UNIVERSITY *of* MARYLAND
SCHOOL OF MEDICINE

RADIOLOGY RESEARCH *UPDATE* *April 2017 Issue 4*

Department of Diagnostic Radiology and Nuclear Medicine

FACULTY SPOTLIGHT

Taehoon Shin, PhD, is an Assistant Professor, Department of Diagnostic Radiology and Nuclear Medicine.

Drawing upon his strong background in MR physics, Dr. Shin has been developing novel MRI techniques to address increasing needs for obtaining images with new image contrast, improving spatial resolution or coverage, and substantially reducing scan time. He designs magnetic field waveforms to obtain the particular MR signal needed for specific applications (pulse sequence design) and to form images using novel image reconstruction techniques from the acquired signal, while minimizing image artifacts. Dr. Shin's primary research focus has been on cardiovascular imaging, and he has recently received over $2M in grant funding from NIH and GE Healthcare.

One of Dr. Shin's primary research interests is developing MR angiographic (MRA) techniques without the use of contrast agents. This is considered a highly promising approach to visualize arteries because of the absence of side effects of ionizing radiation from CT based angiography and nephrogenic systemic fibrosis from gadolinium-enhanced MRA. At the core of the technique is the use of a velocity-selective (VS) excitation pulse which excites magnetic spins based on their velocities but independently of their spatial location in a way that highlights rapidly moving arterial blood while suppressing venous blood and relatively stationary tissues such as muscle. Dr. Shin was recently awarded a $1.59M R01 grant from NHLBI for this technically innovative proposal. The research involves clinical collaboration **with Robert Crawford, MD** (Department of Surgery and Anesthesiology) and **Dheeraj Gandhi, MBBS**, both experts in clinical vascular imaging. While the awarded grant focuses specifically on peripheral angiography, the proposed technique easily can be adapted for other arterial territories such as cerebral, renal and even pedal arteries. In addition to angiographic applications, VS excitation schemes can be highly applicable to other areas of MR development including ASL perfusion, vessel wall imaging and venography.

Dr. Shin's research also involves cardiac imaging. Most cardiac applications use 2D acquisition during breath-hold, which entails fundamental limitations including the effect of suboptimal breath-hold, only moderate resolution in the through-plane direction, and prolonged examination duration. Three dimensional isotropic resolution would be most desirable, but obviously leads to scan times significantly longer than breath-holding allows. The first goal is to substantially speed up the scan through time efficient non-rectilinear sampling schemes and advanced image reconstruction algorithms. Dr. Shin has been developing free-breathing image acquisition techniques while compensating for respiratory motion to visualize the myocardium, atrium and coronary arteries, using funding from an R21 from NIBIB and GE Healthcare. These projects are being conducted in collaboration with **Jean Jeudy, MD** and **Timm Dickfeld, MD** (Division of Cardiology).

Cover page of MRM journal (Vol 70, Issue 5) that includes in-vivo result of the proposed MRA technique.

GANDHI AWARDED GRANT FOR FOCUSED ULTRASOUND

Dheeraj Gandhi, MBBS, received over $300K from the Focused Ultrasound Foundation to study the treatment of neuropathic pain. The objectives of this 30 month pilot, single arm, prospective trail are to evaluate the safety, feasibility, and efficacy of MR-guided focused ultrasound assisted central lateral thalamotomy in the treatment of neuropathic pain.

Mark Your Calendar

4/14 Maryland Neuroimaging Retreat
5/3 Warres Lecture (Ari Blitz, MD)
5/12 Maryland Cancer Imaging Symposium
6/16 John M. Dennis, MD Research Day (Laurie Loevner, MD)

TECHNIQUE HIGHLIGHT: ELUCIDATION OF TONGUE MUSCLE ARCHITECTURE USING DIFFUSION TENSOR IMAGING

By Jiachen Zhuo, PhD; Nahla Elsiad, PhD; Maureen Stone, PhD; Jerry Prince, PhD and Rao Gullapalli, PhD

We are using diffusion tensor imaging (DTI) to study tongue muscle fiber structure in conjunction with tagged cine-MRI to understand the complicated patterns of tongue muscle motion during speech generation. While our fundamental goal is to understand the mechanics of the tongue muscles and their roles in speech production, our ultimate aim is to transfer this understanding to the clinic to enable surgeons to better plan procedures such as glossectomy and inform speech therapists, enabling them to design optimal speech therapy interventions after such procedures.

DTI is very sensitive to motion and even if the patient is asked not to move the tongue, involuntary tongue motion or swallowing can make DTI acquisition quite challenging. Our goal is to develop a free-running DTI technique that detects motion based on feature analysis of the phase maps in DT images and automatically rejects corrupt data and informs the scanner to reacquire that particular view.

Fig. 1 demonstrates how a phase map detects a subject's subtle motion with higher sensitivity during brain imaging. The same phenomenon is observed during acquisition of tongue images, resulting in poor estimation of the diffusion tensor and hence the tongue muscle fiber tracts as shown in **Fig. 2**. When the volumes with the motion are automatically rejected due to phase errors, the consequence is much cleaner tensor estimates resulting in clean genioglossus fiber tracts (**Fig. 2b**). As we continue to make this technique robust, we will be guided by diffusion spectrum images of the tongue from a cadaver as shown in **Fig. 3**, which demonstrates the different fibers and provides a better visualization of crossing fibers to further improve our in vivo image acquisition technique and our reconstruction techniques.

This project is funded by NIDCD (1R01DC014717-01, Sub-PI: Zhuo), "Tongue muscle function after cancer surgery using 4D MRI, DTI, and MRI Tagging."

Legends: Fig. 1 Diffusion weighted images and phases in the brain. Note slight motion can be missed from images, but are captured by analyzing the phase map features. Fig. 2 Fiber tracts from genioglossus within the tongue. Motion corrupted data result in spurious fibers as compared to the motion-free data set. Fig. 3 Diffusion spectrum imaging reveals crossing tongue muscle fibers within different functional groups in post-mortem specimen. GG=genioglossus; SG=styloglossus; T=transverse

Fig. 2a

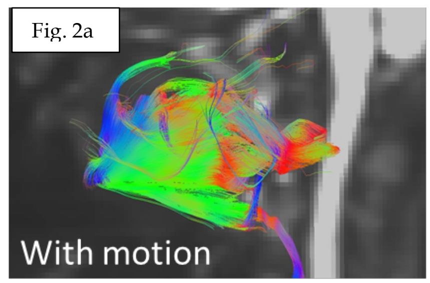


Fig. 1

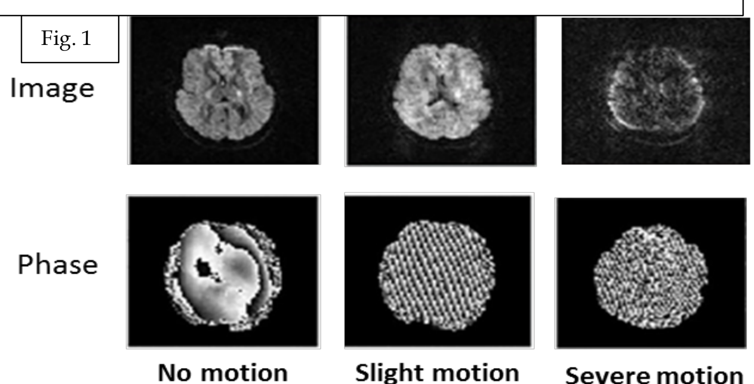


Fig. 2b

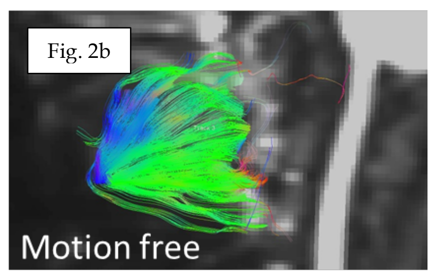
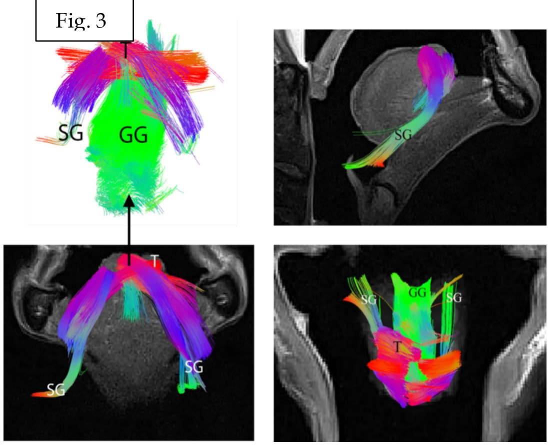


Fig. 3



Featured Publication:

Sours C, Raghavan P, Medina de Jesus A, Roys SR, Jiang L, Zhuo J, Gullapalli RP. **Structural and Functional Integrity of the Intraparietal Sulcus in Moderate and Severe Traumatic Brain Injury**. *J Neurotrauma*. 2017 Feb 27. [Epub ahead of print].

For a list of faculty publications, visit: http://department.radiology.umm.edu/?q=node/1151

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