Electronic Posters: Musculoskeletal

Cartilage

Hall B Monday 14:00-16:00

Computer 1

14:00  3164. Longitudinal T1ρ MRI of Adults with Chondromalacia Following Arthroscopy
Matthew Fenty1, Walter RT Witschey2, Ari Borthakur2, Kalli Grasley2, John Bruce Kneeland3, Jess Lonner4, Ravinder Reddy2
1Center for Magnetic Resonance and Optical Imaging, University of Pennsylvania School of Medicine, Philadelphia, PA, United States; 2Center for Magnetic Resonance and Optical Imaging, University of Pennsylvania School of Medicine, Philadelphia, PA, United States; 3Radiology, Pennsylvania Hospital, Philadelphia, PA, United States; 43B Orthopaedics, Pennsylvania Hospital, Philadelphia, PA, United States

The objective of this study was to measure the longitudinal changes in chondromalacia cartilage T1ρ MRI over a period of 9 months following arthroscopy.

14:30  3165. T1ρ MRI of Menisci and Cartilage in Mild Osteoarthritis Patients at 3T
Ligong Wang1, Gregory Chang1, Michael Recht1, Ravinder R. Regatte1
1NYU Langone Medical Center, New York, NY, United States

The purpose of this study was to assess T1ρ values of cartilage and menisci in patients with mild osteoarthritis (OA) at 3T. Mild OA patients (K-L Score=2, n=15) were scanned. There are significant differences in T1ρ relaxation times between femoral-tibial cartilage and the meniscus (anterior, central, and posterior) in both lateral and medial compartments (P < 0.001). T1ρ relaxation time of the central meniscus was also increased in the medial compared to lateral compartment (P = 0.033). These data could serve as useful reference standards in future studies and suggest that T1ρ MRI might provide useful information about meniscal involvement in OA pathogenesis.

15:00  3166. Pseudo Steady State Fast Spin Echo Acquisition for Quantitative 3D T1ρ Imaging
Weitian Chen1, Reed F. Busse2, Ann Shimakawa1, Eric T. Han1
1MR Applied Science Lab, GE Healthcare, Menlo Park, CA, United States; 2MR Applied Science Lab, GE Healthcare, Madison, WI, United States

Three-dimensional T1ρ imaging is promising in a number of clinical applications. We present a 3D T1ρ imaging method based on pseudo steady fast spin echo acquisition. High SNR and scan efficiency are demonstrated using in-vivo scan. Unlike the other existing 3D T1ρ imaging methods, no prior knowledge of tissue properties are required for the presented method.

15:30  3167. The Relationship Between T1ρ Measurements in the Meniscus and Cartilage in Healthy Subjects and Patients with Osteoarthritis
Zinta Zarins1, Radu Bolbos1, Jean-Baptiste Piallat1, Thomas Link1, Xiaojuan Li1, Sharmila Majumdar1
1Radiology, UC San Francisco, San Francisco, CA, United States

The purpose of this study was to investigate the relationship between T1ρ measurements in cartilage and meniscus using quantitative MRI. Our study involving 64 subjects (including both healthy subjects and patients with osteoarthritis) found that 48% of the subjects had a meniscal tear, with the incidence being highest in the posterior medial horn. Despite these findings, we did not find a significant correlation between the T1ρ cartilage and the posterior medial horn of the meniscus. However, significant correlations were found between the T1ρ of the lateral meniscus and the cartilage sub compartments.

Tuesday 13:30-15:30

Computer 1

13:30  3168. Sodium Imaging of Patients After Matrix-Associated Chondrocyte Transplantation at 7 Tesla: Preliminary Results and Comparison with DGEMRIC at 3 Tesla
Siegfried Trattnig1, David Stelzeneder1, Vladimir Juras2, Pavol Szomolanyi1,2, Goetz Hannes Welsch1,2, Tallal Charles Mamisch3, Stefan Zbyn1
1MR Centre - High field MR, Department of Radiology, Medical University of Vienna, Vienna, Austria; 2Department of Imaging Methods, Institute of Measurement Science, Slovak Academy of Sciences, Bratislava, Slovakia; 3Department of Trauma Surgery, University Hospital of Erlangen, Erlangen, Germany; 4Department of Orthopedic Surgery, Inselspital, Bern, Switzerland

The feasibility of sodium imaging in 12 patients after matrix-associated autologous chondrocyte transplantation was demonstrated at 7 Tesla. The repair tissue was well delineated on sodium imaging at 7T and with one exception lower normalized sodium values and thus a lower glycosaminoglycan content was found in the repair tissue compared to healthy cartilage as a reference. A good correlation between normalized sodium values at 7T and postcontrast T1 relaxation time values at 3T was found. Sodium imaging at 7T is a promising tool in the monitoring of the maturation of repair tissue after matrix-associated autologous chondrocyte transplantation.
The recently described 3D-magnetic resonance observation of cartilage repair tissue (MOCART) score was prepared by standard MR sequences, by an isotropic PDs-weighted 3D-TSE-sequence (PD-SPACE), and by an isotropic 3D-steady-state-free-precession sequence (True-FISP) to assess correlations in the diagnostic performance of the different sequences in post-operative articular cartilage imaging. Although all sequences were able to assess cartilage repair tissue after matrix-associated autologous chondrocyte transplantation, the isotropic sequences with the possible multiplanar-reconstruction provided more information in less time. The PD-SPACE sequence seems slightly superior to the True-FISP sequence due to a better performance in the depiction of the subchondral bone and less artifacts.

The aim of this study was to use a recently described double-echo at steady-state (DESS-T2d) approach in an initial study to assess the morphological Magnetic-resonance Observation of Cartilage Repair Tissue (MOCART) score as well as biochemical T2-values in patients after matrix-associated autologous chondrocyte transplantation of the knee by only one sequence. The results show a good correlation in between standard morphological and multi-echo spin-echo quantitative T2 and the new DESS-T2d approach. Hence the may attract for the clinical use of biochemical MRI.

Objective was to compare T2/T2* relaxation times from patients with osteochondrosis dissecans of the talus and healthy volunteers at 3T. The MR protocol consisted of a PD TSE sequence, and a 3D isotropic TrueFISP sequence. T2 relaxation times were obtained from the multi-echo spin-echo sequence, T2* maps were reconstructed from a sagittal GRE sequence. ROI analysis revealed significant higher T2/T2* values in patients with OCD compared to healthy volunteers. Quantitative T2/T2* mapping is a promising method to provide further information about the physiological status of the cartilage overlying an OCD and may improve the radiological staging.

The reproducibility of morphometric, T1rho, and T2 cartilage biomarkers was evaluated in a multi-site, multi vendor clinical trial. 53 subjects were evaluated during 4 separate MRI sessions to calculate intraclass correlation coefficient (ICC). MRI measurements of cartilage morphometry are highly reproducible in a multi-center/multi-vendor trial. Subregional T1rho analysis has poor reproducibility. Improved reliability is obtained when T1rho analysis is performed using data obtained using the full thickness of the cartilage, allowing analysis at the level of the cartilage plate. Cartilage T2 mapping is sufficiently reproducible to allow for subregional analysis based on depth from articular surface.
Sodium imaging in articular cartilage may be an indicator of osteoarthritis progression. In this work we sought to assess the reproducibility of this technique. Using a dual tuned 1H/23Na quadrature volume coil, 3D DESS proton images and 3D-cones short echo time sodium images were acquired in the same scan session, which was repeated for 11 subjects. DESS images were segmented, and the resulting ROIs were applied to the co-registered sodium images. The technique showed good repeatability: the interclass correlation coefficient for sodium was 0.88 (0.6 – 0.97) and the percent coefficient of variation was 4.2% (2.9%-7.3%).

The aim was to study association of knee cartilage abnormalities and T2-relaxation-time-measurements at baseline and 24 months, using 3T MRI and physical activity levels obtained in 182 asymptomatic subjects aged 45-55 years from the Osteoarthritis Initiative. Cartilage T2 increased significantly over time. Subjects with cartilage abnormalities and higher physical activity had higher T2 at baseline and follow-up and higher increase in T2 over time compared to more sedentary subjects. Interestingly cartilage lesions and higher physical activity induced accelerated cartilage-matrix changes. These results suggest that T2 mapping may be an useful quantitative parameters to assess longitudinal changes in early OA.

We qualitatively and quantitatively compared 6 new three-dimensional (3D) magnetic resonance (MR) methods for evaluating knee cartilage at 3.0T: Fast-spin-echo Cube (FSE-Cube), Vastly undersampled isotropic projection reconstruction balanced steady-state free precession (VIPR-bSSFP), Iterative decomposition of water and fat with echo asymmetry and least-squares estimation combined with spoiled gradient echo (IDEAL-SPGR) and gradient echo (IDEAL-GRASS), Multi-echo in steady-state acquisition (MENSA), and Coherent Oscillatory State Acquisition for Manipulation of Image Contrast (COSMIC). Five-minute sequences were performed twice on 10 healthy volunteers, and once on 5 osteoarthritis (OA) patients. FSE-Cube and VIPR-bSSFP produced high image quality with accurate volume measurement of knee cartilage.

Univariate classification, as is implicitly used in analyses of cartilage matrix using MRI parameters, exhibits limited ability to discriminate between control and degraded tissue. In view of these limitations, we undertook a multivariate support vector machine (SVM) analysis of bovine nasal cartilage (BNC) samples with pathomimetic degradation using trypsin and collagenase. Our current results, that the sets (T1, k2), (T1, T2, k2) and (T1, k2, ADC) exhibit particularly favorable classification properties, are consistent with our previous study, indicating that these parameter combinations may emerge as particularly useful in multivariate cartilage matrix characterization.
Dynamics of Contrast Agent Enhancement of Intact and Enzymatically Degraded Articular Cartilage

Elli-Noora Salo1, Mikko J. Nissi1,2, Katariina Aino Maria Kulmala1, Juha Töyräs1,3, Miika T. Nieminen4,5
1Department of Physics, University of Kuopio, Kuopio, Finland; 2Department of Clinical Radiology, Kuopio University Hospital, Kuopio, Finland; 3Diagnostic Imaging Centre, Kuopio University Hospital, Kuopio, Finland; 4Department of Medical Technology, University of Oulu, Oulu, Finland; 5Department of Diagnostic Radiology, Oulu University Hospital, Oulu, Finland

The dGEMRIC method is sensitive in detecting proteoglycan depletion in cartilage. The aim of this study was to investigate the kinetics of gadopentetate contrast agent in intact and enzymatically degraded cartilage. Diffusion of gadopentetate was followed for 18 hours in bovine cartilage with T1 mapping at 9.4 T. A relatively small difference in diffusion kinetics was observed between intact and degraded samples, although larger uptake of contrast agent was observed in degraded samples. Maximum contrast between intact and degraded superficial cartilage is reached at an early stage, suggesting that visualization of degenerative changes may be possible prior to full equilibration.

Collagen in Native, Undigested Human Patella Cartilage Is Predicted by a Combination of T2 and T1ρ Relaxation Times

Kathryn E. Keenan1, R L. Smith2, Eric Han3, Scott Delp,1,4 Gary S. Beaupre,1,5, Garry E. Gold,1,4,6
1Mechanical Engineering, Stanford University, Stanford, CA, United States; 2Department of Orthopedic Surgery, Stanford University, Stanford, CA, United States; 3Applied Science Lab, GE Healthcare, Menlo Park, CA, United States; 4Bioengineering, Stanford University, Stanford, CA, United States; 5Bone & Joint R&D Center, VAHCS, Palo Alto, CA, United States; 6Radiology, Stanford University, Stanford, CA, United States

T2 and T1ρ relaxation times are combined in a linear model to predict the naturally occurring collagen content variation in the patella of human cadaver specimens that were not chemically digested.

T2 Signal and Orientation Changes Are Early Indicators of Cartilage Degeneration

Kelsey Mairead Mountain1,2, Tadeusz Foniok3, Jeff Dunn,1,3, John Robert Matyas,2,4
1Biomedical Engineering, University of Calgary, Calgary, Alberta, Canada; 2McCaig Institute for Bone and Joint Health, Calgary, Alberta, Canada; 3National Research Council Canada, Calgary, Alberta, Canada; 4Faculty of Veterinary Medicine, University of Calgary, Calgary, Alberta, Canada

The superficial zone of articular cartilage is a dense network of ordered collagen fibres running parallel to the articular surface. The initial histopathological changes of osteoarthritis (OA) occur at this surface; and if detected, could provide insight into OA progression. High-field MRI can detect collagen organization based on changes in T2 relaxation. In this study, T2 was used to assess articular cartilage surface collagen in an animal model of osteoarthritis.

Meniscus & Cartilage

Meniscus & Cartilage

Hall B Monday 14:00-16:00 Computer 2

Infrastructure of Menisci with Mr Imaging

Patrick Omoumi1, Graeme Bydder1, Richard M. Znamirowski1, Jiang Du1, Sheronda S. Statum1, Christine B. Chung1
1University of California, San Diego, San Diego, CA, United States

The non-invasive MR imaging analysis of meniscal infrastructure has not yet been described due to the relatively short T2 properties of this tissue, resulting in lack of signal and contrast with conventional MR techniques. This infrastructure includes 5 different fiber orientations (circumferential, radial, tie, vertical and lamella fibers). Four functional and anatomical zones are also distinguished within meniscal substance: a central fibrocartilaginous portion, a peripheral fibrous portion, a central vascular white zone, and a peripheral vascularized red zone. We show that with the appropriate coil and parameters, MR imaging can show this on a clinical 3T scanner.

Optimization of Human Meniscus Imaging Using Minimal Phase RF Pulse

Ping-Huei Tsai1, Hsiao-Wen Chung1, Teng-Yi Huang2
1Graduate Institute of Biomedical Electronics and Bioinformatics, National Taiwan University, Taipei, Taiwan; 2Department of Electrical Engineering, National Taiwan University of Science and Technology, Taipei, Taiwan

Human meniscus is one of the important tissues related to the maintenance of the performance of knee joint, which plays a critical role in the normal biomechanics. The purpose of this study is to improve the zonal image contrast of human meniscus via imaging at moderately short TE using minimal phase RF pulse with optimized rephasing gradient.
Deformations of collagen matrix in compressed articular cartilage have been well assessed by various microscopic studies. A crimping in the samples with an intact surface layer was observed. In the present work we evaluated the pressure-dependent changes of collagen in arthritic-altered cartilage because of destruction of the strain-limiting tangential layer. In particular, a chevron-type shear discontinuity and a bending of collagen fibres were observed. However, the deformation behavior seems to be different in health compared to osteoarthritis.

We investigated the Gd-DTPA(2-) enhancement kinetics within the menisci of the knee joint over a period of 9 hours in six healthy volunteers. T1-weighted spin-echo sequences were obtained in half-hour intervals at 3.0 Tesla. Menisci were divided into a peripheral zone (outer one-third; vascularized “red zone”), and a central zone (inner two-thirds; moderately vascularized “intermediate zone”, and avascular “white zone”). In the peripheral zones, the enhancement occurred more rapidly than in the central zones. We observed the strongest enhancement between 3 and 4 hours after contrast media application. This time interval may thus be suitable for dGEMRIC of the menisci.

We developed and tested the feasibility of a new dynamic imaging method for kinematic measurement of the knee joint. One subject was scanned using a validated static method, as well as using modified (fast) static and dynamic methods under load and over a range of motion. Differences between the standard and fast static methods were within expected errors. The dynamic method provided more data in a shorter time, and produced similar results to the static scans. The results of this work indicates that this is a viable new method for measuring the kinematic rotations and translations of the knee bones.

Cartilage strain is discussed as potential cause for degeneration and osteoarthritis. Dimension of global/regional cartilage deformation and its distribution in knee cartilage after kneeling/squatting were evaluated. Detected small global cartilage deformation laid within the magnitude of change after common daily exercise/sports, consistent with biomechanical examinations. 3D-volumetry enable anatomy- and individuum-specific analysis by detailed depiction of regional deformation, while global parameters tend to average out...
local changes leading to underestimation of changes. Data indicate areas of deformation across the joint surface and might serve as a base for comparison to degenerative changes in patients and for the development of biomechanical models.

15:00  
**3187. Evaluation of Cartilage T2 Using Loading in Situ MRI in Patients with Knee Injuries**  
Takashi Nishii1, Toshiyuki Shiomi2, Hisashi Tanaka3, Ken Nakata4, Kenya Murase4, Youichi Yamazaki4, Hideki Yoshikawa4, Nobuhiko Sugano1  
1Department of Orthopaedic Medical Engineering, Osaka University Medical School, Osaka, Japan;  
2Department of Orthopaedic Surgery, Osaka University Meidal School; 3Department of Radiology, Osaka University Meidal School; 4Department of Medical Physics & Engineering, Osaka University Meidal School

Knee cartilage T2 with use of loading in situ MR imaging (50% of body weight) was evaluated in 9 patients with knee injuries and 4 normal volunteers, for evaluation of cartilage pressure distribution in vivo. There was significantly larger decrease of T2 by loading at the superficial zone of the medical femoral cartilage in knees without meniscus tear than knees with meniscus tear (p<0.05). Assuming that decrease of T2 is correlated with amount of compressive loading, loading in situ MR imaging with T2 assessment may allow biomechanical assessment of pathological conditions in the cartilage of patients with knee injuries.

Wednesday 13:30-15:30  
**Computer 2**

13:30  
**3188. Quantitative Reproducibility Initial Study of T1 Rho at 3T**  
David W. Stanley1, Kameron R. Shahid2, Joel P. Felmlee2, Kimberly K. Anrami2, Eric T. Han2, Dan W. Rettmann2  
1MR, GE Healthcare, Proctor, MN, United States; 2Radiology, Mayo Clinic, Rochester, MN, United States; 3Applied Science Laboratory, GE Healthcare, Menlo Park, CA, United States; 4Applied Science Laboratory, GE Healthcare, Rochester, MN, United States

Osteoarthritis is a prevalent degenerative joint disease, with radiographic disease in 80% of people over the age of 75. High field-strength MRI and new techniques, such as T1h, may provide a more sensitive means of assessing the degree of early damage to cartilage than plain film radiography or conventional MRI. The goal of this study is to determine the initial reproducibility and reliability of T1h mapping at 3-Tesla and determine the feasibility as a clinical tool. Reproducibility was studied sequentially on one machine as well as over time on multiple machines. These data are important to assure that accurate measurements are obtained and to determine if an external reference must be routinely evaluated for scanner calibration purposes.

14:00  
**3189. Age Dependent Modulation of Aggrecan in Human Knee Cartilage Measured Via Sodium MRI at 7T**  
Victor Babu Kassey1, Adam Shore1, Hari Hariharan1, Ganapathy Ramanathan1, Sonia N. Vallespin2, Thomas Connick1, Anup Singh1, Ravinder Reddy1  
1Center for Magnetic Resonance and Optical Imaging, Department of Radiology, University of Pennsylvania, Philadelphia, PA, United States; 2Cardiovascular MR Unit, Royal Brompton and Harefield NHS Foundation Trust, Chelsea, London, United Kingdom

In the present work, we determined the age dependent variation of molecular changes in human knee cartilage via sodium MRI at ultrahigh fields. Aggrecan has been shown to undergo predominant change in early OA. More than 80% of population over 65 years of age experience pain due to knee OA. Using sodium MRI, we investigated the natural, age dependent molecular changes in the healthy human knee cartilage in vivo. These preliminary results demonstrate that it is feasible to obtain sodium maps of human knee in-vivo at 7T and quantify age dependent molecular changes in knee cartilage of healthy human subjects.

14:30  
**3190. The Transport of Anionic and Nonionic MRI Contrast Agents Into Human Hip Cartilage**  
Eveliina Lammentausta1, Samo Lasic2, Daniel Topgaard2, Olle Söderman2, Leif E. Dahlberg1  
1Department of Clinical Sciences, Malmö, Joint and Soft Tissue Unit, University of Lund, Malmö, Sweden; 2Department of Physical Chemistry, University of Lund, Lund, Sweden; 3Department of Orthopaedics, Malmö University Hospital, Malmö, Sweden

The aim of the study was to investigate the distribution of ionic and non-ionic contrast agent in human hip cartilage. T1 relaxation time of osteochondral plugs were measured before and regularly after the exposure to the contrast agent until ten hours. Significant difference between the two contrast agents was observed. The amount of ionic contrast agent was considerably smaller compared to non-ionic, especially in deep cartilage. Ionic contrast agent reached equilibrium, whereas the amount of non-ionic contrast agent kept increasing even after ten hours. This suggests that maximum uptake of ionic contrast agent is controlled by the properties of cartilage.
The Application of Magnetization Transfer Ratios and T2 Relaxation Time to Patellar Articular Cartilage at 3T

Shuji Nagata1, Kimberly K. Amrami2, David W. Stanley3, Steven L. Williams2, Marilyn M. Wood2, Joel P. Feelmee2, Masafumi Uchida4, Naofumi Hayabuchi1

1Radiology, Kurume University Hospital, Kurume, Fukuoka, Japan; 2Radiology, Mayo Clinic, Rochester, MN, United States; 3GE Healthcare, Milwaukee, WI, United States

The aims of this study are to compare T2 relaxation time and MTR and determine whether MTR map is useful to depict degeneration of patellar articular cartilage as well as T2 map or not. There was a good negative correlation between T2 relaxation time and MTR. MTR map could be useful to depict early degeneration of cartilage as well as T2 mapping and has a potential as an adjunct to T2 relaxation time in early diagnosis of OA.

Thursday 13:30-15:30

Detecting Statistically Significant Changes in Cartilage Thickness with Sub-Voxel Precision

José G. Raya1, Annie Horng2, Lorenz König3, Maximilian F. Reiser2, Christian Glaser2

1Josef Lissner Laboratory for Biomedical Imaging, University of Munich, Munich, Germany; 2Department of Clinical Radiology, University of Munich; 3Technical University of Munich

MRI-based quantification of the cartilage thickness is a robust and well validated technique for the assessment of cartilage degradation in osteoarthritis, and for the analysis of cartilage deformations after exercise. Nowadays changes in cartilage thickness are evaluated by comparing averaged thickness over regions defined on an anatomical basis. In this work we demonstrate that working with a sub-voxel precision allow detecting statistically significant changes in the cartilage thickness between longitudinally acquired datasets with sub-voxel precision. The method has been tested on a small group of healthy volunteers by measuring them before and after 20 min squatting.

Semi-Automated Profile Generation for Functional Cartilage Imaging

Daniel Ross Thedens1, Noelle F. Klocke2, Annunziato Amendola2, Douglas R. Pedersen2

1Radiology, University of Iowa, Iowa City, IA, United States; 2Orthopaedics and Rehabilitation, University of Iowa, Iowa City, IA, United States

A comprehensive assessment of cartilage function may use multiple quantitative techniques such as T2, T1ρ, and dGEMRIC, and may follow the subject over multiple time points. The purpose of this study was to develop a semi-automated technique to generate accurate and reproducible line profiles along the joint surface of the knee for T2, T1ρ, and dGEMRIC to permit direct registration, comparison, and correlation between functional cartilage imaging methods. This work demonstrates the feasibility of an edge-based line growing technique to generate anatomical correspondence between multiple modalities and time points to directly correlate and contrast the measurements from each.

Does Sub-Regional Analysis of DGMERIC Allow for Improved Sensitivity?

Wei Li1, Pottumarthi V. Prasad1

1Radiology, NorthShore University HealthSystem, Evanston, IL, United States

A recent report suggested sub-regional differences in δR1 following Gd-DTPA2−. We have reanalyzed data from a previous report to compare sub-regional analysis against full thickness analysis. We found higher T1pre- and lower T1Gd in the superficial layer compared to full thickness analysis, resulting in a higher δR1. Our preliminary experience supports the use of superficial layer for routine use which potentially could improve the sensitivity, although the present data only showed a modest increase. It is not clear if there is a need to analyze the deep layer for routine use. Some technical limitations regarding sub-regional analysis are discussed.

The Improvement of Region-Of-Interest Statistics in Musculoskeletal MRI

Vladimir Juras1,2, Stefan Zbyn1, Pavol Szomolanyi1,2, Ivan Frollo3, Siegfried Trattnig1

1MR Centre of Excellence, Medical University of Vienna, Vienna, Austria; 2Institute of Measurement Science, Slovak Academy of Sciences, Bratislava, Slovakia

The advanced statistics in region-of-interest based cartilage MRI is introduced. Correction parameters were determined as the fitting errors estimates (R2, RMSE, MSE, MAE) from non-linear least square fitting calculation of T2. Functionality of improved statistics was tested on noise-simulated images. Using the error estimates as a weighting parameters in the ROI evaluation in musculoskeletal MRI may crucially improve the differentiation of native and transplant cartilage tissue even in images suffering of low SNR. This has a great potential to improve the non-invasive monitoring of the post-operative status of patients with cartilage transplants using MR systems with lower B0.
Quantifying Proton Density in Cortical Bone In-Vivo by 3D Ultra-Short Echo-Time Imaging

Hamidreza Saligheh Rad, Shing Chun Benny Lam, James Love, Jeremy F. Magland, Felix W. Wehrli

1Laboratory for Structural NMR Imaging, Department of Radiology, University of Pennsylvania Health System, Philadelphia, PA, United States

The impaired strength of osteoporotic cortical bone is largely a consequence of increased porosity, which manifests in increased bone water fraction. Hence, knowledge of bone water (BW) content would provide an indirect measure of pore volume fraction. Surface interactions in the tight spaces of the lacuno-canalicular system shorten the lifetime of the BW proton signal to less than 1msec, therefore requiring solid-state imaging techniques for its capture and detection. In this work, we developed new ultra-short echo-time (UTE) radial imaging acquisition and processing capabilities for precise quantification of BW in cortical bone.

Osteoarthritis: Regional and Subregional Quantitative Assessment of Trabecular Bone Micro-Architecture Via 7T MRI

Gregory Chang, Klaus M. Friedrich, Ligong Wang, Graham C. Wiggins, Michael Recht, Guoyuan Liang

1Radiology, NYU Langone Medical Center, New York, NY, United States; 2Radiology, Medical University of Vienna, Austria; 3Radiology, NYU Langone Medical Center, New York, United States; 4Electrical and Computer Engineering, Iowa City, IA, United States; 5Radiology and Electrical & Computer Engineering, Iowa City, IA, United States

In this study, we performed a regional and subregional quantitative assessment of trabecular bone micro-architecture of the knee in subjects with osteoarthritis (OA) using high spatial resolution MRI at 7 Tesla. OA subjects demonstrated decreases in numerous parameters of trabecular bone morphology and topology compared to healthy controls. Subregional analyses within the medial femoral condyle, lateral femoral condyle, medial tibial plateau, and lateral tibial plateau allowed the detection of smaller geographic areas of abnormal trabecular bone micro-architecture in OA subjects. This technique may allow more accurate characterization of the spatial distribution of the pathologic changes in the osteoarthritic knee.

Diffusion Tensor Imaging (DTI) as a Probe to Measure Trabecular Bone Orientation In-Vivo

Bailliang Chen, Pierre-André Vuissoz, Amaka Okafor, Martin Fry, Andrew Todd-Pokropek

1Medical Physics and Bioengineering, University College London, London, United Kingdom; 2IADI, Nancy-Université, Nancy, France; 3'U947, INSERM, Nancy, France; 4Academic Unit of Child Health, Sheffield Children's NHS Foundation Trust, Sheffield, United Kingdom

Trabecular bone orientation, together with bone mineral density, plays an important role in evaluating bone quality. This structural information is also a key parameter in bridging bone mechanical behaviour at a macro-scale and its functional adaptation at a cellular scale. Trabecular bone can be considered as a typical porous media. Through anisotropic diffusion within red marrow, DTI can be used as a probe of trabecular bone orientation in-vivo. Here, we present the current results of our in-vivo studies applying DTI to humanibia, its reproducibility and the technique’s ability to reveal trabecular network orientation at a micro-scale.

T2 and T1p Quantification of Cortical Bone in Vivo Using Ultrashort TE (UTE) Pulse Sequences

Jiang Du, Atsushi Takahashi, Michael Carl, Mark Bydder, Nikolaus Szeverenyi, Christine Chung, Graeme Bydder

1Radiology, University of California, San Diego, CA, United States; 2Global Applied Science Laboratory, GE Healthcare Technologies, Menlo Park, CA, United States

Conventional magnetic resonance sequences produce a signal void for cortical bone. By combining half pulse excitation, radial ramp sampling, and fast transmit receiver switching, an ultrashort TE of 8 μs can be achieved for bone imaging and quantification of T1 and T2*. Measurement of T2 and T1p relaxation times in cortical bone may help evaluate bone quality. Here we present techniques to quantify T2 and T1p relaxation times of the cortical bone in vivo on a clinical 3T MR system.

Tuesday 13:30-15:30

Water Diffusion Behavior in Bone Marrow

Silvia De Santis, Silvia Capuani

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Bone-Marrow is found in both diaphysis, where it is free, and in spongy bone, where it fills the pores of the bone-matrix. The diffusion of water contained in the bone-marrow can be investigated by means of the γ exponent, which quantifies the deviation from the ideal Gaussian diffusive conditions. The diffusion behaviour of water in free bone-marrow samples is characterized by γ very close
to unity. Conversely, in trabecular bone marrow the internal gradients at the interface between bone and bone-marrow affect the spin diffusion causing a deviation from the Gaussian behaviour, and $\gamma$ values smaller than unity are observed.

**14:00 3201. Assessment of Bone Marrow Oxygenation Based on T2* and T2 Changes Following Oxygen Inhalation**

*David K W Yeung¹, James F. Griffith¹, Yi-xiang Wang¹, Jing Yuan¹, Queenie Chan², Heather T. Ma¹*

¹Diagnostic Radiology and Organ Imaging, The Chinese University of Hong Kong, Shatin, N.T., Hong Kong; ²MR, Philips Healthcare, Wanchai, Hong Kong

Marrow mesenchymal stem cells can differentiate along osteoblastic, adipocytic or haematopoietic cell lines. Whether a shift occurs in stem cells differentiation in osteoporosis is unknown. Iron-rich red marrow influences T2* and fat-rich yellow marrow affects T2. Our goal was to verify whether breathing oxygen may reduce the amount of deoxyhemoglobin (paramagnetic) in marrow constituents thereby prolonging both T2* and T2. Our results showed that, for the first time, both T2* and T2 of bone marrow increased after oxygen inhalation. The larger $\delta T2*$ compared to $\delta T2$ might reflects a higher oxygen demand in the red marrow than the yellow marrow.

**14:30 3202. Kinetic Study of Bone Marrow Perfusion Using Arterial Spin Labeling**

*Heather Ting Ma¹², Jing Yuan¹, David K. Yeung¹, Yi-Xiang Wang¹, James Francis Griffith¹*

¹Department of Diagnostic Radiology and Organ Imaging, The Chinese University of Hong Kong, Shatin, N.T., Hong Kong; ²Electronic and Information Engineering Department, Harbin Institute of Technology Shenzhen Graduate School, Shenzhen, China

Varied bone marrow perfusion function in some bone diseases has been identified by dynamic contrast enhancement (DCE) MRI. This pilot study explored a non-invasive and quantitative method, combining kinetic model and arterial spine labeling (ASL) technique, to study bone marrow perfusion at lumbar spine. A turbo field echo (TFE) acquisition with STAR labeling (STAR-TFE) was developed for better imaging compared to STAR-EPI. A kinetic model was applied on the ASL signal to provide a quantitative measure of perfusion function. The result shows that ASL combined with kinetic modeling is promising for quantitative study the perfusion in bone marrow.

**15:00 3203. Magnetisation Transfer Contrast of Bone Marrow Oedema in Arthritis**

*Carole Burnett¹, Jill Halstead-Rastrick², Heidi Siddle, Robert Evans, Anthony Redmond³, Richard Hodgson³*

¹LMBRU, Chapel Allerton Hospital, Leeds, United Kingdom; ²Leeds University, United Kingdom; ³University of Leeds

18 patients with arthritis and foot pain were imaged using T2 fat-saturated and SPGR sequences with and without Magnetisation transfer (MT). Regions-of-interest were placed on areas of normal and oedematous bone marrow on the T2 fat-saturated images and transferred to the MT images. MT ratios and the difference between images with and without MT were calculated. Contrast between oedematous and non oedematous bone was calculated. MT ratios and MT differences were significantly higher in oedematous bone. Contrast between oedematous and non oedematous bone was higher with MT. MT may be useful in assessing bone marrow oedema in arthritis.

**Wednesday 13:30-15:30 Computer 3**

**13:30 3204. MR Perfusion Imaging and Spectroscopy Helps Predict Rate of Bone Loss**

*James F. Griffith¹, David K. Yeung¹, Jason SC Leung², Timothy C. Kwok¹, Ping C. Leung²*

¹Diagnostic Radiology and Organ Imaging, The Chinese University of Hong Kong, Shatin, N.T., Hong Kong; ²Community & Family Medicine, The Chinese University of Hong Kong, Shatin, Hong Kong; ³Department of Medicine & Therapeutics, The Chinese University of Hong Kong, Shatin, Hong Kong

It would be useful to have a reliable means of predicting bone loss. As reduced bone perfusion and increased marrow fat content are associated with osteoporosis, this longitudinal study was undertaken to determine how well MR perfusion indices and marrow fat content at baseline could predict bone loss. It showed that reduced bone perfusion indices or increased marrow fat content at baseline is associated with increased bone loss over the ensuring four years with a predictive capacity comparable to traditional risk factors. MR-based indices also reliably distinguished future fast from slow bone losers. MRI has potential in predicting bone loss.
The analysis of the fat/water fraction shows the potential to be able to differentiate between benign pathological changes in marrow perfusion occurring in osteoporosis and other bone diseases. Further research on the pharmacokinetic modeling specific on bone marrow increases our understanding of the physiological and anatomical changes of bone metastases. UTE MRI allows detection of signal from very short T2 tissue that previously returned no signal on conventional MR sequences. Preliminary data from this ongoing study suggests that there is a significant linear relationship between % change in T2* measured by UTE MRI and CT Hounsfield Units of sclerotic bone metastases, hence UTE MRI has potential to quantify changes in the sclerotic bone components of bone metastases. If the relationship of T2* with HU can be extrapolated to electron density this would allow much more accurate quantification of bone density and bone mineral density (BMD) to be performed, which would be useful for radiotherapy planning using MR data and may also be a novel approach to attenuation correction for PET/MR.

UTE MRI and CT Hounsfield Units of sclerotic bone metastases, hence UTE MRI has potential to quantify changes in the sclerotic bone components of bone metastases. If the relationship of T2* with HU can be extrapolated to electron density this would allow much more accurate quantification of bone density and bone mineral density (BMD) to be performed, which would be useful for radiotherapy planning using MR data and may also be a novel approach to attenuation correction for PET/MR.

**Thursday 13:30-15:30 Computer 3**

**3208. Assessment of Benign and Malignant Vertebral Fractures Based on the Measurement of the Fat-Fraction**

Andreas Biffar, Gerwin Schmidt, Andrea Baur-Melnyk, Maximilian Reiser, Olaf Dietrich

1Josef Lissner Laboratory for Biomedical Imaging, Munich, Germany; 2Department of Clinical Radiology, Ludwig Maximilian University of Munich, Munich, Germany

Vertebral bone marrow consists of red and yellow marrow, and therefore in contrast to most other tissues of fractions of fat and water at the same order of magnitude. It is known that benign as well as malignant pathologies change this distribution pattern differently. In this study we determined the fat and water fractions in patients with benign and malignant vertebral compression fractures as well as in normal vertebral bone marrow. The analysis of the fat/water fraction shows the potential to be able to differentiate between benign and malignant lesions.

**3209. Value of Perfusion and Permeability Measurements in Distinguishing Between Benign and Malignant Vertebral Lesions**

Andreas Biffar, Gerwin Schmidt, Steven Sourbron, Olaf Dietrich, Maximilian Reiser, Andrea Baur-Melnyk

1Josef Lissner Laboratory for Biomedical Imaging, Munich, Germany; 2Department of Clinical Radiology, Ludwig Maximilian University of Munich, Munich, Germany

Benign and malignant lesions of vertebral bodies modify their vascular structure and supply. Previous studies of dynamic contrast-enhanced MRI (DCE-MRI) in vertebral bone marrow, trying to assess these changes, were based on descriptive perfusion indices. These suffer from well-known limitations, like dependence on experimental variables and an ill-defined relation to hemodynamic parameters. To solve these problems, we performed a quantitative analysis using a two-compartment model, allowing for the separate
determination of perfusion and permeability. Perfusion parameters were determined in patients with benign and malignant vertebral compression fractures. Perfusion indices might have the potential to distinguish between osteoporotic and pathological fractures.

14:30  **3210. Comparison of a New Whole Body Continuous Table Movement Versus a Standard Whole Body MR Protocol for the Assessment of Multiple Myeloma**

_Sabine Weckbach^1, Henrik J. Michaela^1, Alto Stemmer^2, Stefan O. Schoenberg^1, Dietmar J. Dinter^1_

^1Department of Clinical Radiology and Nuclear Medicine, University Hospital Mannheim, Mannheim, Germany; ^2Imaging & IT Division, Magnetic Resonance, Siemens AG, Healthcare Sector, Erlangen, Germany

A new WB CTM protocol consisting of axial T2-w fs BLADE and T1-w GRE-sequences allows the assessment of patients with multiple myeloma with comparable image quality and identical ability to detect bone marrow and soft tissue lesions compared to a standard step-by-step-protocol with even better organ assessability. Scan time is reduced by 75%. Taking into account the limitations of the technique concerning vertebral fracture assessment this new protocol seems advantageous for patients with pain, allows a higher patient throughput in clinical routine and might facilitate the depiction of extramedullary lesions.

15:00  **3211. Follow-Up of Parametric Maps of the Tumoral Perfusion in Patients with Treated Bone Metastases of Prostate Cancer.**

_Nicolas Michoux^1, Bertrand Tombal^2, Jean-Pascal Machiels^3, Frederic Lecouvet^1_

^1RDGN, Université Catholique de Louvain, Brussels, Belgium; ^2FYCL, Université Catholique de Louvain, Brussels, Belgium; ^3ONCO, Université Catholique de Louvain, Brussels, Belgium

Using dynamic contrast-enhanced magnetic resonance imaging with a pharmacokinetic modeling of the data, the monitoring of the effects of anti-cancer therapy on bone metastases of prostate cancer during the course of the therapy becomes feasible. Ten patients scheduled to receive hormonotherapy or Taxotere therapy were imaged on a 1.5T MR scanner within one week before, 7 and 30 days after initial treatment. Perfusion maps based on Ktrans, ve and vp parameters were reconstructed. Complex changes reflecting either a decrease with a homogenization of the perfusion or an increase with a heterogenization of the perfusion, were observed in responders to therapy.

**Disc, Disc, UTE, UTE**

**Hall B Monday 14:00-16:00 Computer 4**

14:00  **3212. A Novel DTI-Histology Based 3D Model of the Annulus Fibrosus Microstructure Viewed in the Light of Evolutionary Medicine**

_Dan Stein^1, Yaniv Assaf^2, Gali Dar^3, Israel Hershkovits^1_

^1Department of Anatomy and Anthropology, Sackler faculty of medicine, Tel Aviv University, Tel-Aviv, Israel, Israel; ^2Department of Neurobiology, The George S. Wise Faculty of Life Sciences, Tel Aviv University, Israel; ^3Department of Physical Therapy, Faculty of Social Welfare & Health Studies, Haifa University, Mount Carmel, Haifa, Israel

This study utilizes the powerful tools of MRI diffusion in order to bring new understanding to the basic microstructure of the intervertebral disc’s annulus fibrosus. DTI images are presented of the anisotropic properties of the annulus fibrosus from which fiber tracking was extracted, revealing the disc’s collagen structure. Data was correlated with histological images. The architecture of this important structure is far from being fully understood hence viewing it here three dimensionally for the first time, is of extremely high importance for dealing with the very common pathology of low back pain.

14:30  **3213. in Vivo Quantification of Intervertebral Disc Collagen Content Using Magnetization Transfer Ratio Mapping**

_Chenyang Wang^1,2, Walter Witschey^3, Ari Goldberg^4, Mark Elliott^2, Joseph Calabro^5, Ari Borthakur^2, Ravinder Reddy^2_

^1Bioengineering, University of Pennsylvania, Philadelphia, PA, United States; ^2Radiology, University of Pennsylvania, Philadelphia, PA, United States; ^3Biochemistry and Molecular Biophysics, University of Pennsylvania, Philadelphia, PA, United States; ^4Radiology, Hospital of the University of Pennsylvania, Philadelphia, PA, United States; ^5Siemens Medical Solutions

Magnetization transfer (MT) has previously been shown to be sensitive to collagen content in biological tissues. In this study, we quantified MT effect by computing the MT ratio of the intervertebral disc (IVD) on a pixel-by-pixel basis, from in vivo MT MR images. The resulting MT ratio map of healthy IVD showed significantly higher MT ratio in the collagen-rich annular fibrosis compared to the proteoglycan-rich nucleus pulposus. In contrast, the MT ratio of degenerated IVD nucleus pulposus appeared elevated, which suggests possible increase in collagen content in the otherwise proteoglycan-rich tissue as a result of degeneration.
Parametric T2 and T2* Mapping Techniques to Visualize Intervertebral Discs in Patients with Low Back Pain - Initial Results on the Clinical Use with 3.0 Tesla MRI
Goetz Hannes Welsch1,2, David Stelzeneder1, Friedrich Frank Hennig1, Klaus Friedrich1, Georg Scheuerecker1, Tatjana Paternostro-Sluga1, Siegfried Trauttmansdorff1, Tallal Charles Mamisch4

1MR Center, Department of Radiology, Medical University of Vienna, Vienna, Austria; 2Department of Trauma and Orthopaedic Surgery, University Hospital of Erlangen, Erlangen, Germany; 3Department of Physical Therapy, Medical University of Vienna, Vienna, Austria; 4Department of Orthopaedic Surgery, University of Basel, Basel, Switzerland

Quantitative T2 provides information about the interaction of water molecules and the collagen-network within the intervertebral disc (IVD). T2*-mapping may theoretically provide comparable information of the IVD ultrastructure but with the additional benefit of three-dimensional-acquisition capability together with high signal and high spatial resolution in a short scan-time. Aim of the study was to compare and correlate T2- and T2*-relaxation in patients suffering from low back pain. Using T2 as well as T2*-relaxation mapping, all grades of IVD degeneration can be quantified and distinguished. Besides the established T2 methodology, T2* provides a fast and stable tool in the evaluation of IVDs.

Lumbar Intervertebral Disc Pathology: Comparison of Quantitative T2 Mapping with Conventional MR at 3.0 Tesla
Siegfried Trauttmansdorff1, David Stelzeneder1, Sabine Goed1, Tatjana Paternostro-Sluga2, Michael Reissegger1, Tallal Charles Mamisch4, Goetz Hannes Welsch1,4

The objective of our study was to assess the relationship of morphologically defined lumbar disc pathology with quantitative T2 mapping. Segmental evaluation of 265 discs of 53 patients with low back pain was performed and T2 values in different disc compartments were compared to different kinds of disc pathology. T2 mapping in the lumbar spine at 3 Tesla yields additional information about the disc matrix and is a promising noninvasive tool to assess water content and collagen fiber integrity in different disc pathologies.

Tuesday 13:30-15:30  Computer 4

Quantitative In-Vivo Assessment of Intervertebral Disc Degeneration in Lumbar Spine Using ADC Measurements
Hon Yu1, Shadfar Bahri1, Lutfi Tugan Muftuler1, Orhan Nalcio glu1, Vance Gardner2

1Center for Functional Onco-Imaging, University of California, Irvine, CA, United States; 2Orthopaedic Education and Research Institute of Southern California, Orange, CA, United States

Measurement of apparent diffusion coefficient (ADC) was investigated as means for in-vivo assessment of the degenerative states in lumbar discs. Pfirrmann grading, currently only-accepted means to assess disc-degeneration in vivo based on morphology, was utilized along with the signal-intensity ratio of disc to cerebral spinal fluid in T2w to classify the discs beyond the 5-level grades afforded by Pfirrmann grading and then to compare with the measured ADC values. The results indicate a strong negative linear correlation between the ADC values and the degenerative grades of discs demonstrating the potential value of ADC as means for in-vivo assessment of disc-degeneration.

Study Population of Young Adults Using T1rho as a Marker to Detect Early Changes in Intervertebral Disc Degeneration
Sofia Battisti1, Riccardo Del Vescovo, Luigi Stellato, Ari Borthakur2, Gianluca Vadala2, Francesca Martinina, Vincenzo Denaro1, Bruno Beomonte Zobel

1Diagnostic Imaging, Campus Bio-Medico University of Rome, Rome, Italy; 2University of Pennsylvania; 3Orthopedy, Campus Bio-Medico University of Rome

MRI and T1rho-weighted sequences

Ultrashort Time-To-Echo MRI of Human Intervertebral Disc Endplate: Association with Endplate Calcification
Won C. Bae1, Kelli Xie2, Aseem R. Hemmati3, Nozomu Inoue3, Graeme M. Bydder3, Christine B. Chung3, Koichi Masuda1

1Radiology, University of California, San Diego, San Diego, CA, United States; 2Bioengineering, University of California, San Diego, La Jolla, CA, United States; 3Orthopaedic Surgery, University of California, San Diego, San Diego, CA, United States; 4Orthopedic Surgery, Rush University Medical College, Chicago, IL, United States

UTE MR image of human lumbar spine reveals distinct linear signal near disc endplates, unlike signal voids seen in conventional MR images. Calcification of cartilaginous endplate occurs with aging, and it hinders transport across the region. Normal and abnormal (loss) UTE signals were identified and core samples harvested for micro CT. 3D reconstructed models were evaluated for endplate surface roughness and severity of calcium deposits, which were increased in UTE-abnormal samples. These results demonstrated...
unique ability of UTE MRI to directly evaluate endplate region, and association of UTE MRI with calcification of endplate, which may lead to changed transport function.

15:00  
3219.  
**Intervertebral Disc T1rho Relaxation Mapping with Spin-Lock 3D B-FFE Imaging at 3T**

*Jing Yuan1, Yi-Xiang Wang1, James F. Griffith1*

1Department of Diagnostic Radiology and Organ Imaging, The Chinese University of Hong Kong, Shatin, New Territories, Hong Kong

Quantitative T1rho imaging is a non-invasive MRI technique that has been shown to be sensitive to interactions between motionally restricted water molecules and their surrounding macromolecular environment. It should potentially be a clinical tool in identifying early intervertebral disc (IVD) degeneration. In this study, a spin-lock 3D balanced fast field echo imaging was developed for rapid in vivo IVD T1rho relaxation mapping at 3T. A significant reduction of T1rho relaxation was found to be an indication of early IVD degeneration.

**Wednesday 13:30-15:30  Computer 4**

13:30  
3220.  
**Ultrashort TE (UTE) T1rho Magic Angle Imaging of the Achilles Tendon**

*Jiang Du1, Nikolaus M. Szeverenyi1, Sheronda Statham1, Michael Carl2, Richard Znamirovski1, Atsushi Takahashi2, Christine Chung1, Graeme Bydder1*

1Radiology, University of California, San Diego, CA, United States; 2Global Applied Science Laboratory, GE Healthcare Technologies, Menlo Park, CA, United States

There are contradictory views on the T1rho relaxation mechanisms in the literatures. In one view proton exchange between chemically shifted NH and OH groups of PG and the tissue water might be an important relaxation mechanism. In another view the dominant T1rho and T2 relaxation mechanism is a dipolar interaction. Collagen fibers in tendons are highly ordered and subject to strong dipole interactions. We proposed to use a UTE-T1rho sequence to measure T1rho of the Achilles tendon at a series of angles and a series of B1rho fields to investigate the contribution of dipole interaction in T1rho relaxation mechanism.

14:00  
3221.  
**Initial T1 Measurements of the Human Achilles Tendon Using UTE Imaging at 3T**

*Peter Jonathan Wright1, Richard Hodgson1, Robert Evans2, Carole Burnett1, Matthew Robson3*

1LMBRU, Leeds NHS, Leeds, West Yorkshire, United Kingdom; 2University of Leeds, Leeds, United Kingdom; 3University of Oxford, Oxford, United Kingdom

Conventional MRI of the Achilles tendon is limited by its short T2. UTE imaging allows the tissues to be directly visualised, allowing quantification of tendon MR properties. In this study the feasibility of T1 measurement using UTE saturation-recovery imaging was investigated. A UTE saturation-recovery sequence was implemented with clinically acceptable acquisition times and validated against phantoms. It was tested in the ankle of 6 healthy volunteers. Results for fat were comparable with known in vivo values while those for the Achilles tendon were higher than reported post mortem values. This technique may be useful for quantifying Achilles tendonopathy.

14:30  
3222.  
**Quantitative Magnetization Transfer Ultrashort Echo Time Imaging of the Achilles Tendon**

*Richard Hodgson1, Robert Evans2, Peter Wright3, Matthew Robson1*

1Leeds Musculoskeletal Biomedical Research Unit, University of Leeds, Leeds, Yorks, United Kingdom; 2Leeds Musculoskeletal Biomedical Research Unit, Chapel Allerton Hospital, Leeds, Yorks, United Kingdom; 3Centre for Clinical Magnetic Resonance Research, University of Oxford, Oxford, Oxfordshire, United Kingdom

Magnetization transfer in the Achilles tendon was investigated using ultrashort echo time imaging with off resonance saturation pulses (2-100kHz off resonance). The experimental data was fitted to a two-compartment model. Magnetization transfer effects were demonstrated which showed good agreement with the model. The bound water fraction from the model was consistently higher than that reported in white matter in the brain, reflecting the high collagen content in tendon. This technique appears feasible and and may be useful for assessing changes in collagen content which occur in tendonopathy.

15:00  
3223.  
**Contrast Enhanced Short and Ultrashort Echo Time MRI of the Achilles Tendon in Spondyloarthritis**

*Richard Hodgson1, Robert Evans2, Carole Burnett2, Andrew Grainger2, Philip O'Connor2, Laura Coates, Philip Hellawell, Paul Emery, Dennis McGonagle, Matthew Robson3*

1Leeds Musculoskeletal Biomedical Research Unit, University of Leeds, Leeds, Yorks, United Kingdom; 2Chapel Allerton Hospital, United Kingdom; 3University of Oxford

The Achilles tendon was imaged in symptomatic spondyloarthritis patients and normal volunteers using a range of echo times from 0.07-14ms, with and without intravenous contrast. Images of normal tendons showed anterior reticular signal centred near the level of the superior calcaneum. Images of spondyloarthritis patients acquired with TE=2ms showed the most abnormal signal. Contrast enhancement was greatest on UTE images with TE=0.07ms. Abnormal signal on TE=2ms images was more extensive than contrast enhancement on UTE images. These results suggest 3D SPGR images with TE=2ms are useful for detecting tendon abnormality in spondyloarthritis.
Merging UTE Imaging, Water-Fat Separation, and $T_2^*$ Mapping in a Single 3D MSK Scan

Jürgen Rahmer¹, Peter Börnert¹, Holger Eggers¹, Peter Koken¹, Jan P. Groen²
¹Philips Technologie GmbH, Forschungslaboratorien, Hamburg, Germany; ²Philips Healthcare, Best, Netherlands

The separation of water and fat signal contributions, e.g., be achieved by chemical shift encoding, is essential for a number of MSK applications to improve image contrast for clinical diagnosis. Also, ultrashort echo time (UTE) imaging was proposed for MSK MRI, yielding extra information about short $T_2$ species. It is the idea to incorporate both approaches into a multi-echo imaging (ME) sequence, which samples the UTE signal in the first echo and simultaneously delivers water-fat separation, $T_2^*$ mapping and short $T_2$ contrast. An efficient 3D ME approach is presented which allows the generation of water-fat separated images containing short-$T_2^*$ components while extending the $T_2^*$ mapping range down to ~ 1 ms. The 3D approach eases planning and bears the potential to deliver comprehensive diagnostic information by means of a single scan. We apply the technique to imaging of the knee, where short-$T_2$ components are found in tendons, ligaments, and menisci.

Water/Fat Separation of Short $T_2^*$ Tissue Using Multi-Echo Ultra-Short Echo Time (UTE) Imaging and IDEAL

Kang Wang¹, Huanzhou Yu², Jean Brittain³, Scott Reeder¹,⁴, Jiang Du⁵
¹Medical Physics, University of Wisconsin-Madison, Madison, WI, United States; ²Applied Science Laboratory, GE Healthcare, Menlo Park, CA, United States; ³Applied Science Laboratory, GE Healthcare, Madison, WI, United States; ⁴Radiology, University of Wisconsin-Madison, Madison, WI, United States; ⁵Radiology, University of California, San Diego, San Diego, CA, United States

An ultrashort TE (UTE) imaging technique has been developed for the visualization of tissues with short $T_2$ or $T_2^*$, such as menisci and tendons. UTE methods typically utilize fat suppression to improve the contrast for tissues with short $T_2$. However, conventional fat-saturation methods achieve limited success due to the broad short $T_2^*$ water-peak and the complexity of the fat spectrum. In this work, we have combined a 2D multi-slice multi-echo UTE sequence with a water/fat separation technique (IDEAL), to obtain high contrast short $T_2$ images without the use of any preparation pulse and within acceptable scan times.

Ultrashort TE 3D Gradient-Echo Imaging of Human Knee at 3T

Jang-Yeon Park¹, Ute Goerke¹, Steen Moeller¹, Eddie Auerbach¹, Jutta Ellermann¹, Michael Garwood²
¹Center for Magnetic Resonance Research and Department of Radiology, University of Minnesota, Minneapolis, MN, United States

Although UTE and SWIFT have the advantage in imaging ultrashort $T_2$ species, it can be challenging to implement them on clinical scanners due to high technical demands. Recently, we proposed a new ultrashort TE 3D gradient-echo imaging that can effectively cover TE range of ~0.2 ms, which was dubbed SWIFT-LiTE. It is renamed here UTE-GRE to emphasize that a conventional selective pulse like a sinc pulse can also be used for excitation. UTE-GRE was implemented on clinical 3T and human knee data were acquired focusing on menisci. White and red zones were differentiated without contrast agent or image subtraction.

Quantitative Evaluation of Human Cadaveric Posterior Cruciate Ligament: Effect of Trypsin Digestion on T1rho Values.

Patrick Omoumi¹, Eric S. Diaz¹, Jiang Du¹, Sheronda S. Statum¹, Won C. Bae¹, Graeme Bydder¹, Christine B. Chung¹
¹University of California, San Diego, San Diego, CA, United States

Quantitative methods have been developed to probe early degenerative changes for the cartilage, and more recently applied to menisci. $T_2$ values are thought to mainly be influenced by the organization and concentration of collagen fibers, whereas $T_1$rho values are correlated with the concentration of glycosaminoglycans (GAG), the influence of collagen on $T_1$rho values remaining controversial. As in cartilage and menisci, ligaments are mainly composed of collagen GAGs. We sought to evaluate the feasibility of conventional and novel UTE quantitative techniques for $T_1$rho measurements of the PCL, and study the effect of the selective removal of GAG molecules by an enzymatic digestion.

Muscle

Muscle Energetics Changes Throughout Maturation: a Quantitative 31P-MRS Analysis

Anne Tonson¹, Sébastien Ratel², Yann Lefur¹, Patrick Cozzone¹, David Bendahan¹
¹CRMBM - UMR CNRS 6612, Marseille, France; ²BAPS - EA3533, AUBIERE, France

In this study we investigated whether development quantitatively affected muscle energy production and proton handling during a standardized exercise in prepubescent boys and men using 31-Phosphorus Magnetic Resonance Spectroscopy. We mainly found that maturation significantly affects muscle energetics. We showed that although the total energy cost of contraction was unaffected.
throughout the maturation process, the relative contribution of each metabolic pathway to ATP production during a standardized exercise changed with respect to age. Children rely more on oxidative metabolism and less on creatine kinase reaction to meet energy demand during exercise whereas anaerobic glycolysis activity was unaffected by development.

14:30 3229 Changes in Oxidative Metabolism of Skeletal Muscle Induced by Loaded Vibration

Exercise Under Vascular Occlusion

Susanne Heinzer-Schweizer¹, Flurin Item²³, Anke Henning¹, Michael Wyss¹, Jonas Denkinger³, Roland Kreis³, Marco Toigo²³, Urs Boutellier²³, Peter Boesiger¹

¹Institute for Biomedical Engineering, University and ETH Zurich, Zurich, Switzerland; ²Institute of Physiology and Zurich Center for Integrative Human Physiology, University of Zurich, Zurich, Switzerland; ³Exercise Physiology, Institute for Human Movement Sciences, ETH Zurich, Zurich, Switzerland; ⁴Department of Clinical Research, University Bern, Bern, Switzerland

“Strength” training has become a major component sports and rehabilitation. We have developed an exercise paradigm that combines three modalities known to positively influence “strength”. 21 female subjects were recruited, of which 12 were trained. Before and after 5.5 weeks of training, oxygen consumption, lactate levels and body composition were determined, muscle biopsies were acquired, and dynamic 31P spectroscopy measurements were performed. Capillary-to-fiber-ratio, calf lean mass, peak power, resting pH, and resting inorganic phosphate and phosphocreatine concentrations changed significantly with training. A large increase in enhancement of metabolic parameters in a short time is therefore possible using this new exercise paradigm.

15:00 3230 A Comparison of in Vivo and in Vitro Measurements of Skeletal Muscle

Mitochondrial Capacity in Human Skeletal Muscle

Ian R. Lanza¹, K S. Nair¹, John D. Fort¹

¹Endocrinology, Mayo Clinic, Rochester, MN, United States; ²Endocrinology, Mayo Clinic, Rochester, MN, United States; ³Radiology, Mayo Clinic, Rochester, MN, United States

Muscle oxidative capacity can be determined by 31P-MRS from phosphocreatine kinetics. We compared this approach two independent measurements of oxidative capacity performed using mitochondria isolated from skeletal muscle biopsy tissue in 11 volunteers. 31P-MRS was used to monitor the depletion and recovery of phosphocreatine following a 30 second maximal knee extension exercise. Oxidative capacity was also determined from measurements of maximal ATP production and respiration in mitochondria isolated from muscle biopsies. Oxidative capacity measured in vivo was significantly associated with maximal state 3 respiration and ATP production rates. 31P-MRS is a valid tool for assessment of mitochondrial oxidative capacity.

15:30 3231 Estimates of Mitochondrial Capacity Derived from Phosphocreatine Recovery Kinetics in Human Calf and Thigh Muscle Differ Systematically from Published Measurements Using Invasive Methods

Elina Raja Ahmad¹, William Bimson¹, Graham Kemp²

¹Magnetic Resonance and Image Analysis Research C, University of Liverpool, Liverpool, Merseyside, United Kingdom; ²Magnetic Resonance and Image Analysis Research Centre, University of Liverpool, Liverpool, Merseyside, United Kingdom

Analysis of 31P MRS phosphocreatine recovery kinetics provides valuable information about muscle mitochondrial function in vivo. Correct analysis of the data in terms of “mitochondrial capacity” (a function of mitochondrial numbers, function and substrate/O2 supply) depends on the underlying physiology. We compare the results of such analysis in quadriceps and calf muscle at 60% and 90% maximum voluntary contraction force, and with estimates inferred from some published measurements by invasive methods. Results differ little between the two muscles, but systematic quantitative differences between methods of assessing mitochondrial function in vivo remain unexplained.

Tuesday 13:30-15:30 Computer 5

13:30 3232 The PH-Dependence of Post-Exercise PCR and ADP Recovery: A Simple Modelling Approach Reproduces Important Features of 31P MRS Data from Skeletal Muscle

Graham Kemp¹, Nicole van den Broek¹, Klaas Nicolay¹, Jeanine Prompers²

¹Magnetic Resonance and Image Analysis Research Centre, University of Liverpool, Liverpool, Merseyside, United Kingdom; ²Biomedical NMR, Department of Biomedical Engineering, Eindhoven University of Technology, Eindhoven, Netherlands

In 31P MRS studies of recovery from exercise the pH-sensitivities of acid eflux and PCR recovery time constant are correlated, suggesting that intersubject differences in the latter are related to differences in cellular pH control. A simple model of ADP-dependent oxidative ATP synthesis and pH-dependent acid eflux reproduces the pH-dependence of PCR recovery. Here we show that it directly predicts the effect of eflux on this, and indeed also individual values of the PCR and ADP time constants, but that this depends also on the relationship between end-exercise pH and [PCr], which is not under direct experimental control.

14:00 3233 31P MRS of the Biceps Brachii Muscle at 3T

Jonathan W. Howard¹, Gregory Shields¹, Giulio Gambarota¹, Ros M. Gordon¹, Anil w. Rao¹, Rex D. Newbould¹

¹GlaxoSmithKline Clinical Imaging Center, London, United Kingdom

Phosphorous (31P) MR allows for non-invasive monitoring of muscle bioenergetics. The exercise device is one of the most critical components in the experiment. Typically, custom built devices, which require additional time and expertise for the set up, are used.
The aim of the present study was to investigate a simple isometric method for performing 31P spectroscopy on the biceps brachii muscle, and to determine its potential as a model for future 31P investigations.

**14:30**

### 3224. 31P MRS of Resting Muscle at 7T: Differences in the Alkaline PH Compartment Between Different Muscles and Sedentary and Elite Trained Athletes

Hermien E. Kan, Joep van Oorschot, Beatrijs H.A. Wokke, Maarten J. Versluis, Nadine B. Smith, Andrew G. Webb, Jeroen A.L. Jeneson

1C.J. Gorter Center, department of radiology, Leiden University Medical Center, Leiden, Netherlands; 2Biomedical NMR Laboratory, Department of Biomedical Engineering, Eindhoven University of Technology, Eindhoven, Netherlands; 3Department of neurology, Leiden University Medical Center, Leiden, Netherlands

Non-invasive determination of mitochondrial content is an important objective in clinical and sports medicine. Previously, a peak 0.4 ppm downfield from the cytosolic Pi resonance (Pi1) was found in resting skeletal muscle that was tentatively attributed to mitochondrial Pi (Pi2). Here we show a consistently higher Pi2 signal in soleus (SOL) versus tibialis anterior (TA) muscle, as well as in trained versus untrained subjects. Since these results are in quantitative agreement with known differences in oxidative capacity between SOL and TA and trained versus untrained subjects, they support our hypothesis that the Pi2 resonance originates from the mitochondrial compartment in muscle.

### 15:00

### 3225. The Effects of Statins on 31P MRS Measured Skeletal Muscle Metabolite Content and Function

Jill M. Slade, Sean C. Forbes, George S. Abela, Robert McClowry, Ronald A. Meyer

1Radiology, Michigan State University, East Lansing, MI, United States; 2Physical Therapy, University of Florida; 3Cardiology, Michigan State University

Skeletal muscle content and function may be affected by cholesterol lowering medications (statins). 31P MRS was used to quantify resting and exercise induced changes in muscle metabolism. Muscle aerobic capacity was reduced following 80-mg atorvastatin suggesting comprised skeletal muscle function with statin use.

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**Wednesday 13:30-15:30 Computer 5**

### 13:30

### 3226. Metabolic Assessment of Myositis with 1H Magnetic Resonance Spectroscopy

Xin Wang, Antonio J. Machado, Peter B. Barker, John A. Carrino, Laura M. Fayad

1Radiology, Johns Hopkins University, Baltimore, MD, United States; 2Musculoskeletal Radiology, Johns Hopkins University; 3Rad Neuro, Johns Hopkins University

This pilot study employed 1H magnetic resonance spectroscopy to identify potential metabolite alterations in the muscles of subjects with myositis. A significant difference in the choline concentration of subjects with myositis with elevated T2 muscle signal was found compared with those without signal abnormalities by conventional MR imaging. In addition, Choline to lipid ratios were found to be possibly different for subjects with myositis compared with a healthy control group. These results indicate that 1H MRS may yield clues to the physiologic alterations in patients with myositis.

### 14:00

### 3227. Proton MR Spectroscopy Measurements for Metabolomic Changes During Adipogenic Differentiation of Muscle Derived Stem Cells

Song I. Chun, Moo Young Jang, Sun Young Lee, Dong Hwa Kim, Jee Hyun Cho, Jung Woong Shin, Young Il Yang, Chi Woong Mun

1Biomedical Engineering, Inje University, Gimhae, Korea, Republic of; 2Pathology, Paik Hospital, Inje University, Busan, Korea, Republic of; 3Korea Basic Science Institute, Ochang, Korea, Republic of; 4UHRC, Inje University, Gimhae, Korea, Republic of

The purpose of this study is to measure and establish the metabolite change when the Muscle Derived Stem Cells (MDSCs) were differentiated into adipocyte using the 1H MR Spectroscopy. The experiments are classified four groups: Group1-Adipogenic Media, Group2- Papain digested fibrin gel, Group3-Papain digested MDSCs, Group4-Papain digested adipogenic MDSCs. The spectrum from each group has been acquired by utilizing vertical-bore 14.1T NMR/MRI with PRESS pulse sequence. Compare to spectrums of each group, we analyzed metabolite peaks newly formed during the differentiation of the MDSCs. In the results, we can observe that 1H MR spectral peak intensity increases at 0.89/1.24/1.9/2.48/3.0 ~3.1ppm after 14 days of differentiation from MDSCs into adipocyte. In this study, therefore we could observe the metabolite change along with MDSCs differentiation and found the potential possibilities of MRS to evaluate the differentiations of stem cell.

### 14:30

### 3228. 1H-MRS to Evaluate Intramuscular Lipid Changes in HIV-Patients with Lipodystrophy Syndrome by LCmodel

Ana Isabel Garcia, Ana Milinkovic, Iñaki Perez, Xavier Tomas, Sergi Vidal-Sicart, Carles Falcón, Jaume Pomes, Montserrat Del Amo, Josep Malloias

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1H-MR spectroscopy was performed to assess intramyocellular lipids (IMCL) in a group of HIV-patients with lipodystrophy syndrome receiving stable antiretroviral therapy and their changes 6 months after switching the treatment. HIV-patients at baseline revealed higher IMCL than controls, although no significant. Statistical analysis revealed a significant reversal of peripheral
lipatrophy with decreased of the lean mass after switching the treatment, and it was related with IMCL decreased, although no significant. A probable migration of lipid content from intramyocellular to periphery can explain partially the peripheral fat gain and loss of peripheral lean mass, although other factors may participate.

15:00  3239  Assessment of Acetylcarnitine in Individuals with Type 1 Diabetes After Exercise in Eu- And Hyperglycemia Using 1H MR Spectroscopy in Skeletal Muscle
Andreas Boss1, Christoph Stettler2, Michael Ith1, Stefan Jenni2, Chris Boesch1, Roland Kreis1
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Differences in the exercise-induced production of acetylcarnitine, a buffer of acetyl-CoA, in eu- vs. hyperglycaemia have been analyzed by 1H-MR spectroscopy in thigh muscle. Spectra were obtained before and after exercise (120 min. at 55 to 60% VO2max, with indirect calorimetry) in 7 physically active type 1 diabetic males. During both trials, insulinaemia was kept constant and the contribution of the various substrates was determined. Acetylcarnitine was elevated 1h after exercise (p<0.0001). This increase was significantly higher in euglycaemia (p=0.0003) and coincided with higher rates of fat oxidation in this condition. Conclusion: different substrate availability alters the production of acetylcarnitine significantly.

Thursday 13:30-15:30  Computer 5

13:30  3240  Improvements in DTI and Muscle Fiber Tractography of the Human Forearm
Using Rician Noise Suppression and B0-Field Corrections
Martijn Froeling1, Dennis F. Heijtel1, Arno Lataster2, Maarten Drost1, Klaas Nicolay1, Aart J. Nederveen1, Gustav J. Stijkers1
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Diffusion tensor imaging with minimized scan time was performed. The diffusion-weighted images were filtered using a recursive linear minimum mean-square-error estimator and field-inhomogeneity related deformations in the EPI images were corrected. This approach allows for accurate fiber tractography of human forearm muscles based on a single seeding ROI drawn in high resolution T1 weighted images.

14:00  3241  Evaluation of the Skeletal Muscle Morphological Transformation by Stress
Junichi Hata1, Kazuo Yagi1, Keigo Hikishima2, Yuji Komaki1, Keiichi Yano3, Kyouhito Iida4, Kazuo Mima4, Kuni Ohtomo1
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The focus was put on diffusion anisotropy obtained by Diffusion Tensor Imaging: DTI in this research, and it searched for the relation to skeletal muscle morphological transformation by stress. This research added stress to the thigh lower skeletal muscle. The change in muscle cell structure by stress was evaluated by water diffusion anisotropy. The relation between the skeletal muscle cell structure and diffusion anisotropy was shown by this research. And, the possibility of this structure analysis by this method was suggested.

14:30  3242  Evidence of 3-D Fabric Structure in Skeletal Muscle Via In-Vivo DTI and Eigenspace Reconstruction
Danchin Chen1, Dimitrios C. Karampinos1,2, Armen Gharibians1, Kevin F. King1, John G. Georgiadis1,2
1Mechanical Science and Engineering, University of Illinois at Urbana-Champaign, Urbana, IL, United States; 2Beckman Institute for Advanced Science and Technology, University of Illinois at Urbana-Champaign, Urbana, IL, United States; 3GE Healthcare, Waukesha, WI, United States

Driven by the hypothesis that the secondary eigenvector field in DTI of skeletal muscle reflects the muscle ultrastructure transverse to fiber orientation, we superimpose the flow fields of the primary and secondary eigenvectors extracted from DTI data comprising axial slices of the mid-calf. V1 aligns with the local myofiber direction and the V2 field is topologically consistent with the putative orientation of the inter-myocellular force transmission. 3-D reconstruction of the eigenvector flow fields and consistency of the secondary eigenvector orientation in the proximodistal direction provide preliminary evidence of the presence of a woven fabric in skeletal muscle.
This work aims to facilitate diffusion tensor imaging on a clinical 3T MRI system in order to reconstruct the inner shank muscle architecture of rodents. Using a slightly modified EPI-DTI sequence and 3D anatomic scan, we were able to reconstruct the muscular structure within feasible scan time (approx. 45 min). The promising results will be validated by examining the myostructure using high-resolution (0.07 mm) 3D reconstruction techniques (Microscribe MLX) ex-vivo.

Muscle & Miscellaneous

Hall B Monday 14:00-16:00

Computer 6

14:00

3244. Functional Assessment of Skeletal Muscle in Mice Lacking Myostatin by Multiparametric Functional (Mpf-) NMR in Vivo

Celine Baltigand1, Helene Gilson1, Jacques C. Menard2,3, Olivier Schakman3, Claire Wary1,2, Jean-Paul Thissen1, Pierre Georges Carlier1,2

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Inhibiting myostatin (mstn) causes spectacular increase in muscle mass, and has opened the path to therapeutic approaches. Yet possible compromised force production have been reported in isolated muscle. We investigated vascular and metabolic response to exercise in vivo in mstn−/− and wild-type mice using interleaved arterial spin labeling NMR imaging and 31P spectroscopy. Specific force and maximum perfusion were identical. Mitochondrial oxidative capacities were reduced in mstn−/−, while hyperemia was prolonged. These integrated results formed coherent evidence of a non-pathologic shift towards a more glycolytic metabolism in this model as was confirmed by histology.

14:30

3245. Effects of Resistance Training and β-Hydroxy-β-Methylbutyrate (HMB) on Muscle Fiber CSA and Lean Body Mass in Aged Rats: A DTI and DEXA Study

Ihsan S. Masad1,2, Y-M Park3, S-R Lee2, Jacob M. Wilson2, Paul C. Henning3, Bahram H. Arjmandi1, Samuel Colles Grant1,2, J-S Kim3

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SSarcopenia, age-related muscle wasting, has drastic medical and financial impacts on the elderly population. In this study, diffusion tensor imaging (DTI), which is sensitive to muscle architecture, is employed to assess the potential benefits of β-hydroxy-β-methylbutyrate (HMB) and resistance training (RT) in a pre-clinical model of aged rats. DTI was used to evaluate muscle cross sectional area (CSA) while dual energy X-ray absorptiometry was utilized to assess lean body mass (LBMs). As well as increasing LBM, results demonstrate that RT caused hypertrophy in aged soleus muscle, as indicated by increased ADC as well as increased second and third eigenvalues.

15:00

3246. Diffusion Tensor Imaging of the Calf Muscles at 1.5T: Diffusion Property Differences Between Athletes and Non-Athletes

Yoshikazu Okamoto1, Yuka Kujiraoka2, Manabu Minami3

1Radiology, University of Tsukuba Hospital, Tsukuba, Ibaraki, Japan; 2Radiology, Tsukuba Memorial Hospital, Japan; 3University of Tsukuba hospital, Japan

We compared FA, eigenvalues, and ADC for bilateral gastrocnemius medialis (GCM), gastrocnemius lateralis (GCL), soleus (SOL) and anterior tibial (AT) muscles between athletically trained and not-trained skeletal muscle. In all eight muscles, all three eigenvalues and ADC were lower in trained muscle than in not-trained one. There were significant differences in all muscles as for /1 and ADC (P<0.01), all muscles (P<0.05) except for right AT in /2 and left SOL in /3.Our results indicated that chronic muscle hypertrophy due to training caused those differences as a result of decrease of the extracellular space of the muscle.

15:30

3247. Change of MR Diffusion Property During Active Muscle Contraction in the Calf

Yoshikazu Okamoto1, Akira Kunimatsu2, Manabu Minami3

1University of Tsukuba hospital, Tsukuba, Ibaraki, Japan; 2Radiology, University of Tokyo hospital, Japan; 3University of Tsukuba hospital, Japan

We obtained diffusion tensor images (b=500 s/mm²) of bilateral calves of ten volunteers in a 1.5T MR machine at resting and planter flexion states of the right ankle. In gastrocnemius medialis (GCM), the FA, ë1 and ë2 of right to left ratios were increased from 1.05,0.99, and 0.99 to 1.17 (P<0.05), 1.06 (P<0.01), and 1.07 (P<0.01) with statistically significant difference by Paired t-test. In anterior tibialis (AT), ë1 and ë2 ratios were decreased from 0.99 and 1.01 to 0.96 (P<0.05) and 0.94 (P<0.05). We suppose these changes mainly reflect changes of focal temperature and perfusion of each skeletal muscle.
When high field strengths and small transmit-receive coils are used, SNR is no longer the sole limit to high-resolution imaging. Chemical shift and motion artifacts become major concerns. To address these concerns, a Cartesian gradient echo pulse sequence was designed with interleaved echoes for fat/water separation and interleaved navigators for motion correction. In vivo skin images with 100 μm isotropic resolution (1 nL) are presented. Fat/water separation allows the clear delineation of the different skin layers while motion correction effectively removes blurring.

MR relaxometry offers the potential for investigating the microstructural tissue properties and the ability to detect early changes of water mobility resulting from therapy-induced changes. In this study we report the cisplatin induced cell death with the duration of treatment by MR relaxometry in an animal model of squamous cell carcinoma of skin. Our MR data correlated with the findings of histology and biochemical parameters i.e proliferation index and apoptotic index. Results indicate that MR relaxometry measurements are useful to monitor cell death in response that could help selection of proper therapeutic regimen, dose, or duration of drug.

Diffusion tensor imaging (DTI) is a promising clinical modality for early detection of nerve damage. The aim of this study is to develop an optimal DTI protocol for quantitative analysis of the sural nerves in the lower legs and ankles, which has been problematic due to its small size and limited SNR. While strongly facilitated along the elongated fiber in healthy subjects, the diffusion of tissue water loses directionality in diabetic patients due to the loss of fiber density. We present the anatomical localization and nerve fractional anisotropy measurements of the sural nerve to determine the integrity of nerve myelination.

It is often difficult to definitively diagnose intraneural ganglion cysts with conventional MR imaging and to identify the origin of the cyst in a joint via what may often be a subtle connection. The ideal acquisition for imaging these cysts would be a 3D acquisition with isotropic spatial resolution that would achieve optimum reformating in all areas within a reasonable scan time. It is the purpose of this study to demonstrate the clinical utility of 3D FSE-Cube in the evaluation of intraneural ganglion cysts and the important joint connection.

MRI is widely used to image the plantar plates of the metatarsophalangeal joints. High signal at the insertion is routinely interpreted as a tear; however this is controversial. In this study 3T MRI images consistently demonstrated high signal at the plantar plate insertion centrally in asymptomatic subjects. The high signal did not extend to the medial and lateral borders and is not seen on T2 weighted images. Dorsiflexion of the joint demonstrates bands connecting the body of the plantar plate to the proximal phalanx. High signal centrally in the plantar plate is not indicative of a tear in asymptomatic subjects.
Damage to the plantar plates of the metatarsophalangeal joints has been suggested as a cause of forefoot pain and deformity in patients with rheumatoid arthritis (RA). This study looked at 68 plantar plates in patients with RA and forefoot pain using high resolution 3T MRI. Plantar plate pathology was revealed in all patients. However, high signal at the insertion on T2-weighted images (often interpreted as a tear) is not indicative of a tear in patients with RA.

This study uses dynamic contrast enhanced MRI to study the response of bone marrow to therapy. 30 patients with long-standing, active rheumatoid arthritis were imaged before and at 12 and 24 weeks after starting biologic treatment. 3D SPGR images of the wrist were acquired every 19 seconds and the relative early enhancement rate of bone marrow calculated from a carpal bone. There was a statistically significant decrease in the RER at both 12 and 24 weeks after starting treatment. This suggests DCE-MRI of bone marrow may be useful for assessing the response to treatment in rheumatoid arthritis.

In the present 3T study, DCE-MRI was evaluated in the differential diagnosis of psoriatic arthritis (PsA) and erosive arthritis (EOA) of the hand in 26 patients. Significantly higher late enhancement was observed in EOA patients 15 minutes after contrast injection. This study used dynamic contrast enhanced MRI to study the response of bone marrow to therapy. 30 patients with long-standing, active rheumatoid arthritis were imaged before and at 12 and 24 weeks after starting biologic treatment. 3D SPGR images of the wrist were acquired every 19 seconds and the relative early enhancement rate of bone marrow calculated from a carpal bone. There was a statistically significant decrease in the RER at both 12 and 24 weeks after starting treatment. This suggests DCE-MRI of bone marrow may be useful for assessing the response to treatment in rheumatoid arthritis.

In the present 3T study, DCE-MRI was evaluated in the differential diagnosis of psoriatic arthritis (PsA) and erosive arthritis (EOA) of the hand in 26 patients. Significantly higher late enhancement was observed in EOA patients 15 minutes after contrast injection. Results suggest that analysis of synovial membrane inflammation by DCE-MRI could be useful in the differentiation of these two arthritis types which is often difficult based on clinical and laboratory findings alone. As new treatment approaches are particularly adapted for each arthritis entity DCE-MRI could provide additional diagnostic information in differentiating PsA from EOA in clinical routine.

The purpose of this study was to evaluate a 3D-TSE-sequence with optimized acquisition strategies for improved tissue-contrast. Fifteen volunteers and 50 patients were examined at 3T (Magnetom VERIO, Siemens Sector Healthcare) with the PDfs-weighted 3D-TSE-sequence SPACE. Relevant SNR and CNR, i.e. fluid and Cartilage, of the isotropic 3D-TSE-sequence were significantly higher than of conventional 2D-TSE-sequences. Depiction of the femoral trochlea and small structures was significantly better. Small lesions could be better detected with the 3D-TSE-sequence. Diagnostic confidence was not significantly different. This technique holds high potential for further knee-MRI-protocols with excellent image quality and clinical performance compared to current 2D-protocols.
14:30

**3258. 3D-FSE-Cube of the Foot at 3T MRI: Comparison with 2D-FSE Images.**

Mai Hanamiya¹, Takatoshi Aoki¹, Yoshiko Yamashita¹, Yoshiko Hayashida¹, Toru Sato³, Shigeru Hibino⁴, Atsushi Nozaki⁴, Yukunori Korogi¹

¹Radiology, University of Occupational and Environmental Health School of Medicine, Kitakyushu, Fukuoka, Japan; ²Clinical Radiology Service, University of Occupational and Environmental Health Hospital; ³GE Healthcare Japan

Our purpose is to compare 3D-FSE-Cube with 2D-FSE sequence for MR imaging of the ankle at 3.0T MR system. Eight healthy volunteers were examined with 3D-FSE Cube (6 minutes 50 seconds) and 2D-FSE (axial, sagittal and coronal planes, total imaging time; 11 minutes 24 seconds), and 3D-FSE-Cube images were reformatted into images of same planes as 2D-FSE. Bone, cartilage, fluid, and tendon SNRs and bone-tendon CNR were significantly higher with the 3D-FSE-Cube. The 3D-FSE-Cube sequence with parallel imaging at 3.0T MR enables to reduce examination time preserving image quality and evaluate complex anatomy of the ankle on multiple arbitrary planes.

15:00

**3259. 3D-TSE-Imaging of the Ankle - A New Perspective?**

Mike Notohamiprodjo¹, Annie Horng², Bernhard Kuschel², Peter Bär³, Maximilian F. Reiser, Christian Glaser

¹Institute for Clinical Radiology, University Hospitals Munich, Munich, Bavaria, Germany; ²University Hospitals Munich, Institute for Clinical Radiology; ³Siemens Sector Healthcare

The purpose of this study was to evaluate an optimized 3D-TSE-sequence for ankle-MRI at 3T. Fifteen volunteers and 25 patients were examined at 3T with a dedicated 8-channel-ankle coil and the isotropic PD*/fs-weighted 3D-TSE-sequence SPACE featuring optimized variable flip angles, elliptical scanning and radial k-space readout for improved contrast and time efficient acquisition. In comparison to current 2D-TSE-sequences, relevant SNR and CNR were significantly higher. The 3D-reconstruction capabilities provided better visualization of small structures, ligaments and lesions. Diagnostic confidence was not significantly different in the 3D-TSE-sequence. This technique holds high potential for future ankle-MRI protocols.