Computerized Dynamic Posturography Testing in Concussion: A Systematic Review

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Introduction

Computerized dynamic posturography (CDP) is frequently utilized in research and clinical practice for the assessment of sensory deficits following concussion in military and athletic populations. The Sensory Organization Test (SOT) assesses an individual’s ability to integrate visual, proprioceptive, and vestibular inputs in order to maintain upright postural stability under six testing conditions. Each unique circumstance aims to determine how well an individual can respond to conflicting sensory information or the removal of one or more sensory systems.1 The system calculates a composite score along with visual, vestibular, and somatosensory ratios, which inform clinicians of the extent of the individual’s balance impairment and assist with return to sport or duty decisions.2 To our knowledge, there are no systematic reviews that synthesize the psychometric properties of CDP for individuals who have sustained a concussion.

Purpose

The purpose of this study was to conduct a systematic review of the psychometric properties of CDP for the assessment of individuals following concussion.

Methods

PubMed, EBSCOhost, ProQuest, SportDiscus, and CINAHL were searched for relevant peer-reviewed literature published between 1980 and September 2018 using the following terms: concussion, posturography, balance, stability, diagnosis, assessment, Sensory Organization Test, Head Shake Sensory Organization Test, motor control test, Biodex, and NeuroCom. Articles were included if they reported psychometric properties of CDP following concussion. Studies without full text available or not specifying severity of traumatic brain injury (TBI) were excluded. The titles and abstracts of all potentially relevant articles were screened, followed by full text examination by two researchers. In the event of a discrepancy, consensus was reached by tie breaker with a third researcher.

Results

The initial search produced 2,295 results. Eight articles (765 participants) met the inclusion criteria. Five articles reported sensitivity of CDP in concussion populations and two articles reported specificity and likelihood ratios of CDP. Only one study reported the minimal detectable change (MDC) of CDP in concussed populations, and one study examined the practice effects of the measure. Two studies that included the SOT in a battery of tests concluded that CDP, as well as all concussion assessment tools tested, were more effective within a battery than as a standalone assessment. Psychometric properties and relevant key findings are shown in Tables 1 and 2.

Discussion

Validity

Results suggest a correlation between SOT performance and symptomatology. In one study,7 81% of the participants complaining of vertigo, and 69% of these participants performed abnormally on CDP. The SOT was less sensitive than the ImPACT and HeadMinder concussion assessment tools. However, the ImPACT and HeadMinder both measure neurocognitive function, while the SOT quantitatively measures postural stability in stance.5

Sensitivity

The sensitivity of the SOT composite score for sports-related concussions ranged from 57% to 72.5% within 24 hours post-concussion.1,2,5 Register-Mihalik et al.4 reported a sensitivity of 20% up to five days after the initial injury. The sensitivity of the SOT for blast-related concussion was lower than sport-related concussion, which suggests that the effectiveness of the SOT as an assessment postural following concussion may depend on the mechanism of injury.

Specificity

Specificity of the SOT ranged from 82% to 92.3%,1,3,4 Multiple studies included the SOT in an assessment battery with other tools including neuropsychological tests and self-reported symptoms. The sensitivity and specificity of the assessment battery as a whole was higher than those of the individual tests.2,4,5

Although CDP may be useful for measuring sensory deficits following concussion, further research should examine the reliability, ceiling and floor effects, likelihood ratios, MCID, and MDC of CDP in concussed individuals.

Conclusion

TBI prevalence is as high as 20% among military personnel, with the majority being concussions.2 Additionally, 5% of injuries in high school and collegiate athletics are concussions (1.6 to 3.8 million in the United States annually).7 There is no gold standard for concussion diagnosis, and return to sport/duty decisions are often difficult and subjective. This review synthesizes current evidence and identifies a need for further investigation to develop a more comprehensive understanding of the psychometric properties of CDP assessment following concussion.

References


Table 1. Psychometric Properties of CDP

<table>
<thead>
<tr>
<th>Author, Year Design</th>
<th>Study Design</th>
<th>Number of Participants</th>
<th>Study Population</th>
<th>Timeline</th>
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<tbody>
<tr>
<td>Arnett et al., 2008</td>
<td>Cross-sectional</td>
<td>31 participants</td>
<td>NCAA Division I Athletes</td>
<td>24 hours post-baseline if patient sustaining concussion evaluated within 24 hours following injury</td>
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<td>Marzo et al., 2008</td>
<td>Cross-sectional</td>
<td>30 participants</td>
<td>NCAA Division IA and NCAA Division II Athletes</td>
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Table 2. Article Characteristics

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