

Sports Related Concussions: Neuroimaging as a Biomarker- Promising But Not Practical

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There has been a renewed interest in the management of concussive injury. Recent press regarding litigation against the National Football League (NFL) for potential long term neurological consequences from concussive injury has provided fuel to this focus. In a climate of growing pressure upon clinicians to make appropriate decisions regarding concussive injury and return to play, there is an inadequate amount of objective tools to rely upon. Neuropsychological testing relies on a major assumption that neurological dysfunction affects behavior and has been difficult to reliably reproduce despite computerized methods [1]. Neuroimaging biomarkers have the potential to provide guidance in clinical judgments for concussive injuries. Multiple studies have demonstrated evidence of the potential utility of neuroimaging as a biomarker for concussive injury [2,3], but the technology is not yet practical for the evaluation of most athletes.

Concussion is an alteration in mental status after trauma induced biomechanical forces affect the brain that may or may not involve loss of consciousness [4]. Sports related concussions occur in 1.6 to 3.8 million people per a year [5]. Despite a high incidence of injury, concussions are difficult to diagnosis and grade by clinical symptoms. In fact the grading systems have been abandoned for concussions and the categories of simple and complex have been developed. Simple concussions are short lived lasting 7 to 10 days. While complex concussions either persist, loss of consciousness of >1minute, result in prolonged impairment of cognition, or convulsions develop [6]. Clinicians currently rely on neuropsychological testing to make the decisions regarding when athletes can return to play after a concussive injury. Athletes before the season begins go through a battery of functional tests to get a pre-concussive baseline and then after a potential injury go through a post-concussive test to assess for cognitive impairment.

Structural scans, such as MRI and CT, have little utility in concussions since there are little to no detectable pathological changes in concussive injury. Next generation imaging modalities such as fMRI and diffusion tensor imaging (DTI) have demonstrated some promise as biomarkers in concussion injury. DTI measures the integrity of white matter tracts indirectly by assessing the degree and direction of water diffusion through the brain [7]. fMRI detects changes in oxygenated hemoglobin thereby providing neural patterns for tasks performed [7]. Abnormalities of the activation patterns in fMRI patterns during working memory tasks in players with concussions have been reported in multiple studies. However there has not been much reliability with the presence of comorbidities such as depression causing abnormal activation patterns as well [2]. There could be potential utility with this imaging modality if there are distinct thresholds developed with pre- and post-concussive scans. fMRI changes associated with concussed patients include: more diffuse patterns of activation, increased amplitude and activation in the bilateral inferior superior parietal regions, prefrontal cortex, and dorsolateral regions [7]. fMRI abnormalities provide predictive insight into time to recovery; those athletes with the greatest extent of fMRI activation took almost twice as long to recover from their injury than did the less affected athletes [1,3].

From all the neuroimaging modalities for assessment of concussive injury, fMRI demonstrates the most promise as an imaging biomarker. The promise comes from the ability to determine the severity of injury

and time of recovery from concussive changes noted on fMRI. However, fMRI has many inherent limitations. First of all, the prospective studies that have been performed with fMRI have been relatively small in scale. There needs to be larger prospective studies to determine sensitivity and specificity thresholds for the test. In addition, the athletes required pre-concussive fMRI scans to establish baselines before their potential injury. The expenses associated with scanning a whole group of athletes must be weighed against the risk of injury. This expense could probably be affordable to a select few organizations such as the NFL and college football. Another problem that needs to be addressed is that clinicians may have too much information at their disposal with pre-concussive fMRIs. What happens to athletes who have significant abnormalities on their fMRI before a concussive injury, should they still be allowed to play? Are the clinicians responsible for other incidental findings on fMRI and who has access to this confidential information? There are many inherent pitfalls that transcend from medicine to social and legal obligations with this test. However the promise of neuroimaging has the potential to supersede these pitfalls in selection organizations. All of the practical answers for neuroimaging as a biomarker are not available yet.

References

1. Lovell MR, Pardini JE, Welling J, Collins MW, Bakal J, et al. (2007) Functional brain abnormalities are related to clinical recovery and time to return-to-play in athletes. *Neurosurgery* 61: 352-359.
2. Chen JK, Johnston KM, Petrides M, Pitto A (2008) Neural substrates of symptoms of depression following concussion in male athletes with persisting postconcussion symptoms. *Arch Gen Psychiatry* 65: 81-89.
3. Pardini JE, Pardini DA, Becker JT, Dunfee KL, Eddy WF, et al. (2010) Postconcussive symptoms are associated with compensatory cortical recruitment during a working memory task. *Neurosurgery* 67: 1020-1027.
4. Buzzini SR, Guskiewicz KM (2006) Sport-related concussion in the young athlete. *Curr Opin Pediatr* 18: 376-382.
5. Langlois JA, Rutland-Brown W, Wald MM (2006) The epidemiology and impact of traumatic brain injury: a brief overview. *J Head Trauma Rehabil* 21: 375-378.
6. McCrory P, Johnston K, Meeuwisse W, Aubry M, Cantu R, et al. (2005) Summary and agreement statement of the 2nd International Conference on Concussion in Sport, Prague Br J Sports Med 39: 196-204.
7. Jantzen KJ, Anderson B, Steinberg FL, Kelso JA (2004) A prospective functional MR imaging study of mild traumatic brain injury in college football players. *AJNR Am J Neuroradiol* 25: 738-745.

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