

2015 ISMRM Combined Educational and Scientific Course: Traumatic Brain Injury
"MRI in Acute Brain Injury: What's on the Horizon"

Karen A. Tong, M.D.

Department of Radiology, Section of Neuroradiology, Loma Linda University Medical Center
ktong@llu.edu

Highlights:

- TBI is being increasingly recognized as a major cause of morbidity (besides mortality) in all walks of life - whether related to accidents, non-accidental trauma, athletic activity, or military service.
- Because of the heterogeneity and wide spectrum of TBI, it is apparent that there is no single imaging method that is optimal for all situations.
- There are many significant advances in acute MRI TBI imaging, based on technique (MRS, DTI, SWI, fMRI) or function (CBF, metabolism, connectivity, neural networks).
- These exponential advances in MR imaging have outpaced our ability to incorporate the findings into clinical practice.
- Advanced methods of data visualization and interpretation need to be developed.
- Algorithms for integration of imaging data, along with clinical markers, will also be a major goal on the horizon.

Target audience:

Physicians and scientists interested in MRI methods in evaluating acute traumatic brain injury.

Outcome/objectives:

The goal of this presentation is to briefly discuss the advanced MR imaging methods that are available or are being developed or refined for clinical use in TBI evaluation, and identify challenges for future implementation.

Background/Purpose:

By many reports, TBI affects approximately 1.7 million individuals in the U.S. per year (up to 600 per 100,000 people per year), although the actual number is likely more than doubled because many cases of mild TBI are frequently not reported. The WHO estimates a worldwide incidence of 100-300 per 100,000 per year, although many believe the actual number is up to six times higher, again largely due to the lack of inclusion of mild TBI cases, in some reports accounting for up to 95% of all TBI cases. Although TBI is a leading cause of death in individuals under 45 years of age, it has an even greater impact on long-term morbidity and disability. Economic costs of TBI in the U.S. have been estimated at over \$70 billion per year (including direct medical costs, lost wages, lost productivity etc.). Worldwide costs are uncertain.

The growing worldwide burden of TBI makes it imperative to improve the diagnosis and management of patients, who represent a spectrum of pathologies. Advanced MR neuroimaging may provide a unique ability to fine-tune the diagnosis of TBI types, as well as tailor medical management and rehabilitation

strategies for each patient. However, the wealth of imaging data currently makes it difficult to know which pieces of information to use, and how best to utilize them.

Methods:

Although still not yet widely available in all situations, acute MR imaging of TBI holds the promise of improving on the traditional practice of relying on CT to determine if urgent neurosurgical intervention is required in the acute setting, specifically identifying mass-occupying hematomas or severe brain swelling.

Conventional MRI methods in the acute setting can improve on CT, by focusing on injured brain by detecting smaller hemorrhages, focal edema or infarct.

Advanced MRI methods offer the potential to detect even subtler areas of tissue injury, usually in the domain of mild and moderate TBI – and include MR spectroscopy (MRS), Diffusion Tensor Imaging (DTI), Susceptibility weighted imaging (SWI) and quantitative SWI, resting state functional MRI (fMRI) and MR perfusion/permeability imaging.

Discussion:

The wide variety of new and advanced techniques present a challenge in determining how best to utilize the findings, let alone employing them in the routine clinical setting. There is a lack of uniformity and consistency in how these imaging techniques are implemented, processed and analyzed. There is also a need for acquiring normative data for accurate interpretation of findings obtained by advanced MRI techniques. Additional challenges include the transformation of extensive imaging data into easily interpretable information, as well as integration of imaging findings into accepted clinical classification schemes.

Conclusion:

Acute MRI offers the potential to significantly improve the diagnosis and care of patients with traumatic brain injury. However, there are continued challenges to implementation in routine clinical use (and therefore goals of future work) - including limitations in availability, standardization, normative data, methods for easily interpretable data visualization, and incorporation into routine clinical use.

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