Fast NeuroImaging - Emerging Techniques

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Neuro MRI generally involves a static structure, and therefore speed (with a few exceptions) is generally useful as a way to either reduce scan time or obtain more (e.g.) resolution in the same scan time. A variety of methods for speeding up MRI scans for neuroimaging will be discussed, including their benefits and drawbacks. Examples include:

Parallel Imaging and coil arrays: Already a staple of some sequences, parallel imaging reduces scan times by (typically) factors of 2-4, and must be accompanied by appropriately designed coil arrays. It can additionally reduce artifacts in EPI scans (e.g. DWI and fMRI). The scan time reduction generally results in noisier images. Advances in coil arrays will permit some further reduction in scan times (for images that are not noise-limited), while improving the SNR (reduce the image noise) particularly around the cortical surface.

Higher Field Scanners (3T, 7T): For many sites, 3T scanners are now common, particularly for neuroimaging. The challenges for 3T - namely patient heating (SAR), changes in image contrast due to changes in the T1 and T2 of tissues, and undesirable image shading from nonuniform rf fields - have largely been solved or avoided. Solutions will be shown along with a discussion about how these problems are showing up at the next step in magnetic field strength (7T).

Pulse Sequences: The dramatic change in clinical neuro MRI that came with Fast Spin echo pulse sequences (particularly T2 and T2-FLAIR weighted images) illustrated that new pulse sequences can play a key role in advancing Neuro MRI. Rapid pulse sequences that are on the horizon have the potential to reduce scan times by factors of 2-8 with no loss of SNR, but face substantial (but solveable) hurdles. The move to 3D methods in some cases will also be explored - both the rationale and the challenges.

Dynamic imaging: Dynamic imaging, such as contrast-enhanced MR angiography, perfusion imaging, and functional MRI, represent a different class of rapid MRI in neuroimaging, where increased speed may improve diagnostic efficacy even if it comes at the expense of image noise or reduced spatial resolution. Methods for improving the temporal performance of dynamic imaging in neuro MRI will be discussed.

Tackling long sequences: Some methods, while clinically desirable, are often too long for routine clinical use - this includes methods such as cardiac gated phase-contrast MR angiography and multi-angle DWI for white matter diagnosis. Methods to reduce the scan time for sequences such as these will be briefly discussed.

Motion Correction: Sometimes - particularly for inpatient environments with uncooperative patients - a rapid exam means more than just fast scans; it means not having to re-scan often due to patient motion. Several advances in motion-corrected imaging for neuro MRI will be presented.