Fast and Furious MRI
Neuro-Imaging

John P. Karis, MD
Barrow Neurological Institute, Phoenix, AZ, USA

Optimal utilization of recent advancements in multichannel parallel data acquisition, techniques to vastly undersample Fourier space, and increases in field strength pose different problems for different anatomic locations. The principal imaging challenge in body imaging are artifacts secondary to respiratory and cardiac motion, as well as pulsatile blood flow. The field of view utilized in abdominal and thoracic imaging is typically 50-100% larger than those used in neuro and musculoskeletal imaging. Additionally, the slice thickness in neurological and musculoskeletal imaging is also typically two to ten times thinner than for the body imaging exams. Neuro and musculoskeletal exams are therefore first limited by the trade-offs of signal to noise and image resolution and secondarily limited by motion artifacts. The myriad of recent technology advancements consequently need to be applied differently when addressing neuro-imaging needs. Whereas the focus of "Fast and Furious" in abdominal/thoracic imaging is on "Fast", the emphasis in neuro-imaging is more on "Furious".

Turbo/Fast spin echo (TSE/FSE), echo planar imaging (EPI), spiral imaging, and single shot FSE, the early techniques to decrease data acquisition time, were all first utilized clinically in neuro-imaging and currently account for most of the image data obtained for clinical imaging of the brain and spine. Since neuro-imaging studies are first and foremost SNR limited, new technology advancements will be focused on ways to improve overall SNR. The combination of hardware advancements in multichannel RF arrays, pulse sequence modifications that increase the percentage of time that data is sampled, will be used in combination with 3D and/or motion correction techniques to create hybrid imaging sequences that maintain the high SNR and resolution requirements of neuro-imaging.

The desired clinical endpoint is to create complete artifact free imaging studies of the brain or a segment of spine in less than 15 minutes. Successful clinical implementation of these new advancements requires that the techniques result in images with clinically useful image contrast, resolution, and signal. When 3D techniques are utilized, the number of resulting images is also a consideration. Although dataset size has not typically been a concern for the MRI development community, the data is frequently presented to the radiologist as hundreds of thin, low SNR slices in multiple imaging planes, resulting in significant practical issues for both the radiologist and the PACs system. New MRI techniques that consider these practical limitations are the ones that will be implemented into clinical use.