Neuroimaging Correlates of Parent Reported Executive Dysfunction Following Pediatric Traumatic Brain Injury or Orthopedic Injury: A Preliminary Investigation

Adam T. Schmidl, Ph.D., Elisabeth A. Wilde, Ph.D., Kimberly D. Orsten, M.Sc., Xiaqi Li, M.S., & Harvey S. Levin, Ph.D.

INTRODUCTION

Traumatic brain injury (TBI) is a significant cause of mortality and morbidity in young children and adolescents. In addition to various cognitive, behavioral, and social deficits, children who sustain a TBI frequently report significant executive dysfunction.

Studies document executive deficits on standard laboratory measures 
 as well as on more ecologically valid, parent measures of executive functioning.

Additionally, TBI often results in volume loss in various brain regions, especially frontal areas, subcortical regions such as the basal ganglia and the striatum, and white matter bundles such as the corpus callosum and anterior commissure.

Previous studies demonstrate that parent reported executive abilities as measured by scores on the Behavior Rating Inventory of Executive Function (BRIEF) is related to frontal brain volumes in typically developing children.

This study used the current tools to measure the relationship between parent reported and volumetric measures in various brain regions in a group of 28 children with post-concussive symptoms with parent reported scores on the BRIEF 3 months and 1 year following pediatric TBI or orthopedic injury.

RESULTS

The relationship between total gray matter volume in the Clingulate and TBI group.

The relationship between total frontoal gray matter volume and BRIEF indices scores at 3 months post-TBI.

The relationship between left DLPFC gray matter volume and BRIEF indices scores at 12 months post-TBI.

The relationship between global executive composite (GEC), maladaptive index (MI), and behavioral index (BRI) of parent-reported behavior rating inventory of executive function (BRIEF) and brain volumetric measures.

The relationship between total brain volume and BRIEF indices scores at 12 months post-TBI.

DISCUSSION

Results indicate that children with TBI demonstrated widespread differences in frontal volumes 3 months PI when compared to age-matched controls. Some of the most striking differences included total frontal gray matter, left DLPFC gray matter, and total clingulate gray matter.

Moreover, these data indicate significant differences in BRIEF index scores between groups at 3 months PI; however, these differences dissipated at 12 months PI – a pattern indicative of behavioral recovery within the TBI group.

When examining the relationship between brain volumes at 3 months PI and BRIEF index scores at the same time point (data not shown in result section above), no significant relationships existed for either group. Conversely, within the TBI group, brain volumes at 3 months PI were significantly negatively related to BRIEF index scores at 12 months PI.

Although we observed a number of significant correlations, gray matter volume of the MRI DLPFC (in particular the strong negativity related to all three BRIEF index scores; i.e., lower DLPFC volumes indicated more problems on the BRIEF) in the TBI group only. Given this, BRIEF was associated with a relatively stronger relationship with brain volumes than either MIE or GEC.

It is interesting that we did not find many differences in terms of actual volume and/or relationship of white matter to BRIEF scores. It is possible that another explanation as to why we found more executive brain matter differences following TBI. Further, developmental level and mechanism of injury may both contribute to the relationship of white matter integrity thus obscuring the current findings.

It is also notable that we did not find significant relationships between BRIEF scores and brain volumes at 3 months post-TBI except for related to the MI measure. This pattern is consistent with the lack of significant between-group differences in BRIEF scores at 3 months post-TBI, although significant differences at 12 months PI are indicative of cognitive or brain reserve within the TBI group. That is, individuals with greater volumes in certain regions at 3 months PI may be at increased risk for long-term behavioral sequelae.

 Obviously, this explanation is speculative and would be strengthened by longer-term follow-up both with behavioral and magnetic resonance as well as with other imaging analyses (e.g., lesion analysis).