THURSDAY, 6 MAY 2010

SUNRISE EDUCATIONAL COURSE
Hot Topics in Body MRI: Prostate Ablation

Room K1 07:00 – 08:00 *Organizer*s: Talissa Altes, Elmar Max Merkle, and Bachir Taouli

Educational Objectives:
Upon completion of this course participants should be able to:

- List the current available methods for local prostate ablation;
- Describe the indications and non-indications of these methods;
- Explain the results of these methods applied to prostate cancer; and
- Describe the MR results before and after local ablation of prostate cancer.

Moderators: **Clare Allen and Anwar R. Padhani**

07:00 **Prostate Ablation Methods: Overview**
Hashim Uddin Ahmed, M.D.

07:30 **MRI Pre- and Post-Ablation of Prostate Cancer**
Clare Allen, F.R.C.R.D

SUNRISE EDUCATIONAL COURSE
Tissue Contrast in MSK MRI - From Physics to Physiology

Room K2 07:00 – 08:00 O*rganizer & Moderator*: Bernard J. Dardzinski

EDUCATIONAL OBJECTIVES
Upon completion of this course participants should be able to:

- Describe contrast mechanisms in MSK imaging, most notably in imaging of articular cartilage;
- Describe the physics of advanced MR sequences;
- Identify the most suitable new MR sequences for four important indications;
- Implement current MR protocols for daily practice and be aware of the most useful indications for these techniques.

07:00 **Contrast Mechanisms for MR Imaging of Tissues and Fluids with Short T2s and/or T2*s**
Graeme M. Bydder, M.B., Ch.B.

07:30 **MSK Clinical and Research Applications of UTE Imaging**
Christine Chung, M.D.

SUNRISE EDUCATIONAL COURSE

Image Reconstruction

Victoria Hall 07:00 – 08:00 *Organizer & Moderator*: Elfar Adalsteinsson

EDUCATIONAL OBJECTIVES
Upon completion of this course participants should be able to:

- Describe the main steps involved in efficient non-Cartesian image reconstruction;
- Formulate a generalized signal model incorporating gradient encoding, coil sensitivity and Bo inhomogeneity;
- List the pro's and con's of Cartesian and non-Cartesian parallel MRI;
- Compare compressed sensing, HYPR, and k-t BLAST with respect to their use of prior knowledge;
- Describe the principles of separating water and fat signals; and
- Name three different approaches for motion correction and appraise their potential to become routine methods

Sparse Data

07:00 **Compressed Sensing and HYPR**
Julia V. Velikina, Ph.D.

07:30 **Exploiting Spatiotemporal Correlations for Dynamic Imaging**
Jeffrey Tsao, Ph.D.

SUNRISE EDUCATIONAL COURSE

Imaging Biomarkers

Room A1 07:00 – 08:00 *Organizers & Moderators*: Jeffrey L. Evelhoch and Sabrina M. Ronen

EDUCATIONAL OBJECTIVES
Upon completion of this course participants should be able to:

- Describe what a biomarker is and how MR can be used as a biomarker;
- Explain how biomarkers are qualified to be fit for their intended purpose;
- List requirements for use of MR biomarkers in both preclinical studies and clinical trials; and
- Give examples of how imaging biomarkers are being used in at least two of the following areas: multiple sclerosis, oncology, cardiovascular diseases and neurodegenerative diseases.

07:00 **Imaging Biomarkers in Neurodegenerative Diseases**
Kejal Kantarci, M.D.

07:30 **Imaging Biomarkers in Multiple Sclerosis**
Douglas L. Arnold, M.D.

SUNRISE EDUCATIONAL COURSE

Brain: An Absolute Beginner's Guide to Anatomical & Functional MRI

Room A4 07:00 – 08:00 *Organizer & Moderator*: Geoffrey J.M. Parker

EDUCATIONAL OBJECTIVES
Upon completion of this course participants should be able to:

- Identify the neuroanatomical and neurophysiological parameters which are accessible to MR measurement;
- Describe the underlying physics of MR neuroimaging techniques;
- Describe the data acquisition and analysis techniques most commonly used for anatomical and functional MRI of the brain;
- Recognize the potential value of advances such as parallel imaging, fast imaging techniques and high magnetic field strengths for imaging the brain; and
- Name typical clinical applications for which specific MRI techniques are suited.

07:00 **Absolute Beginners' Guide to Diffusion MRI**
Derek K. Jones, Ph.D.

SUNRISE EDUCATIONAL COURSE

Potentials & Challenges of High-Field MRS

Room A5 07:00 – 08:00 *Organizers & Moderators*: Rolf Gruetter and Ivan Tkac

EDUCATIONAL OBJECTIVES
Upon completion of this course participants should be able to:

- Describe advantages and potentials of MRS at very high fields;
- Identify problems and challenges of high field MRS;
- Define the MRS detectable neurochemical profile of the brain;
- Describe principles of metabolite quantification;
- Assess spectral quality and identify main sources of spectral quality deterioration; and
- Explain the importance of B0 shimming at high fields.

Neurochemical Profile

07:00 **MRSI Beyond NAA**
Dennis W.J. Klomp, Ph.D.

07:30 **Metabolite Quantification**
Cristina Cudalbu, Ph.D.

SUNRISE EDUCATIONAL COURSE

Modeling & Quantitative Analysis for Body DCE MRI

Room A 07:00 – 08:00 *Organizers & Moderators*: Henry Rusinek and Min-Ying Lydia Su

EDUCATIONAL OBJECTIVES
Upon completion of this course participants should be able to:

- Describe various DCE models used for different organs including kidney, liver, breast, and prostate;
- Describe analysis methods used to measure vascularity, permeability, and blood flow;
- Implement Monte Carlo noise simulation method to predict parameter bias and precision;
- Compare conventional compartmental kinetic models and distributed models;
- Apply procedures for converting MRI signal intensity to tracer concentration; and
- Explain current method for measuring vascular input function and analyzing its impact on obtained DCE parameters.

07:00 **DCE-MRI Measurement Challenges**
Thomas E. Yankeelov, Ph.D.

07:30 **Contrast Agents**
Youssef Zaim Wadghiri, Ph.D.

SUNRISE EDUCATIONAL COURSE

From Bench to Bedside to Bench: Translation of Animal Models to Clinical Practice & From Clinical Practice to Animal Models

Room A7 07:00 – 08:00 *Organizers & Moderators*: Pia C. Maly Sundgren and Afonso C. Silva

EDUCATIONAL OBJECTIVES
Upon completion of this course participants should be able to:

- Describe the main MRI methods used in experimental studies to understand the underlying disease mechanisms;
- Identify what is known about the underlying disease mechanisms, and which type of MRI investigations could be used for diagnosis and clinical investigation;
- Describe the main MRI methods used in the clinical setting to diagnose the condition, and the rationale behind this; and
- Make the translation from what is - and can be - done in experimental studies to what can be done clinically, and where animal models bring new insight to disease.

Oncology Imaging

Moderators: **Pia C. Maly Sundgren, M.D., Ph.D. and Afonso C. Silva, Ph.D.**

07:00 **Multimodality Radionuclide, Fluorescence, Bioluminescence Small-Animal Imaging including Animal Models for DCE-MRI and DWI MRI**
Jinha M. Park, M.D., Ph.D.

07:30 **Multimodality In-Vivo Molecular and Advanced oncologic Imaging : Human Metrics/Applications where is the Animal Model Validation?**
Meng Law, M.D.,M.B.B.S., F.R.A.C.R.

SUNRISE EDUCATIONAL COURSE

Cardiovascular Imaging: Disease or Problem Based Teaching, Practical Protocols

Room A8 07:00 – 08:00 *Organizers & Moderators*: Victor A. Ferrari, Vivian S Lee and Mitsue Miyazaki

EDUCATIONAL OBJECTIVES
Upon completion of this course participants should be able to:

- Recognize recent advancements and requirements in 3T cardiovascular MRI, as compared to present 1.5T MRI;
- Evaluate the strengths and limitations of current cardiovascular MRI techniques when applied to clinical diagnostic examinations;
- Describe current clinical techniques for assessment of ischemic heart disease and various cardiac diseases using new methods;
- Select the potential clinical applications of time-resolved techniques, and the technical challenges that will need to be resolved for wider applications; and
- Apply current approaches optimally to these diseases.

Image Processing & Visualization

07:00 **4D Flow**
Michael Markl, Ph.D.

07:20 **Function**
Frederick H. Epstein, Ph.D.

07:40 **Perfusion**
Christine H. Lorenz, Ph.D.

SUNRISE EDUCATIONAL COURSE

Trials & Tribulations: Multicenter Trial Headaches & Their Cures

Room A9 07:00 – 08:00 *Organizers & Moderators*: Nicola de Stefano and Jeffrey Joseph Neil

EDUCATIONAL OBJECTIVES
Upon completion of this course participants should be able to:

- Describe multiple methods for setting up and maintaining site quality and certification for multicenter imaging trials;
- Explain the issues related to performing research involving INDs or IDEs;
- Evaluate the sensitivity, specificity and reliability of current imaging methods to detect relevant quantitative changes within the brain; and
- Describe the underlying principles for adopting and evaluating potential surrogate imaging markers for assessment of drug efficacy.

Detecting Relevant Changes in the Brain

07:00 **Sensitivity and Specificity in Real Patients**
Frederik Barkhof, M.D., Ph.D.

07:30 **Data Analysis: Potential Pitfalls and Sources of Error**
Mara Cercignani, Ph.D.

PLENARY SESSION

Room A1 08:15-09:10 *Chair:* Georg M. Bongartz, ISMRM President

08:15 **Young Investigators Awards & Poster Awards**

08:30 **Mansfield Lecture: From Rodin to Radon: Some Unusual Applications of Projection Reconstruction**
Prof. Ray Freeman, D.Sc., Cambridge University, Cambridge, England, UK.
Prof. Freeman would like to acknowledge Dr. Eriks Kupce (Varian Ltd, Yarnton, Oxford, UK) as coauthor.

Clinical Needs & Technological Solutions: Atherosclerosis

Room A1 09:10-10:10 *Organizers & Moderators:* Debiao Li and Matthias Stuber

09:10 ***501***. **Pathogenesis of Atherosclerosis and Vulnerable Plaque**
Erling Falk[1]
[1]Aarhus University Hospital, Aarhus N., Denmark

Atherosclerosis is a systemic, lipid-driven inflammatory disease of the arterial wall leading to multifocal plaque development. The most dangerous plaques are those causing thrombosis, socalled vulnerable plaques. Most thrombi leading to heart attack and large artery stroke are caused by plaque rupture. A ruptured plaque contains a large and soft lipid-rich necrotic core covered by a thin and inflamed fibrous cap. Associated features include big plaque size, expansive remodeling mitigating luminal obstruction (mild stenosis by angiography), neovascularization (angiogenesis), plaque hemorrhage, adventitial inflammation, and a "spotty" pattern of calcifications. These features are potential targets for detection of vulnerable plaques by imaging.

09:30 ***502***. **Techniques and Applications of Atherosclerosis MRI**

Chun Yuan[1]
[1]University of Washington, Seattle, WA, United States

MRI of atherosclerosis is being applied in all major arteries in humans, aiming to identify key factors linked with current or future cardiovascular events, as well as for monitoring lesion progression/regression under medical treatment and for clinical diagnosis. This lecture will review the extensive technical advances of MRI atherosclerosis and the new insights into high risk lesions provided by MRI.

09:50 ***503***. **Molecular Imaging with Targeted Contrast Agents**

Zahi Adel Fayad[1]
[1]Mount Sinai School of Medicine, New York, NY, United States

Atherosclerosis is characterized by the thickening of the arterial wall to form a plaque, a process in which cholesterol deposition, inflammation, extracellular-matrix formation and thrombosis have important roles. Traditionally, diagnosis of atherosclerosis was possible either by directly revealing the narrowing of the lumen or by evaluating the effect of the stenosis on organ perfusion. New imaging approaches allow the assessment of the composition of the vessel walls, enabling atherosclerosis-associated abnormalities in the arteries to be observed, at the cellular/molecular levels. We discuss the use of new nanoparticulates not only for imaging but also for drug delivery and treatment of atherosclerosis.

Hot Topics: MRI & the Arrhythmic Patient

Room K1 10:30 – 12:30 *Organizers & Moderators*: Claudia M. Hillenbrand and Orlando P. Simonetti

EDUCATIONAL OBJECTIVES
Upon completion of this course participants should be able to:

- Select optimal cardiovascular MRI methods to define which patients need defibrillators, CRT, pacemakers;
- Explain the basic steps and concepts associated with MRI planning of RF ablation therapy;
- Evaluate the progress in interventional CVMR and predict future directions in MR-guided RF ablation therapy; and
- Describe the safety risks of imaging patients with pacemakers, and explain recent progress on MRI-compatible pacemakers and defibrillators.

10:30 **MRI Detection of Arrhythmic Substrate**
Katherine C. Wu, M.D.

10:55 **Role of MRI in Patient Selection for CRT**
John N. Oshinski, Ph.D.

11:20 **MR-guided RF Ablation**
Tobias R. Schaeffter, Ph.D.

11:45 **MRI of Patients with Pacemakers and Defibrillators**
Torsten Sommer, M.D.

12:10 Panel Discussion

How to Perform a Multi-Site Neuroimaging Study

Room K2 10:30 – 12:30 *Organizers*: Gary H. Glover, Bryon A. Mueller and Douglas C. Noll

EDUCATIONAL OBJECTIVES
Upon completion of this course participants should be able to:

- Recognize the challenges associated with performing a multi-site MRI experiment, including issues associated with QA, advanced planning, data management, and training;
- Explain how existing multi-center MRI experiments were designed and implemented;

- Describe the unique challenges associated with executing multi-center structural, diffusion tensor, functional, and perfusion imaging experiments; and
- Implement a multi-center study using best practices.

Moderator: **Douglas C. Noll**

10:30 **Foundations for Performing Any Multi-Center Neuroimaging Study**
Gary H. Glover, Ph.D.

10:48 **How to do a STRUCTURAL Multi-Center Neuroimaging Study**
Matt A. Bernstein, Ph.D.

11:06 **How to do a DTI Multi-Center Neuroimaging Study**
Carlo Pierpaoli, M.D., Ph.D.

11:24 **How to do a FUNCTIONAL Multi-Center Neuroimaging Study**
Bryon A. Mueller, Ph.D.

11:42 **How to do an ASL Multi-Center Neuroimaging Study**
Xavier G. Golay, Ph.D.

12:00 **How to do a Multi-Center Neuro-Imaging Study: A Technologist's Perspective**
Maureen Ainslie, M.S., R.T. (R) (MR)

12:18 **Panel Discussion**
Douglas C. Noll, Ph.D.

Clinical Stroke Imaging: From Vessel Wall to Neuron

Room A1 10:30-12:30 *Moderators:* Jeroen Hendrickse and Toshiaki Taoka

10:30 ***504***. **Arterial Luminal Curvature and Fibrous Cap Thickness Affects Critical Stresses Within Atherosclerotic Plaques: An in Vivo MRI-Based Finite Element Method Simulation Study**

Zhongzhao Teng[1], Umar Sadat[1], Zhiyong Li,[12], Chengcheng Zhu[1], Victoria Young[1], Martin John Graves[1], Jonathan H. Gillard[1]
[1]University Department of Radiology, University of Cambridge, Cambridge, United Kingdom; [2]School of Biological Science & Medical Engineering, Southeast University, Nanjing, Jiangsu, China

It has been widely accepted that the plaque rupture is the result of the loading due to blood pressure and flow exceeds the material strength of the fibrous cap (FC) and the site with thin FC is regarded as the vulnerable site. Considerable research has been done to discover the correlation between FC thickness and critical stress conditions, however, the relationship of arterial luminal curvature remains unexplored. We found that stress value taken from the thinnest location will significantly over-estimate the plaque stability. For a better plaque risk assessment, stress at the sites with maximum lumen curvature should be included.

10:42 ***505***. **Impact of the Age of Plaque Haemorrhage on Plaque Stress in Patients with Symptomatic Carotid Artery Disease- A Patient Specific Magnetic Resonance Imaging-Based Finite Element Method Simulation Study**

Umar Sadat[1], Zhongzhao Z. Teng[2], Zhi Yong Li[2], Cheng Cheng Zhu[2], Victoria E. Young[2], Martin J. Graves[2], Jonathan H. Gillard[2]
[1]University Department of Radiology , University of Cambridge, Cambridge, United Kingdom; [2]University Department of Radiology, University of Cambridge, Cambridge, United Kingdom

Patients suffering from a transient ischemic attack (TIA) are at high risk of recurrent TIAs, particularly within the first 4 weeks. The risk of recurrent thromboembolic events gradually decreases afterwards. The United Kingdom National Stroke Strategy warrants emergency management of high-risk patients. High resolution magnetic resonance can assist us to identify high-risk plaques and assess the morphological and biomechanical changes within plaques using computational simulations, thereby refining our risk stratification criteria for management of high-risk patients. In this study we assess the impact of age of plaque haemorrhage on plaque stress in patients suffering from TIAs.

10:54 ***506***. **Carotid Artery Plaque Burden as Measured by Magnetic Resonance Imaging: A Potential Imaging Indicator for Acute Cerebral Ischemic Lesion Volume**

Huilin Zhao[1], Xihai Zhao[2], Ye Cao[1], Jinnan Wang[3], Chun Yuan[2], Xiangyang Ma[4], Jianrong Xu[1]
[1]Radiology, Renji Hospital, Shanghai Jiaotong University School of Medicine, Shanghai, China; [2]Radiology, University of Washington, Seattle, WA, United States; [3]Philips Research North America, Briarcliff Manor, NY, United States; [4]Philips Research Asia, Shanghai, China

Carotid atherosclerosis has been demonstrated to be associated with cerebrovascular events (TIA or stroke). Thus, atherosclerotic disease in carotid arteries may be an effective indicator for the severity and outcomes of stroke, such as cerebral infarct volumes. This study sought to determine the association between carotid plaque burden and cerebral ischemic lesion volume by MRI in 43 symptomatic patients. We found a strong correlation of left carotid artery plaque burden with ispilateral cerebral hemisphere ischemic lesion volumes. Our findings suggest that carotid plaque burden may be a potential imaging indicator for acute cerebral ischemic lesion volume.

11:06 ***507***. **Plaque Burden Measurement by Black-Blood MR Imaging Technique in Intracranial and Extracranial Carotid Arteries in Acute Stroke Patients**

Huilin Zhao[1], Xihai Zhao[2], Ye Cao[1], Jinnan Wang[3], Chun Yuan[2], Xiangyang Ma[4], Jianrong Xu[1]
[1]Radiology, Renji Hospital, Shanghai Jiaotong University School of Medicine, Shanghai, China; [2]Radiology, University of Washington, Seattle, WA, United States; [3]Philips Research North America, Briarcliff Manor, NY, United States; [4]Philips Research Asia, Shanghai, China

Atherosclerosis is a systemic disease frequently involving multiple vascular territories, such as carotid artery and cerebral arteries, which are related to cerebrovascular events. Thus, atherosclerotic disease in one vascular bed may be an indicator for the other vasculatures. This study sought to determine the association of atherosclerotic plaque burden between carotid arteries and M1 segment of middle cerebral arteries using MR black-blood vessel wall imaging in 31 symptomatic patients. We found that development of atherosclerosis has been shown to be parallel in intracranial and extracranial cerebrovascular system in stokes. Our findings suggest that atherosclerotic disease in carotid artery may be an indicator of intracranial cerebrovascular atheroma, or vice versa.

11:18 ***508***. **Cerebrovascular Reactivity Within Perfusion-Territories in Patients with an ICA Occlusion**

Reinoud Pieter Harmen Bokkers[1], Matthias J. van Osch[2], C. J. Klijn[3], L Jaap Kappelle[3], Willem P. Mali[1], Jeroen Hendrikse[1]
[1]Department of Radiology, UMCU, Utrecht, Netherlands; [2]Department of Radiology, LUMC, Leiden, Netherlands; [3]Department of Neurology, UMCU, Utrecht, Netherlands

Patients with a symptomatic occlusion of the internal carotid artery (ICA) and hemodynamic compromise of the brain may benefit from bypass surgery. Our objective was to investigate cerebrovascular reactivity in the perfusion-territories of the cerebral arteries at brain tissue level in patients with an ICA occlusion using arterial spin labeling MRI, and determine whether cerebrovascular reactivity varies within the perfusion-territory of the remaining ICA. Our results show that ASL-MRI can visualize brain tissue with impaired cerebrovascular reactivity. The brain tissue on the side of the occlusion, supplied through collaterals originating from the unaffected ICA, was the most impaired.

11:30 ***509***. **Quantitative MR Perfusion and Ischemic Stroke: Improved Discrimination Between Ischemic and Presumed Penumbra Using QCBF Over Tmax or MTT**

Christopher S. Eddleman[1], Maulin Shah[2], Omar M. Arnaout[1], Richard Bernstein[3], Bernard R. Bendok[1], Hunt H. Batjer[1], Timothy J. Carroll[4]
[1]Neurological Surgery, Northwestern University, Chicago, IL, United States; [2]Biomedical Engineering, Pennsylvania State University, State College, PA, United States; [3]Neurology, Northwestern University, Chicago, IL, United States; [4]Radiology, Northwestern University, Chicago, IL, United States

Time-based indicators of cerebral blood flow, e.g., Tmax and MTT, are often used to grade stroke severity in both MR and CT perfusion studies. However, these measures often overestimate the infarcted territory, thus underestimating salvagable brain. We show that quantitative MR perfusion is superior to time-based measures in distinguishing normally perfused from ischemic brain tissue.

11:42 ***510***. **Is Reduced CBV a Reliable Surrogate Marker for Infarct Core and Can It Be Used to Identify Lesion Mismatch?**

Matus Straka[1], Jun Lee[2], Maarten G. Lansberg[2], Michael Mlynash[2], Gregory W. Albers[2], Roland Bammer[1]
[1]Radiology, Stanford University, Stanford, CA, United States; [2]Stroke Center, Stanford University Medical Center, Stanford, CA, United States

Mismatch between stroke core and penumbra can be used used to identify patients that could benefit from reperfusion therapies. Hyperintense DWI in MRI or hypointense CBV in CT can be used to identify stroke core, and equivalence of CT-CBV and DWI lesion volumes was tested. DSC-MRI CBV was used as a surrogate for CT-CBV and 59 patients were analyzed. Results indicate that only large lesions (>10ml) can be identified on CBV and accuracy and reliability of CBV-based mismatch is lower then of DWI. CBV-based stroke core identification yeilded generally smaller lesions and correlation with DWI was low.

11:54 ***511***. **Model-Based Permeability Estimates Are Preferable to Model-Free Initial Area Under the Curve (IAUC) Measures in the Identification of Hemorrhagic Transformation in Acute Ischemic Stroke**

Andrea Kassner[1,2], Rebecca E. Thornhill[1,2], Swati Matta[1], Fang Liu[1], David J. Mikulis[1,3]
[1]Medical Imaging, University of Toronto, Toronto, Ontario, Canada; [2]Physiology and Experimental Medicine, Hospital for Sick Children, Toronto, Ontario, Canada; [3]Medical Imaging, Toronto Western Hospital, Toronto, Ontario, Canada

Thrombolytic therapy is known to increase the risk of hemorrhagic transformation (HT) in acute ischemic stroke (AIS). Accurate and robust methods for predicting HT are required for improving treatment guidance. Model-based permeability estimation with dynamic contrast-enhanced MRI can predict HT, but the estimates (KPS coefficients) are sensitive to noise and require an arterial input function. However, studies of tumors suggest that a model-free measure, the initial area under the contrast-concentration curve (IAUC) is more robust. We evaluated both KPS and IAUC in AIS patients and found that only KPS successfully delineated HT. Model-based estimates are recommended over IAUC in AIS.

12:06 ***512***. **Pulsed Arterial Spin Labeling Perfusion MRI Correlates with Clinical Severity in Patients with Vertebrobasilar Artery Stenoses**

Bradley J. MacIntosh[1,2], Lars Marquardt[3], Ursula G. Schulz[3], Peter M. Rothwell[3], Peter Jezzard[2]
[1]Imaging & Brain Sciences, Sunnybrook Health Sciences Centre, Toronto, ON, Canada; [2]Clinical Neurology, FMRIB Centre, Oxford, OXON, United Kingdom; [3]Clinical Neurology, Stroke Prevention Research Unit, Oxford, OXON, United Kingdom

Arterial spin labeling is a versatile perfusion MRI technique and recent studies have shown clinical merit. One clinical arena that is under-investigated is perfusion profiles in patients with vertebral or basilar artery (VBA) stenosis. The arrival of the magnetic spin tracer is expected to be delayed in these patients therefore a multiple inflow 3D-GRASE-PASL implementation is used to estimate cerebral blood flow (CBF) and the arterial arrival time (AAT). Patients with presumed severe VBA disease (N=4), on the basis of their clinical history, showed significantly prolonged AAT ($P<0.01$) and reduced CBF ($P=0.08$) when compared to patient with presumed no VBA disease (N=10).

12:18 ***513***. **MR Elastography of Stroke: A Feasibility Study**

Sebastian Hirsch[1], Kaspar Josche Streitberger[1], Jan Rodrigo Hoffmann[2], Randolf Klingebiel[3], Dieter Klatt[1], Sebastian Papazoglou[1], Jürgen Braun[4], Ingolf Sack[1]
[1]Institute of Radiology, Charité - University Medicine Berlin, Berlin, Germany; [2]Institute of Neurology, Charité - University Medicine Berlin, Berlin, Germany; [3]Institute of Neuroradiology, Charité - University Medicine Berlin, Berlin, Germany; [4]Institute of Medical Informatics, Charité - University Medicine Berlin, Berlin, Germany

The characterization of neuronal tissue inside an infarcted region is still a subject of intense research. MR elastography (MRE) is capable of measuring the mechanical connectivity of soft tissue in vivo. This feasibility study aims to assess the potential of MRE for the characterization of tissue regeneration after stroke. The hypothesis was that stroke-related changes of the biomechanical properties of neuronal tissue are detectable by MRE. The results demonstrate through both a decrease in the complex shear modulus and an increase in shear wave amplitudes that tissue integrity is degraded inside a stroke region.

Arterial Spin Labeling

Victoria Hall 10:30-12:30 *Moderators:* Susan T. Francis and Eric C. Wong

10:30 ***514***. **The Effect of Bolus Length and Dispersion on Arterial Spin Labeling Flow Quantification**

Esben Thade Petersen[1], Xavier Golay[2], T QUASAR Reproducibility study[3]
[1]Clinical Imaging Research Centre (CIRC), Singapore, Singapore; [2]UCL Institute of Neurology, London, United Kingdom; [3]28 Centers

Bolus duration and dispersion is often assumed when quantifying flow using ASL. We evaluated their impact on CBF, based on data from 284 healthy subjects (28 sites). The length and dispersion was fitted from multiple arterial-input-functions obtained from data acquired at multiple time-points. Although QUIPSS-II bolus definition (0.64s) was applied, the majority had shorter boluses, compromising the precision of ASL. Furthermore, a considerable correlation (0.63, $p<0.001$) between average bolus-length and CBF from the sites, suggest that part of site differences relates to the bolus duration. Normal Gaussian dispersion ranges from 0.05-0.15s potentially introducing large quantification errors across the brain.

10:42 ***515***. **Determination of Spin Compartment in ASL Signal Using TRUST-MRI**

Peiying Liu Wang[1], Jinsoo Uh[1], Hanzhang Lu[1]
[1]Advanced Imaging Research Center, University of Texas Southwestern Medical Center, Dallas, TX, United States

Although ASL has been widely used for measurement of CBF, we do not know which compartment the labeled spins are located at the time of detection. Here we used the T2 value of the labeled spins to probe whether the detected ASL signal is located in artery, tissue or even vein. Our data suggest that, at typical delay time of 1.5 seconds, most of the detected spins in gray matter are already in the tissue space. For white matter, however, the spins are still virtually all in arteries.

10:54 ***516***. **Depression of Cortical Gray Matter $CMRO_2$ in Awake Humans During Hypercapnia**

Divya S. Bolar[1,2], Bruce R. Rosen[1,2], Karleyton C. Evans[1,3], A Gregory Sorensen[1,2], Elfar Adalsteinsson[1,2]
[1]HST/MGH/MIT Martinos Center for Biomedical Imaging, Charlestown, MA, United States; [2]Harvard-MIT Division of Health Sciences & Technology, Cambridge, MA, United States; [3]Department of Psychiatry, Massachusetts General Hospital, Boston, MA, United States

Hypercapnia induced by CO_2 inhalation causes a robust increase in cerebral blood flow. Far less understood are the effects of CO_2 on neuronal activity and cellular metabolism. In this study, a recently developed method called QUantiative Imaging of the eXtraction of Oxygen and TIssue Consumption (QUIXOTIC) was used evaluate the hypercapnic $CMRO_2$ response in cortical gray matter of awake humans. We report a statistically significant decrease of

25.3% in cortical $CMRO_2$ ($p = 0.036$), from normocapnia to hypercapnia. To our knowledge, this is the first time cortical GM $CMRO_2$ response to hypercapnia has been assessed.

11:06 ***517***. **3D-EPI ASL at Ultra High Field**

Emma Louise Hall[1], Penny A. Gowland[1], Susan T. Francis[1]
[1]Sir Peter Mansfield Magnetic Resonance Centre, University of Nottingham, Nottingham, Nottinghamshire, United Kingdom

3D acquisitions are advantageous to ASL to eliminate slice dependent variation in signal. Here we show the feasibility of 3D-EPI arterial spin labelling (ASL) at 7T. Using SENSE acceleration in two directions the shot length can be significantly reduced allowing improved spatial coverage or spatial resolution to be achieved. 3D-EPI ASL is shown to benefit from increased signal-to-noise ratio and overcome SAR limits reached when using 2D-EPI ASL at 7T.Whole head (20 slice) $2x2x3mm^3$ 3D-EPI perfusion images can be acquired in 5 minutes.

11:18 ***518***. **Whole Brain Pseudo Continuous ASL at 7T Using a Single Coil for Imaging and Labeling.**

Wouter M. Teeuwisse[1], Andrew Webb[1], Matthias J.P. van Osch[1]
[1]C.J.Gorter Center, Radiology, Leiden University Medical Center, Leiden, Netherlands

In this study, whole brain pseudo continuous ASL (pCASL) is implemented at 7T, using the same RF coil for labeling and imaging. The magnitude of B0 inhomogeneities, RF penetration and f0-offsets were measured. For optimal labeling, B0 changes along the vessels were compensated by adjusting the average labeling gradient. A subject-specific frequency offset for the label pulses was calculated and implemented as was the incorporation of high dielectric material placed around the head and neck for higher B1 delivery in the neck. After implementing all of these improvements whole brain pCASL was successfully performed at 7T.

11:30 ***519***. **Optimizing the Inversion Efficiency of Pseudo-Continuous ASL Pulse Sequence Using B0 Field Map Information**

Hesamoddin Jahanian[1,2], Douglas C. Noll[1,2], Luis Hernandez-Garcia[1,2]
[1]Functional MRI Laboratory, University of Michigan, Ann Arbor, MI, United States; [2]Department of Biomedical Engineering, University of Michigan, Ann Arbor, MI, United States

The recent introduction of pseudo-continuous inversion pulses (pCASL) has the potential to greatly facilitate the use of continuous Arterial Spin Labeling (ASL). However, field inhomogeneities, can compromise the tagging efficiency of pCASL, which causes loss in SNR and severe quantification error. We propose a method to restore the loss in labeling efficiency by correcting the phase of the RF pulses in combination with a z-shimming scheme. This will provide more robust perfusion measurements than the conventional pseudo-continuous technique. The method is demonstrated using numerical simulation and In-vivo data.

11:42 ***520***. **Robust Prescan for Pseudo-Continuous Arterial Spin Labeling at 7T: Estimation and Correction for Off-Resonance Effects**

Wen-Ming Luh[1], S Lalith Talagala[2], Peter A. Bandettini[1]
[1]FMRIF, NIMH, National Institutes of Health, Bethesda, MD, United States; [2]NMRF, NINDS, National Institutes of Health, Bethesda, MD, United States

Pseudo-continuous arterial spin labeling can provide optimal SNR efficiency with sufficient long tag at high fields such as 7T but is very sensitive to off-resonance fields at tagging location as often observed at 7T. Here we demonstrate a robust approach using pair-wise modulation of tagging frequency offset with high SNR images from large voxels and short post labeling delay to derive a necessary 'prescan' procedure for estimating and correcting off-resonance effects in 1 minute.

11:54 ***521***. **Partial Volume Correction for Perfusion Estimation from Multi-TI Arterial Spin Labelling**

Michael A. Chappell[1,2], Adrian R. Groves[1], Bradley J. MacIntosh[1,3], Manus J. Donahue[1], Peter Jezzard[1], Mark W. Woolrich[1]
[1]FMRIB Centre, University of Oxford, Oxford, United Kingdom; [2]Institute of Biomedical Engineering, University of Oxford, Oxford, United Kingdom; [3]Imaging Research, Sunnybrook Research Institute, Toronto, Canada

The partial voluming of gray matter (GM), white matter (WM) and CSF in ASL leads to underestimates of GM CBF. Here a correction strategy is proposed for multi-TI ASL as part of the kinetic curve model fitting analysis. The method exploits the differences in kinetics between GM and WM and also employs constraints based on partial volume estimates of the tissue types. The proposed method is shown to provide GM CBF estimates corrected for partial voluming while preserving details within the GM CBF image.

12:06 ***522***. **Voxel Based Perfusion Variability in ASL**

Sanna Gevers[1], Matthias J.P. van Osch[2], Jeroen Hendrikse[3], Reinoud P. Bokkers[3], Dennis Kies[2], Wouter M. Teeuwisse[2], Charles B.L.M. Majoie[1], Aart J. Nederveen[4]
[1]Radiology, Academic Medical Center Amsterdam, Amsterdam, Netherlands; [2]Radiology, Leiden University Medical Center, Netherlands; [3]Radiology, University Medical Center Utrecht, Netherlands; [4]Radiology, Academic Medical Center Amsterdam, Netherlands

Thus far, ASL variability studies have mainly focussed on intrasession and intracenter and multicenter variability of global perfusion and of perfusion in the flow territories of major brain feeding arteries. The purpose of this study was to analyze variability patterns over different brain regions performing a voxel based analysis of variance within and between imaging sessions. The results of our study show that pseudo-continuous ASL with background suppression is least variable over different brain regions whereas other ASL techniques show more variability mainly in vascular regions. Most striking per voxel variances were found in the posterior circulation for pulsed ASL and in the frontal region for continuous ASL.

12:18 ***523***. **Superselective Arterial Spin Labeling Applied for Flow Territory Mapping in Selected Clinical Cases - Advantages Over Existing Selective ASL Methods**

Michael Helle[1], Matthias van Osch[2], David Gordon Norris[3], Susanne Rüfer[1], Karsten Alfke[1], Olav Jansen[1]
[1]Institute of Neuroradiology, UK-SH, Kiel, Germany; [2]C.J. Gorter Center for high field MRI, Department of Radiology, Leiden University Medical Center, Leiden, Netherlands; [3]Donders Institute for Brain, Cognition and Behaviour, Nijmegen, Netherlands

The ability to visualize perfusion territories in the brain is important for many clinical applications but the selectivity of existing methods is restricted to larger vessels. Superselective arterial spin labeling (ASL) is a recently developed technique that overcomes these limitations and permits labeling of small vessels even distal to the Circle of Willis. In this study, superselective ASL is applied for regional perfusion measurements in selected clinical cases (extra-intracranial bypass, arterio-venous malformation and steno-occlusive disease) showing advantages over conventional selective ASL methods and demonstrating benefits in diagnosis, risk analysis and treatment monitoring when added to current MR-protocols.

MR-Guided Clinical Interventions

Room A4 10:30-12:30 *Moderators:* Kim Butts-Pauly and Thomas Kahn

10:30 ***524***. **Wide-Bore 1.5 Tesla MR-System for Monitoring of Hepatic Radiofrequency Ablation: Initial Experience in the Treatment of 60 Metastases**

Stephan Clasen[1], Hansjörg Rempp[1], Andreas Boss[1], Christina Schraml[1], Diethard Schmidt[1], Fritz Schick[2], Claus Claussen[1], Philippe Pereira[3]
[1]Department of Diagnostic and Interventional Radiology, University of Tübingen, Tübingen, Germany; [2]Section of Experimental Radiology, University of Tübingen; [3]SLK Kliniken Heilbronn

MR-guided radiofrequency (RF) ablation using a wide-bore 1.5 Tesla MR-system was evaluated in the treatment of 60 hepatic metastases in 30 patients. Monitoring of ablation therapy was performed by using native T1w and T2w imaging. In addition MR temperature mapping by using the proton resonance frequency shift (PRF) method was applied. Complete coagulation was achieved in 58/60 (96.7%) metastases assessed during the mean follow-up of 5 months (range: 1 – 12 months). In conclusion, MR-guided RF ablation using a wide-bore 1.5 Tesla MR-system is an effective therapy in the local treatment of hepatic metastases.

10:42 ***525***. **Real-Time MR-Guided Biopsies to Target Focal Hepatic Fibrosis Detected with Magnetic Resonance Elastography**

Ryan Babu Perumpail[1], Ning Jin[1], Yi Wang[1], Victoria Lee[2], Jennifer Karp[1], Bradley D. Bolster, Jr.[3], Saurabh Shah[4], Sven Zuehlsdorff[4], Richard Ehman[5], Albert Andrew Nemcek[1], Josh Levitsky[2], Andrew Christian Larson[1], Frank Miller[1], Reed Ali Omary[1]
[1]Radiology, Northwestern University, Chicago, IL, United States; [2]Hepatology, Northwestern University, Chicago, IL, United States; [3]Siemens Healthcare, Rochester, MN, United States; [4]Siemens Healthcare, Chicago, IL, United States; [5]Radiology, Mayo Clinic, Rochester, MN, United States

Magnetic resonance elastography (MRE), a non-invasive method to quantify liver stiffness, has not been directly correlated with MR-targeted biopsy results. We tested the hypothesis that real-time MR-guided biopsies could target focal segments of liver for histopathologic correlation with MRE stiffness measurements. Our results demonstrate the feasibility of real-time MR guidance to biopsy focal liver segments for correlation of fibrosis using MRE targets. Since early-stage hepatic fibrosis can present as focal lesions, MRE can be used to target biopsies to avoid clinical understaging and delayed initiation of therapy.

10:54 ***526***. **Preliminary Clinical Results: MR-HIFU Ablation of Uterine Fibroids with Automatic Volumetric Ablation**

Charles Mougenot[1,2], Julia Enholm[3], Nora Frulio[4], Max O. Köhler[3], Hervé Trillaud[4]
[1]Philips Healthcare, Bordeaux, France; [2]IMF laboratory, Bordeaux, France; [3]Philips Healthcare, Vantaa, Finland; [4]CHU Bordeaux, St André Hospital, Bordeaux, France

High Intensity Focused Ultrasound under MR guidance is a non-invasive thermotherapy procedure used for ablation of uterine fibroids. To improve this treatment, a volumetric heating method combined with temperature control was evaluated at St. André hospital following good clinical practice and using a Philips MR-HIFU platform. Preliminary results based on 13 clinical cases indicate that large volumetric sonications increase the ablation efficiency by a ratio 35. In addition, temperature control provides a reproducible ablation size with a diameter accuracy of 1mm, which enhances treatment safety. No serious adverse events or skin burns were observed.

11:06 ***527***. **Interactive Mr-Guided Percutaneous Nephrostomy Using an Open 1T Mr-Scanner: First Experience in 15 Patients**

Frank Fischbach[1], Markus Porsch, Jürgen Bunke[2], Maciej Pech, Oliver Dudeck, Uwe-Bernd Liehr, Jens Ricke
[1]OvGU, Magdeburg, Germany, Germany; [2]PMS

The advantages of MR fluoroscopy including missing radiation, high tissue contrast, multiplanar imaging and the availability of open high field systems giving good access to the patient and sufficient SNR should encourage broadening the indications for MR-guided interventions. MR-guided percutaneous nephrostomy can be performed in a routine setting. This is especially of interest in patients not suited for sonographic guidance

11:18 ***528***. **Transrectal MRI-Guided Biopsy of the Prostate - Results in a Cohort with 100 Patients with Negative Ultrasound Guided Biopsy and Persisting or Increasing PSA Levels**

Matthias C. Roethke[1], David Schilling[2], Aristotelis G. Anastasiadis[3], Matthias P. Lichy, Arnulf Stenzl[2], Claus D. Claussen, Heinz-Peter Schlemmer[1]

[1]Diagnostic Radiology, University Hospital, Tuebingen, Germany; [2]Urology, University Hospital; [3]Urology, Grossburgwedel Hospital, Germany

Transrectal MRI-guided biopsy of the prostate in a cohort with 100 patients with prior negative ultrasound guided biopsy and persisting or increasing PSA levels. Results show detection rate of MRI-guided biopsy(49%)is considerably higher compared to standard repetition procedure with transrectal ultrasound guided biopsy (up to 26% even after saturation biopsy).

11:30 ***529***. **Preliminary Human Evaluation of MRI-Guided Transurethral Ultrasound Therapy for the Treatment of Localized Prostate Cancer**

Rajiv Chopra[1,2], Michael Bronskill[1,2], Masoom Haider[3,4], Laurence Klotz[5,6]

[1]Imaging Research, Sunnybrook Health Sciences Centre, Toronto, Ontario, Canada; [2]Medical Biophysics, University of Toronto, Toronto, Ontario, Canada; [3]Medical Imaging, Sunnybrook Health Sciences Centre, Toronto, Ontario, Canada; [4]Medical Imaging, University of Toronto, Toronto, Ontario, Canada; [5]Urology, Sunnybrook Health Sciences Centre, Toronto, Ontario, Canada; [6]Surgery, University of Toronto, Toronto, Ontario, Canada

MRI-guided transurethral ultrasound therapy is a minimally-invasive treatment for localized prostate cancer. The purpose of this study was to evaluate the feasibility of performing this treatment in humans. An initial clinical evaluation in prostate cancer patients destined for radical prostatectomy was performed. The predicted thermal damage zone was compared with the actual tissue damage measured on histology.

11:42 ***530***. **Online Guidance of Tumor Targeted Prostate Brachytherapy Using Histologically Referenced MRI**

Cynthia Menard[1], Peter Chung, Jessamine Abed, Anna Simeonov, Jenny Lee, Kristy Brock, Warren Foltz, Gerald O'Leary[2], Christine Elliott[3], Michael Milosevic, Robert Bristow, Gerard Morton[4], Padraig Warde, Masoom Haider

[1]Princess Margaret Hospital, University of Toronto, Toronto, Ontario, Canada; [2]Toronto General Hospital, University Health Network, Toronto, Ontario, Canada; [3]Sentinelle Medical Inc; [4]Odette Cancer Center, University of Toronto, Toronto, Ontario, Canada

We demonstrate feasibility and report technical and clinical performance of a needle navigation system where pathologically referenced multi-parametric interventional MRI guidance improved the determination of tumor boundaries, and enabled accurate tumor-targeted HDR prostate brachytherapy. The value of 3D imaging to document actual location of biopsy cores in reference to anatomic boundaries is emphasized.

11:54 ***531***. **Localizing Prostate Brachytherapy Seeds with SGM**

Gopal Varma[1], Peter Acher[2], Graeme Penney[1], Kawal Rhode[1], Stephen Keevil[1,3], Tobias Schaeffter[1]

[1]Imaging Sciences, King's College London, London, United Kingdom; [2]Department of Urology, Guy's and St Thomas' NHS Foundation Trust, London, United Kingdom; [3]Medical Physics, Guy's and St Thomas' NHS Foundation Trust, London, United Kingdom

Treatment by prostate brachytherapy involves implant of radioactive seeds. Dosimetry requires seed position and number to be accurately defined relative to prostate anatomy. The advantage of soft tissue contrast from MRI allows depiction of the prostate but localization of the seeds is relatively poor. A SGM technique is used to visualize the seeds by post-processing. The derived parameter is found to have a linear correlation with number of seeds and thus provides potential for dosimetry by MR.

12:06 ***532***. **Proof of Principle of an MR-Compatible Robot for MRI-Guided Interventions Using a Unique Tapping Device**

Michiel R. van den Bosch[1], Maaike R. Moman[1], Marco van Vulpen[1], Jan J. Battermann[1], Ed Duiveman[2], Leonard J. van Schelven[2], Jan J.W Lagendijk[1], Marinus A. Moerland[1]

[1]Department of Radiotherapy, University Medical Center Utrecht, Utrecht, Netherlands; [2]Medical Technology & Clinical Physics, University Medical Center Utrecht, Utrecht, Netherlands

This in-vivo study demonstrates the proof of principle of an MR-compatible robot dedicated for MRI-guided interventions. The robot can be placed between patient's legs inside a 1.5T closed bore scanner for transperineal needle insertion. To minimize tissue deformation, it contains a tapping device to automatically tap (rather than push) the needle towards the target position. Four fiducial gold markers were placed into the prostate of a patient with a stage T3 prostate cancer under MRI-guidance using fast MR sequences. This opens the door for MRI-guided interventions as biopsy and brachytherapy in tissue, where deformation might be problematic.

12:18 ***533***. **MR-Compatible Transrectal Prostate Biopsy Robot: A Feasibility Study**

Jurgen Futterer[1], Martijn Schouten[1], Tom Scheenen[2], Jelle Barentsz[3]

[1]Radiology, Radboud University Nijmegen Medical Centre, Nijmegen, Netherlands; [2]Radiology, Radboud University Nijmegen Medical Centre, Nijmegen, Netherlands; [3]Radiology, Radboud University Nijmegen Medical Centre, Nijmegen, Netherlands

The meet the demand of a better sensitivity in MR-guided biopsy of the prostate the robotic system can be employed. We introduce the in-house developed pneumatic actuated MR-compatible robot where needle guide direction can be controlled inside the controller room. Feasibility and accuracy of the MR-compatible robot were validated with phantom measurements.

MR Techniques for Evaluation of Intervertebral Disc & Bone

Room A5 10:30-12:30 *Moderators:* Won Bae and Thomas M. Link

10:30 ***534***. **Ultrashort Time-To-Echo MRI of Human Intervertebral Disc Endplate: Association with Disc Degeneration**

Won C. Bae[1], Tomoaki Yoshikawa[2], Richard Znamirowski[1], Aseem R. Hemmad[2], Bruno C. Vande Berg[3], Christine B. Chung[1], Koichi Masuda[2], Graeme M. Bydder[1]

[1]Radiology, University of California, San Diego, San Diego, CA, United States; [2]Orthopaedic Surgery, University of California, San Diego, San Diego, CA, United States; [3]Radiology, Cliniques Universitaires St Luc, Université Catholique de Louvain, Brussels, Belgium

UTE MR image of human lumbar spine reveals distinct linear signal near disc endplates, unlike signal voids seen in conventional MR images. Normal and abnormal (loss and diminution) patterns of UTE signal were evaluated in 29 lumbar spines at different levels. In addition, disc degeneration was evaluated in T2-weighted spin echo images using Pfirrmann grading system. UTE signal abnormality did not depend on the level, but was increasingly found in levels with advanced disc degeneration. The present results demonstrated unique ability of UTE MRI to directly evaluate region near endplate, and association between endplate MR changes with disc degeneration.

10:42 ***535***. **Quantitative Comparison of T1ρ with T2 in Intervertebral Disc in Vivo at 3T**

Queenie Chan[1,2], Mina Kim[2], Marina-Portia Anthony[2], Kenneth MC Cheung[3], Aaron Chan[2], Tao Chan[2], Pek-Lan Khong[2]

[1]Philips Healthcare, Hong Kong, China; [2]Department of Diagnostic Radiology, The University of Hong Kong, Hong Kong, China; [3]Division of Spine Surgery, Department of Orthopaedics and Traumatology, Faculty of Medicine, The University of Hong Kong, Hong Kong, China

Diagnostic techniques based on conventional T2-weighted images are commonly used for disc degeneration but are subjective and not sensitive to subtle changes in the intervertebral discs (IVDs). Therefore, quantitative assessment would play an important role in greatly improving the evaluation of disc degeneration. In this study, we performed quantitative T1ρ and T2 measurements in human lumbar IVDs. Our results suggest that different degenerative-related changes taking place in between the central nucleus pulposus and the outer annulus fibrosus can be quantitatively assessed using T1ρ and T2 mapping which may provide complementary information to better understand pathophysiological mechanisms in disc degeneration.

10:54 ***536***. **T1ρ MRI and Discography Opening Pressure Are Quantitative Biomarkers of Disc Degeneration in Vivo**

Matthew Fenty[1], Chenyang Wang[1], Walter RT Witschey[1], Rachelle Berger[1], Philip Maurer[2], Dawn M. Elliott[3], Ravinder Reddy[1], Ari Borthakur[1]

[1]CMROI, Department of Radiology, University of Pennsylvania School of Medicine, Philadelphia, PA, United States; [2]3B Orthopaedics, Philadelphia, PA, United States; [3]Department of Orthopaedic Surgery, University of Pennsylvania School of Medicine, Philadelphia, PA, United States

The objective of this study is to evaluate T1ρ MRI as quantitative biomarker of disc degeneration in patients being treated for Lower Back Pain (LBP) by comparing it to invasive discography opening pressure. A significant and strong correlation exists between non-invasive MRI T1ρ values and in vivo opening pressure measurements. T1ρ is a quantitative measure of degeneration that is consistent across both control subjects and LBP patients.

11:06 ***537***. **Short Time T2 Variability of the Lumbar Intervertebral Disc – in Vivo MRI Study at 3 Tesla**

David Stelzeneder[1], Sabine Goed[1], Götz Hannes Welsch[1,2], Clemens Hirschfeld[1], Tatjana Paternostro-Sluga[3], Karin Pieber[3], Klaus Friedrich[1], Michael Reisegger[1], Tallal Charles Mamisch[4], Siegfried Trattnig[1]

[1]Department of Radiology, MR Centre, Medical University of Vienna, Vienna, Austria; [2]Department of Trauma Surgery, University of Erlangen, Erlangen, Germany; [3]Department of Physical Medicine and Rehabilitation, Medical University of Vienna, Vienna, Austria; [4]Department of Orthopedic Surgery, University of Bern, Inselspital, Bern, Switzerland

The purpose of our study was to evaluate the short-time variability of T2 relaxation time values in the supine position in different compartments of the lumbar intervertebral disc. We performed a segmental analysis of two serial T2 mapping sequences obtained with a delay of 40 minutes. There was a significant T2 decrease in the anterior nucleus and an increase in the posterior annulus region. The data can be interpreted as a water shift from the anterior to the posterior compartments of the intervertebral disc, what can be a result of supine position with slight hip flexion.

11:18 ***538***. **Quantitative Evaluation of Diffusion Tensor Imaging at 3T in Human Lumbar Intervertebral Disc Degeneration**

Queenie Chan[1,2], Marina-Portia Anthony[2], Zhongping Zhang[2], Kenneth MC Cheung[3], Mina Kim[2]

[1]Philips Healthcare, Hong Kong, China; [2]Department of Diagnostic Radiology, The University of Hong Kong, Hong Kong, China; [3]Division of Spine Surgery, Department of Orthopaedics and Traumatology, Faculty of Medicine, The University of Hong Kong, Hong Kong, China

Detecting early stages of disc degeneration is a major challenge in degenerative disc disease (DDD) as current diagnostic techniques are not sensitive or completely objective. Therefore, a quantitative assessment of disc degeneration would significantly improve the evaluation of DDD. In this study, we examined diffusion tensor imaging (DTI) in human lumbar intervertebral discs (IVDs) to investigate changes in tissue microstructure. Our results show that fractional anisotropy can quantitatively assess 1) structural difference between a nucleus pulposus and an annulus fibrosus and 2) degenerative changes in IVDs, suggesting DTI may be a potential biomarker for DDD.

11:30 ***539***. **Assessment of Glycosaminoglycan Distribution in Human Lumbar Intervertebral Discs Using Chemical Exchange Saturation Transfer**

Mina Kim[1], Queenie Chan[2], Marina-Portia Anthony[1], Kenneth MC Cheung[3], Dino Samartzis[3], Tao Chan[1], Pek-Lan Khong[1]

[1]Department of Diagnostic Radiology, The University of Hong Kong, Pokfulam, Hong Kong, China; [2]Philips Healthcare, Hong Kong; [3]Division of Spine Surgery, Department of Orthopaedics and Traumatology, The University of Hong Kong, Hong Kong

Detecting early disc degeneration is of vital importance in order to identify subjects that are suitable for treatment. However, current diagnostic techniques are not sensitive to the early stages of intervertebral disc (IVD) degeneration, which involves the loss of proteoglycans. Recently, it has been suggested that glycosaminoglycan content can be quantified by chemical exchange saturation transfer (gagCEST). In the present work, we conducted gagCEST imaging for IVDs of human volunteers. Our results show that in vivo gagCEST quantification is feasible at 3 Tesla and may potentially be a useful clinical tool in identifying early degenerative changes in the human IVDs.

11:42 ***540***. **Ultra-Short Echo-Time (UTE) Imaging Based Estimation of Cortical Bone Stiffness**

Chamith S. Rajapakse[1], Hamidreza Saligheh Rad[1], Shing Chun Benny Lam[1], James Love[1], Jeremy F. Magland[1], Felix W. Wehrli[1]

[1]University of Pennsylvania School of Medicine, Philadelphia, PA, United States

It is well known that intracortical remodeling occurs resulting in increased porosity with advancing age and impaired strength. UTE MRI now offers the potential to estimate true bone tissue fraction as 1-BWF where BWF is bone water fraction. Here, we investigated the feasibility of estimating cortical bone stiffness in healthy volunteers using micro-finite-element analysis on the basis of BWF maps derived from UTE imaging. The preliminary results suggest that the incorporation of BWF to the FE analysis can enhance the assessment of mechanical competence of cortical bone in vivo compared to the mechanical and structural measures derived from conventional imaging.

11:54 ***541***. **Correlation of ^{1}H NMR Characteristics and Mechanical Properties in Human Cortical Bone**

R. Adam Horch[1,2], Jeffery S. Nyman[3,4], Dan F. Gochberg[1,5], Mark D. Does[1,2]

[1]Vanderbilt University Institute of Imaging Science, Vanderbilt University, Nashville, TN, United States; [2]Biomedical Engineering, Vanderbilt University, Nashville, TN, United States; [3]VA Tennessee Valley Healthcare System, Vanderbilt University, Nashville, TN, United States; [4]Orthopaedics & Rehabilitation Medicine, Vanderbilt University, Nashville, TN, United States; [5]Radiology and Radiological Sciences, Vanderbilt University, Nashville, TN, United States

The complex ^{1}H NMR behavior of human cortical bone can be attributed to distinct microanatomical proton environments in the bone matrix and pore spaces. Herein, the multiexponential ^{1}H transverse relaxation of human cortical bone was studied in conjunction with numerous mechanical properties relevant to overall bone integrity. Numerous NMR-mechanical correlations were observed, indicating links between cortical bone proton pools and bone health. These correlations allow bone mechanical properties to be predicted from NMR measurements and provide a contrast mechanism that MRI protocols could exploit as a novel bone health diagnostic.

12:06 ***542***. **Bone Water Concentration as a New Metric for Cortical Bone Quality**

Hamidreza Saligheh Rad[1], James Love[1], Jeremy F. Magland[1], Mary F. Leonard[2], Felix W. Wehrli[1]

[1]Laboratory for Structural NMR Imaging, Department of Radiology, University of Pennsylvania Health System, Philadelphia, PA, United States; [2]Nephrology, Children's Hospital of Philadelphia, Philadelphia, PA, United States

Increased porosity is a major cause of impaired strength of cortical bone. Ultra-short TE MRI has been shown to be able to quantify bone water, which is either collagen-bound or residing in the pores of the Haversian and lacuno-canalicular system. In this preliminary work we compare bone water concentration (BWC) in the tibial mid-shaft in a group of subjects with 3D bone mineral density (BMD) at the same location as well as areal BMD at the hip and spine. BWC is found to be inversely related to BMD at all sites and increasing with age.

12:18 ***543***. **SWIFT Versus X-Ray in Dental Imaging**

Djaudat Idiyatullin[1], Curt Corum[1], Steen Moeller[1], Hari S. Prasad[2], Michael Garwood[1], Donald R. Nixdorf[3]

[1]CMRR, University of Minnesota, Minneapolis, MN, United States; [2]Division of Oral Pathology in the Department of Diagnostic & Biological Sciences, University of Minnesota, Minneapolis, MN, United States; [3]Division of TMD & Orofacial Pain and Department of Neurology, University of Minnesota, Minneapolis, MN, United States

A comprehensive comparison of the traditional X-ray imaging modality versus to a novel magnetic resonance imaging (MRI) technique, called SWeep Imaging with Fourier Transform (SWIFT) in dental application (in-vitro) is presented. It is shown that the distinctive feature of SWIFT images is the visualization of the morphology of densely mineralized enamel and dentin simultaneous with dental caries and neurovascular architecture in the pulp. Additionally, fine structures that are normally difficult to detect with radiographs, such as cracks within the tooth and accessory canals can be identified in scanning time relevant for in-vivo applications. All conclusions supported with histology of teeth.

Parallel Imaging: Stretching the Limit

Room A6 10:30-12:30 *Moderators:* Ricardo Otazo and Jeffery Tsao

10:30 ***544***. **Fast MR Parameter Mapping Using K-T PCA**

Frederike Hermi Petzschner[1,2], Irene Paola Garcia Ponce[3], Martin Blaimer[4], Peter M. Jakob[3], Felix A. Breuer[4]

[1]Ludwig-Maximilians University, Institute of Clinical Neurosciences, Munich, Bavaria, Germany; [2]Bernstein Center for Computational Neurosciences, Munich, Germany, Germany; [3]University of Würzburg, Experimental Physics 5, Germany; [4]Research Center Magnetic Resonance Bavaria, Germany

In this work, k-t PCA is demonstrated to be a promising acceleration technique for MR relaxation measurements, since the dynamics along the relaxation curve can be described by only a small number of principal components. In-vivo IR-TrueFISP experiments for quantitative T1, T2 & M0 parameter mapping acquired with up to 8-fold acceleration by using the k-t PCA concept are presented.

10:42 ***545***. **k-T Group Sparse Reconstruction Method for Dynamic Compressed MRI**

Muhammad Usman[1], Claudia Prieto[1], Tobias Schaeffter[1], Philip G. Batchelor[1]

[1]King's College London, London, United Kingdom

Up to now, besides sparsity, the standard compressed sensing methods used in MR do not exploit any other prior information about the underlying signal. In general, the MR data in its sparse representation always exhibits some structure. As an example, for dynamic cardiac MR data, the signal support in its sparse representation (x-f space) is always in compact form. In this work, exploiting the structural properties of sparse representation, we propose a new formulation titled 'k-t group sparse compressed sensing'. This formulation introduces a constraint that forces a group structure in sparse representation of the reconstructed signal. The k-t group sparse reconstruction achieves much higher temporal and spatial resolution than the standard L1 method at high acceleration factors (9-fold acceleration).

10:54 ***546***. **Parallel Imaging Technique Using Localized Gradients (PatLoc) Reconstruction Using Compressed Sensing (CS)**

Fa-Hsuan Lin[1], Panu Vesanen[2], Thomas Witzel, Risto Ilmoniemi, Juergen Hennig[3]

[1]A. A. Martinos Center, Charlestown, MA, United States; [2]Helsinki University of Technology, Helsinki, Finland; [3]University Hospital Freiburg, Freiburg, Germany

The parallel imaging technique using localized gradients (PatLoc) system has the degree of freedom to encode spatial information using multiple surface gradient coils. Previous PatLoc reconstructions focused on acquisitions at moderate accelerations. Compressed sensing (CS) is the emerging theory to achieve imaging acceleration beyond the Nyquist limit if the image has a sparse representation and the data can be acquired randomly and reconstructed nonlinearly. Here we apply CS to PatLoc image reconstruction to achieve further accelerated image reconstruction. Specifically, we compare the reconstructions between PatLoc and traditional linear gradient systems at acceleration rates in an under-determined system.

11:06 ***547***. **Designing K-Space Trajectories for Simultaneous Encoding with Linear and PatLoc Gradients**

Daniel Gallichan[1], Gerrit Schultz[1], Jürgen Hennig[1], Maxim Zaitsev[1]

[1]University Hospital Freiburg, Freiburg, Germany

Recent work has shown that MR imaging can be performed using non-linear encoding gradients (PatLoc). Here we investigate the possibilities of combining non-linear encoding gradients with simultaneous use of the conventional linear gradients. We introduce the concept of a 'local k-space' to compare trajectories, as well as presenting a combination of a split-radial 4D trajectory which is able to exploit the advantages of varying spatial resolution across the FoV whilst retaining control over the resolution in the centre.

11:18 ***548***. **A Time-Efficient Sub-Sampling Strategy to Homogenise Resolution in PatLoc Imaging**

Hans Weber[1], Daniel Gallichan[1], Gerrit Schultz[1], Jürgen Hennig[1], Maxim Zaitsev[1]

[1]University Hospital Freiburg, Dept. of Diagnostic Radiology, Medical Physics, Freiburg, Germany

Varying spatial resolution is one of the characteristic properties of MR imaging when using nonlinear gradient fields for spatial encoding, as realised by PatLoc. In the particular configuration of two orthogonal quadrupolar encoding fields, voxel size is inversely proportional to the distance to the FOV centre. In this work we present an iterative reconstruction method for sub-sampled PatLoc data that improves the local resolution at the centre and leads to shorter scan times for equivalent central resolution recovery. The method is demonstrated on simulated and experimentally acquired data.

11:30 ***549***. **An Assessment of O-Space Imaging Robustness to Local Field Inhomogeneities**

Jason P. Stockmann[1], R Todd Constable[2]

[1]Biomedical Engineering, Yale University, New Haven, CT, United States; [2]Diagnostic Radiology, Neurosurgery, and Biomedical Engineering, Yale University, New Haven, CT, United States

O-Space imaging permits highly-accelerated acquisitions using non-linear gradients to extract extra spatial encoding from surface coil profiles as compared with linear gradients. For accurate reconstruction to occur, however, the curvilinear frequency contours created by the gradients must intersect one another at the appropriate locations, making the technique potentially vulnerable to local field inhomogeneity, such as the susceptibility gradients arising in the head near the sinuses. This work shows that with appropriate regularization, O-Space imaging is robust to typical levels of field inhomogeneity. Field inhomogeneity is shown to manifest itself as noise-like artifacts throughout the FOV rather than gross geometric distortion.

11:42 ***550***. **Highly Accelerated Multislice Parallel Imaging: Cartesian Vs Radial**

Stephen R. Yutzy[1], Nicole Seiberlich[2], Jeffrey L. Duerk[1,2], Mark A. Griswold[2]
[1]Biomedical Engineering, Case Western Reserve University, Cleveland, OH, United States; [2]Radiology, University Hospitals of Cleveland and Case Western Reserve University, Cleveland, OH, United States

Multiband imaging allows for multiple simultaneously acquired slices, thus giving an SNR benefit over conventional slice selection without potential artifacts from secondary phase encoding. While methods have been shown that can separate the slides using parallel imaging for Cartesian trajectories, these methods are not compatible with non-Cartesian sampling. Here we demonstrate the possibility of reconstructing two simultaneously acquired radial slices using an acquisition/reconstruction method known as radial CAIPIRINHA. We show that this method is capable of higher accelerations than possible with comparable Cartesian trajectories.

11:54 ***551***. **Blipped CAIPIRHINA for Simultaneous Multi-Slice EPI with Reduced G-Factor Penalty**

Kawin Setsompop[1,2], B A. Gagoski[3], J Polimeni[1,2], T Witzel[1], V J. Wedeen[1,2], L L. Wald[1,2]
[1]Radiology, A. A. Martinos Center for Biomedical Imaging, Massachusetts General Hospital, Charlestown, MA, United States; [2]Harvard Medical School, Boston, MA, United States; [3]EECS, Massachusetts Institute of Technology, Cambridge, MA, United States

The acquisition of simultaneous slices in EPI has the potential to increase the temporal sampling rate of fMRI or the number of diffusion directions obtained per unit time in diffusion imaging. In this work, we introduced a blipped CAIPIRINHA technique applicable to EPI acquisition and demonstrated its associated low g-factor penalty and 3x acceleration of the slices per second of acquisition. 3x slice-accelerated SE-EPI was acquired with retain SNR of close to unity. The 3x blipped CAIPIRINHA was also combined with 2x Simultaneous Image Refocusing (SIR) acquisition to create 6 simultaneous multi-slice GE-EPI acquisition with low g-factor penalty.

12:06 ***552***. **SNR Quantification with Phased-Array Coils and Parallel Imaging for 3D-FSE**

Charles Qingchuan Li[1], Weitian Chen[2], Philip J. Beatty[2], Anja C. Brau[2], Brian A. Hargreaves[1], Reed F. Busse[3], Garry E. Gold[1]
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Current clinical MRI techniques often employ parallel imaging, partial Fourier and multicoil acquisition to decrease scan time while maintaining image quality. To aid in image quality assessment, image noise statistics can be measured by reconstructing noise-only acquisitions through an identical linear pipeline as signal data, which may involve signal data-dependent steps such as parallel imaging, partial Fourier homodyne and multichannel reconstructions. In this study it was shown that SNR and CNR measurements performed in 146 clinical knee MRIs using this quantification method significantly differ from the measurements obtained using the traditional foreground and background volume of interest approach.

12:18 ***553***. **A Mathematical Model Toward Quantitative Assessment of Parallel Imaging Reconstruction**

Yu Li[1], Feng Huang[1], Wei Lin[1], Arne Reykowski[1]
[1]Advanced Concept Development, Invivo Diagnostic Imaging, Gainesville, FL, United States

In this work, we propose a mathematical model that gives explicit representations for three different types of errors in parallel imaging reconstruction. These errors have different patterns in image space and affect the image quality in different fashions. This model offers a tool to extensively investigate how to quantitatively assess imaging quality beyond signal to noise ratio. Based on the proposed model, practical reconstruction techniques can be developed to suppress three types of errors to different degrees for improved overall imaging performance.

Advances in Liver MRI & New Contrast Media

Room A7 10:30-12:30 *Moderators:* Daniel T. Boll and Bachir Taouli

10:30 **Introduction**

Scott B. Reeder

10:54 ***554***. **Hepatic MR Imaging for Differentiation of Biopsy-Proven Steatosis, Iron Deposition, and Combined Disease: One-Dimensional in / Opposed Phase Analysis Vs. Two-Dimensional Computer-Aided Dixon Discrimination**

Mustafa Rifaat Bashir[1], Elmar Max Merkle[1], Daniel Tobias Boll[1]
[1]Radiology, Duke University Medical Center, Durham, NC, United States

Steatosis hepatis functions as an inducer of hepatic iron metabolism dysregulation. MR two-point Dixon T1w imaging with subsequent comprehensive four-phase decomposition analysis facilitated not only metabolite decomposition of intrahepatic lipids and iron ions in steatosis hepatis and hepatic iron overload, but also allowed decomposition of metabolites in combined disease in an in-vivo patient population employing manual as well as computer-aided two-dimensional metabolite discrimination algorithms, with liver biopsy functioning as reference standard.

11:06 ***555***. **Simultaneous Measurement of Hepatic Lipid and Iron with High-Speed T2-Corrected Single-Voxel Spectroscopy (HISTO): Analysis of Water-Lipid Compartments**

Puneet Sharma[1], Hiroumi D. Kitajima[1], Khalil N. Salman[2], Bobby Kalb[3], Diego R. Martin[3]
[1]Radiology, Emory Healthcare, Atlanta, GA, United States; [2]Radiology, Emory University, Atlanta, GA, United States; [3]Radiology, Emory University School of Medicine, Atlanta, GA, United States

This investigation analyzes use of a fast T2-corrected MRS method (HISTO) for the simultaneous measurement of hepatic lipid and iron. The multi-echo acquisition allows correction of lipid fraction, while providing R2 measures of water and lipid separately. HISTO was performed in lipid phantoms with variable iron content, and in 3 patients with induced iron susceptibility. It was found that R2-water exhibited strong correlation with iron amount, while R2-lipid showed no dependence, suggesting compartmental division of iron effects. Since imaging evaluates bulk R2*, correlation with iron may be influenced by lipid content. HISTO isolates R2-water and R2-lipid for robust iron assessment.

11:18 ***556***. **Preliminary Clinical Experience with a Multiecho 2-Point DIXON (MDIXON) Sequence at 3T as an Efficient Alternative for Both the SAR-Intensive Acquired In- And Out-Of-Phase Chemical Shift Imaging as Well as for 3D Fat-Suppressed T1-Weighted Sequences Used**

Thomas G. Perkins[1], Jeremy L. Van Tilburg[2], Gwenael Herigault[3], Holger Eggers[4], Adri Duijndam[3], Gabriele Beck[3], Shahid M. Hussain, [2,5]
[1]Philips Healthcare, Cleveland, OH, United States; [2]The Nebraska Medical Center, Omaha, NE, United States; [3]Philips Healthcare, Best, Netherlands; [4]Philips Research, Hamburg, Germany; [5]The University of Nebraska Medical Center, Omaha, NE, United States

Body MRI protocols at 3T are often lengthy due to decreased duty cycle, high SAR, and general inefficiencies of the sequences used. This study (n=22) assessed a new sequence, 2-point mDIXON (mDIXON), which, like the original DIXON, can provide in-phase (IP), out-of-phase (OP), water, and fat images with increased duty cycle and better image quality compared to existing methods. New mDIXON is a more efficient alternative and can replace the existing 2D IP and OP as well as gadolinium-enhanced 3D T1-weighted (eTHRIVE) sequences. The new strategy based on mDIXON will lead to much shorter body MRI exam times at 3T.

11:30 ***557***. **Is There an Effect of Gd-EOB-DTPA on Hepatic T2 Signal Intensity and Apparent Diffusion Coefficient?**

Hersh Chandarana[1], Ely Felker[1], Bachir Taouli[1,2]
[1]Radiology, NYU Langone Medical Center, New York, NY, United States; [2]Radiology, Mount Sinai Medical Center, New York, NY, United States

Gd-EOB-DTPA is recently FDA approved liver-specific contrast agent which has shown potential in liver lesion detection and characterization when delayed (~ 20 min.) post-contrast imaging is performed. However, extending imaging protocol by 20 minutes is not convenient. One approach to decrease imaging time is to perform T2 (T2WI) and diffusion imaging (DWI) after contrast injection between equilibrium and delayed phases of enhancement. In this study, we evaluated effect of Gd-EOB-DTPA on liver and lesion signal intensity on T2WI and DWI and demonstrated minimal effect on liver T2 SI, and no significant change on liver and lesion apparent diffusion coefficient (ADC).

11:42 ***558***. **Gd-EOB-DTPA-Enhanced MRI in Cirrhotic Liver in Rats; with Reference to Transporter Activity and Morphological Change of Bile Canaliculi**

Natsuko Tsuda[1], Osamu Matsui[2]
[1]Bayer Yakuhin, Ltd, Osaka, Japan; [2]Kanazawa University Graduate School of Medical Science, Kanazawa, Japan

The purpose of this study was to analyze the difference of signal intensity on Gd-EOB-DTPA-enhanced MRI between normal and cirrhotic livers in rats in correlation with the expressions of the transporters of Gd-EOB-DTPA and the morphopathological change of bile canaliculi and to discuss the possible mechanisms of the signal profile of Gd-EOB-DTPA-enhanced MRI in cirrhotic livers. As a result, it was found that liver cirrhosis would interfere with the uptake of Gd-EOB-DTPA mediated by oatp1 and promote the elimination of Gd-EOB-DTPA mediated by mrp2. Therefore, the combination of oatp1 down-regulation and mrp2 up-regulation would lead to significant signal loss on Gd-EOB-DTPA-enhanced MRI. In addition to the up-regulation of mrp2, the morphological change in bile canaliculi and microvilli would have an impact on Gd-EOB-DTPA elimination.

11:54 ***559***. **Lesion Detectability on T2-Weighted Liver Imaging with Parallel RF Transmission at 3.0 Tesla: Intraindividual Comparison with Conventional MR Imaging.**

Guido Matthias Kukuk[1], Juergen Gieseke[1,2], Sebastian Weber[1], Frank Traeber[1], Jan Ullrich[1], Nuschin Morakkabati-Spitz[1], Daniel Thomas[1], Hans Heinz Schild[1], Winfried Albert Willinek[1]
[1]Department of Radiology, University of Bonn, Bonn, NRW, Germany; [2]Philips Healthcare, Best, Netherlands

High field MRI has introduced new challenges especially for body imaging with respect to B1 field non-uniformities. Parallel RF transmission allows for more homogeneous excitation, thus improving image quality especially for T2-weighted liver imaging at 3.0 Tesla. Therefore, we evaluated 52 patients in an intraindividual study design to determine the effect of parallel RF transmission on lesion detectability for T2-weighted imaging as compared to conventional MR imaging. Our data demonstrate a significantly higher detection rate of focal liver lesions using parallel RF transmission.

12:06 ***560***. **Respiratory Self-Gating for Free-Breathing Abdominal R2* Mapping**

Ning Jin[1], Andrew C. Larson[1,2]
[1]Departments of Radiology and Biomedical Engineering, Northwestern University, Chicago, IL, United States; [2]Robert H. Lurie Comprehensive Cancer Center, Chicago, IL, United States

Accurate R2* measurements are critical for a wide range of applications. Abdominal R2* mapping requires breath-holding (BH) to avoid respiratory motion artifacts. However, overall spatial resolution and slice coverage is limited by the requisite BH duration. We developed a respiratory self-gated (RSG)

imaging strategy for free-breathing abdominal R2* mapping. The purpose of our study was to compare conventional BH R2* measurements to FB RSG R2* measurements in the liver and kidneys. 3D RSG-mGRE effectively reduced respiratory motion induced artifacts and produced accurate FB R2* maps in the liver and kidneys.

12:18 ***561***. **Hemodynamics of Portal Hypertension with 4D Radial Phase Contrast Imaging: Feasibility at 3.0T**

Rakhee Wadhwa Verma[1], Kevin Johnson[2], Benjamin Landgraf[1], Alex Frydrychowicz[1], Christopher J. Francois[1], Oliver Wieben, [1,2], Scott B. Reeder[1,2]

[1]Radiology, University of Wisconsin-Madison, Madison, WI, United States; [2]Medical Physics, University of Wisconsin-Madison, Madison, WI, United States

Portal hypertension (PHTN) is a secondary complication in patients with cirrhosis and is associated significant morbidity, including varices and variceal bleeding, ascites, and portal venous thrombosis. The purpose of this study is to demonstrate the feasibility of high spatial resolution time resolved 3D radial phase contrast (PC) for evaluation of the hemodynamics of PHTN using a 32-channel phased array coil at 3.0T. The feasibility of comprehensive evaluation of the hemodynamics of PHTN is demonstrated in patients with cirrhosis.

Hyperpolarized Carbon-13 MR

Rooom A8 10:30-12:30 *Moderators:* Ferdia A. Gallaher and Sarah J. Nelson

10:30 ***562***. ***In Vivo* Pyruvate Dehydrogenase Flux Measured by Hyperpolarized Magnetic Resonance Correlates with *ex Vivo* Pyruvate Dehydrogenase Activity**

Michael Samuel Dodd[1,2], Helen J. Atherton[1], Marie A. Schroeder[1], Lisa C. Heather[1], Lowri E. Cochlin[1], Kieran Clarke[1], George K. Radda[1], Damian J. Tyler[1]

[1]Department of Physiology, Anatomy and Genetics, Oxford University, Oxford, Oxfordshire, United Kingdom; [2]Department of Cardiovascular Medicine, Oxford University, Oxford, Oxfordshire, United Kingdom

The recent advent of hyperpolarized ^{13}C-MRS has opened a new window on *in vivo* cardiac metabolism. The use of hyperpolarized [1-^{13}C]pyruvate has previously been shown to provide an *in vivo* measure of pyruvate dehydrogenase (PDH) flux, which directly correlates with disease severity. The aim of this work was to compare *in vivo* measurements of PDH flux with *ex vivo* measurements of PDH enzymatic activity. Using well established mechanisms for modulating PDH activity, we have shown that *in vivo* PDH flux, as measured by hyperpolarized ^{13}C MRS, significantly correlates with *ex vivo* PDH activity, as measured by well established biochemical assay.

10:42 ***563***. **Dynamic Interleaved Imaging of Hyperpolarized Metabolites for Lactate Dehydrogenase Kinetics**

Kevin Kai-Chi Leung[1,2], Albert Pofu Chen[3], Wilfred W. Lam[1], Angus Zoen Lau[1,2], Charles H. Cunningham[1,2]

[1]Imaging Research, Sunnybrook Health Sciences Centre, Toronto, Ontario, Canada; [2]Medical Biophysics, University of Toronto, Toronto, Ontario, Canada; [3]GE Healthcare, Toronto, Ontario, Canada

This abstract describes the use of spectral-spatial RF pulses and rapid flyback echo planar encoding techniques to acquire 13C images of pyruvate and lactate at high spatial and temporal resolution, upon the injection of hyperpolarized [1-13C]pyruvate into in vitro lactate dehydrogenase enzyme mixture and in vivo rat model. The comparable pyruvate-to-lactate conversion time course and fit to a two-pool kinetic model obtained with dynamic imaging and MR spectroscopy demonstrate the feasibility of mapping first order enzymatic conversion rates in heterogeneous tumors and tissue types non-invasively with hyperpolarized 13C MR imaging.

10:54 ***564***. **Hyperpolarized ^{13}C MR Spectroscopic Imaging of Disease State in a Switchable MYC-Oncogene Model of Liver Cancer**

Simon Hu[1], Asha Balakrishnan[2], Robert Bok[1], Peder E. Larson[1], Sarah J. Nelson[1], John Kurhanewicz[1], Andrei Goga[2], Daniel B. Vigneron[1]

[1]Dept. of Radiology and Biomedical Imaging, University of California, San Francisco, San Francisco, CA, United States; [2]Dept. of Medicine, Division of Hematology/Oncology, University of California, San Francisco, San Francisco, CA, United States

Development of hyperpolarized technology utilizing dynamic nuclear polarization has enabled the monitoring of ^{13}C metabolites *in vivo* at very high SNR. In this work, hyperpolarized ^{13}C 3D-MRSI was used to measure liver metabolism in mice after expression of the MYC proto-oncogene was switched on and then off in the liver. Mice in various disease stages were studied, and significant differences in hyperpolarized lactate and alanine levels were detected ($P < 0.01$). In addition, biochemical assays showed increased LDH expression and activity in the MYC-driven tumors.

11:06 ***565***. **Hyperpolarized [1-^{13}C]pyruvate and [1,4-^{13}C]fumarate Magnetic Resonance Spectroscopy Can Detect Response to the Vascular Disrupting Agent, Combretastatin-A4-Phosphate**

Sarah E. Bohndiek[1,2], Mikko I. Kettunen[1,2], De-en Hu[1,2], Timothy H. Witney[1,2], Ferdia A. Gallagher[1,2], Kevin M. Brindle[1,2]

[1]Department of Biochemistry, University of Cambridge, Cambridge, Cambridgeshire, United Kingdom; [2]Cancer Research UK Cambridge Research Institute, Cambridge, Cambridgeshire, United Kingdom

Hyperpolarization dramatically increases the sensitivity of the 13C magnetic resonance experiment, allowing the uptake and metabolism of hyperpolarized substrates to be followed in vivo. Vascular disrupting agents target the proliferating endothelial cells in tumour vasculature, so rarely cause tumour shrinkage. Our aim was to assess whether hyperpolarized [1-13C]pyruvate and [1,4-13C]fumarate magnetic resonance spectroscopy could detect response to

treatment with Combretastatin-A4-Phosphate within 24 hours of treatment and to compare these methods with data obtained by Dynamic Contrast Enhanced MRI (using Gd-DTPA) and Diffusion Weighted Imaging.

11:18 ***566***. **Imaging of Elevated Branched Chain Amino Acid Metabolism in Tumors with Hyperpolarized ^{13}C Ketoisocaproate**

Magnus Karlsson[1,2], Pernille Rose Jensen[1,2], Rene in 't Zandt[1,3], Georg Hansson[1], Anna Gisselsson[1,3], Jensen Duus[4], Sebastian Meier[4], Mathilde Hauge Lerche[1,2]

[1]Imagnia AB, Malmoe, Sweden; [2]Albeda Research Aps, Valby, Denmark; [3]Eijdo Research AB, Malmoe, Sweden; [4]Carslberg Research Center, Valby, Denmark

Hyperpolarized ^{13}C magnetic resonance (MR) spectroscopy has in many cases the potential to deliver the sensitivity and detailed spectral information to report on the chemical fate of tracer molecules in different tissues. In a preclinical study we here show that á-ketoisocaproic acid (KIC) can be used to assess molecular signatures of tumors using hyperpolarized MR spectroscopy. KIC is metabolized to leucine by the enzyme branched-chain aminotransferase (BCAT), which is a putative marker for metastasis and a target of the proto-oncogene *c-myc*.

11:30 ***567***. **Imaging of Blood Flow Using Hyperpolarized ^{13}C-Urea in Preclinical Murine Models**

Cornelius von Morze[1], Peder E. Larson[1], Simon Hu[1], Kayvan Keshari[1], David M. Wilson[1], Jan Henrik Ardenkjaer-Larsen[2], John Kurhanewicz[1], Daniel B. Vigneron[1]

[1]Department of Radiology and Biomedical Imaging, UCSF, San Francisco, CA, United States; [2]GE Healthcare, Hillerød, Denmark

We demonstrate regional imaging of blood flow in preclinical murine models with hyperpolarized (DNP) ^{13}C-urea. A bSSFP pulse sequence was developed, with progressively increasing flip angles for efficient sampling of the hyperpolarized magnetization. This allowed temporal and volumetric imaging at a spatial resolution of 2.5mm x 2.5mm x 8mm with a time resolution of 6 s. Regional signal dynamics were quantified, and estimates of relative blood flow to the kidneys and the liver were made. Differences were observed in blood flow patterns to normal and cancerous hepatic tissues. The blood flow maps were compared to results of metabolic maps of 1-^{13}C-pyruvate.

11:42 ***568***. **Detecting Response to Treatment in Human Breast Adenocarcinoma Using a Co-Administration of Hyperpolarized [1-^{13}C]pyruvate and [1,4-$^{13}C_2$]fumarate**

Timothy H. Witney[1,2], Mikko I. Kettunen[1,2], De-en Hu[1,2], Ferdia A. Gallagher[1,2], Kevin M. Brindle[1,2]

[1]Department of Biochemistry, University of Cambridge, Cambridge, Cambridgeshire, United Kingdom; [2]Cancer Research UK Cambridge Research Institute, Cambridge, Cambridgeshire, United Kingdom

In the current study, we used a co-administration of hyperpolarized [1-^{13}C]pyruvate and [1,4-$^{13}C_2$]fumarate as a sensitive marker of cell death in a model of human breast adenocarcinoma following treatment with a DNA damaging agent. The results show that a decrease in pyruvate - lactate exchange coincides with the induction of cell death in breast cancer cells both *in vitro* and *in vivo*, with an increase in fumarate - malate exchange shown to correlate to the onset of necrosis.

11:54 ***569***. **Analysis of Mitochondrial Metabolism in Cancer Cells by Combining Hyperpolarization and Isotopomer Analysis**

Crystal E. Harrison[1,2], Ralph J. DeBerardinis[3,4], Ashish K. Jindal[1], Chendong Yang[3], A Dean Sherry[1,5], Craig R. Malloy[1,6]

[1]Advanced Imaging Research Center, UT Southwestern, Dallas, TX, United States; [2]Physics, UT Dallas, Richardson, TX, United States; [3]Pediatrics, UT Southwestern, Dallas, TX, United States; [4]McDermott Center for Human Growth and Development, UT Southwestern, Dallas, TX, United States; [5]Chemistry, UT Dallas, Richardson, TX, United States; [6]Veterans Affairs, NorthTexas Health Care System, Dallas, TX, United States

While most research in cancer metabolism has focused on lactate formation (the Warburg effect), less is known about the mitochondrial pathways utilized during cell growth. Hyperpolarized [1-13C]-pyruvate provides insight into both the Warburg effect and mitochondrial metabolism, including activity of pyruvate dehydrogenase (PDH) and pyruvate carboxylase (PC). To combine the sensitivity of hyperpolarization with the precision of isotopomer analysis, we pre-incubated glioblastoma cells with [3-13C]-pyruvate prior to a short incubation with hyperpolarized [1-13C]-pyruvate. Using this technique, we observed real-time accumulation of hyperpolarized, 13C-labeled lactate and bicarbonate, and determined that the latter arose from the direct activity of PDH.

12:06 ***570***. **Investigating the Metabolic Effects of Heart Failure Progression *In Vivo* Using Hyperpolarized Magnetic Resonance**

Helen Jennifer Atherton[1], Michael S. Dodd[1], Carolyn A. Carr[1], Daniel J. Stuckey[1], Kieran Clarke[1], George K. Radda[1], Damian J. Tyler[1]

[1]Physiology, Anatomy and Genetics, University of Oxford, Oxford, Oxfordshire, United Kingdom

Using hyperpolarized magnetic resonance spectroscopy (MRS), we determined *in vivo* the temporal metabolic changes associated with heart failure progression post myocardial infarction (MI). Two weeks post MI, PDH flux was equivalent in failing and control hearts. In contrast levels of [1-^{13}C]citrate, [1-^{13}C]acetyl carnitine and [5-^{13}C]glutamate were reduced in infarcted hearts reflecting a perturbation in Krebs cycle metabolism. Reduced [1-^{13}C]lactate was also observed post MI indicating decreased glucose uptake and/or glycolysis. This study highlights the importance of assessing metabolism at multiple time points *in vivo*, and demonstrates the potential of hyperpolarized MRS for investigating the metabolic effects of progressive diseases.

12:18 ***571***. **Indirect Detection of Enzymatic Processes by Hyperpolarized NMR: Temporal Information, Enhanced Spectral Resolution and Slow Spin Relaxation**

Talia Harris[1], Patrick Giraudeau[1], Lucio Frydman[1]
[1]Chemical Physics, Weizmann Institute of Science, Rehovot, Israel

The outstanding sensitivity arising from ex situ DNP has triggered high expectations concerning the in vivo monitoring of metabolism and disease. So far such gains have materialized for experiments focusing on low-γ nuclei, whose relatively long T_1s enables them to withstand the transfer from the cryogenic hyperpolarizer to the reacting centers of interest. This study demonstrates that, when suitably merged with spatially-encoded methods, also indirectly-detected ^{1}H NMR spectroscopy can be exploited in time-resolved hyperpolarized analyses. The principles and opportunities opened by this approach are exemplified by Choline's phosphorylation by Choline Kinase, and by Acetylcholine's hydrolization by Acetylcholine Esterase.

HARDI & Tissue Characterization

Room A9 10:30-12:30 *Moderators:* Cristina Granziera and Geoffrey J.M. Parker

10:30 ***572***. **Reduced Encoding Persistent Angular Structure**

Andrew Sweet[1], Daniel C. Alexander[1]
[1]Department of Computer Science, University College London, London, United Kingdom

Persistent angular structure (PAS) MRI is a method that recovers complex white matter fibre configurations within single voxels of high angular resolution diffusion MRI (HARDI) data. It continues to exhibit impressive performance in comparison to other state of the art methods, but at the expense of a longer computation time. Here, we introduce a reduced encoding representation that cuts this computation time to around a quarter of its original value, while retaining performance on synthetic data. Minor differences between the reduced and original encoding are observed in real brain data, but do not necessarily represent decreased performance.

10:42 ***573***. **Estimating the Number of Fiber Orientations in Diffusion MRI Voxels: A Constrained Spherical Deconvolution Study**

Ben Jeurissen[1], Alexander Leemans[2], Jacques-Donald Tournier[3], Derek K. Jones[4], Jan Sijbers[1]
[1]Visionlab, University of Antwerp, Antwerp, Belgium; [2]Image Sciences Institute, University Medical Center Utrecht, Utrecht, Netherlands; [3]Brain Research Institute, Florey Neuroscience Institutes (Austin), Melbourne, Victoria, Australia; [4]CUBRIC, School of Psychology, Cardiff University, Cardiff, United Kingdom

Recent advances of high angular resolution diffusion imaging allow the extraction of multiple fiber orientations per voxel and have spawned an interest for classification of voxels by the number of fiber orientations. In this work, we estimated the number of fiber orientations within each voxel using the constrained spherical deconvolution method with the residual bootstrap approach. We showed that multiple-fiber profiles arise consistently in various regions of the human brain where complex tissue structure is known to exist. Moreover, we detect voxels with more than two fiber orientations and detect a much higher proportion of multi-fiber voxels than previously reported.

10:54 ***574***. **Can Spherical Deconvolution Give Us More Information Beyond Fibre Orientation? Towards Novel Quantifications of White Matter Integrity**

Flavio Dell'Acqua[1], Andrew Simmons[1], Steven Williams[1], Marco Catani[1]
[1]Centre for Neuroimaging Sciences, Institute of Psychiatry, King's College London, London, United Kingdom

In recent years Spherical Deconvolution methods have been applied to diffusion imaging to improve the visualization of multi-fibre orientation in brain regions with complex white matter organization. However, the potential to quantify white matter integrity with SD has not been explored. In this study we show that assuming a fibre response function based on a restricted diffusion model may lead to a better interpretation of spherical deconvolution results, relaxing the requirement of an exact knowledge of the fibre response and possibly help the development of new fibre specific indices of white matter integrity.

11:06 ***575***. **Apparent Fibre Density: A New Measure for High Angular Resolution Diffusion-Weighted Image Analysis**

David Raffelt[1,2], Stuart Crozier[2], Alan Connelly[3,4], Olivier Salvado[1], J-Donald Tournier[3,4]
[1]The Australian E-Health Research Centre, CSIRO, Brisbane, QLD, Australia; [2]Department of Biomedical Engineering, University of Queensland, Brisbane, QLD, Australia; [3]Brain Research Institute, Florey Neuroscience Institutes (Austin), Melbourne, VIC, Australia; [4]Department of Medicine, University of Melbourne, Melbourne, VIC, Australia

Apparent Fibre Density is a new measure that is based on information provided by Fibre Orientation Distributions. Voxel wise comparisons of Apparent Fibre Density can be made over all orientations permitting differences to be attributed to a single fibre within voxels with multiple fibre populations.

11:18 ***576***. **Dependence of Axon Diameter Index on Maximum Gradient Strength**

Tim B. Dyrby[1], Penny L. Hubbard[2], Maurice Ptito[3], Matt G. Hall[4], Daniel C. Alexander[4]
[1]Danish Research Centre for Magnetic Resonance, Copenhagen Univerviersity Hospital, Hvidovre, Denmark; [2]Imaging Science and Biomedical Imaging, University of Manchester, Manchester, United Kingdom; [3]School of Optometry, University of Montreal, Montreal, Canada; [4]Centre for Medical Image Computing, University College London, London, United Kingdom

We aimed to elucidate the dependence of the axon diameter index on the maximum available gradient strength (G_{max}). Optimised protocols were produced that were sensitive to a-priori axon diameters of 1, 2 and 4 μm for G_{max} = 60, 140, 200 and 300mT/m, and data were acquired on fixed monkey brain. The mapped axon diameter index was sensitive to G_{max} but relatively constant for >140mT/m. Simulations suggest that at low G_{max} (60mT/m), axon diameters <3μm are indistinguishable, which explains the unexpectedly high values at low G_{max}.

11:30 ***577***. **The Analytic Distribution of Fractional Anisotropy in Diffusion MRI**

Leigh A. Johnston[1,2], Adel Foda[2], Michael J. Farrell[2,3], Gary F. Egan[2,3]

[1]School of Engineering & NICTA VRL, University of Melbourne, Melbourne, VIC, Australia; [2]Howard Florey Institute, Florey Neuroscience Institutes, Melbourne, VIC, Australia; [3]Centre for Neuroscience, University of Melbourne, Melbourne, VIC, Australia

Statistical analyses of fractional anisotropy images in diffusion MRI studies are traditionally approached using parametric tests, under Gaussianity assumptions, or nonparametric resampling techniques. We present an analytic form for the distribution of FA, both for Gaussian distributed tensor eigenvalues for which FA follows a transformed doubly noncentral beta distribution, and a generalisation to arbitrary eigenvalue distributions. These powerful result permits application of valid inference statistical tests to FA maps in all experimental conditions.

11:42 ***578***. **Probabilistic Quantification of Regional Cortical Microstructural Complexity**

Hamied Ahmad Haroon[1,2], Richard J. Binney, [2,3], Geoff J M Parker[1,2]

[1]Imaging Science and Biomedical Engineering, School of Cancer and Imaging Sciences, The University of Manchester, Manchester, England, United Kingdom; [2]The University of Manchester Biomedical Imaging Institute, The University of Manchester, Manchester, England, United Kingdom; [3]Neuroscience and Aphasia Research Unit, School of Psychological Sciences, The University of Manchester, Manchester, England, United Kingdom

Model-based residual bootstrapping applied to constrained spherical deconvolution analysis of HARDI provides probabilities of observing *n* fiber orientations in every voxel of the brain. We hypothesized that the distribution of these probabilities for each *n* within cortical and subcortical regions would reflect the varying underlying neural microstructural complexity associated with each. We show evidence supporting this hypothesis and show consistency between hemispheres and amongst a small group of healthy subjects. This may offer non-invasive sensitivity to cortical cytoarchitecture that may be useful in cortical parcellation and in the identification of cortical lesions.

11:54 ***579***. **The FA Connectome: A Quantitative Strategy for Studying Neurological Disease Processes**

Stephen Rose[1,2], Kerstin Pannek, [1,3], Olivier Salvado[4], Parnesh Raniga[4], Fusun Baumann[5], Robert Henderson[5]

[1]UQ Centre for Clinical Research, University of Queensland, Brisbane, Queensland, Australia; [2]Centre for Medical Diagnostic Technologies in Queensland, University of Queensland, Brisbane, Queensland, Australia; [3]Centre for Magnetic Resonance, University of Queensland, Brisbane, Queensland, Australia; [4]The Australian e-Health Research Centre, CSIRO, Brisbane, Queensland, Australia; [5]Neurology, Royal Brisbane and Women's Hospital, Brisbane, Queensland, Australia

Structural connectivity indices derived using diffusion based HARDI or q-ball imaging in conjunction with functional parcellation of the cortex from high resolution MRI, has provided insight into the anatomical conformation of many of the important neural networks in the living brain. We are developing the concept of the FA connectome, i.e. combining a measure of fractional anisotropy, a quantitative diffusivity metric that reflects the integrity of WM pathways, with the connectivity matrix. When applied to study Amyotrophic Lateral Sclerosis, this technique shows identifies a number of key corticomotor pathways with reduced mean FA compared to control participants.

12:06 ***580***. **Novel Spherical Phantoms for Q-Ball Imaging Under in Vivo Conditions**

Amir Moussavi[1], Bram Stieltjes[2], Klaus H. Fritzsche[3], Frederik B. Laun[4]

[1]Medical Physics in Radiology, German Cancer Research Center, Heidelberg, Germany; [2]Radiology, German Cancer Research Center, Heidelberg, Germany; [3]Medical Imaging and Biological Informatics, German Cancer Research Center, Heidelberg, Germany; [4]Medical Physics in Radiology, German Cancer Research Center, Heidelberg, Germany

Spherical shaped diffusion phantoms that mimic in vivo fiber crossings are presented. Two crossing angles (45° and 90°) and two packing types of the fibers in the crossing were realized (stacked and interleaved). The fractional anisotropy of individual fibers is can be adjusted between 0.52 and 0.95. High quality ODF maps with a voxel resolution of 2x2x5 mm^3 were acquired using a standard diffusion weighted echoplanar diffusion sequence. Thus, the presented phantoms allow for validity measurements of Q-ball imaging and reconstruction approaches.

12:18 ***581***. **A Diffusion Hardware Phantom Looking Like a Coronal Brain Slice**

Cyril Poupon[1], Laurent Laribiere[1], Gregory Tournier[1], Jeremy Bernard[1], Denis Fournier[1], Pierre Fillard[1], Maxime Descoteaux[2], Jean-Francois Mangin[1]

[1]CEA I2BM NeuroSpin, Gif-sur-Yvette, F91191, France; [2]Université de Sherbrooke, Sherbrooke, Quebec, Canada

Diffusion-weighted imaging has become an established technique to infer the micro-structure of the brain. Its more popular application, fiber tractography, is still the only possibility to infer in vivo the structural connectivity of the brain. Despite the plethora of tractography algorithms in the literature, it is almost impossible to validate them. In this work, we present a novel hardware phantom dedicated to the validation of HARDI models and tractography algorithms. Its geometry was designed to mimic a coronal slice location of a human brain, depicting a large set of specific configurations (crossings, kissings, splittings)

BRONZE CORPORATE MEMBER LUNCHTIME SYMPOSIUM
Bracco

Room A6 12:30-13:30 Moderator: Emanuel Kanal

Safety & Diagnostic Efficacy: Key Requisites For Successful MR Imaging

12:30 **MR Contrast Media Safety: the Requisites**
Emanuel Kanal, M.D.

12:42 **Improving Diagnostic Performance in Vascular Imaging**
J. Paul Finn, M.D.

12:54 **Improving Diagnostic Performance in MR Mammography**
Laura Martincich, M.D.

13:06 **Improving Diagnostic Performance in Pediatric Imaging**
Günther Schneider, M.D., Ph.D.

13:18 **Questions & Answers**
Emanuel Kanal, M.D.

Hot Topics: Emerging & Cross-Cutting Techniques in Pediatric Imaging

Room K1 13:30 15:30 *Organizers & Moderators*: Patricia Ellen Grant and Claudia M. Hillenbrand

EDUCATIONAL OBJECTIVES
Upon completion of this course participants should be able to:

- Identify the main issues related to basic clinical pediatric (neuro-) radiology and translational imaging research in children;
- Explain the basic steps and concepts associated with (a) cardiovascular MR planning and imaging, and (b) assessment of body organ integrity or disease (i.e., via perfusion and diffusion) in the pediatric population;
- Evaluate the progress in fetal and neonatal imaging and to explain progress in advanced neuroimaging;
- Demonstrate additional knowledge of clinically adaptable pediatric imaging strategies; and
- Transfer and implement optimized pediatric protocols in their clinical or research practice.

Part II: Hot Topics in Pediatric Imaging Outside the Brain

13:30 **Imaging of Congenital Cardiac Defects and MR Guided Planning Of Surgery**
Mark A. Fogel, M.D.

14:00 **Emerging Diffusion and Perfusion Techniques in Pediatric Body Imaging**
Shreyas S. Vasanawala, M.D., Ph.D.

14:30 **Assessment of Renal Function in Children**
Pierre-Hugues Vivier, M.D.

15:00 **Pediatric PET-MR**
Ruth Lim, M.D.

ARS Training

Room K2 13:30 15:30 *Moderator*: Walter Kucharczyk

Improving Your Educational Presentations: How to Use an Audience Response System

Session open to all registrants

The use of an Audience Response System (ARS) in educational presentations has been shown to increase knowledge retention, create a more effective learning environment through interactivity. We want our educational speakers to be able to make the most effective use of this increasingly popular technology in future meetings. This session is aimed at all educational speakers, and anyone else who would like to learn how to use an Audience Response System.

13:30 **Introduction**
Walter Kucharczyk

14:30 **Demonstration I**
Caroline Reinhold

14:45 **Demonstration II**
David A. Bluemke

Ischemic Heart Disease: What You See is What You Get

Room A4 13:30-15:30 *Moderators:* Andrew E. Arai and Jeanette Schulz-Menger

13:30 ***582***. **Integrating High Spatial-Resolution, 3D Whole-Heart Viability Imaging and Coronary MRA at 3Tesla**

Qi Yang[1], Kuncheng Li[1], Xiaoming Bi[2], Jing An[3], Heng Ma[1], Feng Huang[4], Renate Jerecic[3], Debiao Li[5]
[1]Radiology, Xuanwu Hospital,Capital Medical University, Beijing, China; [2]Siemens Medical Solutions; [3]Siemens Healthcare, MR Collaboration NE Asia; [4]Invivo Corporation; [5]Radiology, Northwestern University, Chicago, IL, United States

Previous contrast-enhanced whole-heart coronary MRA(CMRA) studies at 3.0T have shown high sensitivity and moderate specificity for the detection of stenosis in patients suspected of coronary artery disease (CAD). However, a major advantage of 3.0T contrast-enhanced CMRA is the potential to combine lumenographic information and associated myocardial viability in the same setting. The feasibility of integrating high spatial-resolution, 3D whole-heart viability imaging and coronary MRA at 3 Tesla has been evaluated in volunteer studies. No clinical results using this technique at 3T were available so far.

13:42 ***583***. **Three-Dimensional Stress Cardiac Magnetic Resonance Perfusion Imaging for the Detection of Coronary Artery Disease**

Robert Manka[1], Cosima Jahnke[2], Sebastian Kozerke[1], Viton Vitanis[1], Gerard Crelier[1], Rolf Gebker[2], Bernhard Schnackenburg[2], Peter Boesiger[1], Eckart Fleck[2], Ingo Paetsch[2]
[1]Institute for Biomedical Engineering, University and ETH Zurich, Zurich, Switzerland; [2]German Heart Institute Berlin

Dynamic 3D-CMR stress perfusion imaging provides high image quality and high diagnostic accuracy for the detection of significant coronary artery disease.

13:54 ***584***. **Fully Quantitative Perfusion Pixel Maps of First-Pass Contrast-Enhanced MRI for Coronary Artery Disease Detection: A Preliminary Evaluation in Patients**

Li-Yueh Hsu[1], Peter Kellman[1], Hui Xue[2], Jens Guehring[2], Sven Zuehlsdorff[3], Sujata M. Shanbhag[1], W Patricia Bandettini[1], Marcus Y. Chen[1], Andrew E. Arai[1]

[1]Laboratory of Cardiac Energetics, National Heart Lung and Blood Institute / NIH, Bethesda, MD, United States; [2]Imaging and Visualization, Siemens Corporate Research, Princeton, NJ, United States; [3]CMR Research and Development, Siemens Medical Solutions, Chicago, NJ, United States

In this study we present an automated approach for generating fully quantitative myocardial blood flow (MBF) pixel maps from first-pass contrast-enhanced perfusion MR images. The results of the MBF pixel maps were evaluated in patients with known or suspected coronary artery disease and correlated with coronary angiography. Our results show that the performance of MBF pixel maps is comparable to clinical interpretation. This automated approach shows the feasibility of quantitative perfusion imaging for coronary artery disease detection.

14:06 ***585***. **Free-Breathing, Black-Blood Cardiac Imaging Using Single-Shot BSSFP Sequence: A Feasibility Study**

Xiaoming Bi[1], Jingsi Xie[2], Christopher Glielmi[1], James Carr[2], Debiao Li[2], Sven Zuehlsdorff[1]

[1]Siemens Healthcare, Chicago, IL, United States; [2]Northwestern University, Chicago, IL, United States

The goal of this work was to 1) investigate the feasibility of free-breathing BB cardiac imaging using a single-shot bSSFP sequence; 2) compare the efficacy of two BB methods: double inversion recovery (DIR) and T2IR for this application. Parameters for DIR and T2IR were optimized based on numerical simulations. Volunteer studies show that good quality 2D cardiac images can be consistently acquired with effective blood suppression. DIR preparation results in images with higher SNR and CNR while T2IR provides effective blood nulling regardless of blood flow direction at the cost of myocardium signal intensity.

14:18 ***586***. **Balanced Steady-State Free Precession Magnetic Resonance Images Edema in Acute Reperfused Myocardial Infarction – a Translational Study in Animals and Humans**

Andreas Kumar[1], Nirat Beohar[2], Jain Mangalathu Arumana[3], Debiao Li[3], Matthias G. Friedrich[1], Rohan Dharmakumar[3]

[1]Stephenson CMR Centre, University of Calgary, Calgary, AB, Canada; [2]Dept. of Cardiology , Northwestern University, Chicago, IL, United States; [3]Dept. of Radiology, Northwestern University, Chicago, IL, United States

We assessed the role of balanced steady-state free precession magnetic resonance for imaging of myocardial edema in acute reperfused myocardial infarction. In an experimental animal model as well as in patients with ST-elevation myocardial infarction, we found a close correlation of hyperintense b-SSFP signal areas with T2-STIR as a reference standard. Contrast-to-noise was not different between both sequences, and the area of b-SSFP hyperintensity was consistently larger than the area of irreversible injury on late contrast enhancement, consistent with b-SSFP reflecting the area-at-risk in acute ischemia-reperfusion injury. B-SSFP may evolve as a novel approach for myocardial edema imaging.

14:30 ***587***. **Myocardial T_2 Using Single-Shot Turbo Spin Echo: Regional Trends in Healthy Controls and Myocardial Infarction**

Kelvin Chow[1], Jacqueline A. Flewitt[2,3], Jordin D. Green[4], Matthias G. Friedrich[2,3], Richard B. Thompson[1]

[1]Biomedical Engineering, University of Alberta, Edmonton, Alberta, Canada; [2]Cardiac Sciences, University of Calgary, Calgary, Alberta, Canada; [3]Radiology, University of Calgary, Calgary, Alberta, Canada; [4]Siemens Healthcare, Calgary, Alberta, Canada

A modified single-shot turbo spin echo (HASTE) sequence was used to generate quantitative T_2 maps in a single breath-hold per slice. Whole heart T_2 maps (3 short-axis slices) for a population of healthy subjects show regional variations in T_2, with increased values at the apex and decreased values on the lateral wall of the basal slice. T_2 maps for a patient with acute myocardial infarction shows elevated T_2 in inferoseptal regions overlapping with occluded artery perfusion territory and regions of late gadolinium enhancement. 11 patients showed abnormal (mean + 3SD) T_2 in 33% of regions.

14:42 ***588***. **Heterogeneous Tissue Injury After AF Ablation Defined by LGE MRI**

Christopher John McGann[1], Eugene Kholmovski, Joshua Blauer, Akram Shaaban, Brent Wilson, Josh Bertola, Carl Bohman, Edward DiBella, Rob MacLeod, Dennis Parker, Nassir Marrouche

[1]Cardiology and Radiology, University of Utah Health Sciences Center, Salt Lake City, UT, United States

Late gadolinium enhancement (LGE) weeks to months post atrial fibrillation ablation injury shows left atrial (LA) wall enhancement due to scarring. LGE imaging has proven useful in guiding repeat procedures by identifying regions of viable tissue and incomplete pulmonary vein isolation. Here we show heterogeneous LA tissue injury immediately post ablation with non-enhancing regions on LGE imaging. These imaging findings have not previously been described and may be useful to further define tissue injury caused by RF energy delivery and help predict late scarring.

14:54 ***589***. **Cardiac Fat -Water Imaging: Early Experience and Clinical Utility**

Mark L. Schiebler[1], Karl K. Vigen[2], Christopher J. Francois[2], Scott K. Nagle[2], Ann Shimikawa[3], Hanzhou Yu[3], Jean H. Brittain[4], Scott B. Reeder[2]

[1]Radiology, UW Madison , Madison, WI, United States; [2]Radiology, UW Madison, Madison, WI, United States; [3]Applied Science Lab, General Electric, Menlo Park, CA, United States; [4]Applied Science Lab, General Electric, Madison, WI, United States

Cardiac imaging with fat water separation is useful in defining a number of cardiac and extracardiac disorders:pericarditis, mediatstinal masses, and myocardial viability all show improved detection with fat water separation techniques.

15:06 ***590***. **Accurate Left Ventricular Chamber Quantification Is Feasible Using Cardiovascular Magnetic Resonance at 7T**

Florian von Knobelsdorff-Brenkenhoff[1,2], Tobias Frauenrath[3], Marcel Prothmann[2], Matthias Dieringer[2,3], Fabian Hezel[3], Wolfgang Renz, [3,4], Kerstin Kretschel[1,2], Thoralf Niendorf, [2,3], Jeanette Schulz-Menger[1,2]

[1]Franz-Volhard-Klinik for Cardiology, HELIOS Klinikum Berlin, Berlin, Germany; [2]Experimental and Clinical Research Center (ECRC), Charité Campus Buch, Humboldt-University, Berlin, Germany; [3]Berlin Ultrahigh Field Facility, Max-Delbrueck Center for Molecular Medicine, Berlin, Germany; [4]Siemens Healthcare Sector, Erlangen, Germany

We explored the feasibility to accurately assess left ventricular (LV) dimensions and function at 7T by using 2D FGRE cine imaging and comparing the results to SSFP at 1.5T as the current gold standard. FGRE at 7.0T provided excellent blood/myocardium contrast and LV parameters with close agreement to SSFP. Thus, the combination of small slice thickness (4mm) and ultrahigh field together wit local TX/RX coils facilitated a sufficient SNR and CNR, which holds the promise for accurate functional cardiac imaging at 7T.

15:18 ***591***. ***In Vivo* Cardiac MR Elastography in a Single Breath Hold**

Arunark Kolipaka[1], Philip A. Araoz[1], Kiaran P. McGee[1], Armando Manduca[1], Richard L. Ehman[1]

[1]Radiology, Mayo Clinic, Rochester, MN, United States

Current implementations of cardiac MRE are slow and require multiple breath holds to collect the data required for processing. This work shows an optimized MR elastography (MRE) acquisition strategy capable of obtaining 4 wave images of one polarization of motion in the diastolic and systolic phases of the cardiac cycle, each in one breath hold. The phase-difference SNR and stiffness measurements of the myocardium are comparable in volunteers at end-diastole and end-systole. This technique is also capable of acquiring multiple phases of the cardiac cycle in one breath hold.

Advanced Imaging Techniques in Psychiatric Disorders

Room A5 13:30-15:30 *Moderators:* Gabriele R. Ende and Yukio Miki

13:30 ***592***. **In Vivo 3D Lithium MRI of the Human Brain**

Fernando Emilio Boada[1], Yongxian Qian[1], Ariel Gildengers[2], Mary Phillips[2], David Kupfer[2]

[1]MR Research Center, University of Pittsburgh, Pittsburgh, PA, United States; [2]Psychiatry, University of Pittsburgh, Pittsburgh, PA, United States

Bipolar Disorder (BPD) is a devastating mental illness that is often treated using Lithium Carbonate therapy. Unfortunately, lithium carbonate therapy has life-threatening side effects. Moreover, its mechanisms of action and preferred accumulation sites in the in vivo brain continue to be unknown sixty years after its original introduction. A methodology for studying the spatial distribution of lithium carbonate in the brain of BPD subjects could, therefore, be an invaluable tool for studying this disease. In this work we present the first demonstration of 3D lithium MRI in the in Vivo human Brain at 7 Tesla.

13:42 ***593***. **4T ^{7}Li MRSI in the Brains of Bipolar Disorder Subjects**

Jing-Huei Lee[1,2], Matthew M. Norris[1], Caleb M. Adler, [2,3], Elizabeth E. Macaluso[2], Wen-Jang Chu, [2,3], Richard A. Komoroski, [2,3], Stephen M. Strakowski, [2,3]

[1]Biomedical Engineering, University of Cincinnati, Cincinnati, OH, United States; [2]Center for Imaging Research, University of Cincinnati, Cincinnati, OH, United States; [3]Psychiatry, University of Cincinnati, United States

This work proposes and compares two approaches for ^{7}Li MRSI data analysis: Method I: 1D-3D vs. Method II: 3D-1D approach. The result shows that there is virtually no difference between these two approaches. However, Method I is preferred for use in future data analysis since it is simple in practice. Furthermore, this study is the first demonstration of the ^{7}Li distribution in the brain of bipolar patients who are on lithium therapy. The distribution is not uniform throughout the entire brain for all patients, which is unexpected. Further investigations are ongoing.

13:54 ***594***. **Decreased PHi and [ADP] in Anterior Cingulate Cortex of Bipolar Disorder: Further Evidence of Mitochondrial Dysfunction**

Jonathan Dudley[1], Wen-Jang Chu[2,3], Xin Wang[1], Matt Norris[1], Jing-Huei Lee[1,3]
[1]Biomedical Engineering, University of Cincinnati, Cincinnati, OH, United States; [2]Psychiatry, University of Cincinnati, Cincinnati, OH, United States; [3]Center for Imaging Research, University of Cincinnati, Cincinnati, OH, United States

The theory of mitochondrial dysfunction in bipolar disorder (BD) has been supported by numerous MRS studies. However, the absolute quantitation of phosphor metabolites in this disease has not been well studied. This work is to determine phosphor metabolite concentrations in the anterior cingulate cortex among different subject groups. The results were in concordance with the theory of mitochondrial dysfunction, showing a decrease in intracellular pH and [ADP] in manic and mixed BD patients relative to controls.

14:06 ***595***. **Metabolic Changes in Medication-Free Patients with Bipolar and Unipolar Disorder**

Ulrike Dydak[1,2], Jonathan M. Nixon[1], Mario Dzemidzic[3], Harish Sai Karne[4], Amit Anand[4]
[1]School of Health Sciences, Purdue University, West Lafayette, IN, United States; [2]Department of Radiology and Imaging Sciences, Indiana University School of Medicine, Indianapolis, IN, United States; [3]Department of Neurology, Indiana University School of Medicine, Indianapolis, IN, United States; [4]Department of Psychiatry, Indiana University School of Medicine, Indianapolis, IN, United States

Changes in brain metabolism were studied in medication-free patients with bipolar and unipolar disorder and compared to matched healthy controls. 2D MRSI data acquired in an axial slice including thalamus, anterior and posterior cingulate cortex (ACC & PCC) were analyzed using LCModel. Significant decreases in NAA/ creatine were found in bipolar patients compared to healthy controls in the right thalamus and right ACC. Furthermore, when comparing bipolar to unipolar patients, significant decreases in the choline/creatine ratio were observed in the right thalamus. No significant group differences were found in the PCC nor any of the left hemisphere regions of interest.

14:18 ***596***. **Dissociation of Anterior Cingulate Glutamate and Induced Theta EEG Activity in Schizophrenia.**

Antonio Napolitano[1], Kathrin Doege[2], Mallikarjun Pavan[2], Peter Liddle[2], Dorothee P. Auer[1]
[1]Academic Radiology, University of Nottingham, Nottingham, Nottinghamshire, United Kingdom; [2]Division of Psychiatry, University of Nottingham, United Kingdom

The glutamate hypothesis stimulated over the last two decades several MRS studies to research alterations of glutamate levels in schizophrenia. In this study, we used a combined EEG/MRS protocol to investigate whether prefrontal glutamate levels are altered in patients with early schizophrenia and whether there is an interrelation between glutamate and theta activity in schizophrenia.

14:30 ***597***. **Tissue Specific Changes in Brain Phosphodiesters in Late Life Major Depression**

David G. Harper[1,2], J. Eric Jensen,[2,3], Caitlin Ravichandran,[2,4], E. Yusuf Sivrioglu[5], Daniel Iosifescu[6,7], Perry Renshaw[8], Brent Forester,[29]
[1]Geriatric Psychiatry, McLean Hospital, Belmont, MA, United States; [2]Psychiatry, Harvard Medical School, Belmont, MA, United States; [3]Neuroimaging Center, McLean Hospital, Belmont, MA, United States; [4]Laboratory for Psychiatric Biostatistics, McLean Hospital, Belmont, MA, United States; [5]Psychiatry, Uludag University, Bursa, Turkey; [6]Psychiatry, Massachusetts General Hospital, Boston, MA, United States; [7]Psychiatry, Harvard Medical School, Boston, MA, United States; [8]Psychiatry, University of Utah, Salt Lake City, UT, United States; [9]Geriatric Psychiatry, Mclean Hospital, Belmont, MA, United States

Biological membranes serve numerous, essential cellular functions. MRI findings in late life depression include increased white matter hyperintensities and reduced fractional anisotropy as measured by diffusion tensor imaging suggesting that membrane integrity, especially in white matter, may be compromised. Phosphatidylethanolamine, in the inner mitochondrial membrane, serves an essential function and is synthesized via a unique pathway not involving phosphoethanolamine. We hypothesized that glycerophosphocholine (GPCho) and glycerophosphoethanolamine (GPEtn), particularly in white matter, will be increased in late-life depression, and we hypothesized that GPEtn will be altered fundamentally differently than GPCho due to the additional pathway of the inner mitochondrial membrane and that GPEtn would therefore show changes in gray matter.

14:42 ***598***. **^{1}H MRS Measurement of Brain Glutathione Supports Increased Oxidative Stress in Major Depressive Disorder**

Sanjay J. Mathew[1], Xiangling Mao[2], Sarah Pillemer[1], James W. Murrough[1], Dikoma C. Shungu[2]
[1]Psychiatry, Mount Sinai School of Medicine, New York, NY, United States; [2]Radiology, Weill Cornell Medical College, New York, NY, United States

A large body of anecdotal evidence now implicates increased oxidative stress in a number of pathophysiologic models of major depressive disorder (MDD). In this study, the first *in vivo* ^{1}H MRS measurements of the primary cellular antioxidant glutathione (GSH) were made in the occipital lobe of MDD patients and found to be significantly decreased compared to healthy control subjects, which supports the presence of increased oxidative stress in the disorder.

14:54 ***599***. **Evidence of Age Effects in Cortical Areas But Not in the Subcortex of ADHD Children: A Multi-Voxel *In Vivo* ^{31}P Spectroscopy Study at 4 Tesla**

Jeffrey A. Stanley[1], Dalal Khatib[1], Rachel M. Dick[1], Olivia A. McGarragle[1], Frank P. MacMaster[1], Vaibhav A. Diwadkar[1], Arthur L. Robin[1], David R. Rosenberg[1]
[1]Psychiatry and Behavioral Neurosciences, Wayne State University School of Medicine, Detroit, MI, United States

Attention Deficit Hyperactivity Disorder (ADHD) is a serious public health problem that affects between 3 to 9% of children and accounts for between 30 to 40% of child referrals to mental health services. While the cause of this illness remains poorly understood, ADHD is increasingly seen as a neurodevelopmental disorder. *In vivo* ^{31}P spectroscopy is a neuroimaging method that is sensitive in detecting biochemical changes as the brain develops. The purpose of this study is to provide further evidence of a developmental mechanism where early maldeveloped corticostriatal pathways may impact the maturational integration of prefrontal corticostriatal pathways in pediatric ADHD.

15:06 ***600***. **Disruption of Commissural White Matter Tracts in Pediatric Bipolar Disorder**

Hao Huang[1], Kirti Saxena[2], Annie Walley[2], Min Xu[1], Nancy Rollins[3]
[1]Advanced Imaging Research Center, University of Texas Southwestern Medical Center, Dallas, TX, United States; [2]Department of Psychiatry, University of Texas Southwestern Medical Center, Dallas, TX, United States; [3]Department of Radiology, University of Texas Southwestern Medical Center, Dallas, TX, United States

Identifying early signs of bipolar disorder is important because it may enable health care providers to intervene earlier and prevent progression of increased morbidity and personal dysfunction. Commissural tracts including corpus callosum (CC) and anterior commissure (AC) are the research target in this study. In our study, we acquired high resolution DTI from 10 pediatric bipolar patients and 10 age matched control subjects. We found that AC and anterior segment of CC has statistically smaller FA. Compared to DTI results of adult BP, the disruption pattern caused by BP demonstrates anterior to posterior pattern from childhood to adult.

15:18 ***601***. **Atypical Development of White Matter Microstructure in Adolescents with Autism Spectrum Disorders**

Kun-Hsien Chou[1], I-Yun Chen[2], Ya-Wei Cheng[2], Jean Decety[3], Yang-Teng Fan[2], Ching-Po Lin[2,4]
[1]Institute of Biomedical Engineering, National Yang-Ming University, Taipei, Taiwan; [2]Institute of Neuroscience, National Yang-Ming University, Taipei, Taiwan; [3]Departments of Psychology and Psychiatry, The University of Chicago, Chicago, United States; [4]Institute of Biomedical imaging and Radiological Sciences, National Yang-Ming University, Taipei, Taiwan

Autism spectrum disorders is a common brain developmental disorder that occurs in one in 150 children. It is characterized by early onset of impaired social reciprocity and communication difficulties, along with restricted interest and stereotyped behavior. Several brain morphometry studies suggested that cascade failure of neurodevelopment is the most likely the core deficit of ASD. But whether aberrant WM development persisted into later childhood and adolescence was a crucial issue to probe. The aim of the present study was to examine WM microstructure using diffusion tensor imaging (DTI) and to investigate its relations to age in adolescents with ASD.

Summits in Clinical Cardiovascular Applications: Practical Tricks for Cardiac MRI

Room A9 13:30 – 15:30 *Organizer*: Georg M. Bongartz

EDUCATIONAL OBJECTIVES
Upon completion of this course participants should be able to:

- Design appropriate scanning protocols for cardiac MR imaging;
- Describe the basic clinical indications for cardiac MRI;
- Discriminate among various cardiac diseases by their typical properties in MRI;
- Identify the pitfalls and challenges of the various cardiac MRI techniques; and
- Compare and optimally apply the pulse sequences used for cardiac perfusion, function, viability, and velocity imaging in MRI.

Moderators: **Victor A. Ferrari and Han Wen**

07:00 **Stress Perfusion**
Sven Plein, M.D.

13:50 **Viability**
Katherine C. Wu, M.D.

14:10 **Function**
Sandor Kovacs, M.D., Ph.D.

14:30 **Coronary Angiography**
Qi Yang, M.D.

14:50 **Phase Contrast Velocity Mapping**
Ann F. Bolger, M.D.

15:10 Panel Discussion

MR Physics & Techniques for Clinicians

Room K1 16:00 – 18:00 *Organizers & Moderators*: Marcus T. Alley and Michael Markl

EDUCATIONAL OBJECTIVES
Upon completion of this course participants should be able to:

- Define and describe the fundamental principles of MR imaging, including the definition of spin magnetization, the Larmor relationship, relaxation phenomena, and the process of using the spin magnetization to produce an image;
- Explain imaging pulse sequences based upon spin and gradient echoes, including fast spin-echo and echo planar techniques;
- Design MR imaging protocols for diagnostic applications considering image contrast, spatial resolution, acquisition time, signal-to-noise ratio, and artifacts; and
- Describe the principles of parallel imaging, high-field imaging, perfusion imaging, diffusion imaging, and functional MR imaging.

16:00 **Diffusion**
Christian Beaulieu, Ph.D.

16:40 **Perfusion**
Roland Bammer, Ph.D.

17:20 **fMRI**
Karla L. Miller, Ph.D.

Guess that Artifact! : Case-Based Teaching

Room K2 16:00 – 18:00 *Organizers & Moderators*: Mark A. Griswold and Harald H. Quick

EDUCATIONAL OBJECTIVES
Upon completion of this course participants should be able to:

- List and evaluate principle categories of artifacts;
- Explain sources of commonly encountered artifacts and methods to avoid them; and
- Recommend further tests for problem solving and troubleshooting artifacts.

A competition in the evaluation of MR artifacts.

16:00 **Game Show Format…**
Mark A. Griswold

16:00 **Game Show Format…**
Harald H. Quick

Structural & Functional Changes of the Brain with Age

Room A1 16:00-18:00 *Moderators:* Nicola de Stefano and Stefan Sammet

16:00 ***602***. **MR Elastography and MRI Volumetry of the Aging Brain**

Kaspar Josche Streitberger[1], Dagmar Krefting[2], Friedemann Paul[3], Dieter Klatt[1], Sebastian Papazoglou[1], Sebastian Hirsch[1], Jürgen Braun[2], Ingolf Sack[1]
[1]Institute of Radiology, Charité - University Medicine Berlin, Berlin, Germany; [2]Institute of Medical Informatics, Charité - University Medicine Berlin, Berlin, Germany; [3]Neurocure, Charité - University Medicine Berlin, Berlin, Germany

Physiological aging of the brain is accompanied by ubiquitous degeneration of neurons and oligodendrocytes. An alteration of the cellular matrix of an organ impacts its macroscopic viscoelastic properties, which are characterized by mechanical parameters such as stiffness and internal friction. To date Magnetic Resonance Elastography (MRE) is the only non-invasive technique for measuring the shear viscoelastic properties of living brain. This study compares the decrease of brain stiffness with years of age in normal volunteers observed by MRE with loss of brain volume found by MRI volumetry.

16:12 ***603***. **Structural Brain Changes Throughout Adulthood**

Antonio Giorgio[1,2], Luca Santelli[3], Valentina Tomassini[1], Rose Bosnell[1], Stephen M. Smith[1], Nicola De Stefano[2], Heidi Johansen-Berg[1]
[1]FMRIB Centre, University of Oxford, Oxford, United Kingdom; [2]Neurology and Neurometabolic Unit, University of Siena, Siena, Italy; [3]Department of Neuroscience, University of Padua Medical School, Padua, Italy

Normal ageing is associated with gradual deterioration of brain structures. However, there is mixed evidence over the precise time course and spatial distribution of change. We studied a group of 66 adults aged between 23 and 81 years using voxel-based morphometry (VBM)-style analysis and diffusion tensor imaging (DTI). We found widespread reductions in GM volume from middle age onwards but earlier reductions were detected in frontal cortex. WM decline was detected earlier (in young adulthood) and more sensitively using DTI-based measures of microstructure than using markers of WM volume derived from conventional T1-weighted imaging.

16:24 ***604***. **Voxel-Based Multiple Regression of Multimodal MRI: Applications to Physiological Aging**

Andrea Cherubini[1], Patrice Péran[1], Carlo Caltagirone[1], Gianfranco Spalletta[1]
[1]Santa Lucia Foundation, Rome, Italy

We explored for the first time with a voxel-based approach the simultaneous variation induced by physiological aging on four quantitative MR parameters sensitive to complementary tissue characteristics (VBM, T2* relaxometry, DTI). This allowed us to compare the performance of different predictors and to identify without a priori information the best biomarker of age-induced structural variation for each voxel. Our results showed that brain areas most affected by age are evenly distributed between white matter and grey matter. Moreover, the best quantitative predictors in most brain areas resulted to be iron deposition and microstructural damage rather than macroscopic atrophy of tissues.

16:36 ***605***. **White Matter Structural Correlates of Cognitive Performance in the Temporal Lobe Projections**

Efrat Sasson[1], Glen M. Doniger[2], Ofer Pasternak[3], Tal Gonen[4], Yaniv Assaf[5]
[1]Neurobiology department, Tel Aviv University, Tel Aviv, Israel; [2]Department of Clinical Science, NeuroTrax Corporation, Newark, NJ, United States; [3]Brigham and Women's Hospital, Harvard Medical School, Boston, MA, United States; [4]Psychology department, Tel Aviv University, Tel Aviv , Israel; [5]Neurobiology department, Tel Aviv University, Tel Aviv , Israel

In this study we used the inter-subject variability in different cognitive domains to relate cognitive performance and WM integrity in five temporal projections: the uncinate fasciculus, fornix, cingulum, inferior longitudinal fasciculus, and superior longitudinal fasciculus. Subjects were 51 healthy volunteers, 25-80 years, completed cognitive tests and were scanned using DTI and DTI tractography was performed. The fibers exhibiting substantial correlation with cognitive performance are known to play an important part in the corresponding functional domain. Using the methodology performed here, DTI tractography enables anatomical definition of region of interest for correlation analysis of any behavioral parameters with diffusion indices.

16:48 ***606***. **DTI, T2 Relaxation and Volumetry of the Human Brain Corpus Striatum Across the Lifespan**

Khader M. Hasan[1], Indika S. Walimuni[1], Humaira Abid[1], Larry A. Kramer[1], Richard E. Frye[2], Jack M. Fletcher[3], Linda Ewing-Cobbs[2]

[1]Diagnostic and Interventional Imaging, University of Texas Health Science Center at Houston, Houston, TX, United States; [2]Pediatrics, UTHSC, Houston, TX, United States; [3]Psychology, University of Houston, Houston, TX, United States

In this work, we report for the first time a comprehensive account of the macro and microstructure of these structures using a large cross-sectional healthy cohort across the healthy lifespan (N=281 males and females aged 6-68 years). We demonstrate using a validated novel DTI and atlas-based tissue segmentation approach that the MRI microstructural correlates of volume decrease of these structures bilaterally, in both men and women are a T2 relaxation that follows a U curve that is commensurate with a fractional ansiotropy increases with age and a U curve mean diffusivity. A strong correlation between T2 and mean, radial and axial diffusivities is also noted. The interplay between T2 relaxation and DTI metrics was also examined.

17:00 ***607***. **Longitudinal Age-Related Changes in Radial and Axial Diffusion Using Tract-Based Spatial Statistics**

Thomas Richard Barrick[1], Rebecca Anne Charlton[2], Ai Wern Chung[2], Christopher Alan Clark[3], Hugh Stephen Markus[2]

[1]Centre for Clinical Neuroscience, Saint George's, University of London, London, United Kingdom; [2]Centre for Clinical Neuroscience, Saint George's, University of London, United Kingdom; [3]Institute of Child Health, University College London, United Kingdom

The aim of this study is to use tract based spatial statistics to investigate local age-related white matter structural change on a voxel-by-voxel basis over a 2-year period. 74 middle-aged and elderly individuals were scanned at both time-points and fractional anisotropy, axial and radial diffusivity were measured. Significant increases in average radial diffusivity and decreases in FA were found throughout the white matter in contrast to greater variability in change (both increase and decrease) of axial diffusivity. This study is the first to investigate longitudinal change in axial and radial diffusivity with age.

17:12 ***608***. **Assessment of Age-Related Microstructural Changes in the Thalamus by Diffusional Kurtosis Imaging**

Maria Fatima Falangola[1,2], Caixia Hu[1], Vitria Adisetiyo[1], Ali Tabesh[1], Wende R. Gelb[1], Jens H. Jensen[1], Joseph A. Helpern[1,2]

[1]Radiology, New York University Langone Medical Center, New York, NY, United States; [2]2Center for Advanced Brain Imaging, Nathan Kline Institute, Orangeburg, NY, United States

The thalamus is a major subcortical relay station that filters incoming primary sensory input and modulates processed cortical information through reciprocal cortico-thalamic connections. Therefore, it is a key region for fronto-temporal communication and is crucial for modulating emotion and cognition in humans. We applied Diffusional Kurtosis Imaging (DKI) to investigate the age-related non-Gaussian patterns of microstructure change in the thalamus. The data presented here suggest that non-Gaussian metrics, particularly MK and Kra are the most useful in detecting developmental changes in the thalamus.

17:24 ***609***. **Quantitative Mapping of the Age-Dependence of Cerebral Blood Flow Using Pulsed Arterial Spin Labeling**

J. Jean Chen[1], H. Diana Rosas, [12], David H. Salat[1]

[1]A. A. Martinos Center for Biomedical Imaging, Massachusetts General Hospital, Harvard Medical School, Charlestown, MA, United States; [2]Department of Neurology, Massachusetts General Hospital, Harvard Medical School, Boston, MA, United States

Accurate measurement of regional cerebral blood flow (CBF) changes in aging using conventional techniques is hampered by low repeatability and partial-volume effects. In this work, we examine the feasibility of pulsed arterial-spin labelling in obtaining quantitative CBF maps in healthy adults, evaluating the impact of potential partial-volume effects and the robustness of calibration techniques. We observed cortical CBF decrease with healthy aging, with heightened reduction co-localizing with regions previously reported to exhibit decline in metabolism. These findings were independent of the choice of CBF calibration technique, and partial-volume effects were found to bias CBF in areas of significant cortical thinning.

17:36 ***610***. **Age and Gender Variations in T_1 Measurements of White and Grey Matter Structures Within the Human Brain at 7 T**

Peter Jonathan Wright[1,2], Olivier Mougin[1], Susan Pritchard[1], Eleanor Cox[1], Penny Gowland[1]

[1]SPMMRC, University of Nottingham, Nottingham, United Kingdom; [2]LMBRU, Leeds NHS, Leeds, West Yorkshire, United Kingdom

With the increasing life expectancy of humans in the developed world and neurological diseases such as Parkinson's becoming ever more prominent, a growing interest has emerged examining normal changes in brain tissue in later life. 30 healthy subjects between 40-80 years were scanned at 7 T using an MPRAGE sequence to measure T_1 recovery values in ROI of the brain. Significant age

variations were observed between grey matter, anterior and posterior white matter ($p = 0.02$) dominated by male subjects and splenium and genu of the corpus callosum ($p < 0.02$), dominated by female subjects.

17:48 ***611***. **Correlation of Change in Phase and R2* with Putative Iron Content in Deep Gray Matter of Healthy Adults**

Manju Liu[1], Mark E. Haacke[1], Charbel A. Habib[1], Yanwei Miao[2], Yashwanth Katkuri[1]
[1]Department of Radiology, Wayne State University, Detroit, MI, United States; [2]Department of Radiology, The First Affiliated Hospital, Dalian, Liaoning, China

In this project we applied a two region analysis to avoid this problem and to study not only iron increases but the overall area of iron content as a function of age.

Clinical Brain Tumor Imaging: Diagnosis to Prognosis

Victoria Hall 16:00-18:00 *Moderators:* Marco Essig and Meng Law

16:00 ***612***. **Spatially Quantifying Microscopic Tumor Invasion and Proliferation Using a Voxel-Wise Analytical Solution to a Glioma Growth Model and Serial Diffusion MRI**

Benjamin M. Ellingson[1,2], Scott D. Rand[1,2], Mark G. Malkin[1,3], Robert Prost[2], Jennifer M. Connelly[1,4], Pete S. LaViolette[1,5], Devyani P. Bedekar[1,2], Kathleen M. Schmainda[1,2]
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The objective of the current study was to develop a voxel-wise analytical solution to a glioma growth model using serial diffusion MRI in order to spatially map and quantify regions of microscopic tumor invasion and proliferation. Results demonstrate a strong correlation between proliferation rate and MR spectroscopic measurements of choline-to-N-acetylaspartate ratio. Proliferation rate and cell motility rates were shown to increase with increasing malignancy, as well as easily distinguish between radiation necrosis and recurrent tumor. This technique may be valuable for assessing tumor dynamics and predicting response to treatment in all types of cancers.

16:12 ***613***. **DCE MRI Derived Kep Is a Surrogate Marker of MMP-9 Expression in Patients with Glioblastoma Multiforme**

Rishi Awasthi[1], Nuzhat Husain[2], Priyanka Soni[2], Prativa Sahoo[3], Sanjay Behari[4], Shaleen Kumar[5], Rakesh Pandey[6], Ram Kishore Singh Rathore[3], Rakesh Kumar Gupta[1]
[1]Radiodiagnosis, Sanjay Gandhi Post Graduate Institute of Medical Sciences, Lucknow, Uttar Pradesh, India; [2]Pathology, Chhatrapati Shahuji Maharaj Medical University, Lucknow, UP, India, Lucknow, Uttar Pradesh, India; [3]Mathematics and Statistics, Indian Institute of technology Kanpur, Kanpur, Uttar Pradesh, India; [4]Neurosurgery, Sanjay Gandhi Post Graduate Institute of Medical Sciences, Lucknow, Uttar Pradesh, India; [5]Radiotherapy, Sanjay Gandhi Post Graduate Institute of Medical Sciences, Lucknow, Uttar Pradesh, India; [6]Pathology, Sanjay Gandhi Post Graduate Institute of Medical Sciences, Lucknow, Uttar Pradesh, India

DCE-MRI was performed on 17 patients with Glioblastoma multiforme (GBM). Various perfusion metrics were analyzed and correlated with immunohistochemically obtained MMP-9 expression. Among the perfusion metrics, Kep was found to have the best correlation with MMP-9 expression suggesting that it can be used as a surrogate for MMP-9 expression. A total of 8 patients were also followed up clinically to observe the duration of survival. The MMP-9 expression and quantified perfusion metrics were also correlated with the duration of survival. MMP-9 expression showed a significant negative correlation with the duration of survival indicating the possible role of MMP-9 in tumor progression as one of the factors. The Kep, Ktrans, Ve, rCBV and rCBF also correlated significantly with the duration of survival proving the utility of DCE MRI in forecasting tumor progression in malignant glioma. We suggest that Kep holds promise as a surrogate for MMP9 expression in GBM.

16:24 ***614***. **Metabolic Characterization of Recurrent Grade 2 Glioma Using Proton HR-MAS Spectroscopy**

Llewellyn Jalbert[1], Adam Elkhaled[1], Radhika Srinivasan[1], Hikari Yoshihara[1], Colleen Cloyd[1,2], Gabriela Bourne[1], Susan M. Chang[3], Soonmee Cha[1], John Kurhanewicz[1,4], Sarah J. Nelson[1,4]
[1]Department of Radiology & Biomedical Imaging, University of California - San Francisco, San Francisco, CA, United States; [2]School of Pharmacy, University of California - San Francisco, San Francisco, CA, United States; [3]Department of Neurological Surgery, University of California - San Francisco, San Francisco, CA, United States; [4]Department of Bioengineering & Therapeutic Sciences , University of California - San Francisco, San Francisco, CA, United States

Proton High Resolution Magic Angle Spectroscopy (^{1}H HR-MAS) has offered new insight into tumor physiology that may be valuable in understanding the process of glial tumorigenesis. Fifty-four patients w/ pathologically confirmed WHO Grade 2 recurrent glioma underwent pre-surgical MRI / 3D MRSI, image guided biopsy excision, and ^{1}H HR-MAS analysis. Patients whose tumors had histologically upgraded to WHO Grade 3 exhibited greater concentrations of PC (p=.008), GPC (p=.049), glucose (p=.002), and total

choline (p=.01). Our ^{1}H HR-MAS results may contribute in identifying low-grade glioma patients whose tumors have become more aggressive and assist in treatment planning and selection.

16:36 ***615***. **Correlation of Metabolic Characteristics with Diffusion Tensor Imaging in Human Gliomas**

Greg A. Fellows[1], Alan J. Wright[2], Tom R. Barrick[3], Dominick J O McIntyre[4], Chris A. Clark[5], B Anthony Bell[6], Franklyn A. Howe[7]

[1]Department of Neurosurgery, King's College Hospital London NHS Trust, London, United Kingdom; [2]Radiology, UMC st. Radboud University Hospital, Nijmegen, Netherlands; [3]Clinical Neuroscience, St George's, University of London, London, United Kingdom; [4]CRUK Cambridge Research Institute, Cambridge, United Kingdom; [5]Radiology and Physics Unit, UCL Institute of Child Health, London, United Kingdom; [6]Academic Neurosurgery, St George's, University of London, London, United Kingdom; [7]Cardiac & Vascular Sciences, St George's, University of London, London, United Kingdom

Gliomas are the most common primary brain tumour, and in their most aggressive form, glioblastoma multiforme, are associated with a mean survival of 9-12 months. Despite maximal therapy, nearly all gliomas eventually recur. The majority of this recurrence is at the limits of previous resection / radiotherapy margins. We have combined 1H spectroscopy metabolite maps and DTI structural metrics of 30 histologically confirmed glioma patients to increase our understanding of the tissue changes that occur within the tumour and at the tumour-brain interface. We identify metabolite correlations with DTI metrics as a surrogate marker for tumour infiltration.

16:48 ***616***. **An Image Similarity-Guided Correspondence Correction for Voxel-Wise Analysis Applied to MR Imaging of Glioblastoma Multiforme Acquired Pre- And Post-Chemoradiotherapy**

Jeremy David Hoisak[1,2], Eng-Siew Koh[1,3], Eugene Yu[4], Andrea Kassner[4], Normand J. Laperriere[1,3], Cynthia Ménard[1,3], David A. Jaffray[1,2]

[1]Radiation Medicine Program, Princess Margaret Hospital, Toronto, Ontario, Canada; [2]Medical Biophysics, University of Toronto, Toronto, Ontario, Canada; [3]Radiation Oncology, University of Toronto, Toronto, Ontario, Canada; [4]Medical Imaging, University of Toronto, Toronto, Ontario, Canada

Response assessment with a voxel-wise analysis of serial image change has advantages over conventional tumor measurements, but is susceptible to uncertainties from inconsistent voxel correspondences between scans arising from a dynamic tumor morphology. A correspondence correction method based on a metric of voxel similarity was applied to a functional diffusion map (fDM) analysis of co-registered T1-weighted and diffusion-weighted images of glioblastoma multiforme acquired pre- and post-chemoradiotherapy. The correction resulted in a statistically significant alteration in the quantification of apparent diffusion coefficient (ADC) change pre- and post-therapy, and has the potential to improve the accuracy of subsequent determinations of therapy outcome.

17:00 ***617***. **Glycerolphosphocholine Is the Predominant Choline-Containing Compound and Is Correlated with Proliferation in Non-Enhancing Astrocytoma**

Tracy Richmond McKnight[1], Kenneth James Smith[1], Susan Chang[2], Mitchel Berger[2]

[1]Radiology and Biomedical Imaging, University of California San Francisco, San Francisco, CA, United States; [2]Neurological Surgery, University of California San Francisco, San Francisco, CA

We performed 1D HRMAS and 2D TOCSY MR spectroscopy on a cohort of biopsies from high and low grade non-contrast-enhancing astrocytoma. We quantified PC, GPC, free Cho, and the GPC:PC concentration ratio as well as cell proliferation and cell density. Our results show that GPC is the predominant choline-containing compound in non-enhancing astrocytoma irrespective of grade and that there is a positive association between Ki-67, tCho, and GPC, but not PC. These results suggest that the presence of contrast-enhancement influences choline metabolism in astrocytoma.

17:12 ***618***. **Correlation of DTI Metrics with Proliferation Index and Survival Analysis in Glioblastomas**

Sona Saksena[1], Rajan Jain[1], Jayant Narang[1], Lonni Schultz[2], David Hearshen[1], Lisa Scarpace[3], Norman Lehman[4], Tom Mikkelsen[3]

[1]Radiology, Henry Ford Hospital, Detroit, MI, United States; [2]Biostatistics and Research Epidemiology, Henry Ford Hospital, Detroit, MI, United States; [3]Neurosurgery, Henry Ford Hospital, Detroit, MI, United States; [4]Pathology, Henry Ford Hospital, Detroit, MI, United States

DTI data were acquired from thirty-four patients with glioblastomas with an aim to retrospectively correlate the changes in fractional anisotropy (FA) and apparent diffusion coefficient (ADC) with degree of proliferation index determined histologically and patient survival analysis. We found that patients with ADCmin (¡Ü0.6) and FAmean (¡Ü0.2) had lower progression free survival rate or poorer prognosis. In conclusion, DTI can be used as a clinical prognostic biomarker for disease free survival in patients with glioblastomas and might be useful for planning initial treatment strategy in these patients.

17:24 ***619***. **Effects of Bevacizumab on the Tumor Vascularity Assessed with DCE-MRI in Recurrent Anaplastic Astrocytomas**

Weiting Zhang[1], Teri N. Kreisl[1], Jeffrey Solomon[2], Richard C. Reynolds[1], Daniel R. Glen[1], Robert W. Cox[1], Howard A. Fine[1], John A. Butman[1]

[1]National Institutes of Health, Bethesda, MD, United States; [2]Medical Numerics, Inc., Germantown, MD, United States

DCE-MRI was used to monitor the effects of bevacizumab on physiologic measures of tumor vascularity, such as blood brain barrier permeability, represented as Ktrans , and vascular perfusion represented as fpv, in patiens with recurrent anaplastic astrocytoma. Bevacizumab dramatically reduces Ktrans, fpv, and enhancing tumor volume as early as 4 days and this effect persisted at least for 4 weeks. Tumors with larger baseline enhancing tumor volume and greater baseline Ktrans were related to poorer prognosis.

17:36 ***620***. **Assessing the Effects of Radiation Therapy on Normal Brain Tissue in Patients with Glioma Using Susceptibility-Weighted Imaging at 7 Tesla**

Janine M. Lupo[1], Cynthia Chuang[2], Bert Jimenez[1], Susan M. Chang[3], Igor J. Barani[2], Christopher P. Hess[1], Sarah J. Nelson[1,4]

[1]Department of Radiology and Biomedical Imaging, University of California, San Francisco, San Francisco, CA, United States; [2]Department of Radiation Oncology, University of California, San Francisco, United States; [3]Department of Neurosurgery, University of California, San Francisco, United States; [4]Department of Bioengineering and Therapeutic Sciences, University of California, San Francisco, United States

The potential effects of radiotherapy on neurocognitive ability and quality of life has recently become of great importance as new treatments extend survival in less malignant grade brain tumors. We used Susceptibility-Weighted Imaging at 7T to evaluate the long-term effects of radiation therapy on normal-appearing brain tissue in 20 glioma patients. Microbleeds appeared in irradiated patients after 2 years from receiving therapy, but not in patients treated with only chemotherapy. The prevalence of these lesions increased over time since receiving radiation therapy. The majority of these microbleeds resided within tissue that received 98% of the maximum dose.

17:48 ***621***. **Functional Diffusion Maps (FDMs) Applied to FLAIR Abnormal Regions Can Detect Pseudoprogression from Recurrent Tumor in Malignant Glioma**

Benjamin M. Ellingson[1,2], Mark G. Malkin[1,3], Scott D. Rand[1,2], Jennifer M. Connelly[1,4], Pete S. LaViolette[1,5], Devyani P. Bedakar[1,2], Kathleen M. Schmainda[1,2]

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Patients with malignant gliomas undergoing cytotoxic therapy have been shown to have an increase in the size of contrast-enhancing lesions due to radiation necrosis; however, growing or progressing gliomas also are trademarked by an increase in the size of contrast-enhancing lesions. This phenomenon, known as pseudoprogression, is of significant clinical interest because routine anatomical MRI techniques cannot relibly distinguish these two mechanisms of contrast enhancement during therapy. In the current study, we examine the kinetic profiles of hyper- and hypocellular volumes using functional diffusion maps (fDMs) applied in FLAIR abnormal regions in order to detect pseudoprogression from recurrent tumor in malignant glioma patients treated with cytotoxic therapies.

DSC Perfusion & DCE

Room A4 16:00-18:00 *Moderators:* Peter Gall and Kathleen M. Schmainda

16:00 ***622***. **Improving DSC-MRI by Orientation-Corrected Phase-Based AIF and VOF**

Matus Straka[1], Rexford D. Newbould[2], Milos Sramek[3], Gregory W. Albers[4], Roland Bammer[1]

[1]Radiology, Stanford University, Stanford, CA, United States; [2]Clinical Imaging Centre, GlaxoSmithKline, London, United Kingdom; [3]Commision for Scientific Visualization, Austrian Academy Of Sciences, Vienna, Austria; [4]Stroke Center, Stanford University Medical Center, Stanford, CA, United States

Quantitative perfusion measurements require accurate measurements of tracer concentration. Magnitude T2*-based data suffer from various artifacts and non-linearities and make quantification of (mainly vascular) tracer concentration difficult. Concentration can be derived from change in resonante frequency (phase of MR signal), however this effect depends on orientation of given vessel versus main magnetic field. Image-based filtering to enhance cylindrical structures is used to estimate vessel orientation from DSC-MRI data. This information is used to correct the phase information and improve quantification of Gd concentration in large vessels.

16:12 ***623***. **Brain Perfusion with MRI: Arterial Input Function Localization with the Support of MR Angiography**

Bora Buyuksarac[1], Mehmed Ozkan[1]
[1]Bogazici University, Istanbul, Turkey

In perfusion weighted images, the anatomic locations of the arteries are not clearly visible. The conventional arterial input function selection technique is to locate a region on a perfusion image that is supposed to include an artery and select the pixels of which time curves meet the criteria of steepness, narrowness and high signal intensity change. In this study, we alternatively employ MR angiography (MRA) images for more accurate results in localizing the arteries. With this method we achieve automated multiple AIF selection, through which regional CBF images on various brain slices are calculated.

16:24 ***624***. **New Criterion for Automatic AIF Selection in DSC Perfusion MRI to Exclude Partial Volume Effects**

Egbert JW Bleeker[1], Matthias JP van Osch[1], Alan Connelly[2,3], Mark A. van Buchem[1], Andrew G. Webb[1], Fernando Calamante[2,3]
[1]C.J.Gorter Center for High Field MRI, Department of Radiology, Leiden University Medical Center, Leiden, Netherlands; [2]Brain Research Institute, Florey Neuroscience Institutes (Austin), Melbourne, Australia; [3]Department of Medicine, University of Melbourne, Melbourne, Australia

The current criteria for AIF selection algorithms determine "correct" measurements based on the shape of the first passage. However, this shape can be altered by partial volume effects, which often occur in AIF measurements due to the relatively low spatial resolution. A new criterion is proposed, based on tracer kinetic theory, that uses the additional information of the steady state to detect partial volume effects in the AIF measurement. This study shows that the proposed criterion should be a valuable addition to the current selection criteria.

16:36 ***625***. **Quantitative Cerebral Perfusion with SCALE-PWI: Accelerated Image Acquisition and Optimized Image Reconstruction**

Jessy J. Mouannes[1], Wanyong Shin[2], Saurabh Shah[3], Anindya Sen[4], Sameer Maheshwari[1], Timothy J. Carroll[1,4]
[1]Biomedical Engineering, Northwestern University, Chicago, IL, United States; [2]National Institute on Drug Abuse, National Institute of Health, Baltimore, MD, United States; [3]Siemens Medical Solutions USA, Chicago, IL, United States; [4]Radiology, Northwestern University, Chicago, IL, United States

The multi-scan Bookend technique allows accurate, reliable and reproducible quantitative cerebreal perfusion measurements. An accelerated and simplified version of the Bookend technique protocol has been achieved through a Self-CALibrated Epi Perfusion Weighted Imaging (SCALE-PWI) MRI pulse sequence, with scan time under 2 minutes and allowing inline reconstruction of quantitative images of cerebral perfusion. A study of two different delay times between consecutive modules of SCALE-PWI and a water correction factor (WCF) parameterization for SCALE-PWI are presented at 1.5T. The results show that a fast imaging protocol for SCALE-PWI (with zero delay) with appropriate WCF parameterization provide accurate quantitative cerebral perfusion.

16:48 ***626***. **Measurement of Cerebral Blood Flow and Cerebral Blood Volume in Humans Using Washout of Hyperoxic Contrast**

David Thomas Pilkinton[1], Santosh Gaddam[1], Mark A. Elliott[1], Ravinder Reddy[1]
[1]Center for Magnetic Resonance and Optical Imaging, University of Pennsylvania, Philadelphia, PA, United States

It has long been thought that hyperoxia alters the hemodynamics of the brain substantially, confounded attempts to measure hemodynamic quantities with hyperoxic contrast. However, recent studies have shown that cerebral blood flow (CBF) experiences only a small (<4%) reduction upon breathing low to moderate oxygen concentrations ($FiO2 \leq 0.5$). . Since hyperoxic contrast exhibits fast washout times, accurate measurements of dynamic parameters are feasible. We have shown here that that accurate measurements of CBV and CBF can be made dynamically during the washout of hyperoxic contrast using indicator-dilution theory in a manner akin to traditional dynamic susceptibility contrast (DSC) measurements.

17:00 ***627***. **On the Role of Tissue–blood Exchange on the Relaxation Effect of Paramagnetic Blood Tracers**

José Rufino Solera Ureña[1], Salvador Olmos Gassó[1], Valerij G. Kiselev[2]
[1]Aragon Institute of Engineering Research, Universidad de Zaragoza, Zaragoza, Spain; [2]Dept. of Diagnostic Radiology, Medical Physics, University Hospital Freiburg, Freiburg, Germany

The signal attenuation observed in DSC–MRI measurements is considered largely to obey to susceptibility-induced magnetic inhomogeneities at the mesoscopic scale. Another mesoscopic process contributing to increased spin dephasing is the diffusion of tissue water carrying a transverse magnetisation M into the blood pool, where it then experiences faster relaxation due to the presence of paramagnetic contrast agent. To quantify this effect, an effective extravascular dephased volume is defined. Analytical expressions are given for various exchange regimes and numerical estimates are compared with the vascular volume. Results indicate that in the brain the exchange of tissue magnetisation across the blood–brain barrier is permeability limited and does not contribute significantly to the signal dephasing. However, the contribution of magnetisation exchange may be important in organs with increased capillary permeability and/or blood volume. The method is applicable to other problems in quantitative perfusion MRI.

17:12 ***628***. **PET Validation of Vascular-Space-Occupancy CBV Measurement**

Jinsoo Uh[1], Ai-Ling Lin[2], Kihak Lee[2], Peter Fox[2], Hanzhang Lu[1]
[1]Advanced Imaging Research Center, University of Texas Southwestern Medical Center, Dallas, TX, United States; [2]Research Imaging Institute, University of Texas Health Science Center, San Antonio, TX, United States

This study validates the use of VASO-MRI for quantitative measurement of cerebral blood volume in unit of ml blood in 100 ml brain. We measured CBV values using PET and VASO-MRI on the same subjects and compared them. The results showed that VASO-MRI provides quantitative and accurate estimations of CBV values in the human brain. Our data also demonstrated that VASO CBV has a higher SNR compared to the PET technique in addition to providing a higher spatial resolution.

17:24 ***629***. **Quantitative Assessment of Perfusion and Permeability in Multiple Sclerosis: Feasibility and Initial Results**

Michael Ingrisch[1], Steven Sourbron[1], Dominik Morhard, Lisa-Ann Gerdes[2], Tania Kümpfel[2], Reinhard Hohlfeld[2], Maximilian F. Reiser, Christian Glaser
[1]Josef Lissner Laboratory for Biomedical Imaging, Institute of Clinical Radiology, Ludwig Maximilian University, Munich, Germany; [2]Institute for Clinical Neuroimmunology, Ludwig Maximilian University, Munich, Germany

We evaluate the feasibility of a 3D DCE-MRI measurement for the absolute quantification of perfusion and permeability in Multiple Sclerosis and present initial results. 19 patients were examined, perfusion and permeability were quantified with 2-compartment models in white matter, non-enhancing(NE) and contrast-enhancing(CE) lesions. The results show clear separation of WM and CE lesions in the permeability estimates; WM perfusion was lower than standard values from literature. The parameter variation in NE- and CE-lesions was relatively large, suggesting a potential for lesion characterization and monitoring of the effects of disease-modifiying drugs.

17:36 ***630***. **Steady State Effects on Cerebral Blood Flow Measurements Using Dynamic Contrast-Enhanced Perfusion MRI: A Simulation Study**

Adam Espe Hansen[1], Henrik Pedersen[1], Henrik BW Larsson[1]
[1]Functional Imaging Unit, Glostrup Hospital, University of Copenhagen, Glostrup, Denmark

Dynamic contrast enhanced (DCE) perfusion MRI of the passage of a Gd bolus requires rapid imaging, which will introduce steady state effects. We simulate the time development of the longitudinal magnetization during a typical R_1 time course and evaluate the influence of steady state effects on the estimation of cerebral blood flow (CBF). We find that steady state effects can seriously affect CBF estimates if the saturation prepulse is not exact. The CBF bias can be minimized to a few percent if a large alfa flip angle of the order of 30 degrees is used.

17:48 ***631***. **Towards More Accurate Modeling of DCE Data: Development of a Multi-Compartment Phantom**

Jeff R. Anderson[1], Joseph J H Ackerman[1], Joel R. Garbow[1]
[1]Washington University in St. Louis, St. Louis, MO, United States

Dynamic contrast enhanced (DCE) MRI is a powerful tool for the imaging of cancer in vivo. However, debate still remains in the literature about which DCE signal model(s) best reflect(s) the image time-course data. An in vitro phantom, based on semi-permeable hollow fibers, has been constructed as a novel platform to assess the quantitative limits of DCE-MRI parameter estimation. Time-of-flight effects allow the intra-lumen signal to be suppressed in the presence of lumen flow and, thus, the kinetic characteristics defining contrast-agent diffusion through the fiber walls into the extra-lumen space to be quantitatively assessed.

Methodology for MR Elastography

Room A5 16:00-18:00 *Moderators:* Richard L. Ehman and Jessica A. Mende

16:00 **Introduction**

Richard L. Ehman

16:12 ***632***. **Wide Dynamic Range MR Elastography of Liver**

Dieter Klatt[1], Detlef Stiller[2], Thomas Kaulisch[2], Heiko Nießen[2], Kerstin Riek[1], Sebastian Papazoglou[1], Thomas Elgeti[1], Ingolf Sack[1], Jürgen Braun[3]
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MR elastography (MRE) enables the measurement of the complex shear modulus G* of biological tissue. Using MRE, the frequency dependency of G* has been examined in the past within a limited dynamic range due to inherent technical restrictions. In this study, G* of liver in a wide dynamic range of more than 4.5 octaves was measured by combining MRE at a 1.5T human scanner system with MRE at a 7T animal scanner. The results of both systems agreed excellently and revealed a power-law behavior of G* between 25Hz and 600Hz vibration frequency. The springpot-model was used for calculating viscoelastic parameters.

16:24 ***633***. **Frequency Dependence of Mouse Brain Tissue Stiffness Measured in Vivo with MR Elastography**

Erik Holt Clayton[1], Joel R. Garbow[2], Philip V. Bayly[1,3]

[1]Mechanical Aerospace & Structural Engineering, Washington University in St. Louis, Saint Louis, MO, United States; [2]Biomedical MR Laboratory, Mallinckrodt Institute of Radiology, Washington University School of Medicine, Saint Louis, MO, United States; [3]Biomedical Engineering, Washington University in St. Louis, Saint Louis, MO, United States

Multifrequency MR elastography (MRE) has been used to measure mechanical stiffness of human brain tissue. The development of cancer treatment protocols may benefit from similar studies in rodent models. Here the viscoelastic material properties of mouse brain were determined by MRE over a range of driving frequencies (600 - 1800 Hz). A novel non-invasive brain actuator was devised to introduce propagating shear waves. Wave motion was imaged with a phase-locked spin echo pulse sequence. Displacement data were inverted in a least-squares manner to obtain complex modulus estimates. Results suggest the frequency response of brain tissue may provide diagnostic value.

16:36 ***634***. **Improving Spatial Resolution of Strain-Encoded (SENC) Magnetic Resonance Elastography (MRE) for Enhancing Stiff-Mass Detection**

Ahmed Amr Harouni[1], Jakir Hossain[1], Michael A. Jacobs[2], Nael Fakhry Osman[1,2]

[1]Electrical and computer Engineering, Johns Hopkins University, Baltimore, MD, United States; [2]Department of Radiology, Johns Hopkins University, Baltimore, MD, United States

Early detection through periodic screening is the key to decrease beast cancer mortality. Fast Strain-encoded (FSENC) MR with a limited hardware was previously introduced to detect different stiffness by measuring the strain. In this work, we introduce a new hardware capable of periodically compressing the breast, which allows us to achieve higher resolution while maintaining same SNR by prolonging scan time. Simple controls and redundant safety measures were added to ensure accurate, repeatable and safe in-vivo experiments. Results show that high-resolution SENC images have four-fold CNR increase relative to low-resolution FSENC images, which leads to better tumor detection.

16:48 ***635***. **Focused Acoustic Driver to Generate High-Frequency Shear Waves in Deep Regions for Magnetic Resonance Elastography**

Mikio Suga[1,2], Takayuki Obata[2], Masashi Sekine[3], Masaya Hirano[4], Hisayuki Miura[5], Ken Arai[5], Shinya Ozawa[5], Hiroo Ikehira[2]

[1]Graduate School of Technology, Chiba University, Chiba , Japan; [2]Molecular Imaging Center, National Institute of Radiological Sciences, Chiba, Japan; [3]Research Center for Frontier Medical Engineering, Chiba University, Japan; [4]GE Healthcare Japan, Tokyo, Japan; [5]Graduate School of Technology, Chiba University, Chiba, Japan

Magnetic resonance elastography (MRE) can noninvasively visualize shear waves patterns within tissue. To acquire an accurate shear modulus map in high spatial resolution in deep regions, external drivers must generate a precisely controlled high frequency and a large amplitude vibration. In this study, we develop a simple and robustly designed focused acoustic driver to enhance shear wave amplitude in deep regions by high frequency using a piezoelectric actuator. From the results of the experimental studies, it was shown that the focused acoustic driver increases the SNR of the shear wave image in the deep region and improves shear modulus quantitatively.

17:00 ***636***. **Effect of Off-Frequency Encoding in Magnetic Resonance Elastography**

Curtis L. Johnson[1], Danchin Chen[1], Harish Sharma[2], Bradley P. Sutton,[2,3], William C. Olivero,[2,4], John G. Georgiadis[1,2]

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The effects of encoding displacement at a frequency other than the driving frequency with Magnetic Resonance Elastography (MRE) were investigated. Off-frequency responses can occur due to possible nonlinearities in the overall dynamic system being actuated. Results demonstrated that undesired off-frequency encoding could result in errors in mean estimated stiffness of tissue, as well as local fluctuations in estimated stiffness, which will have implications for MRE with nonlinear dynamic systems.

17:12 ***637***. **SSFSE Sequence for Fast Elastography in the Presence of Susceptibility**

Ken-Pin Hwang[1,2], Zhenghui Zhang[3], Brandy J. Reed[4], Michelle L. Underwood[4], Roger Jason Stafford[4], Peggy T. Tinkey[5], David C. Alsop[6,7], Rajesh Uthamanthil[5]

[1]Applied Science Laboratory, General Electric Healthcare, Houston, TX, United States; [2]Department of Imaging Physics, UT MD Anderson Cancer Center, Houston, TX, United States; [3]GE Healthcare, Waueksha, WI, United States; [4]Department of Imaging Physics, University of Texas MD Anderson Cancer Center, Houston, TX, United States; [5]Department of Veterinary Medicine and Surgery, University of Texas MD Anderson Cancer Center, Houston, TX, United States; [6]Department of Radiology, Beth Israel Deaconess Medical Center, Boston, MA, United States; [7]Department of Radiology, Harvard Medical School, Boston, MA, United States

The use of a modified phase contrast gradient echo sequence has been shown to be a robust technique for MR elastography of the liver. However, each phase encoded view requires long motion encoding gradients that extended the echo time, making the sequence

sensitive to susceptibility and lengthening overall acquisition time. In this work we combine a motion encoding preparation sequence with an SSFSE sequence originally designed for diffusion weighted imaging. Phase information from a single set of motion encoding gradients is preserved for each echo in the echo train, thus accelerating acquisition in a spin echo based sequence.

17:24 ***638***. **Improvements in Shear Modulus Reconstruction In-Vivo Breast Data Using a Viscoelasitc Material Model in Optimization Driven Mr Elastography**

Matthew Mcgarry[1], Irina Perreard[2], Adam Jeffry Pattison[1], Elijah van Houten[3], John Weaver[2], Keith Paulsen[1]

[1]Thayer School of Engineering, Dartmouth College, Hanover, NH, United States; [2]Department of Radiology, Dartmouth-Hitchcock Medical Center, Lebanon, NH, United States; [3]Department of Mechanical Engineering, University of Canterbury, Christchurch, New Zealand

This work demonstrates the improvements in in-vivo breast shear modulus reconstruction gained through considering the effects of viscoelasticity in a model-based, optimization driven MR elastography algorithm. Three cases with 12 reconstructions are presented where increased shear modulus in the region of a malignant tumor is apparent using a viscoelastic material model. It is shown that using an undamped linear elastic model produces inconclusive results. The improvements are due to a reduction in the model-data mismatch by using a viscoelastic model to fit tissue, which is known to have a significant viscous component.

17:36 ***639***. **Validity Study of Spin Echo EPI Based Hepatic MR Elastography at 3.0T**

David W. Stanley[1], Kevin J. Glaser[2], Meng Yin[2], Jun Chen[2], Richard L. Ehman[2]

[1]MR, GE Healthcare, Proctor, MN, United States; [2]Department of Radiology, Mayo Clinic, Rochester, MN, United States

The purpose of this study was to evaluate a SE-EPI MRE protocol and compare it to a standard GRE MRE protocol at both 1.5T and 3.0T in healthy volunteers with no known liver disease to determine if the signal variations characteristic of the different imaging sequences and field strengths cause a significant change in the SNR of the data or adversely affect the estimates of tissue stiffness.

17:48 ***640***. **Measuring the Effect of Formalin Fixation on Ex Vivo Tissue Material Properties Using High Resolution 3D Quasi-Static MR Elastography at 7 Tesla for Improved Biomechanical Registration of Histopathology, and Correlation with the Effect of Fixation on T<su**

Deirdre Maria McGrath[1], Warren D. Foltz[1], Kristy K. Brock[1,2]

[1]Radiation Medicine Program, Princess Margaret Hospital, Toronto, Ontario, Canada; [2]Department of Radiation Oncology, University of Toronto, Toronto, Ontario, Canada

Correlation of 3D histopathology with in vivo images improves the understanding of disease representation in imaging. The pathology fixation process changes the material properties of tissue non-uniformly and if biomechanical registration is used, measures of these effects are required. A high resolution 3D quasi-static MR elastography (MRE) method at 7 T is presented for voxel-wise mapping of Young's modulus across tissue volumes, and is applied to ex vivo canine prostate samples, pre- and post-fixation. The measures are validated using indentation testing. The effect of fixation on T1, T2 and ADC is also measured, to determine the relationship with material property changes.

Receive Arrays & LNAs

Room A6 16:00-18:00 *Moderators:* James A. Bankson and Mary P. McDougall

16:00 ***641***. **An 8-Channel TX, 16-Channel RX Flexible Body Coil at 7 Tesla Using Both Branches of Centrally Fed Strip Lines as Individual Receive Elements**

Stephan Orzada[1,2], Stefan Maderwald[1,2], Mark Oehmigen[1], Mark E. Ladd[1,2], Klaus Solbach[3], Andreas K. Bitz[1,2]

[1]Erwin L. Hahn Institute for Magnetic Resonance Imaging, Essen, NRW, Germany; [2]Department of Diagnostic and Interventional Radiology and Neuroradiology, University Hospital Essen, Essen, NRW, Germany; [3]High Frequency Engineering, University Duisburg-Essen, Duisburg, NRW, Germany

To further increase the capabilities of centrally fed strip line elements, they can be split up into two branches for reception, thereby doubling the number of elements. In this work a flexible body coil with 8 transmit and 16 receive channels built from centrally fed strip line elements with meanders is presented for imaging at 7 Tesla. The new array shows enhanced parallel imaging performance, while good decoupling and transmit penetration are maintained.

16:12 ***642***. **A 7-Tesla High Density Transmit with 28-Channel Receive-Only Array Knee Coil**

Matthew Finnerty[1], Xiaoyu Yang[1], Tsinghua Zheng[1], Jeremiah Heilman[1], Nicholas Castrilla[1], Joseph Herczak[1], Hiroyuki Fujita[1,2], Tamer S. Ibrahim[3,4], Fernando Boada[3,4], Tiejun Zhao[5], Franz Schmitt[6], Bernd Stoeckel[5], Andreas Potthast[6], Karsten Wicklow[6], Siegfried Trattnig[7], Charles Mamisch[7], Michael Recht[8], Daniel Sodickson[8], Graham Wiggins[8], Yudong Zhu[8]

[1]Quality Electrodynamics, LLC., Mayfield Village, OH, United States; [2]Departments of Physics and Radiology, Case Western Reserve University, Cleveland, OH, United States; [3]Department of Bioengineering, University of Pittsburgh, Pittsburgh, PA, United States; [4]Department of Radiology, University of Pittsburgh, Pittsburgh, PA, United States; [5]Siemens Medical Solutions USA, Inc., Malvern, PA, United States; [6]Siemens Healthcare, Erlangen, Germany; [7]Department of Radiology, Medical University of Vienna, Vienna, Austria; [8]Department of Radiology, NYU Langone Medical Center, New York, United States

As more advanced 7T MRI technology continues to emerge, the development of a wider anatomical range of RF coils has become a greater priority. In an effort to take advantage of the greater spatial resolution and higher SNR at 7T, a 12-rung birdcage transmitter and 28-channel receive-only array coil has been developed. To overcome the challenges associated with the shorter wavelength within the human body at 7T, several novel design strategies have been utilized.

16:24 ***643***. **Age-Optimized 32-Channel Brain Arrays for 3T Pediatric Imaging**

Boris Keil[1], Azma Mareyam[1], Kyoko Fujimoto[1], James N. Blau[1], Veneta Tountcheva[1], Christina Triantafyllou[1,2], Lawrence L. Wald[1,3]

[1]A.A. Martinos Center for Biomedical Imaging, Department of Radiology, MGH, Harvard Medical School, Charlestown, MA, United States; [2]A.A. Martinos Imaging Center, Mc Govern Institute for Brain Research, MIT, Cambridge, MA, United States; [3]Harvard-MIT Division of Health Sciences and Technology, MIT, Cambridge, MA, United States

Compromising the size and shape of pediatric brain arrays so that "one size fits all" or using adult brain or knee arrays causes a significant degradation of SNR and parallel imaging performance compared to a coil of the appropriate size and shape for a given aged child. Unfortunately, rapid head growth in the first years of life requires either a flexible array approach or multiple sizes which span the size range with reasonable discrete increments. In this work, we developed and tested four incremental sized 32-channel receive only head coils for pediatric patients spanning an age range of 6 months to 7 years old. The constructed coils show significant SNR gains for both accelerated and unaccelerated imaging in pediatric brain imaging.

16:36 ***644***. **16-Channel Custom-Fitted Bilateral Breast Coil for Parallel Imaging in Two Directions**

Anderson N. Nnewihe[1,2], Thomas Grafendorfer[3], Bruce L. Daniel[1], Paul Calderon[3], Marcus T. Alley[1], Fraser Robb[3], Brian A. Hargreaves[1]

[1]Radiology, Stanford University, Stanford, CA, United States; [2]Bioengineering, Stanford University, Stanford, CA, United States; [3]GE Healthcare

High spatial and temporal resolution imaging could be used to better classify breast lesions with the potential to improve breast cancer diagnosis. In this work we compare a novel 16-channel bilateral breast coil to a standard commercially-available 8-channel coil, in terms of SNR and parallel imaging capability in two directions. Overall we have demonstrated that a closely-fitted surface array can substantially improve both SNR and parallel imaging capability compared with standard 8-channel bilateral breast coils.

16:48 ***645***. **Modular Multi-Channel Parallel-Imaging Microfluidics Platform with Exchangeable Capillary Diameters**

Dario Mager[1], Andreas Peter[1], Elmar Fischer[2], Patrick James Smith[1], Jürgen Hennig[2], Jan Gerrit Korvink[1,3]

[1]Dept. of Microsystems Engineering – IMTEK, University of Freiburg, Freiburg, Germany; [2]Dept. of Diagnostic Radiology, Medical Physics, University Hospital Freiburg, Freiburg, Germany; [3]Freiburg Institute of Advanced Studies (FRIAS), University of Freiburg, Freiburg, Germany

Solenoidal receiver coils have been directly patterned onto glass capillaries using inkjet printing; in an extension of work that has successfully been used to produce planar receiver coils. Each patterned capillary is housed in a PCB/PMMA holder, which acts as a parallel imaging system for microfluidic analysis.

17:00 ***646***. **Travelling Wave Parallel Imaging**

David Otto Brunner[1], Jan Paska[2], Ingmar Graesslin[3], Jürg Froehlich[2], Klaas Paul Pruessmann[1]

[1]Institute for Biomedical Engineering, University and ETH Zurich, Zurich, Switzerland; [2]Electromagnetic Fields and Microwave Laboratory, ETH Zurich, Zurich, Switzerland; [3]Philips Research Europe, Hamburg, Germany

Since the sample becomes considerably larger than the wavelength in human ultra high field MRI, the electrodynamic degrees of freedom within the loaded bore increases. Using a mode selectively fed waveguide section coupling into the loaded bore it is demonstrated that parallel imaging techniques in transmission and reception such as RF shimming and SENSE can be applied in a

travelling wave approach in the absence of a RF array coil close by the object. A direct dependence between the parallel imaging performance of this 8 channel system and the number of modes in the waveguide could be shown.

17:12 ***647***. **A Modular Automatic Matching Network System**

Matteo Pavan[1], Klaas Paul Pruessmann[1]
[1]ETH Zurich, Zurich, Switzerland

In MR measurement, coils are detecting proton signal; they are usually connected through a matching network to very low noise amplifier. The Noise Figure of the amplifier depends on the impedance that its input port sees. To optimize SNR, is important to match this impedance to the one that is reducing at the minimum the noise figure. A new approach for automatic impedance measurement is here presented. This new approach is easy and modular in such a way that it can be scaled to any number of reception channels.

17:24 ***648***. **Accurate Noise Level and Noise Covariance Matrix Assessment in Phased Array Coil Without a Noise Scan**

Yu Ding[1], Yiu-Cho Chung[2], Orlando P. Simonetti[1]
[1]The Ohio State University, Columbus, OH, United States; [2]Siemens Medical Solutions, Columbus, OH, United States

In this study, we propose an novel method to assess noise level and noise covariance matrix in the k-space data when both signal and noise are present. Experimental results show that the noise level as well as the noise covariance matrix can be accurately derived from multi-frame k-space data without deploying a separate noise scan.

17:36 ***649***. **A Magnetic-Field-Tolerant Low-Noise SiGe Pre-Amplifier and T/R Switch**

David Ian Hoult[1], Glen Kolansky[1]
[1]Institute for Biodiagnostics, National Research Council Canada, Winnipeg, Manitoba, Canada

The noise figure and gain of GaAs field effect transistors degrade in magnetic fields. A SiGe bipolar transistor is advocated as a replacement giving at 123 MHz a noise figure of 0.6 dB with ~ 20 dB current blocking. Our SiGe pre-amplifier has a noise figure < 1dB from 90 to 200 MHz, a gain of 30 dB, a bandwidth of 73 to 163 MHz and a group delay of 5.4 ns. The accompanying 300 W quarter-wave PIN diode transmit/receive switch has 0.1 dB noise figure, an insertion loss of 1 dB and isolation of ~ 65 dB.

17:48 ***650***. **Frequency Selective Negative Feedback to Avoid Preamplifier Oscillation in Multi-Channel Arrays**

Thomas Grafendorfer[1,2], Greig Scott[2], Paul Calderon[3], Fraser Robb[4], Shreyas Vasanawala[5]
[1]RX & ATD Coils, GE Healthcare, Stanford, CA, United States; [2]Electrical Engineering, Stanford University, Stanford, CA, United States; [3]MR Hardware Engineering, GE Healthcare, Fremont, CA, United States; [4]Advanced Technology, GEHC Coils, Aurora, OH, United States; [5]Radiology, Stanford University, Stanford, CA, United States

Placing the preamplifiers close to the coil elements in multi-channel arrays increases preamplifier-decoupling performance, which leads to better SNR and better acceleration performance. Unfortunately it also opens a new feedback path that can easily lead to oscillation. We developed a new strategy by applying frequency selective negative feedback that suppresses the gain at the so-called match split peaks outside the frequency band relevant for MRI. This greatly reduces the possibility for oscillation, and the gain within the signal band stays more or less unaffected.

MR of Cancer Cell Models

Room A7 16:00-18:00 *Moderators:* Kristine Glunde and John R. Griffiths

16:00 ***651***. **De Novo Lipogenesis from Glutamine in Human Glioma Cells**

Anthony Mancuso[1], Justin R. Cross, Craig B. Thompson
[1]Cancer Biology, University of Pennsylvania, Philadelphia, PA, United States

Rapidly growing cancer cells require high rates of phospholipid biosynthesis for the formation of new membranes. Cancer cells produced fatty acids for lipids de novo, primarily from glucose. An improved understanding of the pathways involved in de novo lipogenesis could greatly advance the development of new therapeutics that inhibit cancer cell growth. In this work, FA synthesis from both glucose and glutamine was examined with ^{13}C NMR spectroscopy in cultured human glioma cells. Cells were cultured in T-flasks and extracted for high-resolution analysis. The results show that glucose is the primary source for de novo lipogenesis while glutamine contributes ~30%.

16:12 ***652***. **The Interdependence of Choline Kinase and Phospholipase D: Adaptation Mechanisms in Choline Phospholipid Metabolism of Human Breast Cancer Cells**

Balaji Krishnamachary[1], Mayur Gadiya[2], Noriko Mori[1], Yelena Mironchik[1], Kristine Glunde[1], Zaver M. Bhujwalla[1]
[1]JHU ICMIC Program, Russell H. Morgan Department of Radiology & Radiological Science, The Johns Hopkins University School of Medicine, Baltimore, MD, United States; [2]JHU ICMIC Program, Russell H.

Morgan Department of Radiology & Radiological Science, The Johns Hopkins University School of Medicine, Baltimore, MD, United States

A hallmark of cancer is an increase of cellular phosphocholine (PC) and total choline-containing compounds (tCho), which are closely related to malignant transformation, invasion and metastasis. Enzymes in choline metabolism present attractive targets that can be exploited for treatment. Here we have shown that at least two of these enzymes are interdependent. Downregulation of choline kinase (Chk) with siRNA results in increased phospholipase D1 (PLD1) expression and downregulation of PLD1 results in increased Chk expression, typifying the ability of cancer cells to adapt. These data support multiple targeting of enzymes in the choline pathway using a multiple siRNA approach.

16:24 ***653***. **Down Regulation of HIF-1 Alpha in MDA-MB-231 Human Breast Cancer Cells Alters Choline Phospholipid Metabolism**

Tariq Shah[1], Balaji Krishnamachary[2], Flonne Wildes[2], Zaver M. Bhujwalla[1]
[1]JHU ICMIC Program, Russell H Morgan Department of Radiology and Radiological Sciences, Johns Hopkins School of Medicine , Baltimore, MD, United States; [2]JHU ICMIC Program, Russell H Morgan Department of Radiology and Radiological Sciences, Johns Hopkins School of Medicine, Baltimore, MD, United States

The hypoxia inducible factor (HIF) recognizes and binds to consensus sequences called hypoxia response elements on the promoter regions of several genes, increasing their transcription. As a result hypoxia plays an important role in the cancer phenotype. Here we silenced HIF-1 alpha expression in invasive MDA-MB-231 breast cancer cells and characterized metabolic changes using a magnetic resonance compatible cell perfusion system with cells maintained under controlled pH, temperature, and oxygenation conditions. HIF-1 alpha silenced cells acquired a less aggressive metabolic phenotype with reduced choline kinase expression, together with reduced total choline and phosphocholine, compared to parental cells.

16:36 ***654***. **MRS Detection of Altered Choline Metabolism Following HSP90 Inhibition**

Alissa Brandes[1], Chris S. Ward[1], Judy S. Hwang[1], Sabrina M. Ronen[1]
[1]Radiology, UCSF, San Francisco, CA, United States

Although most anticancer therapies cause a drop in PC levels,, treatment with the HSP90 inhibitor 17-AAG has been shown to have the unique consequence of increasing PC. Our study investigated the mechanism behind this observed increase by monitoring the uptake and metabolism of [1,2-13C]-choline in live cells and cells extracts using 1H, 31P and 13C MRS and performing assays on the activity of enzymes involved in choline metabolism. Our data indicate that the observed increase in PC levels in 17-AAG-treated cancer cells is due to an increase in the synthesis of PC from extracellular choline, along with increased breakdown of PtdCho via PLC.

16:48 ***655***. **Silencing GDPD5, a Novel Anticancer Target, Increases Glycerophosphocholine in Human Breast Cancer Cells**

Mailin Döpkens[1,2], Tiffany R. Blackwell[1], Farhad Vesuna[1], Venu Raman[1], Balaji Krishnamachary[1], Zaver M. Bhujwalla[1], Dieter Leibfritz[2], Kristine Glunde[1]
[1]JHU ICMIC Program, Russell H. Morgan Department of Radiology and Radiological Science, The Johns Hopkins University School of Medicine, Baltimore, MD, United States; [2]Department of Chemistry and Biology, University of Bremen, Bremen, Germany

Altered choline phospholipid metabolism in breast cancers provides multiple targets for anticancer therapy. In addition to increasing total choline levels, malignant transformation of breast cancer cells results in a switch from high glycerophosphocholine (GPC) and low phosphocholine (PC) to low GPC and high PC. The glycerophosphocholine phosphodiesterase (GPC-PDE) genes responsible for the low GPC levels in breast cancer cells have not been identified. Here we demonstrate that glycerophosphodiester phosphodiesterase domain containing 5 (GDPD5), a gene encoding a GPC-PDE, is at least partially responsible for the low GPC levels in breast cancer cells, and may be a useful therapeutic target.

17:00 ***656***. **Noninvasive Monitoring of PI3K Inhibition: Reduced Hyperpolarized Lactate and PC Are Independent of Genetic Background in Glioblastoma**

Humsa S. Venkatesh[1], Charles D. James[2], Daphne A. Haas-Kogan[2], Sabrina M. Ronen[1]
[1]Radiology and Biomedical Imaging, University of California, San Francisco, San Francisco, CA, United States; [2]Neurological Surgery, University of California, San Francisco

As the PI3K pathway is activated in 88% of glioblastomas, it is the target of several novel therapies. The purpose of this investigation is to study GBM cells with different genetic backgrounds in order to establish hyperpolarized lactate and PC as biomarkers of PI3K inhibition. Two inhibitors of PI3K signaling and agents that do not affect signaling were investigated. Hyperpolarized lactate and PC dropped only when signaling was inhibited and this observation was mechanistically linked to a drop in HIF-1, which controls expression of LDH and choline kinase. This suggests an application for these metabolites as noninvasive biomarkers for PI3K-targeted anticancer treatments.

17:12 ***657***. **Hyperpolarized [1-13C] Pyruvate Metabolism in a Human Prostate Tissue Culture Bioreactor**

David J. Joun[1], Mark Albers[1], Kayvan Keshari[1], Robert Bok[1], Christopher Ward, Donna Peehl[2], Sabrina Ronin, Daniel Vigneron, John Kurhanewicz

[1]Radiology, UCSF, San Francisco, CA, United States; [2]Urology, Stanford, Stanford, CA, United States

We demonstrate for the first time that the pathologic and metabolic integrity of benign and malignant human prostate tissues can be maintained in a NMR compatible 3-D tissue culture bioreactor for 32 hours. After administration of hyperpolarized [1-13C] pyruvate, the generation of labeled hyperpolarized lactate and LDH activity was significantly higher in malignant tissues (N=3) relative to benign human prostate tissues (N=3). Moreover, there was minimal overlap of the labeled hyperpolarized lactate signal between individual cancer and benign tissues suggesting that hyperpolarized lactate will be an accurate biomarker of prostate cancer in patients.

17:24 ***658***. **The Glucose Dependent Transcription Factor ChREBP Contributes to Glucose-Dependent Anabolic Synthesis and Cell Proliferation**

Xuemei Tong[1], Anthony Mancuso[2], Fangping Zhao, Joshua J. Gruber, Craig B. Thompson

[1]University of Pennsylvania, Philadelphia, PA, United States; [2]Cancer Biology, University of Pennsylvania, Philadelphia, PA, United States

Many human tumors display high rates of aerobic glycolysis, de novo fatty acid synthesis and nucleotide biosynthesis. Although these metabolic alterations might not be initiating events in oncogenesis, blocking them may be a useful strategy for slowing carcinogenesis. The carbohydrate responsive element binding protein (ChREBP) is a critical mediator of glucose-dependent metabolism. In this study, the metabolic effects of ChREBP knockdown in human colon cancer cells were examined with ^{13}C NMR and ^{14}C scintillation. The results demonstrated that knockdown reduced aerobic glycolysis and growth-related biosynthesis. It also increased TCA cycle flux and oxygen consumption, resulting in a less cancerous phenotype.

17:36 ***659***. **Metabolic Profiling of Post-Radiation Prostate Biopsy Tissues**

Vickie Yi Zhang[1,2], Mark Swanson[1], Laura Tabatabai[3], Jeff Simko[3], Lynn DeLosSantos[1], Daniel Vigneron[1], John Kurhanewicz[1]

[1]Radiology, University of California, San Francisco, San Francisco, CA, United States; [2]Joint Bioengineering Program, University of California, Berkeley/San Francisco, San Francisco, CA, United States; [3]Pathology, University of California, San Francisco, San Francisco, CA, United States

Synopsis: This study used quantitative 1-D 1H HR-MAS spectroscopy of snap frozen prostate biopsies to investigate the metabolic profiles of healthy versus cancer prostate tissues after radiation therapy. Metabolite concentrations were correlated with pathology and Ki-67 immunohistochemistry to identify a metabolic phenotype of proliferating residue cancer. Significantly higher concentrations of PC+GPC, lactate and glutamate were observed in benign versus residual proliferating cancer tissues after radiation treatment.

17:48 ***660***. **Measurements of Mean Nuclear and Cell Sizes Using Ultra-Short Diffusion Times**

Junzhong Xu[1], Jingping Xie[1], Ke Li[1], Jerome Jourquin[2], Mark D. Does[1], Daniel F. Gochberg[1], Vito Quaranta[2], John C. Gore[1]

[1]Institute of Imaging Science, Vanderbilt University, Nashville, TN, United States; [2]Cancer Biology, Vanderbilt University, Nashville, TN, United States

Tumor cell nuclear size usually can be found only by invasive biopsy. In the present work, a novel approach, which employs an oscillating gradient spin echo (OGSE) method, has been developed to measure nuclear size with ultra-short diffusion times (low as ~0.13ms). Both simulations and experiments were performed and the results obtained from OGSE diffusion measurements are consistent with light microscopy, proving the feasibility of our method. This new approach provides structural parameters which may be helpful for the assessment of tumor malignancy, tracking intracellular changes in tissues, and potentially monitoring tumor response to treatment in vivo.

Atherosclerosis, Coronary & Vessel Wall Imaging

Room A8 16:00-18:00 *Moderators:* Suzanne C. Gerretsen and Yi Wang

16:00 ***661***. **Diagnostic Performance of Non-Contrast Whole-Heart Coronary Magnetic Resonance Angiography Combined with Black-Blood Arterial Wall Imaging in Patients with Suspected Coronary Artery Disease**

Qinyi Dai[1], Zhaoqi Zhang[1], Yi He[1], Wei Yu[1], Biao Lu[1], Zhanming Fan[1], Jing An[2], Lixin Jin[3], Renate Jerecic[3], Guobin Li[4], Wolfgang Rehwald[5], Debiao Li[6]

[1]Radiology, AnZhen Hospital, Beijing, China; [2]Siemens Mindit Magnetic Resonance, Siemens Healthcare, MR Collaboration NE Asia; [3]Siemens Limited China, Siemens Healthcare, MR Collaboration NE Asia; [4]Siemens Mindit Magnetic Resonance Ltd.; [5]Siemens Healthcare USA; [6]Northwestern University, Chicago, IL, United States

The combined Whole-heart coronary MRA and black-blood-coronary-wall-imaging hasn't been reported to detect CAD yet. Continuous slices for wall imaging of 48 segments were positioned along the suspected lesions of WH CMRA. A positive diagnosis of

CAD was made when stenosis ¡Ý50% at least one of the techniques. 15/48 segments were diagnosed as CAD by x-ray angiography. The sensitivities of WH CMRA only and both techniques were (12/15) and (14/15), NPVs were (33/36) and (33/34), respectively. There was no difference in specificity or PPV. The combination of two techniques improves the diagnostic accuracy to detect CAD over WH CMRA alone.

16:12 ***662***. **Contrast-Enhanced Whole-Heart Coronary MRA in 5 Minutes Using Radial EPI**

Himanshu Bhat[1], Qi Yang[2], Sven Zuehlsdorff[3], Debiao Li[1]

[1]Radiology and Biomedical Engineering, Northwestern University, Chicago, IL, United States; [2]Radiology, Capital Medical University, Xuanwu Hospital, Beijing, China; [3]Siemens Medical Solutions USA, Inc., Chicago, IL, United States

Whole-heart coronary MRA is challenging due to the long data acquisition time on the order of 8-12 minutes. The purpose of this work was to optimize a radial EPI technique for contrast-enhanced whole-heart coronary MRA, with the goal of combining the scan efficiency of EPI with the motion insensitivity of radial sampling.

16:24 ***663***. **MRI Assessment of Endothelial Damage and Angiogenesis in Porcine Coronary Arteries Using Gadofosveset**

Steen Fjord Pedersen[1], William P. Paaske[2], Troels Thiem[3], Steffen Ringgaard[4], Samuel A Thrysøe[4], Won Yong Kim[5]

[1]Aarhus University Hospital, Aarhus, Denmark; [2]1Dept. of Cardiothoracic and Vascular Surgery T, Aarhus University Hospital, Skejby, Denmark; [3]Dept. of Cardiology, Aarhus University Hospital, Skejby, Denmark; [4]MR-center, Aarhus University Hospital, Skejby, Denmark; [5]Dept. of Cardiology, and MR-center, Aarhus University Hospital, Skejby, Denmark

Endothelial damage and angiogenesis are essential in atherosclerotic plaque development and destabilization .We sought to examine whether contrast enhanced MRI using gadofosveset would enable the detection of endothelial damage and neovessels in balloon injured porcine coronary arteries. MRI showed contrast enhancement of the injured vs. the non-injured control artery with a significant increase in the diameter of (30±19 % versus 4±8%; P=0.01). Ex-vivo coronary vessel wall MRI contrast enhancement was in agreement with extravasated Evans blue with a kappa value of 0.64 ($p<0.001$). and there was a linear correlation between coronary MRI contrast-enhancement and microvessel density ($r=0.78$, $p<0.001$).

16:36 ***664***. **Assessment of Coronary Endothelial Dysfunction in Young Healthy Smokers Using 3T Phase Contrast Cine MRI and Cold Pressor Test**

Shingo Kato[1], Hajime Sakuma[1], Kakuya Kitagawa[1], Motonori Nagata[1], Yeonyee. E Yoon[1], Shinichi Takase[1]

[1]Department of Radiology, Mie University Hospital, Tsu, Mie, Japan

Blood flow volumes in the LAD artery and in coronary sinus (CS) at rest and during cold pressor test were quantified in 10 young non-smokers and 6 age-matched smokers using 3T MR imager. Coronary flow was significantly augmented during CPT in non-smokers (LAD: 28.5 ± 6.8mL/min to 36.5 ± 7.3mL/min, p=0.017). However, the CPT/rest coronary flow ratio was significantly reduced in smokers when compared with non-smokers (0.86 ± 0.26 vs 1.33 ± 0.38, p=0.02). CPT test using 3T MR imager allows for non-invasive assessment of coronary endothelial dysfunction.

16:48 ***665***. **Reproducible Coronary Vessel Wall Imaging at 3T Using Improved Motion Sensitized Driven Equilibrium (IMSDE).**

Suzanne Gerretsen[1], Jinnan Wang[2,3], Jeffrey H. Maki[3], Caroline Jaarsma[1], Daniel Herzka[4], Boacheng Chu[3], Vasily V. Yarnykh[3], Chun Yuan[3], Tim V. Leiner[1]

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This study investigated the reproducibility of the recently developed improved Motion Sensitized Driven Equilibrium (iMSDE) technique for MR imaging of the coronary vessel wall at 3T. 19 volunteers underwent MRI of the right coronary artery lumen and vessel wall twice. Lumen diameter and vesselwall thickness measurements were performed, and measurements of the two scanning sessions were compared. In 15/19 volunteers two measurements of both coronary lumen and vessel wall were acquired successfully. This study demonstrated that iMSDE is able to visualize the coronary vessel wall of healthy volunteers at 3T with good reproducibility of lumen diameter and wall thickness measurements.

17:00 ***666***. **Correlation of Atherosclerotic Plaque Compositions in Coronary and Carotid Arteries**

Qian Zhao[1], Xihai Zhao[2], Jianming Cai[3], Feiyu Li[2], Jianli Yang[1], Chun Yuan[2], Zulong Cai[3]

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Atherosclerosis has been shown to be a systematic disease which often involves multiple arterial vascular beds. Recently, a number of studies demonstrated that there is a significant correlation between coronary and carotid atherosclerosis. This study sought to evaluate

the association between coronary and carotid plaque compositions. Our results showed coronary plaque types significantly associating with carotid plaque compositions. In particular, coronary mixed plaque might be may be effective classifiers of carotid plaque compositions, especially for carotid IPH.

17:12 ***667***. **Wall Shear Stress as a Stimulus for Intra-Plaque Hemorrhage in Carotid Atherosclerotic Plaque: An MRI-Based CFD Pilot Study**

Gador Canton[1], Huijun Chen[1], Minako Oikawa[2], Hunter R. Underhill[1], Wei Yu[3], Thomas S. Hatsukami[4], Chun Yuan[1], William Sean Kerwin[1]

[1]Radiology, University of Washington, Seattle, WA, United States; [2]Cardiovascular Medicine, Tohoku University, Sendai, Japan; [3]Radiology, Beijing Anzhen Hospital, Beijing, China; [4]Surgery, University of Washington, Seattle, WA, United States

The aim of this study was to explore the hypothesis that intra-plaque hemorrhage, a feature associated with adverse outcomes and atherosclerotic plaque progression, is more likely to occur in plaques with elevated levels of wall shear stress (WSS). We used multi-sequence MRI to characterize seven human carotid atherosclerotic plaques and an MRI-based computational fluid dynamics (CFD) model to solve the equations governing the blood flow. The results from this pilot study indicate a possible link between the presence of hemorrhage within a lipid-rich necrotic core in human carotid atherosclerotic plaques and the shear stress force acting on the luminal surface.

17:24 ***668***. **Identification of Lipid Deposits and Quantification of Carotid Endarterectomy Plaque Components Using High Resolution MRI and Image-Guided Proton MRS at 11.7T**

Haiying Tang[1], Vladimir Reiser[1], Zhi-Qiang Zhang[1], Ting-Chuan Wang[1], Suzanne S. Eveland[1], Zhu Chen[1], Ben T. Chen[1], Edward A. O'Neill[1], Michael Klimas[1]

[1]Merck Research Laboratories, Rahway, NJ, United States

Patients with carotid plaque undergo endarterectomy based on empirical guidelines, primarily the magnitude of stenosis. Patients who would derive benefit from carotid endarterectomy are those with lipid rich, vulnerable plaque at high risk of rupture. We hypothesis that non-invasive MRI technique can provide distinguishable signal features of plaque components such as fibrous tissue, lipid-rich necrotic core, intra-plaque hemorrhages, and calcifications, therefore can help identify at-risk patients preoperatively. The purpose of this study is to demonstrate the capability of MRI and MRS methods for characterizing plaque composition and quantifying lipid deposition, thereby facilitating development of noninvasive, quantitative predictor of plaque stability.

17:36 ***669***. **3D Projection Reconstruction Based Respiratory Motion Correction Technique for Free-Breathing Coronary MRA**

Himanshu Bhat[1], Lan Ge[1], Sonia Nielles-Vallespin[2], Sven Zuehlsdorff[3], Debiao Li[1]

[1]Radiology and Biomedical Engineering, Northwestern University, Chicago, IL, United States; [2]Cardiovascular MR Unit, Royal Brompton And Harefield NHS Foundation Trust, London, United Kingdom; [3]Siemens Medical Solutions USA, Inc., Chicago

Current navigator based free-breathing coronary MRA techniques measure the position of the diaphragm and use a fixed correlation factor to estimate the position of the heart. Such techniques suffer from errors due to the indirect estimation of heart position and are plagued by low scan efficiencies (typically between 30 and 50 %). The purpose of this work was to develop a 3D projection reconstruction (3D PR) based coronary MRA technique which accepts all the data during the scan, irrespective of respiratory position, and retrospectively corrects for respiratory motion by using 3D image registration.

17:48 ***670***. **Multimodality Imaging of Carotid Artery Plaques: 18F-FDG PET, CT, and MRI**

Robert Kwee[1], Gerrit Teule, Robert van Oostenbrugge, Werner Mess, Martin Prins, Rob van der Geest[2], Paul Hofman, Jos van Engelshoven, Joachim Wildberger, Eline Kooi

[1]Maastricht University Medical Center, Maastricht, Limburg, Netherlands; [2]Leiden University Medical Center,Leiden, Netherlands

The present study demonstrated that overall correlations between 18F-FDG PET findings and morphological and compositional CT/MRI findings of carotid plaques are weak. Correlations between CT and MRI findings are moderate-to-strong, but measurements of lipid-rich necrotic core and calcifications are significantly larger at CT, whereas measurements of fibrous tissue are significantly larger at MRI. There is also considerable variation in absolute differences between CT and MRI measurements, implying that CT and MRI are not interchangeable. Future prospective longitudinal studies should determine which imaging modality is most effective for risk stratifying patients for stroke.

Novel Approaches to Image Analysis

Room A9 16:00-18:00 *Moderators:* Babak A. Ardekani and Ting Song

16:00 ***671***. **Ultra Fast Registration of Multiple MR Volumes Using MOPED**

Mark E. Bastin[1], Benjamin D. Panter[2], Robert J. Tweedie[2], William J. Hossack[3], Alan F. Heavens[2]

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Registration is a critical step in the calculation of imaging biomarkers derived from functional, diffusion, perfusion and permeability MRI. These datasets typically comprise many tens of volumes, and contain up to 100 individual images, registration of which leads to a significant computational overhead in the processing pipeline. In this abstract we present initial results from the application of a novel registration method based on the MOPED algorithm, developed in the field of astronomy, which has the potential to reduce significantly the time taken to align high dimensional MRI data.

16:12 ***672***. **Multi-Modal Structural Networks: Mapping of Connectivity Through Diffusion, Functional, and Structural Assessment of Intervening Pathways**

John A. Bogovic[1], Min Chen[1], Aaron Carass[1], Pierre-Louis Bazin[2], Dzung Pham[2], Susan M. Resnick[3], Jerry L. Prince[1,4], Bennett Allan Landman, [4,5]

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Understanding anatomical connectivity and multivariate relationships in neuroimaging data may be essential to elucidate multiple small changes across the brain that combine to manifest in observable phenotypes. While there are powerful tools to assess connectivity through graphs using diffusion weighted MRI (DW-MRI), association of DW-MRI metrics with connectivity necessitates ad hoc choices. Herein, we show how connectivity can be interpreted by multimodal characterization of the tissues through which estimated tracts pass (in addition to metrics on the DW-MRI tracts). We define and compute multi-modal structural networks, which are multivariate graphs representing connectivity among structural regions.

16:24 ***673***. **MR-Based Whole-Body PET Attenuation Correction in Hybrid PET/MRI: A Computationally Inexpensive Algorithm for T1, T2, and Proton Density Weighted Images**

Harry Robert Marshall[1,2], Robert Z. Stodilka, [12], Benoit Lewden[2], Jean Theberge[1,2], Eric Sabondjian, [12], Alexandre G. Legros[2], Andrea J. Mitchell[2], Lela Deans[2], Jane M. Sykes[2], R Terry Thompson, [12], Frank S. Prato[1,2]

[1]Medical Biophysics, The University of Western Ontario, London, ON, Canada; [2]Imaging, Lawson Health Research Institute, London, ON, Canada

Whole-body attenuation correction of PET images remains a crucial unsolved problem in hybrid PET/MRI. We present an algorithm capable of taking any of T1, T2, or proton density weighted MRI images as input and producing a PET attenuation map of comparable quality to a gold standard CT-derived attenuation map. The idea is that no "special" MRI sequences need to be acquired solely for the purposes of attenuation correction. The algorithm was tested on nine low resolution canine images with significant motion artefacts to ensure robustness.
The algorithm ran to completion in under one minute making it practical for clinical use.

16:36 ***674***. **MRI Measurement of Ischemic Brain Penumbra Using an Inelastic Collision Model**

Hassan Bagher-Ebadian[1,2], Panayiotis D. Mitsias[1], Mohammad Hossein Asgari[1], Michael Chopp[1,2], James Russel Ewing[1,2]

[1]Department of Neurology, Henry Ford Hospital, Detroit, MI, United States; [2]Department of Physics, Oakland University, Rochester, MI, United States

Experimental and clinical studies indicate that the likelihood for progression to infarction in the penumbra of physiologically impaired but potentially salvageable tissue surrounding the central core of focal cerebral ischemia is an important factor in evaluating treatment efficacy. Thus, a multi-parametric analysis that increases the ability of investigators to detect and characterize ischemic penumbra in the early stages of stroke have a profound clinical significance. In this study, a mechanical model of inelastic collision is recruited and adapted to information theory for constructing a model-based algorithm for multi-parametric analysis of MR information in acute stroke to detect ischemic brain penumbra.

16:48 ***675***. **A General Framework for the Analysis of Vessel Encoded Arterial Spin Labelling**

Michael A. Chappell[1,2], Tom W. Okell[1], Peter Jezzard[1], Mark W. Woolrich[1]

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Vessel Encoded ASL offers non-invasive vascular territory images. By spatially modulating the ASL label over a series of acquisitions blood from individual arteries is uniquely encoded such that its contribution can subsequently be extracted in the analysis.

We propose a framework for the analysis of VE-ASL that combines the advantages of the two leading analysis approaches and is able to estimate perfusion even in areas supplied by multiple arteries in the face of limited data quality and quantity.

17:00 ***676***. **In Vivo Myelin Water Imaging Using 3D Multi-Gradient-Echo Pulse Sequences**

Claudia Lenz[1], Klaus Scheffler[1], Markus Klarhöfer[1]
[1]Radiological Physics, University of Basel Hospital, Basel, Switzerland

Quantitative imaging of the myelin water fraction (MWF) is able to show demyelinating processes and therefore provides insight into the pathology of white matter diseases such as multiple sclerosis. So far, mapping of the MWF most often was performed using single-slice multi-echo spin-echo sequences. Lately, a different approach, using multi-gradient-echo pulse sequences, was introduced by one study measuring formalin-fixed brains and has been adapted to in vivo measurements by different groups since then. In this work, we present a solution for 3D in vivo myelin water imaging with whole brain coverage by applying multi-gradient-echo pulse sequences and using a non-negative least squares algorithm to analyze the T2* decay.

17:12 ***677***. **Inferring Axon Properties with Double-PGSE MRI Using Analytical Water Diffusion Model**

Wenjin Zhou[1], David H. Laidlaw[1]
[1]Computer Science, Brown University, Providence, RI, United States

We present an analytical water diffusion model for inferring axon properties using double-PGSE MRI accounting for finite gradient pulses. Our estimation results demonstrate the feasibility of revealing axon properties including axon caliber using this approach. The model utilizes the signal intensity dependency on two gradient-pair direction variation to compensate for high-q requirement in single-PGSE experiments. Since many gradient directions can be acquired in rather short time on the current MRI scanner, this approach may suggest potential for clinical axonal-property estimation.

17:24 ***678***. **A Rapid, Robust, Anatomy and Atlas Guided Lesion Quantification Framework from Diffusion Weighted MR Images**

Sumit K. Nath[1], Dattesh Dayanand Shanbhag[1], Rakesh Mullick[1], Uday Patil[1], Marie Luby[2], Katherine D. Ku[2], Lawrence L. Latour[2], Steven Warach[2], - NINDS Natural History of Stroke Investigators[2]
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A novel anatomical and atlas guided split-and-merge algorithm is presented for quantifying potential lesions in diffusion weighted MR images. Compared with a conventional non split-and-merge method, our approach leads to highly improved results when analyzed with ground truth.

17:36 ***679***. **Robust Automatic Rodent Brain Extraction Using Pulse-Coupled Neural Networks in 3D**

Nigel Chou[1], Jolena Tan[1], Asad Abu Bakar Md Ali[1], Kai-Hsiang Chuang[1]
[1]Laboratory of Molecular Imaging, Singapore Bioimaging Consortium, Agency for Science, Technology and Research (A*STAR), Singapore, Singapore

We present an automatic brain-extraction algorithm optimized for rodents, based on a pulse-coupled neural network (PCNN) operating in 3D. PCNN 'links' pixels with similar intensity, then a morphological operation is used to separate regions, of which the largest is selected as the brain mask. Using Jaccard index and True-positive Rate as a measures of similarity to a manual gold-standard, this method showed improved performance compared to an existing algorithm (Brain Surface Extraction) and a PCNN algorithm operating in 2D mode (on slices). Additional advantages include reduced user intervention and accurate segmentation of the olfactory bulb and paraflocculus of cerebellum.

17:48 ***680***. **Non-Invasive and Temporally Resolved Measurement of Ischaemic Tissue Damage in Acute Stroke Using Quantitative ^{23}Na Magnetic Resonance Microscopy at 7 T**

Friedrich Wetterling[1], Lindsay Gallagher[2], Mhairi I. Macrae[3], Sven Junge[4], Andrew John Fagan[5]
[1]School of Physics, Trinity College Dublin, Dublin, Ireland; [2]Glasgow Experimental MRI Centre, , Division of Clinical Neuroscience, Faculty of Medicine, University of Glasgow, Glasgow, Scotland, United Kingdom; [3]Glasgow Experimental MRI Centre, Division of Clinical Neuroscience, Faculty of Medicine, University of Glasgow, Glasgow, Scotland, United Kingdom; [4]Bruker BioSpin GmbH, Ettlingen, Germany; [5]Centre for Advanced Medical Imaging, St. James's Hospital, Dublin, Ireland

In the current study, quantitative ^{23}Na Magnetic Resonance Microscopy (qNa MRM) was used to measure the time course of Tissue Sodium Concentration (TSC) in order to investigate regional variations in TSC behavior in the first 8 hours after stroke in a rodent model. The timecourse of the TSC evolution was reproducible (n=5) with similar regional delays evident in the timepoint at which the TSC increased during the first hours after MCAO in each rat. The delay time parameter could be used as a measure of ischaemic core tissue growth, non-invasively and temporally resolved, thereby offering an alternative method to post-mortem histology.