of Visual Neurorehabilitation. Preliminary Data

Matteo Bendini1, Ingrid Inches1, Marissa Barabas2, Massimo Prior3, Monica Ronzon1, Stefano Curtolo1, Davide Canonico5, Carlo Alberto Marzi4, Francesco Di Paola1
1Neuroradiology Department, Ca' Foncello Hospital Treviso, Italy, Treviso, Italy; 2Department of Neurological and Vision Sciences, University of Verona, Italy; 3Faculty of Psychology, University of Padua, Italy; 4Department of Physics, Ca' Foncello Hospital Treviso, Italy

Aim: Establish if f-MRI and DTI are valid (objective) tools to evaluate postchiasmatic damage. Materials and methods: 7 patients with HVFDs underwent to a neuro-psychological evaluation. A f-MRI and DTI sequences were applied to study the visual activation and the optic radiation. Two patients underwent to a visual rehabilitation treatment. Results: In all patients did not show an activation in
the visual cortex ipsilateral to the injury. The contralateral visual area showed a normal pathway of activation. In the two patients treated, higher activation in the contralateral visual areas was observed. Conclusions: f-MRI and DTI are valid tools to study HVFDs.

2449. Diffusion Tensor Imaging of the Pediatric Optic Nerve: Intrinsic and Extrinsic Pathology Compared to Normal Controls
Joshua Paul Nickerson1, Michael B. Salmela2, Chris John Koski3, Trevor Andrews2, Christopher G. Filippi4
1Radiology, Fletcher Allen Healthcare/The University of Vermont, Burlington, VT, United States; 2School of Medicine, University of Vermont, Burlington, VT, United States; 3Political Science, James Madison University, Harrisonburg, VA, United States; 4Neuroradiology, Fletcher Allen Healthcare/The University of Vermont, Burlington, VT, United States

MRDTI normative data from the optic nerves in 70 normal children was compared to diffusion parameters in children with lesions both intrinsic and extrinsic to the visual pathway. Significant decrease in FA and increase in ADC was present in intrinsic lesions, while extrinsic lesions where only mass effect on the nerves was present did not affect diffusivity or anisotropy. This may improve presurgical planning for visual pathway lesions.

2450. Spinal Cord White Matter Integrity in Patients with Cervical Spondylosis Is Related to Severity of Spinal Canal Stenosis: A Combined MRI and Diffusion Tensor Imaging Study
Antoine Feydy1, Pavel Lindberg1, Francois Rannou2, Jean-Luc Drape1, Marc A. Maier3
1Radiology B, Hopital Cochin, Paris, France; 2Rehabilitation, Hopital Cochin, Paris, France; 3LNRS, Universite Paris Descartes, Paris, France

We used DTI to test if the severity of spinal canal stenosis is related to the degree of spinal white matter integrity in patients with cervical spondylosis. Patients and controls were studied with DTI of cervical spinal cord. The patients had lower FA than controls and increased spinal canal stenosis. The mean degree of spinal canal stenosis correlated with mean FA, i.e., patients with least cervical canal space had lowest FA values of the whole cervical spinal cord. The results show that DTI can quantify spinal cord white matter degeneration related to spinal canal stenosis in patients with cervical spondylosis.

Advanced Imaging of Spine & Spinal Cord
Hall B Monday 14:00-16:00

2451. Diffusion Tensor Imaging of the Normal and Injured Pediatric Spinal Cord at 1.5 T
Feroze B. Mohamed1, Louis N. Hunter2, Nadia Barakat1, Chia-Shang Liu1, Haris Saif3, Amer Samdani2, Randal Betz2, Scott H. Faro1, John Gaughan1, Mary J. Mulcahey2
1Temple University, Philadelphia, PA, United States; 2Shriners Hospital for Children; 3Massachusetts General Hospital

To measure and establish normative DTI parameters of healthy spinal cord tissue in children with idiopathic scoliosis as a means for comparison with children with spinal cord injury (SCI). 5 subjects with idiopathic scoliosis and 5 subjects with SCI were imaged twice using DTI. The SCI subjects showed reduced FA values and increased D values compared with control subjects. Test-retest reproducibility showed excellent inter class correlation (ICC) in all the control group DTI index values (>0.9) while the SCI group showed moderate ICC (>0.7). There were statistically significant correlations between the DTI indices and several ISNCSCI clinical impairment scores.

2452. Reduced Field of View Imaging for Twice-Refocused Diffusion EPI Using a Perpendicular Refocusing Slab
Rafael Luis O’Halloran1, Samantha J. Holdsworth1, Stefan Skare1, Roland Bammer1
1Department of Radiology, Stanford University, Stanford, CA, United States

A simple method for reducing the phase field of view in twice-refocused DTI EPI is presented and compared with full of view imaging in DTI of the upper spine. The 180-degree refocusing slice select pulses are played out on the phase encoding axis instead of the slice-encoding axis. This allows the phase field of view to be reduced to the width of the perpendicular refocusing slab without introducing wrap. Results show that the reduced field of view method produces diffusion weighted images of the cervical and thoracic spine that are less distorted than those of standard full field of view EPI for the same scan time.

2453. Spinal Cord Diffusion Tensor Imaging (DTI) and 1H-MR Spectroscopy (MRS) at 1.5T and 3T
Virginie Callot1, Yann Le Fur1, Jean-Philippe Ranjeva2, Guillaume Duhamel1, Patrick J. Cozzone1
1Centre de Résonance Magnétique Biologique et Médicale (CRMBM), CNRS, UMR 6612, Faculté de Médecine, Marseille, France

Diffusion Tensor Imaging (DTI) and single-voxel 1H-MR spectroscopy (MRS) of the spinal cord (SC) are challenged by several difficulties, including strong magnetic field inhomogeneities, respiratory and cardiac movements, and small size of the spinal cord. Whereas several studies have shown promising results, there is scant literature comparing 1.5T and 3T MRI and MRS. In this abstract, we investigate the efficiency of the available manufacturer MRS and DTI sequences, in terms of image/spectra quality and metrics, at
A greater understanding of diffusion indices within the healthy spinal cord is necessary for comparison with clinical populations. Here we measured fractional anisotropy and apparent diffusion coefficient values for cervical (C2-C7), thoracic (T3-T8) and lumbar (T10-L1) regions of the cord. FA vs. ADC values were plotted and three clusters were determined using a k-means partition to characterize each region of the spinal cord. DTI indices in the healthy cord were observed to be relatively consistent across regions, indicating that changes in these indices as a result of trauma at any level can be characterized relative to these observed indices.

The objective of the current study was to characterize the diffusion tensor MRI (DTI) properties of the cervical spinal cord in patients diagnosed with cervical spondylosis. Axial DTI was performed throughout the region of highest cord compression in 17 patients with cervical spondylosis using a clinical 1.5T MRI system. Results showed spatially localized regions of high FA and low MD at the site of compression. Longitudinal ADC was significantly lower than historic controls, whereas transverse ADC was significantly higher than historic controls in regions adjacent to the site of compression. Results from this study suggest that FA and MD can be used to localize regions of the spinal cord under the largest degree of compression.

The two approaches yielded markedly different diffusion measures in controls, in stenotic regions and in non-stenotic regions. Further examination revealed that the eigenvector orientation approach included signal from CSF and hence gave artifactual results.

Reduced Field of View rFoV diffusion weighted imaging techniques improve quantitative ADC and FA data for sagittal acquired thoracic imaging at 3Tesla relative to 1.5T. While lower field has less distortions limiting the necessity of such techniques, the reduced SNR at 1.5T makes them less desirable using clinically acceptable scan times. Here we optimize the rFoV technique in thoracic spine to obtain the best possible data in a clinical population.

We describe a reproducible in vivo human cervical spinal cord diffusion tensor imaging (DTI) protocol at 3T. The data acquisition and analysis procedures are described with examples from healthy (n = 17) and pathological human spinal (n = 2) cords. The described comprehensive approach (1) accounts for the natural curvature of the human spinal cord by covering C1-6 with separate
Chronic pain is thought to arise due to maladaptive changes occurring at the level of the spinal cord. To investigate such changes in humans, a non-invasive neuroimaging technique is desirable. We have investigated the functional response in the spinal cord of 18 healthy subjects to noxious stimulation using punctate and thermal stimulation of the left and right arms. Group analysis, revealed distinct regions of activity within the spinal cord that were dependent on both the side of stimulation and the type of stimulus used. These results present the first non-invasive evidence for a lateralised and stimulus-specific spinal cord response.

The goal of this study was to determine the feasibility of performing quantitative magnetization transfer (qMT) at high resolution in the spinal cord on clinical 3T systems. While MT imaging has been used to assess brain tissue microstructure, similar studies in the spinal cord have been limited due to high resolution demands and motion. Presumably, spinal cord qMT studies would benefit from the increased SNR at 3T; however, such studies are limited by SAR constraints. To address these issues, we developed a high resolution qMT imaging protocol of the cervical spinal cord at 3T and acquired data in healthy subjects.

We have developed and validated a method for fast, simultaneous and high-quality imaging of the brain and cervical spinal cord (< 14 mins., 1 mm isotropic resolution) with the potential to detect, besides volumetric changes at cortical level, also changes at cervical level. It is based on a 3D MDEFT scan using an 8-channel receive head coil. Measures of cross sectional cord area, obtained with the MDEFT-based method, are in good agreement with the established standard based on 3D MPRAGE scans with dedicated spine coils, as determined in a group of healthy controls and subjects with traumatic cervical spinal cord injury.

We studied MRS in the cervical spinal cord of amyotrophic lateral sclerosis (ALS) patients, healthy controls, and people with a mutation in the SOD1 gene. Single voxel PRESS/CHESS MRS was used to measure NAA, choline, creatine, and myo-inositol. We found metabolic changes in both ALS and people positive for the SOD1 mutation. Among ALS patients, metabolite ratios correlate with clinical measures of disease severity. The findings in the SOD1 positive sample suggests that metabolic changes occur prior to the onset of clinical symptoms.

A variety of tests of sensorimotor function are used to characterize outcome after experimental spinal cord injury (SCI). These tests, however, do not provide information about chemical and metabolic processes in the injured CNS. Here, proton magnetic resonance spectroscopy (MRS) was used to monitor chemical changes in CNS (brain and spinal cord) in vivo following SCI. Significant differences were found between control rats and injured rats. Multivariate data analysis was applied. Our findings suggest that MRS is a helpful tool to monitor metabolic changes in vivo in the brain and the spinal cord itself after spinal cord injury.
Virginie Callot¹, Guillaume Duhamel¹, Mohamed Tachrount¹, Yann Le Fur¹, Patrick J. Cozzone¹
¹Centre de Résonance Magnétique Biologique et Médicale (CRMBM), CNRS, UMR 6612, Faculté de Médecine, Marseille, France

Non invasive investigations of the mouse spinal cord pathologies are currently based on anatomic and diffusion MRI. In this work, we investigated whether high-field MR Spectroscopy would be able to provide complementing biochemical information useful to describe the lesion and the repair processes. This preliminary study demonstrates the feasibility of longitudinal follow-ups with localized 1H-MRS in injured mouse spinal cord.

2465. In Vivo MR High Resolution T1rho Mapping of the Spine at 3T Using a Reduced-FOV Approach
Ajit Shankaranarayanan¹, Emine U. Saritas², Dwight G. Nishimura³, Weitian Chen¹, Eric Han¹
¹Global Applied Science Lab, GE Healthcare, Menlo Park, CA, United States; ²Dept of Electrical Engineering, Stanford University, Palo Alto, CA, United States; ³Dept of Electrical Engineering, Stanford University, Palo Alto, CA, United States

It has been suggested that MR T1rho relaxation time may potentially be valuable to assess proteoglycan (PG) loss in the early stages of disc degeneration, a known cause for back pain. Previous T1rho mapping techniques have shown this to be true. However, clinical applicability of these techniques in spine is somewhat limited by either long scan time, lower resolution or insufficient coverage. This work aims to overcome these limitations by applying reduced-FOV technique, previously shown for diffusion imaging to T1rho imaging. In vivo experiments have been performed on 3T to show the usefulness of such a targeted approach in terms of higher resolution and shorter scan times while providing good coverage in spine.

2466. Ultrashort TE Imaging After Percutaneous Vertebroplasty
Akio Hiwatashi¹, Takashi Yoshiura¹, Koji Yamashita¹, Hironori Kamano¹, Hiroshi Honda¹
¹Clinical Radiology, Kyushu University, Fukuoka, Japan

uTE is feasible to evaluate cement distribution after percutaneous vertebroplasty.

2467. Bone Marrow Perfusion Magnetic Resonance Imaging in Patients with Osteoporotic Vertebral Compression Fractures: Peak Enhancement Ratio Is an Independent Predictor for Intravascular Vacuum Phenomena
Wei-Che Lin¹,², Hsiu-Ling Chen¹, Yu-Fan Cheng¹, Chun-Chung Lui¹
¹Department of Diagnostic Radiology, Chang Gung Memorial Hospital - Kaohsiung Medical Center, Chang Gung University College of Medicine, Kaohsiung, Taiwan, Taiwan; ²Department of Biomedical Imaging and Radiological Sciences, National Yang-Ming University, Taipei, Taiwan, Taiwan

Decrease bone marrow perfusion as reflected by lower peak enhancement ratio (PER) value in dynamic contrast-enhanced MRI (DCE-MRI) can independently predict the presence of intravascular cleft in patients with osteoporotic vertebral compression fractures. DCE-MRI can help distinguish the more frail patients after VCF suitable for more tailored anti-osteoporotic therapy and can also identify delicate osteoporotic patients for advance treatment before an injury can occur.

2468. Quantitative Assessment of the Cervical Spinal Cord Damage in Neuromyelitis Optica Using Diffusion Tensor Imaging at 3T
Wenshu Qian¹, Henry Mak¹, Queenie Chan¹, Koon Ho Chan³, Mina Kim¹
¹Diagnostic Radiology, The University of Hong Kong, Hong Kong, China; ³Philips Healthcare, Hong Kong, China; ²Medicine, The University of Hong Kong, Hong Kong, China

Neuromyelitis optica (NMO) is an inflammatory and demyelinating disease which consists of optic neuritis and myelitis. Since it usually involves acute and severe attacks, early diagnosis is of vital importance for proper treatment. However, current diagnostic imaging techniques are not sensitive to degenerative changes in early stage of NMO. In this study, we aimed to investigate the normal appearing cervical spinal cord damage in patients with NMO using diffusion tensor imaging (DTI). Our results show DTI-derived metrics can sensitively assess the microstructural abnormalities, suggesting DTI may have great potential as a useful diagnostic tool in detecting early stage of NMO.