Radiology Research Day 2012

March 28, 2012

Hamilton Golf and Country Club

Judges:
Dr. Andrea Doria (Visiting Professor)
Dr. Meg Chiavaras (Radiology)
Dr. Marcin Wierzchicki (Medical Physics and Applied Radiation Sciences)

08:00-08:30  Welcome reception
08:30-08:40  David Koff: Introductory address
08:40-10:00  Oral presentations

OPTICAL PROPERTY RECOVERY FOR THE ANALYSIS OF BRAIN TUMOUR MARGINS
Derek J Cappon, Zhaojun Nie, Thomas J Farrell, Qiying Fang, John Proviast, Naresh Murty, William McMillan, Joseph E Hayward

THE MR IMAGING FEATURES OF MYXOMAS AND MYXOSARCOMAS
Sanjay Gupta

A STUDY COMPARING DIFFERENT ORAL CONTRAST MEDIA IN SMALL BOWEL DISTENSION IN CT ENTEROGRAPHY
Dr. A. De, Dr. E. Leduc, Dr. N. Muhn, Dr. R. Rebello, M. Schmuck

EVALUATION OF RESTING STATE BOLD WITHIN LOCALLY ADVANCED BREAST CANCER
Evan McNabb, Aravindhan Jegatheesan, Michael D. Noseworthy

ASSESSING THE RELIABILITY AND QUALITY OF ONLINE UTERINE FIBROID EMBOLIZATION RESOURCES
Jatin Kachher, Ke Wu, Siresha Athreya

CHARACTERIZATION OF ISCHEMIC INFARCTS OF THE STRIATUM NUCLEUS: A RETROSPECTIVE PILOT STUDY
Shauna Kennedy, Ramiro Larrazzabal, Luciana Ribero

FRACTAL DIMENSION COMPARED TO RESTING STATE NETWORK ANALYSIS OF BOLD MRI IN ALZHEIMER'S DISEASE
Mohammed A. Warsi, William Molloy, Michael D. Noseworthy

10:00-10:30  Break

10:30-11:30  Oral presentations

REVISED ULTRASONOGRAPHIC CRITERIA FOR POLYCYSTIC OVARY SYNDROME: VALIDATED THRESHOLDS FOR ELEVATED FOLLICLE POPULATION AND OVARIAN VOLUME
Andrew K Peppin, Marla Lujan, Eric D Brooks, Jonathan K Reines, Brittany Y Jarrett, Narry Muhn, and Ehsan Haider

DEVELOPMENT OF A MONTE CARLO SIMULATION TOOL FOR THE LIGHT TRANSPORTATION INSIDE SCINTILLATION CRYSTALS
Xi Yang, Tom Farrell, Hao Peng

AUDIT OF CT GUIDED TRANSTHORACIC BIOPSIES AT A TERTIARY REFERRAL CENTER
N. Lougheed, S. Athreya

HYBRID PCA-OPTIMIZATION FRAMEWORK FOR ASSESSING DCE-MRI IN PROSTATE CANCER
Aravindhan Jegatheesan, Michael D. Noseworthy, Colm Boylan, Bobby Shayan, Gabriela Gohla, and John Fredrick MacGregor

ADDITIVE VALUE OF MRI OF THE SPINE ON MRI OF THE SACROILIAC JOINTS IN THE IMAGING EVALUATION OF PATIENTS WITH SUSPECTED OR ESTABLISHED SPONDYLOARTHROPATHY
Euan Stubbs

11:30-12:00  Today and tomorrow: Anatomic and Functional / Molecular Imaging of Musculoskeletal Disorders
Dr. Andrea Doria

12:00-1:30  Lunch and Poster Session
THE TYPICAL IMAGING CHARACTERISTICS OF COMMON LIVER LESIONS USING HEPATOCYTE-SPECIFIC CONTRAST AGENTS
Brian Stewart

JURAVINSKI HOSPITAL AND CANCER CENTRE BREAST IMAGING EDUCATION SERIES
Michael Di Ianni, Michelle Walker, Terry Minuk

INFECTIONS IN LIVER: A PICTORIAL REVIEW
George A, Ghandehari H, Haider E

DOSIMETRY IN SPECT
Sarah McNeil, Troy Farncombe

SIMULTANEOUS DUAL ISOTOPE TOMOSCIINTIMAMMOGRAPHIC RECONSTRUCTION WITH MONTE CARLO BASED CROSSTALK CORRECTION
Muhammad Irfan Karamat, Troy H. Farncombe

MONITORING EXERCISE-INDUCED MUSCLE CHANGES USING DIFFUSION TENSOR IMAGING (DTI)
Conrad Rocket, Andrew Davis, Greg Wells, and Michael D. Noseworthy

BREATHE HOLDING HAS NO EFFECT ON BOLD SIGNAL IN THE KIDNEY
Marla Shaver and Michael D. Noseworthy

DIFFUSION TENSOR IMAGING OF LUMBAR MUSCLES IN SUBJECTS WITH AND WITHOUT LOW BACK PAIN
Gavin E.G. Jones, Dinesh A. Kumbhare, Srinivasan Harish, Michael D. Noseworthy

2D/3D REGISTRATION ALGORITHM FOR LUNG BRACHYTHERAPY
P S Zvenarev, T J Farrell, R Hunter, M Wierzbicki, J Hayward and R K Sur

1:30- 3:00  Oral Presentations

DIFFUSE REFLECTANCE SPECTROSCOPY FOR MEASURING BLOOD CONCENTRATIONS
Diana L. Glennie, Daniel McKee, Joseph E. Heyward, Achilleas Thoma, Thomas J. Farrell

AN IMAGING ALGORITHM USING QUANTITATIVE CT DENSITOMETRY MEASUREMENTS AND LESION SIZE FOR THE DIFFERENTIAL DIAGNOSIS OF ADRENAL ADENOMAS AND METASTASES
R. Yuan, B. NG, E. Miller, G. Pond, M. Smoch, C. Boylan

STUDY OF DYNAMIC CHANGES IN 31P OF CALF MUSCLE DURING EXERCISE USING A QUADRATURE SPLIT BIRDCAGE RF COIL
Alireza Akbari, Dinesh A. Kumbhare, Michael D. Noseworthy

CLINICAL PREDICTORS OF ABNORMAL FINDINGS ON UNENHANCED COMPUTED TOMOGRAPHY OF THE HEAD IN NON-TRAUMA PATIENTS IN THE EMERGENCY DEPARTMENT.
Xi Wang, John You

DEVELOPMENT OF A SOLID-STATE SILICON-PHOTOMULTIPLIER (SIPM) BASED GAMMA CAMERA.
Dost M. Khan, Troy H. Farncombe

COMPLICATIONS OF UTERINE ARTERY EMBOLIZATION: A META-ANALYSIS
Martin JL., Bhanot K, Athreya S

QUANTITATIVE ANALYSIS OF MYOCARDIAL DAMAGE THROUGH SPECT IMAGING USING PINHOLE COLLIMATOR GEOMETRY
A. Ihsani, T. H. Farncombe

RISK FACTORS THAT MAY INCREASE THE CHANCE FOR POST-EMBOLIZATION HEMORRHAGE FOR PATIENTS PRESENTING WITH AN ACUTE GI BLEED.
Vu Luong, Mehran Midia, Eli Graybiel, Adrian Bruno.

3:00-3:30  Break

3:30-4:00  Presentation of awards.
Speakers in order

OPTICAL PROPERTY RECOVERY FOR THE ANALYSIS OF BRAIN TUMOUR MARGINS

Derek J Cappon, Zhaojun Nie, Thomas J Farrell, Qiyin Fang, John Provias, Naresh Murty, William McMillan, Joseph E Hayward

Graduate Student

Diffuse reflectance (DR) spectroscopy is a technique that can be used for the determination of the optical properties of tissue. The degree to which light is absorbed and scattered while travelling through a turbid medium such as tissue can be quantified by analyzing spatially resolved DR signals and recovering the absorption and scattering coefficients ($\mu_a$ and $\mu_s$). A novel Monte Carlo based algorithm has been developed for recovery of these coefficients in brain tissue. Testing of the algorithm demonstrates that is able to recover these values to a high degree of accuracy, and its performance when subjected to random noise is evaluated.

This algorithm is applied to the real time processing of data collected during optical biopsy: a technique used during surgical tumour resection to locate malignant tissue remaining in the margins. A dual modality optical biopsy instrument has been developed for use in the brain which acquires both diffuse reflectance and time-resolved fluorescence (TRF) spectra. Combining these modalities into one instrument improves tissue diagnostic capabilities through the integration of spectral data, and allows for real time correction of fluorescence data based on optical properties recovered from DR spectra.
THE MR IMAGING FEATURES OF MYXOMAS AND MYXOSARCOMAS

Sanjay Gupta
Fellow

Clinical Relevance: The MR imaging features of myxoid sarcoma are extensively described in the current literature. Nevertheless, differentiating this entity from other myxoid lesions on the basis of MRI alone can present difficulty. Of note, intramuscular myxomas often demonstrate similar morphologic and signal characteristics, and commonly constitute the most problematic differential diagnostic entity to radiologists. This is particularly true when the myxoid component of a sarcoma is high, or for the cyst-like form of intramuscular myxoma, which demonstrates an enhancement pattern characteristic of myxoid sarcoma. There are, however, a number of other distinctive features associated with intramuscular myxoma that, anecdotally, are absent in cases of sarcoma. This includes the presence of edema on T2-weighted images, commonly at the poles of the lesion, and a perilesional fat rind associated with up to 65% of intramuscular myxoma.

Purpose: The primary purpose of the current study is to determine whether cases of pathology-proven myxoid sarcoma can be confidently differentiated from cases of pathology-proven intramuscular myxoma on the basis of MRI alone. As a secondary objective, we aim to determine what MRI features (morphologic, signal intensity, enhancement characteristics) are suggestive of a given pathologic entity, and further, whether the presence of perilesional edema or fat rind constitutes a reliable imaging sign for identifying cases of intramuscular myxoma.

Materials and Methods: Retrospective chart review yielded 14 cases of intramuscular myxoma and 14 cases of myxoid sarcoma with pre-intervention multisequence, multiplanar MRI. 6 images were collected for each case, and all cases were input in a random order into a powerpoint-based slide presentation. The images will be presented to 3 blinded musculoskeletal radiologists at our institution, with an accompanying questionnaire regarding the imaging features and diagnosis for each case. All cases will then be reviewed, by a single unblinded MSK radiologist, for the presence of perilesional edema, fat rind and other relevant imaging features, in order to determine their specificity and sensitivity in the diagnosis of intramuscular myxoma versus myxoid sarcoma.

Results: Pending

Conclusion: Pending
A STUDY COMPARING DIFFERENT ORAL CONTRAST MEDIA IN SMALL BOWEL DISTENSION IN CT ENTEROGRAPHY

Dr.A.De, Dr.E.Leduc, Dr.N.Muhn, Dr.R.Rebello, M.Schmuck

Resident

PURPOSE/ BACKGROUND: Adequate small bowel distension is a prerequisite in the interpretation of CT enterography. The aim of the study is to compare the efficacy of 4 oral contrast agents in achieving small bowel distension. To our knowledge, this comparison has not been performed by other investigators.

MATERIALS AND METHODS: THIS is a retrospective study comparing 4 oral contrast agents - water, Polyethylene Glycol (PEG), Metamucil and Lactulose. The sample size has been estimated based on a non-inferiority study. CT enterography studies of 64 patients in each cohort, meeting inclusion criteria, and lacking exclusion criteria, will be analyzed. To date, 221 scans of the total 256 have been performed and make up the dataset for this pilot study.

The study involves 2 arms:
Qualitative study - 2 blinded body radiologists independently reviewed the randomized coronal CT enterography images and assigned a score of 1 – 5 on a Likert scale, based on their impression of the degree of bowel distension in each quadrant.
Quantitative study - A blinded radiology fellow and resident independently read the same randomized coronal CT enterography images and measured the diameter of the widest loop of bowel in each quadrant.

RESULTS: Statistical analysis from the quantitative arm (preliminary data from the first 221 patients) reveals that the mean small bowel loop diameter in the Lactulose cohort was significantly higher than the other 3 agents in all 4 quadrants.
At this time, statistical analysis from the qualitative arm is incomplete but suggests a slight advantage of Lactulose with statistically higher ratings on the Likert scale over the other agents in at least 1 quadrant. Once the remainder of the patients in the Lactulose cohort are examined, we may see more consistent results in the other quadrants.

CONCLUSION: Using Lactulose for CT enterography results in better subjective and objective small bowel distension than water, Metamucil and PEG.
EVALUATION OF RESTING STATE BOLD WITHIN LOCALLY ADVANCED BREAST CANCER

Evan McNabb, Aravindhan Jegatheesan, Michael D. Noseworthy

Graduate Student

PURPOSE: Dynamic Contrast Enhanced MRI (DCEMRI) is the current clinical standard for kinetic analysis of breast cancer [1]. However, the tradeoff for spatial rather than temporal resolution [1, 2] conflicts mathematical modeling. Alternatively, blood oxygen level dependent (BOLD) MRI has shown promise for measuring tumour hypoxia which can indicate treatment response [3]. BOLD imaging of prostate and rectal cancers has easily been done and modeled using chaotic models [4]. However, breast, being a more fatty tissue, with large local magnetic susceptibility problems and complex cardiac and respiratory motion, makes BOLD imaging challenging. Therefore, the aim of the current work was to optimize breast BOLD imaging.

MATERIALS AND METHODS: In a study approved by our Research Ethics Board, 11 subjects with locally advanced breast cancer were scanned using a 3T Philips Achieva MRI. DCE scans were performed using a 3D T1-weighted sequence with a 8 channel bilateral breast coil (TR/TE=5.8/2.8ms; 352x352 matrix; FOV=34cm; 95 slices; 2mm thickness; SENSE factor=2; 6.2s temporal resolution). Resting state BOLD scans were performed using a T2*-weighted echo planar imaging (EPI) sequence (12 slices, TR/TE=1000/35ms; 144x144 matrix; FOV=25.8cm; 6mm thickness). Six patients were scanned without fat suppression; three with SPAIR pulses (TI=311.4ms), and two using SPIR pulses. Regions of Interest (ROI) were drawn on early phase DCE high intensity tumour areas. These were subsequently co-registered to BOLD scans.

RESULTS AND DISCUSSION: Tumour BOLD contrast was maximally visible using SPIR fat suppression (SNR=536.7 +/- 166.1; CNR=400.6 +/- 119.0), though there were resultant geometric distortions in the phase-encode direction. BOLD signal temporal standard deviation appeared to correlate with local regions of DCEMRI changes when using SPIR. Therefore, for BOLD modeling studies of breast we suggest SPIR fat suppression. Furthermore, BOLD signal temporal variability may be a useful statistic for breast cancer therapeutic monitoring.

ASSESSING THE RELIABILITY AND QUALITY OF ONLINE UTERINE FIBROID EMBOLIZATION RESOURCES

Jatin Kaicker, Ke Wu, Sriharsha Athreya

Undergraduate Student

BACKGROUND: The objective of this study was to critically examine and summarize the best internet resources providing information about UFE that may be pertinent to medical trainees at all stages, interventional radiology specialists, gynecologists, family physicians and patients.

METHODS: The term ‘Uterine Fibroid Embolization (UFE)’ was entered into the Google, Yahoo, Bing search engines, with the top 20 hits assessed. The hits were categorized as organizational or non-organizational. Additionally, 23 radiological and obstetrical organization websites were assessed. The DISCERN instrument and Journal of the American Medical Association (JAMA) benchmarks (authorship, attribution, currency, disclosure) were used to critically appraise the online information. Overall mean and question specific DISCERN score were generated. The scope, strength, weaknesses and unique features were highlighted for the top 5 organizational and non-organizational websites.

RESULTS: A total of 83 websites were reviewed, 23 removed in accordance with the exclusion criteria and 35 duplicate websites, for a total of 25 unique sites. It was found that 44% (11/25 websites) were organizational (family medicine, radiology, obstetrics/gynecology) and 56% (14/25 websites) were non-organizational (teaching resources or patient sites). The overall mean DISCERN score was 49.38 (10.57). Two tailed, unpaired T test demonstrated no statistically significant difference between organizational and non-organizational websites (P=0.190). JAMA benchmarks revealed 52% (13/25 websites) with Authorship, 68% (17/25 websites) with Attribution of References, 76% (19/25 websites) with Disclosure and 48% (12/25 websites) with currency.

CONCLUSION: The overall quality of websites for UFE is of moderate quality, with important but not serious shortcomings. The best websites for UFE provided relevant information about the nature of the procedure, benefits/risks and were interactive, with a clear target audience. DISCERN scores were compromised by sites failing to provide resources for shared decision making, additional sources of support/information and discussing the consequence of no treatment. JAMA benchmarks revealed lack of authorship and currency.
CHARACTERIZATION OF ISCHEMIC INFARCTS OF THE STRIATUM NUCLEUS: A RETROSPECTIVE PILOT STUDY

Shauna Kennedy, Ramiro Larrazabal, Luciana Ribero

Resident

PURPOSE: Pilot study to characterize patient characteristics, topographic patterns and etiologies of acute MCA territory infarcts. The "comma" shaped infarct of the striatum nucleus is of particular interest, the incidence of which is compared to lacunar or large vascular territory infarcts in the MCA territory.

MATERIALS AND METHODS: Retrospective analysis of 100 patients has been performed in this pilot study, from an acute stroke registry of the Hamilton General Hospital. Published templates were used to establish topography of the acute MCA ischemic infarcts, then subdivided into comma shaped infarcts of the striatum nucleus, lacunar infarcts (1.5 cm) and large territory infarcts (with and without involvement of the striatum nucleus). Potential etiologies include ICA disease (≥50% stenosis), MCA disease (≥50% stenosis) and cardioembolic disease (TOAST criteria), determined by carotid Doppler, Circle of Willis CTA/MRA/DSA and echocardiography, respectively. Clinical risk factors such as hypertension, dyslipidemia, diabetes mellitus and smoking were collected.

RESULTS: Of 245 patients evaluated, 100 (55 male, 45 female) had acute MCA infarcts, 77 were large territory, 12 were lacunar and 11 were comma shaped of the striatum nucleus. The median age was 74 (range 31-91). Of 11 comma shaped infarcts, 1 had MCA stenosis, 3 had ICA stenosis and 3 had cardioembolic risk factors. Of 12 lacunar infarcts, 4 had cardioembolic risk factors, none with MCA or ICA stenosis. Of 77 large territory infarcts, 1 had MCA stenosis, 15 had ICA stenosis and 23 had cardioembolic risk factors. 3 patients with comma shaped infarcts had all 3 modalities – 1 case is attributed to ICA disease, 1 to cardioembolic disease and 1 is undetermined.

CONCLUSIONS: Comma shaped infarcts while uncommon make up 11% of this study, with only 2 having determined etiologies (1 ICA, 1 cardioembolic). This pilot study is limited by an absence of data in all patients, as few acute stroke patients receive CTA/MRA/DSA, Carotid Doppler and echocardiography. For continuation of this study to infer causation, cases only with all modalities should be selected.
FRACTAL DIMENSION COMPARED TO RESTING STATE NETWORK ANALYSIS OF BOLD MRI IN ALZHEIMER'S DISEASE

Mohammed A. Warsi, William Molloy, Michael D. Noseworthy

Graduate Student

BACKGROUND: We investigated temporal fractal structure of BOLD-fMRI in Alzheimer's disease (AD) and age-matched controls (NC). The default mode network (DMN) exhibits diminished functional connectivity in AD. Fractal dimension (FD) is a measure of connectivity or tissue vascular temporal chaotic behavior\(^1\). FD was compared to functional connectivity in DMN using resting state network (RSN) analysis.

METHODS: 36 mild/moderate AD subjects (MMSE=22±3) and 16 NC were scanned at rest. Nine AD returned 10±2 months later. Standard T1/T2-weighted images guided T2* (BOLD) weighted acquisition (TE=35ms, FOV=24cm, 64x64matrix, 5mm thick). FD maximized temporal frequency (\(\alpha=70^\circ\), TR=250ms, 3 slices, 2400 time-points) while RSN expanded spatial coverage (\(\alpha=90^\circ\), TR=2000ms, 24 slices, 300 time-points). FD regions-of-interest included putamen and posterior cingulate cortex (PCC). FD included relative dispersion (RD) and power spectrum (PS). DMN nodes were assessed as previously described\(^2\) with normalized correlation \((Z\text{-values})\).

RESULTS: PS correlated with RD (r=0.29/p=0.023), as did FD in putamen and PCC (r=0.44/p<0.001). FD was consistent over time (r=0.81/p=0.003). NC had higher FD than AD (NC-FD=1.21, AD-FD=1.19) and FD was 0.04 lower at follow-up (P>0.05). The DMN mean Z-values correlated with FD in putamen (r=0.40/p=0.022) and PCC (r=0.44/p=0.001) and were lower in AD than NC (lateral-parietal cortex: AD=0.53, NC=0.64, p=0.027).

CONCLUSIONS: Mild disease state likely contributed to small differences between AD and NC. FD relates to functional connectivity and is a reliable and reproducible measure of complexity. FD decreases as AD progresses. Unlike RSN, FD is not limited to functional networks. FD could be compare to structural connectivity using diffusion tensor imaging.

REVISED ULTRASOUND CRITERIA FOR POLYCYSTIC OVARY SYNDROME: VALIDATED THRESHOLDS FOR ELEVATED FOLLICLE POPULATION AND OVARIAN VOLUME

Andrew K Peppin, Marla Lujan, Eric D Brooks, Jonathan K Reines, Brittany Y Jarrett, Naray Muhn, and Ehsan Haider

Fellow

BACKGROUND: The ultrasonographic criteria for polycystic ovaries (PCO) supported by the 2003 international consensus criteria for polycystic ovary syndrome (PCOS) do not appear to adequately discriminate between the normal and PCOS condition. A threshold of 12 or more follicles throughout the entire ovary is likely too low – leading to the misconception that PCO are a highly common finding in healthy women.

METHODS: One hundred and four women with PCOS and 76 healthy female control subjects were prospectively evaluated by transvaginal ultrasonography. Receiver operator characteristic (ROC) curve analyses were performed to determine appropriate diagnostic thresholds for: 1) follicle counts throughout the entire ovary (FNPO), 2) follicle counts in a single cross-section (FNPS) and 3) ovarian volume (OV). The level of intra- and inter-observer reliability when five observers used the proposed criteria on 100 ultrasound cases was determined.

RESULTS: Diagnostic potential was highest for FNPO (0.949), followed by FNPS (0.873) and OV (0.859) as judged by the area under the ROC curve. A FNPO threshold of 25 follicles had the best compromise between sensitivity (84%) and specificity (90%) when discriminating between controls and PCOS. Similarly, 9 follicles in a single cross-section had 67% sensitivity and 91% specificity and an OV of 10 cm³ had 84% and sensitivity 76% specificity. Levels of intra-observer reliability were 0.78, 0.76 and 0.84 for FNPO, FNPS and OV, respectively. Inter-observer reliability was 0.71, 0.71 and 0.83, respectively.

CONCLUSIONS: Follicle counts throughout the entire ovary have better diagnostic potential to distinguish between controls and women with PCOS compared to FNPS or OV. Clinically, levels of inter- and intra-observer reliability were similar among methods, yet observers reported greater diagnostic confidence when evaluating FNPO. Twenty-five or more follicles per ovary is a reliable threshold for detecting PCOS. Whenever possible, images throughout the entire ovary should be collected for sonographic evaluation of PCOS.
DEVELOPMENT OF A MONTE CARLO SIMULATION TOOL FOR THE LIGHT TRANSPORTATION INSIDE SCINTILLATION CRYSTALS

Xi Yang, Tom Farrell, Hao Peng

Graduate Student

Our group aims to develop a whole body PET/MRI system of both depth-of-interaction (DOI) and time-of-flight (TOF) capability with the use of silicon photomultipliers (SiPMs). The scintillation crystal is a critical component in positron emission tomography (PET) systems. It impacts a number of PET system performance parameters, including spatial, energy, and time resolution. The time resolution is of particular importance for the development of PET systems of TOF capability that use novel scintillation crystal materials (i.e., LaBr3) and photodetector technologies. The goal is to develop a new simulation tool to achieve improved accuracy by addressing several limitations in the existing simulation packages, including more advanced surface treatments, temporal dependency of photon arrival, and rigorous experimental validations.

The time-resolved light output result obtained from the Monte Carlo simulation matched the analytical prediction well for mid-position photons in a different positions and geometries in crystal. The dependency of light propagation within crystals as a function of crystal configurations (i.e. width and height) and surface treatment conditions are being investigated. Some preliminary experimental results (energy spectrum) for 2x2x20 mm$^3$ LSO crystal are obtained.
AUDIT OF CT GUIDED TRANSTHORACIC BIOPSIES AT A TERTIARY REFERRAL CENTER

N. Lougheed, S. Athreya.

Resident

PURPOSE: The purpose of this audit is to determine complication rates, diagnostic rates, and false positive/negative results from CT guided transthoracic core needle biopsies in a tertiary referral centre and comparison with the Society of Interventional Radiology (SIR) standards of practice.

MATERIALS AND METHODS: Research ethics board approval was obtained. Using the PACS system, all CT guided transthoracic biopsies were isolated for the year of 2010. Reports and/or images were reviewed to determine the lesion size, lesion site, needle size, number of core biopsies obtained, and rates of complications. Post biopsy chest radiograph reports and/or images were reviewed in some cases. Pathology/microbiology results were then reviewed. Complication and diagnostic rates were compared with published Society of Interventional Radiology (SIR) standards.

RESULTS: 261 CT Guided Transthoracic Biopsies were performed at our institution in 2010. 33% (85) had minor complications. 9% (23) had a pneumothorax requiring a chest tube. 12% (31) of biopsies were non-diagnostic. 0.02% (6) non-diagnostic biopsies were proven to be malignant by repeat biopsy or surgery. 0.01% (3) biopsies showed benign tissue but were proven malignant by repeat biopsy or surgery.

CONCLUSION: CT guided transthoracic biopsy is a safe and effective technique to obtain tissue diagnosis. Regular audits are necessary to improve outcomes and minimize complications.
HYBRID PCA-OPTIMIZATION FRAMEWORK FOR ASSESSING DCE-MRI IN PROSTATE CANCER

Aravinthan Jegatheesan, Michael D. Noseworthy, Colm Boylan, Bobby Shayegan, Gabriella Gohla, and John Fredrick MacGregor

Graduate Student

BACKGROUND: Due a variety of limitations in clinical imaging, assessment of DCE-MRI is limited to visual examinations and curve modeling[1]. One alternative to assess DCE-MRI has been toward statistical techniques such as principal component analysis (PCA)[2,3]. PCA is a data driven method that decomposes correlated variables into uncorrelated variables. The vectors that define the new space, called principal components (p), are composed as linear combination of the old variable space.

METHOD: The problem with a data driven method is that the derived PCs are dependent on the underlying data and not necessarily clinically relevant. However by characterizing PCA as an optimization problem[4] it is possible develop a hybrid method, in which components are defined as $p_a = \max_{p_a} [(p_a^T X^T X p_a) - \lambda \cdot ||(w_a ||w_a) - (p_a ||p_a)||]$, which is data driven but also can be conditioned by a priori information. With REB approval, DCE-MRI (TE=2.3ms, TR=4.3ms, slice thickness=6mm, FOV=220mmx220mm, 36 temporal samples, 16-24 slices) and anatomical scans were performed on seventy (age 63.7±7.6) patients with suspicion of prostate cancer. Patients with prostate cancer had radical prostatectomy. DCE-MRI for each subject was manually segmented and unfolded spatially to a 2D dataset. The wash-in point for each patient was located and ideal wash-in($w_1$) and washout($w_2$) curves were constructed as a step function and linear decreasing ramp. The projected score value of each voxel was determined for the first two PCs and the result refolded to produce 3D hybrid PCA wash-in and washout images. The resulting images were visually compared to whole mount specimens to determine correlation in location and extent.

RESULTS: The results from the hybrid PCA wash-in curve were able to correlate location to the histopathology in 12 of the 18 patients for whom the histopathology was available. The results from the washout curve were more promising with 15 of 18 patients correlating extent and location.

ADDITIVE VALUE OF MRI OF THE SPINE ON MRI OF THE SACROILIAC JOINTS IN THE IMAGING EVALUATION OF PATIENTS WITH SUSPECTED OR ESTABLISHED SPONDYLOARTHROPATHY.

Euan Stubbs

Fellow

CLINICAL RELEVANCE: Over the past decade there has been a large change in the rheumatological management of seronegative spondyloarthropathy. There is now emphasis on early diagnosis and institution of treatment at an early stage of disease thus reducing the morbidity associated with the structural bone changes of more advanced spondyloarthropathy. MRI of the sacroiliac joints plays an important role in the rheumatological assessment of such patients and a number of institutions include spinal MRI imaging in their ‘routine’ spondyloarthropathy protocol.

We aim to assess if routine use of spinal MRI in addition to Sacroiliac joint MRI as part of standard spondyloarthropathy protocol improves diagnostic confidence and accuracy.

- 1) Does it improve the diagnosis of SpA in patients with inflammatory back pain?
- 2) Does it add value in patients with known/established diagnosis of SpA?
- 3) Does this change patient management in the setting of a tertiary Rheumatology service?

MATERIALS AND METHODS: Retrospective review of 120 consecutive rheumatology referred MR whole spine and MR sacroiliac joint examinations performed to diagnose or monitor spondyloarthropathy. These examinations shall be read by two radiologists independently in 4 sitting, blinded to the other components of the examination. Qualitative assessment for each case at each sitting will be recorded and the data analysed to ascertain if the addition of spinal MRI to sacroiliac joint MRI adds value to our confidence in the diagnosis of spondyloarthropathy. Intercrader reliability analysis shall be performed and the final ‘MRI diagnosis’ will also be compared with the ‘Gold Standard’ final specialist rheumatologist diagnosis from chart review.

RESULTS AND CONCLUSIONS: Pending (Final round of data collection March 31 2012)
DIFFUSE REFLECTANCE SPECTROSCOPY FOR MEASURING BLOOD CONCENTRATIONS

Diana L. Glennie, Daniel McKee, Joseph E. Hayward, Achilleas Thoma, Thomas J. Farrell

Graduate Student

BACKGROUND. The ability to measure changes in blood volume in tissue can be a very valuable tool for monitoring the effects of a wide range of therapeutic interventions, from radiation therapy to skin-flap transplants. Due to the unique reflectance spectra of oxy- and deoxy-hemoglobin, the major chromophores found in blood, diffuse reflectance spectroscopy (DRS) is a good candidate for this task.

EVALUATION. In order to test the ability of DRS to monitor changes in blood volume in human skin, volunteers were given two subcutaneous injections of local anesthetic in the distal portions of their deltoid muscles. The first injection contained only lidocaine (a vasodilator), while the second contained both lidocaine and epinephrine (a vasoconstrictor). The resulting skin reddening or blanching was recorded over the course of two hours using DRS.

DISCUSSION. Each of the collected reflectance spectra was processed into an index representing the skin redness as a result of increased hemoglobin in the measurement area. This value was corrected for melanin content, which can mask the actual amount of hemoglobin present.

CONCLUSION. DRS is an effective, non-invasive, and real-time method for monitor changes in blood concentration in human skin. It has a wide range of applications across many different medical disciplines, such as measuring radiation-induced erythema in radiation therapy patients, and monitoring the viability of transplanted tissues. Both of these examples are currently being investigated and preliminary data will be presented.
AN IMAGING ALGORITHM USING QUANTITATIVE CT DENSITOMETRY MEASUREMENTS AND LESION SIZE FOR THE DIFFERENTIAL DIAGNOSIS OF ADRENAL ADENOMAS AND METASTASES

R. Yuan, B. NG, E. Miller, G. Pond, M. Smuch, C. Boylan

Fellow

PURPOSE: To test whether quantitative CT densitometry measurements of the adrenal mass with a density >10HU on non-enhanced CT (NECT) can be used to differentiate adenomas from metastases.

MATERIALS AND METHODS: Diagnoses of 66 (age 35-88 years, 60% male) adrenal masses (21 metastasis, 45 adenoma) were confirmed by biopsy (n=15) or follow-up imaging (n=51). Custom software was used to measure the lesion size, and the number of pixels of the mass with a density lower than a given HU cutoff, expressed as the percentage of the total pixel of the mass (i.e. % Low Attenuation Area, %LAA). A series of HU cutoffs from -30 ~ 40HU with a 2HU increment, resulting in total 24 HU cutoffs were used.

Logistic regression and Receiver Operating Characteristic (ROC) Curve were used to test and compare the ability of each %LAA in differentiating adenomas from metastases. The %LAA with the best performance and lesion size were fit into a linear regression model to separate adenomas from metastases. The area under the ROC curve from the regression model was compared to that using the %LAA, and lesion size alone.

RESULTS: Adenomas were significant smaller than metastases (diameter: 13±7 vs. 26±11mm, respectively p<0.01). Logistic regression showed the %LAA at 2HU yielded the best performance differentiating adenomas from the metastases, and the percentage threshold ≥14% was found to be 100% specific and 60% sensitive for differentiation adenomas from metastases. The linear regression model incorporating both %LAA at 2HU and lesion size yielded the largest area under the ROC curve indicating that it is superior to either measure alone for the differentiation of adenomas from metastases.

CONCLUSION: Combining CT densitometry measure (i.e., %LAA at 2HU) and size of mass provides an accurate tool to differentiate adenomas from metastases on NECT in the mass with a density >10HU on NECT.

CLINICAL RELEVANCE: This approach saves the medical resource in these lipid-poor adenomas which would have led to contrast CT, MRI, follow-up imaging, and biopsy.
STUDY OF DYNAMIC CHANGES IN $^{23}$Na OF CALF MUSCLE DURING EXERCISE USING A QUADRATURE SPLIT BIRDCAGE RF COIL

Alireza Akbari, Dinesh A. Kumbhare, Michael D. Noseworthy

Graduate Student

INTRODUCTION Sodium ($^{23}$Na) is one of the most important cations in the body as it plays an important role in fluid homeostasis, nervous system function, and muscle health and function. Monitoring changes in $^{23}$Na content of skeletal muscle can help assess muscle performance in health and disease. Here, we used dynamic $^{23}$Na magnetic resonance spectroscopy to assess exercise-induced changes in calf muscles using a novel homemade split birdcage coil.

MATERIALS AND METHODS $^{23}$Na MR spectra were obtained using a novel home built split birdcage coil tuned to 33.8MHz and a GE Signa HD 3T short-bore MR scanner. The study was conducted on two healthy volunteers. Localization was done using a 3D-fSPGR sequence. Subsequently a slab of calf muscle was selected (FOV=16x16cm$^2$, slice thickness=4cm). A total of 90 $^{23}$Na MR spectra (FIDCSI sequence, TR=500ms, NEX=8, 4s temporal resolution) were acquired before (1min duration), during (2min. isometric calf muscle flexion at 75% maximum voluntary contraction), and following exercise (3 minutes recovery). Relative muscle $^{23}$Na content was determined from the integral of the spectrum between 20 and -20ppm.

RESULTS AND DISCUSSION Mean muscle $^{32}$Na content increased 34% during exercise. Recovery to pre-exercise resting state was approximately 3 minutes. This technique could be of use in evaluating diseases involving ion channels such (e.g. paramyotonia congenital [1]) and muscular dystrophies (e.g. Duchenne’s [2]). We are planning on using this approach to assess muscle function/recovery in chronic obstructive pulmonary disease (COPD) and cystic fibrosis (CF).

CLINICAL PREDICTORS OF ABNORMAL FINDINGS ON UNENHANCED COMPUTED TOMOGRAPHY OF THE HEAD IN NON-TRAUMA PATIENTS IN THE EMERGENCY DEPARTMENT.

Xi Wang, John You

Resident

PURPOSE: To identify predictors of clinically significant abnormal unenhanced head CT amongst ED patients with no history of trauma.

MATERIALS AND METHODS: A retrospective review of consecutive unenhanced head CTs was performed on patients in our ED from January 2004 to June 2006. Patients were eligible for this study if they were 18 years of age or older, with no history of trauma or known intracranial pathology. We collected clinical data from the CT requisitions and official radiology reports. We used logistic regression to identify clinical variables predictive of a clinically significant abnormal CT in the derivation cohort (CTs from January 1, 2004 to August 15, 2005) and assessed the reproducibility of our findings in a validation cohort (all subsequent CTs to June 30, 2006).

RESULTS: Of 29,469 consecutive head CTs performed at our institution between January 1, 2004 and June 30, 2006, 3,967 were eligible for this study. 548 (13.8%) of these CT scans revealed clinically significant abnormalities. We identified six independent clinical predictors of having a significant abnormality on head CT: age (adjusted odds ratio [OR] per 10 year increase 1.17 95% confidence interval [CI] 1.08-1.28), focal neurological deficit (adjusted OR 5.4, 95% CI 3.9-7.5), altered mental status (adjusted OR 2.3, 95% CI 1.7-3.3), history of malignancy (adjusted OR 4.1, 95% CI 2.3-7.4), nausea and/or vomiting (adjusted OR 2.2, 95% CI 1.1-4.3), and derangements in coagulation profile (adjusted OR 1.9, 95% CI 1.1-3.4).

CONCLUSION: We have identified several potential clinical predictors of abnormal head CT in non-trauma ED patients. Prospective validation of a clinical prediction rule is warranted.

CLINICAL RELEVANCE: Head CTs are frequently ordered for non-trauma patients in the ED. Amidst growing concerns regarding healthcare spending potential savings could be substantial if head CT use in these patients was more selective.
DEVELOPMENT OF A SOLID-STATE SILICON-PHOTOMULTIPLIER (SIPM) BASED GAMMA CAMERA.

Dost M. Khan, Troy H. Farncombe

Graduate Student

Interest in simultaneous multi-modality medical imaging systems has increased since the advent of PET/CT and SPECT/CT. Due to concerns regarding radiation exposure through the use of CT, greater interest in MRI/PET and MRI/SPECT has occurred. In these systems, conventional photomultiplier tubes (PMT’s) cannot be used as they are very sensitive to the magnetic field. Alternative solid-state photodetectors such as silicon photomultipliers (SiPM’s) are potential candidates to replace these PMTs. SiPM’s are insensitive to the magnetic fields, very small in size and operate at a lower electrical potential.

Due to their small size (e.g., 3x3 mm), a large number of SiPM detectors would be required to cover a clinical gamma camera. A conventional gamma camera has a photo-detector density of ~1 PMT per 4000 mm², while a SiPM-based gamma camera would have a photodetector density of ~1 SiPM per 10mm², thus representing an increase in the number of detectors by a factor of 400. With this increase in the number of detectors comes additional electronic complexity due to the vast increase in the readout/processing electronics.

In this work, we are developing a small field of view (~6.5 x 6.5 cm) pixelated gamma camera. We will investigate the sensitivity, uniformity, energy resolution and spatial resolution of the gamma camera using radio isotopes (⁵⁷Co, ⁹⁹ᵐTc, ¹¹¹In, ¹²²Na). We will also test the working of our gamma camera in the presence of magnetic field. This work will serve as a foundation for scaling the electronic acquisition system to a larger field view system.
COMPLICATIONS OF UTERINE ARTERY EMBOLIZATION: A META-ANALYSIS

Martin JL, Bhanot K, Athreya S

Undergraduate Student

INTRODUCTION: The aim of this paper is to combine the results of various types of studies, in order to generate a more generalizable understanding of complications from UAE.

METHODS: A literature review was conducted in the PUBMED, MEDLINE, Cochrane, and CINAHL databases, and a meta-analysis was performed. Results were stratified into three categories: 1) Randomized clinical trials (RCTs) 2) Non-randomized studies 3) Case studies.

RESULTS: In the RCT group, the most common complications were menorrhagia (8.57%), bilateral UAE failure (4.00%), discharge and fever (4.00%), and post-embolization syndrome (2.86%). Rare and serious complications included DVT (.286%), severe vasovagal event (.286%), and hematometra (.286%).

In the non-randomized studies, the most common complications were amenorrhea (4.26%), pain (3.59%), discharge & fever (3.37%). Rare and serious complications included Asherman syndrome (.018%), septicemia (0.009%), and cardiopulmonary arrest or resuscitation (0.045%).

In the case study group, the most common complications were discharge & fever (22 cases), repeat UAE (6 cases), and fibroid expulsion (5 cases). Rare and serious complications included PE (1 case), MI (1 case), and watershed infarcts in the brain (1 case). Three deaths were noted.

CONCLUSIONS: Although more effective than surgery, UAE does come with its own risks. Post-procedural as well as delayed complications can present a challenge to the patient and clinician if not caught early. By educating the referring clinician, family physician and the patient, fewer post-procedural complications will be missed, and delayed complications can be caught by the patients. Since routine imaging follow-up does not offer much benefit, the detection of complications is in the hands of the patient.
QUANTITATIVE ANALYSIS OF MYOCARDIAL DAMAGE THROUGH SPECT IMAGING USING PINHOLE COLLIMATOR GEOMETRY

A. Ihsani, T. H. Farncombe

Graduate Student

The quantification of myocardial damage due to ischemia or infarction is an active field of clinical research. Currently, SPECT myocardial perfusion imaging using Tc-99m labelled sestamibi is the modality of choice for clinicians due to the high sensitivity and specificity and the lower cost of equipment and radiotracers compared to PET. While current SPECT imaging technology can easily distinguish significant regional changes in myocardial perfusion, it is more difficult to distinguish lesser degrees of damage or multi-vessel damage due to the fact that this technique is non-quantitative (i.e., relative uptake measurement only), and that the uptake of tracer does not completely correlate with perfusion.

The aim of this research is to provide absolute quantification of myocardial perfusion through the use of better radiotracers (i.e., Tc-99m teboroxime) and by optimizing the data acquisition procedure and image reconstruction method. We are investigating the optimal position of multiple detectors over two intersecting half-rings in order to obtain sufficient angular and temporal sampling to yield quantitative images with a resolution that is adapted to the size of the myocardial muscle. Additionally, all the detectors employ a single pinhole collimator for higher detail in the projections due to magnification.

Simulations using Tc-99m-teboroxime test phantoms have shown promising results, however, the research is not limited to a single radiotracer. The completion of our research will be marked by the optimization of the SPECT scanner geometry as well as the exploration of other radiotracers such as Tc-99m-tetrofosmin, Tc-99m-sestamibi and Tl-201 due to their specific behaviour in the presence of fibrotic tissue and ischemia. The final goal is to obtain kinetic parameters from semi-direct image reconstruction methods; that is, without an arterial input function.
RISK FACTORS THAT MAY INCREASE THE CHANCE FOR POST-EMBOLIZATION HEMORRHAGE FOR PATIENTS PRESENTING WITH AN ACUTE GI BLEED.

Vu Luong, Mehran Midia, Eli Graybiel, Adrian Bruno.

Resident

INTRODUCTION: Acute non-variceal upper and lower GI hemorrhage is associated with significant morbidity and mortality. 5-10% of patients do not respond to endoscopic intervention or conservative medical treatment hence, requiring embolization or surgery. The associated high operative mortality rates of surgical intervention has made endovascular management with super-selective catheterization of the culprit vessel the first line therapy for a massive UGI bleed refractory to endoscopic treatment. Although many published studies support the feasibility and success of this approach despite the choice of the embolic agent used, the factors that influence clinical outcome, especially predictors of early re-bleeding, are poorly understood. To further investigate this topic, we retrospectively gathered data reviewed from our institution.

PURPOSE: To identify the risk factors to failed endovascular intervention. In turn, this would raise awareness, foster appropriate management algorithm, and change in technique.

MATERIALS & METHODS: From 2005 to 2011, 139 patients who presented with non-variceal upper and lower GI bleeds, who underwent subsequent embolization at our institution were retrospective studied. Of those 139 patients, 31 experienced post-embolization hemorrhage. From this patient group, based on previous published literature we focused on certain variables in which we felt may have increased the chance for rebleeding.

RESULTS: Pending. There was a minor glitch in the data. We decided to add other risk factors in last minute. As a result, the statistician is currently working on re-evaluating the data/stats. It will be done well before research day.

CONCLUSION: Pending as we decided to add more risk factors into the statistical analysis to add more merit to our previous results.
POSTER PRESENTATIONS

THE TYPICAL IMAGING CHARACTERISTICS OF COMMON LIVER LESIONS USING HEPATOCYTE-SPECIFIC CONTRAST AGENTS

Brian Stewart
Fellow

Prior to the relocation of a number of hepatobiliary surgeons to The Juravinski Hospital under Hamilton's new health care model, the radiologists at the Juravinski were collectively unfamiliar with performing focused magnetic resonance (MR) liver imaging. Dynamic contrast-enhanced imaging plays a dominant role in the characterization of hepatic lesions, particularly in MR imaging. In MR imaging of the liver, hepatobiliary-specific contrast agents (HSCAs) are used to improve lesion detection, characterize lesions as hepatocellular or nonhepatocellular, and specifically diagnose lesions, notably focal nodular hyperplasia. An education module (power point and poster presentation) was created to allow radiologists and residents to become familiar with typical appearances of common benign and malignant liver lesions at HSCA-enhanced MR imaging. This educational tool will help achieve maximal diagnostic accuracy with liver imaging and hence minimize the number of invasive biopsies performed for indeterminant lesions.
JURAVINSKI HOSPITAL AND CANCER CENTRE BREAST IMAGING EDUCATION SERIES

Michael Di Ianni, Michelle Walker, Terry Minuk

Fellow

The JHCC Breast Imaging Teaching File is an electronic educational resource intended for use by radiology residents during their breast imaging rotations. Based in Powerpoint, the teaching file consists of multiple modules which address core concepts in breast imaging, including: normal anatomy and physiology, approach to mammographic interpretation, benign and malignant masses, benign and malignant calcifications, and challenge cases. The modular nature of the teaching file is intended to facilitate the addition of content by future breast imaging fellows or residents. Expansion topics could include discussion of the breast screening program, breast-related procedures, breast MRI, and evolving techniques such as tomosynthesis and elastography.
INFECTIONS IN LIVER: A PICTORIAL REVIEW

George A, Ghandehari H, Haider E

Fellow

AIM: Our aim is to review with pictorial illustration the radiological features of some of the commonest liver infections from around the world that we have seen in Canada. We hope that our presentation will help to reduce the need for invasive procedures like tissue biopsy in diagnosing these cases. We will also discuss radiological management of these infections where appropriate.

BACKGROUND: Increased movement of people across the world has resulted in infections common in some parts of the world to present in parts of the world where these infections are not endemic, thereby posing a diagnostic dilemma. In this context it is important for Radiologists around the world to be aware of characteristic radiological features of various infections in the liver. Interventional radiology is playing a significant part in management of liver infections, and this role continues to increase with time.

DISCUSSION: In this presentation, we have included liver parenchymal pyogenic infections (amoebiasis and bacterial infections including chlamydia and Neisseria gonorrhea), parasitic infections (hydatid and schistosomiasis) and viral infections (Hepatitis B and C). We have also described with pictorial illustration some of the commonest biliary tract infections namely parasitic (cholangiiasis and fascioliasis) and viral (HIV). We will discuss conditions which can mimic liver infections. We will provide some clues to differentiate these conditions from liver infections.
DOSIMETRY IN SPECT

Sarah McNeil, Troy Farncombe
Graduate Student

Currently, in nuclear medicine there are several common methods used to calculate the doses that patients receive during a procedure. Most of these methods use look-up tables of factors to determine the dose a source organ would contribute to a given target organ, and a summation of all source and target organs is used to represent the absorbed dose (i.e. the MIRD method). These methods are used in programs such as OLINDA. As Monte Carlo simulations become more prevalent and faster with the advent of newer technology, there is a possibility of using this technique to calculate patient dose. Many image reconstruction programs exist that use Monte Carlo based photon transport to obtain a reconstructed image, one such program is called SIMIND. This program tracks the progress of particles through a patient, and models photon interactions. The goal of my research is to use the SIMIND program to store locations of energy deposition within a given patient, which in turn can be used to calculate dose. Progress has been made in storing energy deposited in simple simulations; further goals include modelling known dose distributions.
SIMULTANEOUS DUAL ISOTOPE TOMOSCINTIMAMMOGRAPHIC RECONSTRUCTION WITH MONTE CARLO BASED CROSSTALK CORRECTION

Muhammad Irfan Karamat, Troy H. Farncombe

Graduate Student

In SPECT multiple energy windows can be acquired, which has made simultaneous multi-isotope acquisition possible not possible with PET. Simultaneous multi-isotope SPECT imaging has a number of applications, for example, cardiac, brain and cancer imaging. The major concern in simultaneous multi-isotope is the significant crosstalk contamination between the multiple isotopes used. Monte Carlo (MC) based scatter compensation is thought to offer the most realistic crosstalk and scatter compensation modeling. However, in typical implementations, the inherent long calculation times (often several hours or days) associated with this technique makes it unsuitable for clinical applications.

While the advent of ever increasingly fast computers has reduced the computation times, we have taken an alternative approach to improve simulation times. We have previously developed a number of different variance reduction techniques (VRT) that have made Monte Carlo-based crosstalk compensation feasible to use in clinical time frames. Accelerated SPECT Monte Carlo simulation using multiple projection sampling (MPS) and convolution based force detection (CFD), is being used to accelerate the Monte Carlo photon transport modeling. We have developed an iterative Monte Carlo-based image reconstruction technique that simulates the photon downscatter from one isotope into the acquisition window of a second isotope. By accurately modeling the photon transport through the object of interest using Monte Carlo, we can accurately estimate the amount of scatter contamination contained in a given projection view. Once known, we then use this information in an iterative algorithm to compensate for the photon contamination. We use modified ordered subset-expectation maximization (OS-EM), named as simultaneous ordered subset-expectation maximization (Sim-OSEM) to perform this step. $^{123}$I has previously been used to detect presence of disease specific hormones. It is thought that it can be used to detect the presence of a tumour marking hormone in malignant lesions in breast cancer. Therefore $^{123}$I can complement $^{99m}$Tc (used for scintimammography) in differentiating benign and malignant breast lesions in case of breast cancer. Current study focuses on crosstalk compensation in simultaneous $^{99m}$Tc/$^{123}$I tomoscintimammography. We have undertaken a number of simulation tests to verify this approach and are starting on experiments in phantoms to further validate the accuracy of this approach.
MONITORING EXERCISE-INDUCED MUSCLE CHANGES USING DIFFUSION TENSOR IMAGING (DTI)

Conrad Rockel, Andrew Davis, Greg Wells, and Michael D. Noseworthy

Graduate Student

INTRODUCTION: Analysis of fluid dynamics and structural change within exercising skeletal muscle can reveal information about healthy and diseased muscle function. Here we investigated whether exercise-induced temporal diffusion changes within skeletal muscle could be evaluated using DTI.

METHODS: Three male volunteers (mean age 34.6yrs) underwent 2 bouts of exercise, one hour apart. Exercise consisted of 2.5min plantar flexion at 50% maximum load, using an MRI-compatible ergometer. Eight consecutive DTI volumes (TE/TR=74/6000ms, 6 directions, b=400s/mm², 16x4mm thick slices; each 2minutes in duration) through the right calf were collected prior to and following each exercise session. Regions-of-interest (ROIs) were drawn on the gastrocnemius and soleus muscles and registered to each consecutive DTI volume. DTI metrics (mean diffusivity, MD, and eigenvalues) were calculated for each ROI across time.

RESULTS: MD and tensor eigenvalues increased to a peak at the second post-exercise time point for both exercise bouts, after which diffusivity declined across excitations. There was no apparent difference in tensor metrics between exercise bouts. The soleus showed a slight post-exercise increase in DTI metrics but otherwise appeared temporally consistent.

DISCUSSION: The magnitude of post-exercise gastrocnemius MD increases and recovery are consistent with previously published studies [1-3]. However, in contrast to previous studies, we found gastrocnemius diffusion metrics consistently increasing to a peak between 3 and 4 minutes post-exercise. The increased diffusivity seen with exercise has been attributed to water and temperature changes [4]. The post-exercise peak could be the result of reactive hyperemia, as relaxing muscle removes vascular occlusions that occur in muscle contraction, and blood is allowed to reperfuse into the tissue. The differences between gastrocnemius and soleus could be due to the exercise protocol, or due to the heavily-vascularized soleus being able to maintain consistent blood flow throughout exercise, resulting in little change in tissue fluid levels.

BREATH HOLDING HAS NO EFFECT ON BOLD SIGNAL IN THE KIDNEY

Marla Shaver and Michael D. Noseworthy

Graduate Student

PURPOSE: Abnormal oxygenation can be observed in many renal diseases, and BOLD MRI has been shown to be a reasonable option for evaluating renal oxygenation [1]. Current studies implement breath holding to obtain motion-free kidney images for T2* or R2* mapping [2]. In this study, we used real-time BOLD imaging to investigate whether breath holding plays a significant role in modulating kidney microvasculature.

MATERIALS AND METHODS: The kidneys of healthy subjects (n=6) were imaged using a T2* weighted (BOLD) GRE EPI sequence. The acquisition plane was prescribed along the longitudinal axis of the right kidney, the direction of motion during breathing. During BOLD scanning, subjects were instructed to hold their breath for as long as possible, breathe when needed, and repeat this for the duration of the scan. The images were processed with a template matching algorithm previously used for kidney analysis [3]. Regions of interest (ROI) were selected for the renal medulla and cortex using AFNI [4], and temporal segments obtained during breath holding were selected. Following normalization to time=0, mean, median, skewness and kurtosis were calculated, over time, during each breath hold. We hypothesized BOLD signal would decrease with breath holding.

RESULTS: No trends could be identified in the BOLD signal intensity during breath holding in the cortex or medulla for individual subjects or the average of all subjects. There was no correlation with any ROI statistics and breath holding.

CONCLUSION: Because no trends were present in the BOLD data, it is evident that breath holding has no effect on kidney BOLD signal. As a result, utilizing breath holds for data acquisition in renal BOLD experiments should not affect the results of these studies.

DIFFUSION TENSOR IMAGING OF LUMBAR MUSCLES IN SUBJECTS WITH AND WITHOUT LOW BACK PAIN

Gavin E.G. Jones, Dinesh A. Kumbhare, Srinivasan Harish, Michael D. Noseworthy

Graduate Student

PURPOSE: Currently, there is no objective clinical method to evaluate the muscular impairment that may be responsible for low back pain (LBP) symptoms, making physician’s choices about treatment and patient monitoring difficult. In this study, we used of magnetic resonance (MR) diffusion tensor imaging (DTI) as a means to quantify impairments of the lumbar paravertebral muscles. DTI measures of lumbar multifidus (LM) and erector spinae (ES) muscles, in subjects with and without symptoms of LBP, were correlated with standardized questionnaires which measure LBP associated disability.

Materials and Methods: In a study approved by our local REB, 54 subjects (26 asymptomatic controls and 28 LBP subjects) were scanned using a 3T GE Sigma HD MRI. DTI scans were done with one b=0 and 15 diffusion encoding directions (b=400 s/mm²), TR/TE=10000/62ms, RBW=125kHz, 64x64 matrix, NEX=4, 20 slices (5mm thick, 0kip), and FOV=40cm. The scans covered L3-L5. DTI analysis was done as previously described [1]. In addition an asymmetry index was calculated: (FA_left−FA_right)/(FA_left+FA_right). Questionnaires used were Oswestry Low back pain, Godin Activity, and Visual Analog scale (pain index). Statistical analysis was done using a 2-way repeated measures ANOVA, with Spearmann’s correlation.

RESULTS: No significant correlation between any DTI metric and either questionnaire result or demographic information (age, weight or BMI) was found. However, the asymmetry index was significantly greater in the LBP group (p<0.05) than in the controls. Also, the within-ROI standard deviation was significantly greater in the LBP (p<0.05).

CONCLUSIONS: The fact that there is greater asymmetry in DTI metrics such as FA is consistent with asymmetric damage to the ES based on both previous work on tonic muscle activity [2] and cross sectional area [3,4].

2D/3D REGISTRATION ALGORITHM FOR LUNG BRACHYTHERAPY

P S Zvonarev, T J Farrell, R Hunter, M Wierzbicki, J Hayward and R K Sur

Graduate Student

High dose rate (HDR) brachytherapy is an effective method of treatment for obstructive lung cancer. For brachytherapy, a catheter is inserted into the bronchus close to tumour using a bronchoscope. Immediately prior to delivering radiation, two orthogonal x-ray images are taken using a c-arm to localize the catheters. These images allow for accurate reconstruction of the catheter location, but do not allow visualization of the tumour or organs at risk due to the poor soft tissue contrast. Thus, this step in the treatment planning process has the potential to compromise the goal of the treatment. Although soft tissue is recognized on CT images, presently it is impractical to move a patient to a CT suite prior to each treatment. Diagnostic or treatment planning CT images are generally available; however, these images cannot be directly fused with the orthogonal x-ray images due to differences in patient positioning. To account for positioning differences, a 2D/3D registration algorithm was developed to register the orthogonal images with the diagnostic CT volume thereby allowing for accurate localization of the treatment catheters in the CT volume.

The proposed rigid registration algorithm was developed using intensity-based matching approach with similarity metric calculated as a product of three components: mutual-information, gradient-based and mean square difference-based metrics. The development and evaluation of the algorithm was performed using an anthropomorphic thorax phantom. The proposed registration algorithm showed robustness to various degrees of initial displacement, equipment geometry imperfections, and to the presence of foreign bodies, such as catheters, ECG leads and wires. The measured mean registration error was 1.9 mm respectively. In addition to phantom evaluation, the algorithm performance was tested using one real lung patient data set. The mean registration error for patient data was 4.1 mm.