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Message from the Director

By the time we publish this newsletter the holiday festivities will be well under their. The Rockefeller Center Christmas tree lighting has occurred and all the other holidays preparations and plans are well under their way.

As I look back at 2017 I cannot be more proud of all the achievements by the TMII group and family as highlighted in this newsletter. We have also a very exciting 2018 ahead of us with a lot of ongoing and new initiatives and plans which you can read about in this issue.

I like to mention a few of these things.

The microPET/CT scanner support is now available with exciting results and studies being collected and planned. The 1st annual Radiology Research Retreat on December 9 lead by Dr. Bachir Taouli featuring one of the top thought leaders in the field of biomedical imaging Dr. Dick Ehman from Mayo. The 8th annual TMII Symposium on April 27 with heavy hitters in the latest field of Artificial Intelligence such as Yann le Cunn from Facebook. Not to forget the art exhibition Windows to Our Body on April 26.

Please take a took at our upcoming lectures

and don't miss the 3rd Annual Medical Imaging & Bioengineering Lecture on December 8th by Frank Preiswerk, one of the winners of the 2017 ISMRM Young Investigator Award.

Finally, I wish you and loved ones a very Merry Christmas and great holidays and looking forward to working with you in 2018!

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WHAT'S NEW?

TMII News & Updates

TMII would like to congratulate Dr. Priti Balchandani on her recent promotion to Associate Professor. You can read about her group's exciting work at 7T in the Science Spotlight section of this issue as well as earlier issues which can be found on our website.

The 1st annual Radiology Research Retreat will be held on December 9th, 2017 with a keynote presentation by Dr. Richard Ehman. Registration is still open for the whole Mount Sinai Radiology community. https://www.eventbrite.com/e/1st-annual-radiology-research-retreat-tickets-36072627199

Guarav Verma (Balchandani Lab) has was presented the Trainee Innovation Idea prize in the Postdoctoral fellow Category for his work "Non-invasive detection of metabolic abnormalities in brain tumors" at 2017 SinaInnovations.

Also from the Balchandani lab, PhD student Judy Alper's review paper on MRI of Trigeminal Neuralgia was accepted in World Neurosurgery.

At this year's RSNA meeting Dr. Stephanie Hectors (Taouli Lab) received the Trainee Research Prize for her work quantifying tumor

heterogeneity with multiparametric MRI.

TMII would also like to welcome Beth Fisher, our new Associate Researcher who will be supporting our new micro PET/CT in the Small Animal Imaging Center.

Lastly, TMII will again have the art exhibition, "Windows to Our Body" at the Grady Alexis Gallery at El Taller from April 26 to May 3, 2018. We are now accepting submissions to be considered for the show. For more details please see https://tmii.mssm.edu/symposium/wtob2/

UPCOMING EVENTS

3rd Annual Medical Imaging & Bioengineering Lecture

> Dec 8, 2017 3pm - 4pm, Hess Davis Auditorium: Frank Preiswerk, PhD- Postdoctoral Fellow in Radiology at Brigham & Women's Hospital - *A novel hybrid MRI-ultrasound platform with applications in image-guided therapy*

PPG Seminar Series

> TBD -: Rachel Yehuda, PhD - Professor of Psychiatry at ISMMS - *Examining the interface between Stress, Trauma and PTSD*

TMII Frontiers of Imaging Seminar Series

> Jan 25, 2018 12pm - 1pm, Hess 5-101: Michael Garwood, PhD - Professor of Radiology at University of Minniesota *MRI for Real World Environments and Populations*

8th Annual TMII Symposium

> April 26, 2018 8am - 5pm, Hess Davis Conference Center: tmii.mssm.edu/TMII2018 for more details

For more information on these and other events go to: http://tmii.mssm.edu/blog

Imaging the Heart and Arteries with State of the Art Simultaneous PET and MRI

Philip Robson, PhD

Dr. Robson is a member of the Cardiovascular Imaging group at TMII. His research interests include the development of hybrid PET/MR imaging technology and its clinical applications in cardiovascular disease.

Over the last 5-10 years a new imaging modality has emerged that combines positron emission tomography (PET), a nuclear imaging technique that is highly sensitive and can detect cellular and metabolic changes in active disease, with magnetic resonance (MR) imaging that has excellent soft tissue contrast, high spatial and temporal resolution, and, using advanced MR techniques, can characterize tissue based on subtle physiological, functional or structural differences (e.g. T1 mapping, perfusion
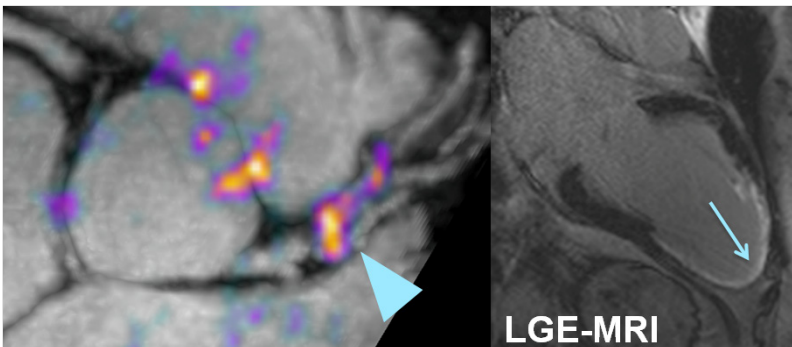
LGE-MRI

Coronary PET/MR shows active disease at the site of the culprit plaque (arrowhead) in the coronary artery responsible for the infarction (arrow) seen on late gadolinium enhanced (LGE) MRI (right). Uptake of the PET tracer sodium 18F-fluoride, shown orange on the PET image fused with MR angiogram (left), identifies active micro-calcification in the coronary plaque.

imaging, and diffusion tensor imaging). Hybrid PET/MR has many advantages, including reducing radiation exposure compared to PET/CT imaging, MR-based correction of motion in PET imaging, and the opportunity to gather highly complementary information about molecular, physiological and anatomical changes from the two imaging modalities at the same time with perfect spatial and temporal co-registration for multi-parametric approaches. TMII has led the way in PET/MR

research, installing the first such system in North America in 2011.

The cardiovascular imaging group is interested primarily in measuring the biological processes involved in atherosclerosis, the disease that causes plaque build-up in the arteries which leads to heart attack and stroke. Inflammation and micro-calcification are key components of the complex biology of atherosclerosis and are important markers of high risk plaque. Inflammation can be measured by the increased uptake of the PET tracer 18F-fluorodeoxyglucose (18F-FDG) by metabolically active cells in the plaque; micro-calcification by the adhesion of 18F-fluoride to newly-forming foci of calcification. By combining PET with MR imaging the group aims to add complementary evaluation of plaque features such as the lipid rich necrotic core and intra-plaque hemorrhage to learn more about the characteristics of the disease and what are the crucial signs of high-risk plaque.

Dr. Robson's work is focused on the heart and the coronary arteries that supply the muscle with blood and nutrients. His work involves optimization of attenuation correction methods for cardiac PET/MR and is currently focused on developing MR-based motion correction for PET/MR imaging of the heart. By using novel pulse sequence design and image reconstruction techniques, he is aiming to utilize 100% of the acquired MR and PET data to create high quality images of the heart and arteries and the

inflammation and micro-calcification in the atherosclerotic plaques associated with coronary artery disease. An important aspect of conventional cardiac MR imaging is the requirement of breath-holding to freeze the anatomy while imaging. This can be challenging for many patients. Dr. Robson's work also aims to employ advanced MR-based motion correction techniques to enable free-breathing cardiac MR imaging, improving the quality and robustness of these protocols and bringing the benefits of imaging to all patients.

Inflammation plays an important role in other heart diseases, such as cardiac sarcoidosis. The cardiac PET/MR group is also utilizing PET/MR to provide improved evaluation of the active inflammation and resulting myocardial scarring than can be achieved with PET and MR alone. This provides more detailed assessment for cardiologists to evaluate risk, plan best treatment options and monitor the response of the patient to therapy.

Dr. Robson's work has led to landmark publications including some of the first successful applications of imaging the activity of micro-calcification and inflammation in atherosclerotic plaque in the coronary arteries using 18F-fluoride and 18F-FDG PET/MR imaging1 and the development of combined PET and MR protocols for evaluating cardiac sarcoidosis2 and amyloidosis3. [1. JACC Cardiovasc Imaging. 2017 Oct;10(10 Pt A):1103-111, 2. JACC Cardiovasc Imaging. 2017 Jun 9. pii: S1936-878X(17)30450-3, 3. J Am Coll Cardiol. 2016 Dec 20;68(24):2712-2714]

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Nuclear Medicine Research

With the introduction of the Mediso micro PET/CT to the Small Animal Imaging Center in September, TMII has expanded its extensive nuclear medicine research capabilities which already included a human Siemens Biogrpah 3T PET/MRI, access to human Siemens Biograph PET/CT along with a gamma counter and dose calibrators.

In addition to commercially available radioisotopes, TMII has just entered into a business agreement with NYU Medical Center's new Radiochemestry facility. This new relationship will provide TMII, its collaborators, and users access to many investigational radioisotopes, i.e. Fallypride, FLT, PIB and PBR for human IND use along with Cu64 for use in animal models.

To further support the start of new studies, TMII has developed and SOP for submitting IND applications and, once approved, doing research with these radioisotopes.

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Multiparametric MRI in Renal Transplantation: Leveraging Quantitative MRI for the Diagnosis of Renal Transplant Dysfunction

Octavia Bane, PhD

Dr. Octavia Bane joined the Body/Cancer MRI lab of Professor Bachir Taouli as a postdoctoral research fellow in Spring 2013. After successfully defending her PhD on quantification of myocardial blood volume with blood pool contrast agents in the departments of Biomedical Engineering and Radiology at Northwestern University, she was recruited to work on multiparametric MRI of hepatocellular carcinoma. Octavia held an NCI T32 Institutional Training Grant fellowship from the Department of Oncology at Mount Sinai in 2014-2015. With Dr. Taouli and Dr. Sara Lewis, Octavia advanced the Body MRI's lab expansion into renal imaging, helping to successfully obtain funding for and leading the study on quantitative MRI in renal transplant. She successfully competed for an NRSA F32 individual postdoctoral fellowship (2016-2018) with the National Institute of Diabetes, Digestive and Kidney Diseases (NIDDK), studying quantitative functional MRI for characterization of renal transplant dysfunction, under the mentorship of Dr. Taouli and Dr. Madhav Menon, transplantation nephrologist of the Recanati-Miller Transplantation Institute, and Jeff L. Zhang, PhD, Assistant Professor in Biomedical Engineering and Radiology at the University of Utah. Octavia's current research interests focus on the development of multiparametric MRI protocols and techniques for assessment of renal dysfunction in transplanted and native kidneys.
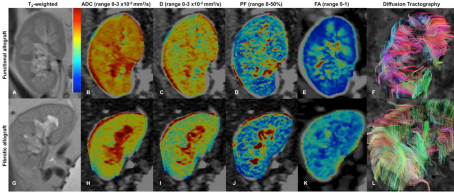
Advanced diffusion maps show overall lower values in a patient with moderate renal allograft fibrosis (G-L) compared to a patient with functional allograft (A-F).

Multiparametric (mp)MRI has the unique potential to identify intrinsic causes of renal transplant dysfunction. Previous work has shown that functional MRI can provide insight into renal function using DCE-MRI (with low dose gadolinium contrast agent, to estimate renal perfusion and flow), intravoxel incoherent motion diffusion-weighted imaging (IVIM-DWI, to provide information on flow and diffusion), diffusion tensor imaging (DTI), T1 (which has been shown to reflect tissue inflammation and edema) and T2* relaxometry (influenced by the BOLD effect, which reflects oxygen bioavailability). Octavia's preliminary results in the first 20 patients with renal transplantation studied with mpMRI show that IVIM-DWI and T1 parameters are sensitive to the presence of allograft fibrosis, and complementary to qualitative evaluation of cortico-medullary differentiation on anatomical images. Correlation with the degree of allograft fibrosis and with collagen deposition is forthcoming. Her work on mpMRI in renal allograft dysfunction has received the 2nd prize in the poster competition at the 2nd International Symposium on Functional Renal Imaging in Berlin (October 2017).The pilot data collected in the renal transplant study will support future R01 grant applications on renal transplant fibrosis from the Body MRI lab.

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Brains Behind the Operation

Rebecca Feldman, PhD

When Rebecca was eight years old, her mom gave her a kit about the size of a lunch box that contained a couple of bar magnets, a horse-shoe magnet, some coils of wire, a tube of iron filings, and a package of red activity cards. The activity cards may or may not have ended up as kindling. However, the patterns cast by the iron filings in the magnetic field were mesmerizing and the electromagnet - created from the coils of wire - and the way it interacted with both the permanent magnets and the iron filings must have left and impression.

Rebecca Feldman went on to study electrical engineering in the Engineering Science program at the University of Toronto. She obtained her PhD from the University of Western Ontario. She's a P.Eng (licensed by the Association of Professional Engineers and Geoscientists of Alberta – APEGA) and was selected as a Junior Fellow of the International Society for Magnetic Resonance in Medicine (ISMRM) in 2016. Rebecca's love of magnetic fields never dissipated. She is now a scientist in the High Field Imaging Lab lead by Dr. Priti Balchandani and has been working at TMII since 2013.

The heart of Dr. Feldman's research is neuroimaging and pulse sequence design. She focuses on leveraging the power of high field magnetic resonance imaging (MRI) to better understand and treat neurological disorders and diseases.


High Resolution Neuroimaging of Epilepsy
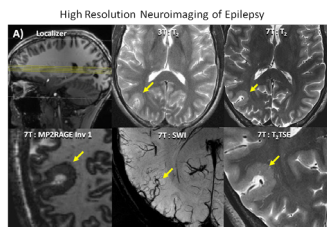
One part of her research focuses on developing novel MRI techniques. MRI imaging using TMII's 7T magnet can produce images of the brain with amazing detail. However, there are technical challenges associated with imaging at 7T. Of particular concern is increased radio frequency (RF) power deposition which can cause tissue heating if not properly managed as well as the artifacts caused by an uneven, inhomogeneous, distribution of the magnetic fields used to excite a signal in the region of interest.

One of Dr. Feldman's sequences, called Semi-Adiabatic Spectral Spatial Imaging (SASSI), reduces the inhomogeneity effects for spectroscopic imaging at high field while also reducing RF power deposition. SASSI is now being used to obtain multi-voxel spectroscopic images of the hippocampus of patients with focal epilepsy (patients whose previous MRI exam at lower fields were non-lesional). Her preliminary work has demonstrated a reduction in the NAA/Cr ratio in the hippocampus ipsilateral to suspected seizure onset zone.

Dr. Feldman's experiments with magnetic fields continue to produce mesmerizing patterns all these years later. Rebecca's attempts to capture these images appear in the pages of the calendar that she has helped put together the last few years and have been immortalized on the walls of the TMII.
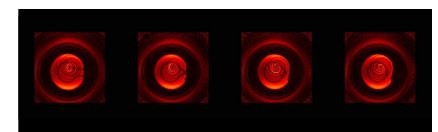
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The Brain Imaging Center community enjoyed a well-attended 4th Annual BIC Symposium on October 19, 2017. The BIC Symposium Organizing Committee arranged a series of excellent speakers who addressed several disparate approaches to utilizing 'neuroimaging throughout the lifespan'. After opening remarks by BIC Chief Rita Goldstein PhD, approximately 150 attendees posed questions after invited talks that ranged from 'the brains of super-agers' (Lisa Feldman Barrett PhD, Northeastern, Harvard, MGH), to 'imaging the infant brain' (Rebecca Saxe PhD, MIT, McGovern Institute), 'development of large-scale functional brain networks in children' (Vinod Menon PhD, Stanford), 'functional MRI in individual brains: methods, costs and benefits' (Jack Gallant PhD, Berkeley), 'episodic simulation of past and future events' (Preston Thakral PhD, Harvard) and 'from consciousness to its physical substrates' (Melanie Boly MD, PhD, U.Wisconsin Madison). Local presentations 'addressing reverse inference in psychiatric neuroimaging' (Sophia Frangou MD, PhD) and 'measuring and modulating core symptoms in obsessive-compulsive disorder' (Emily Stern PhD), a data-blitz of 8-minute talks on work selected for six attendee's and a reviewed 39 poster session provided a very full and informative day.

Congratulations to the poster session winners- #1 spot: "Association between C-Reactive Protein and Nucleus Accumbens Functional Connectivity in Patients with Depression" - Abigail Collins, Laurel S. Morris, Sara Costi, Nicholas Van Dam, Scott Russo, Emily Stern, James W. Murrough; #2 spot: "Neuroimaging of Olfactory Autobiographical Memories" - Denise Croote, Catarina Saiote, Daniela Schiller.

Judges for the structured scoring of posters determined three equally-ranked #3 spots: "Neural Activation and Functional Connectivity in response to Visual and Auditory Food Stimuli pre and post Roux-en-Y Gastric Bypass (RYGB) and Sleeve Gastrectomy (SG)" - Shaunte Baboumian, Spiro Pantazatos, Shiva Kothari, James McGinty, Jens Holst, Allan Geliebter; "Neuroimaging Pre and Post Bariatric Surgery" - Allan Geliebter, Shaunte Baboumian, Gloria Arkaifie; "Human Optic Nerve Diffusion Imaging - Technical Advances in Clinical Application" - Joo-won Kim, Sheng-Kwei Song, Robert Naismith, Junqian Xu.

Many Thanks to the Organizing Committee- Daniela Schiller PhD, Mercedes Perez-Rodriquez MD, PhD, James Murrough MD and Paula Croxson PhD, for a great program. The program book and accumulating photos from the day are available from the BIC website- https://bic.mssm.edu/blog/bicday/bicdayregistration/bic-4th-annual-symposium-supplement-2017/

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