



A Pilot Study Investigating Neuropsychological Consultation as an Intervention for Persistent Postconcussive Symptoms in a Pediatric Sample

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Objective To examine the efficacy of a one-time neuropsychological consultation as an intervention for youth with persistent postconcussive symptoms following mild traumatic brain injury.

Study design Using a prospective interrupted time series design, we enrolled 80 patients aged 8-17 years referred consecutively for clinical neuropsychological consultation. Patients needed to have sustained injury between 2 and 12 months prior to enrollment. Parent and child postconcussive symptom ratings were used as the primary outcome measures and were collected at 6 time points, 3 before the neuropsychological consultation and 3 after. Repeated measure ANOVA was used to estimate the magnitude of change in symptom ratings before and after the neuropsychological intervention.

Results The decrease in symptoms for the week prior to consultation was nonsignificant by both child ($P = .63$) and parent ($P = .19$) report. In contrast, for both reporters, the decrease in symptoms at 1 week and 3 months postconsultation was significant ($P < .0001$). The difference in reported change was also significant when comparing the week before the intervention to the 3 months after (child: $P < .0001$; parent: $P = .0009$).

Conclusions Postconcussive symptoms decreased significantly following the neuropsychological consultation. The primary limitation of the study is that it lacked randomization and a control group. The results warrant further research into the benefits of neuropsychological consultation after mild traumatic brain injury and provide justification for clinical providers to consider referring to neuropsychologists in the face of persistent postconcussive symptoms. (*J Pediatr* 2016;169:244-9).

After pediatric mild traumatic brain injury (mild TBI [mTBI]; aka, concussion), methodologically rigorous studies using performance-based tests provide little evidence that difficulties persist beyond the initial postinjury days to weeks.¹⁻⁸ In contrast, when examining outcomes using subjectively reported symptoms, a minority of patients display more persistent problems.⁹ One factor that has been found to increase the risk of persistent symptoms is more severe mTBI, such as injury characterized by intracranial pathology or need for hospitalization.¹⁰⁻¹³ However, the effect of injury-related factors tends to diminish over time,¹⁴ and many “postconcussive” symptoms are driven by nonneurologic factors as Lishman¹⁵ noted over 25 years ago in his influential review.

Postconcussive symptoms (eg, headache, fatigue, inattention) are nonspecific, occurring often in normal samples.¹⁶⁻¹⁸ Symptoms after pediatric mTBI are also associated with multiple other noninjury factors including premorbid symptoms,¹⁴ premorbid learning and psychosocial problems,^{13,19,20} postinjury symptom exaggeration and/or feigning,²¹⁻²³ demographic factors,¹⁴ maladaptive coping,²⁴ comorbid bodily injury and pain,²⁵ parental attributional biases,²⁶ and parental anxiety and family stress.^{7,27} In recent years, one of the most common clinical management recommendations after mTBI has been to “rest” the brain until asymptomatic, which may itself have an iatrogenic effect and lead to increased symptom reporting.²⁸

Remarkably, few studies have focused on nonacute intervention after pediatric mTBI.³⁰ In both adults and children, the only intervention that has demonstrated reasonably consistent success in reducing morbidity is the provision of psychoeducation, advice, and reassurance soon after injury.^{30,31} No rigorous studies have investigated how to treat the minority of children who display symptoms that persist for weeks or months.

Neuropsychological evaluation is now widely recognized as important in the clinical management of individuals who sustain mTBI.³²⁻³⁴ No empirical work has directly examined the value of this. In this pilot study, we sought to examine the efficacy of a one-time neuropsychological consultation as an intervention for youth with persistent symptoms following mTBI using an interrupted time series design. We hypothesized that youth and their parents would report reduced

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HBI	Health and Behavior Inventory
mTBI	Mild TBI
TBI	Traumatic brain injury

postconcussive symptoms after the intervention controlling for other factors that were associated significantly with symptom reporting in the sample.

Methods

The project was approved by the university-affiliated institutional review board. Potential participants were recruited prospectively from consecutive referrals to an outpatient pediatric concussion program. Patients were considered eligible if they were aged 8-17 years old and had sustained mTBI between 2 and 12 months prior to enrollment. Children who had complicated mTBI (defined as any trauma-related intracranial pathology on neuroimaging) were included if Glasgow Coma Scale score was never less than 13. Children who underwent neurosurgical intervention or who were referred forensically were excluded. Participant recruitment is detailed in **Figure 1** (available at www.jpeds.com).

Postconcussive symptom ratings were obtained from both children and a primary caregiver using the Health and Behavior Inventory (HBI) at 6 data points, 3 before the neuropsychological consultation and 3 after. After obtaining informed consent, parents and children were administered the HBI over the phone at the time of enrollment. Parent and child postconcussive symptom ratings were also collected by phone 1 week before the neuropsychological assessment and as part of the data collection on the day of the neuropsychological consultation, as well as again by phone at 1 week, 1 month, and 3 months after the neuropsychological appointment. Telephone data were collected by a research assistant, who answered procedural questions about the study but did not provide any clinical advice or counseling.

The outpatient neuropsychological consultation included record review, interviews with parents and children, and a battery of standardized tests. The tests provided objective measures of the patient's estimated IQ, single word reading, processing speed, attention, executive functioning, memory, fine-motor functioning, and psychosocial adjustment, as well as noncredible effort, exaggeration, and/or feigning. Parents also completed a background questionnaire. After the evaluation was completed, tests were scored and then feedback about the results was provided directly to the parents and patients by the treating pediatric neuropsychologist. The feedback included general education about concussion, information about injury and noninjury factors contributing to the child's specific symptoms, and recommendations to address any concerns. Total visit time was approximately 3 hours. After the visit, a report summarizing the results and recommendations was sent to the family. The neuropsychologists had no follow-up face-face contact with the families during the study period, although in rare cases they had brief telephone contact with the parents after the visit.

Measures

The HBI³⁵ is a 20-item rating scale that is recommended as a core instrument by the Common Data Elements TBI Out-

comes Workgroup.³⁶ It measures the frequency of 20 common postconcussive symptoms. Each symptom is rated on a scale from 0 (never) to 3 (often) based on its frequency over the past week. The scale's construct validity has been established through factor analysis. It has been used to investigate the outcomes of mild-to-severe TBI and is sensitive to various markers of injury severity.^{12,37,38} Both parent and child forms were used.

As part of the neuropsychological assessment, background information for all participants was collected using a standardized questionnaire completed by the parents. Data were confirmed and clarified during clinical interviews conducted by the neuropsychologists. A participant was considered to have a positive history of the psychiatric and developmental disorders presented in **Table I** (eg, anxiety, attention deficit hyperactivity disorder) if the child had ever been diagnosed or treated for the condition by a healthcare provider. The conditions were not considered mutually exclusive. Injury-related information was gathered during interviews with parents and participants, as well as from available medical records.

Analyses

All analyses assumed a 2-sided test of hypothesis, a significance level of 0.05 and were run in SAS v 9.4 (SAS Institute, Cary, North Carolina). Patient characteristics are summarized as means and SDs or count and percent. Repeated measures ANOVA was used to estimate the magnitude of change

Table I. Patient characteristics

	N	Mean (SD) or N (%)
Age	80	15.0 (2.2)
Time since injury at time of enrollment (wk)	80	18 (11.3)
Male sex	80	44 (54%)
Maternal education (y)	71	14.5 (2.3)
Child ethnicity	80	
Caucasian		48 (59%)
Hispanic		17 (21%)
Other		16 (20%)
Any preinjury mental health or neurodevelopmental diagnosis	72	33 (46%)
Attention deficit hyperactivity disorder	72	14 (19%)
Learning disability	72	14 (19%)
Depression	72	11 (15%)
Anxiety	72	13 (18%)
Oppositional defiant disorder/conduct disorder	72	5 (7%)
Substance abuse	72	1 (1%)
Previous uncomplicated mTBI	72	
0		48 (67%)
1		12 (17%)
More than 1		12 (17%)
Previous complicated mTBI or moderate/severe TBI	72	0
Sports-related injury	72	32 (44%)
Injury-related loss of consciousness or posttraumatic amnesia	72	30 (37%)
Litigation related to the injury	72	22 (31%)
Total number of nonneuropsychological healthcare visits after the neuropsychological consultation	71	10.9 (13.1)

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