The Utility of Vestibular and Ocular Assessment Tools in Diagnosing a Sports-Related Concussion: A Critically Appraised Topic

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INTRODUCTION

- The overall average Sport-related concussion (SRC) incidence rate is 26.1 SRCs per 100,000 athlete-exposures.1
- A multi-faceted evaluative approach to SRC management is recommended that includes assessments of self-reported symptoms, motor control, mental status, and neurocognition.7
- Dizziness and balance problems occur in 50% of concussed athletes and vision problems occur in 30%.1,4
- Many current diagnostic assessments fail to take into consideration vestibular and ocular deficits.
- High sensitivity and internal consistency are important components for determining the clinical utility of sideline SRC assessment tools.

CLINICAL QUESTION

Do vestibular and ocular assessments have suitable levels of internal consistency and sensitivity for diagnosing sport-related concussions?

METHODS

Search Strategy

Terms Used to Guide Search Strategy (PIO):
- Patient: Athletes
- Intervention: Vestibular/Ocular assessment tools
- Outcome: Internal Consistency & Sensitivity

Sources of Evidence Searched:
- PubMed
- Google Scholar
- Cinahl
- SPORTDiscuss
- Global Health Library

Inclusion and Exclusion Criteria

Inclusion:
- Studies that investigated SRC incidence or detection
- Athletes
- Outcomes of internal consistency and/or sensitivity
- Published in the last decade (2006-2016)
- Limited to English Language

Exclusion:
- Non-athletes
- Specified outcomes not measured

RESULTS

The studies reviewed were identified as the “best evidence” and met all the inclusion criteria (Table 1). There were 5 articles identified; 4 studies1,3-5 demonstrated that vestibular and ocular assessments have a high internal consistency and three studies1,3,5 showed high sensitivities for diagnosing SRCs.

Combining near point convergence (NPC), smooth pursuits, and vestibular-ocular reflex increased the accuracy of vestibular and ocular assessment tools to 87.5%. The sensitivity of adding NPC to the diagnostic process is 0.83 and stands out as being a beneficial tool in diagnosing a sports-related concussion.2

Figure 1: Demonstrations of vestibular/ocular assessment components

Table 1 - Characteristics of Included Studies

<table>
<thead>
<tr>
<th>Study</th>
<th>Participants</th>
<th>Intervention</th>
<th>Outcome Measures</th>
<th>Main Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Balaban et al. (2016)</td>
<td>100 athletes</td>
<td>Symptom profile, functional gait index, dizziness handicap inventory, battery of oculomotor, vestibular, and reaction time (OVRT) reflexes</td>
<td>Sensitivity</td>
<td>High internal consistency (0.97) High Sensitivity False positive (11%) due to history of motion sickness.</td>
</tr>
<tr>
<td>Kontos et al. (2016)</td>
<td>72 active collegiate student-athletes</td>
<td>Vestibular and ocular motor screening (VOMS) test</td>
<td>Internal consistency</td>
<td>High internal consistency &amp; sensitivity</td>
</tr>
<tr>
<td>McDavitt et al. (2016)</td>
<td>72 active collegiate student-athletes</td>
<td>Sensory organization test (SOT), Balance error scoring system, VOMS components</td>
<td>Internal consistency</td>
<td>11% of patients reported symptoms after 1 VOMS test. Vestibular ocular reflex &amp; visual motion sensitivity were most predictive.</td>
</tr>
<tr>
<td>Mucha et al. (2014)</td>
<td>98 athletes</td>
<td>6 domains of VOMS: smooth pursuit, horizontal/vertical saccades, near point convergence, horizontal vestibular ocular reflex, vision motion sensitivity</td>
<td>Internal consistency &amp; sensitivity</td>
<td>High internal consistency &amp; sensitivity</td>
</tr>
<tr>
<td>Pearce et al. (2015)</td>
<td>3 trials</td>
<td>Neopoint convergence (NPC) testing, neurocognitive and symptom assessments</td>
<td>Internal consistency</td>
<td>1.95-0.98</td>
</tr>
</tbody>
</table>

DISCUSSION

Vestibular and ocular deficits following a SRC are contributed to the impact mechanism occurring on the occipital and temporal regions of the brain. With the increasing number of vision and balance problems reported in patients, it is important to take these into consideration during the multi-faceted SRC evaluation process.3,4

Research shows that dizziness and visual problems are becoming more prevalent in concussed athletes.3,4 The 6th International Consensus Statement on Concussion in Sport states that there is a need for a standardized assessment tool on-field evaluations that takes into consideration the rapidly changing signs and symptoms; such as those affecting the vestibulo-ocular system.2

Figure 1: Demonstrations of vestibular/ocular assessment components

Clinical importance:
- Vestibulo-ocular system should be incorporated as a component of the systematic approach to diagnosing a SRC.
- They are cost effective and easily accessible compared to computerized assessment tools.
- They are simple and are an effective use of time during the acute SRC assessment and management period.

REFERENCES

One out of every ten injuries sustained in high school athletic programs is a sport-related concussion (SRC).1 Computerized neurocognitive testing (CNT) is one of the multifaceted approaches in managing SRC. A recent consensus statement deemed developmental conditions, may influence the diagnosis, management, and return to play outcomes following SRC.2

- Concurrency is a complex pathophysiological process affecting the brain that is induced by traumatic biomechanical forces.3
- The ImPACT assesses verbal memory, visual memory, visual motor, and reaction time. (See Figure 1)
- These tests fail to accommodate to those with neurological impairments such as athletes with attention-deficit disorder (ADHD) and/or a learning disorder (LD).

Developmental, behavioral, and learning disorders have emerged as disabling health conditions that affect one in six children in the United States.4

### Table 1: Characteristics of Included Studies

<table>
<thead>
<tr>
<th>Brooks et al.1</th>
<th>Elbin et al.4</th>
<th>Salinas et al.5</th>
<th>Zuckerman et al.3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cohort Study</td>
<td>Cross-sectional Study</td>
<td>Cohort Study</td>
<td>Case Control Study</td>
</tr>
<tr>
<td>Participants</td>
<td>2,860 boys and 2,290 girls high school athletes</td>
<td>37,016 high school varsity athletes</td>
<td>436 high school athletes</td>
</tr>
<tr>
<td>Intervention</td>
<td>ADHD and/or LD vs. No ADHD and/or LD</td>
<td>ADHD and/or LD vs. No ADHD and/or LD</td>
<td>ADHD and/or LD vs. No ADHD and/or LD</td>
</tr>
<tr>
<td>Outcomes Measures</td>
<td>ImPACT scores and symptoms reporting</td>
<td>Mean and standard deviation of CNT and ImPACT</td>
<td>Mean and S/D of ImPACT scores of each group</td>
</tr>
<tr>
<td>Main Findings</td>
<td>Boys with ADHD had worse reaction time (p&lt;.001) and more cognitive-sensory (p&lt;.03, t=4.04) and sleep arousal symptoms (20%) compared to control.</td>
<td>Adolescents with ADHD had reduced verbal memory (p&lt;.06), visual memory (p&lt;.04), and impulse control scores (p&lt;.001) compared to control.</td>
<td>Significant differences between LD only and control were found for all composite scores except impulse control (p&lt;.001).</td>
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<tr>
<td>- Controls</td>
<td>Athletes with ADHD had lower verbal memory (SD=10), visual memory (SD=13.5), visual motor (SD=4.6), and higher reaction time (SD=9) than the control.</td>
<td>Adolescents with ADHD had reduced verbal memory (p&lt;.06), visual memory (p&lt;.04), and impulse control scores (p&lt;.001).</td>
<td>Significant differences for all composite scores between ADHD and control (p&lt;.001).</td>
</tr>
<tr>
<td>- Controls</td>
<td>Athletes with ADHD had lower verbal memory (SD=10.34), visual memory (SD=14.9), visual motor (SD=7.95), and higher reaction time than the control (SD=10).</td>
<td>Athletes with ADHD were nearly twice as likely to have sustained a prior concussion (ADHD 14%, non-ADHD 7.4%).</td>
<td>Significant differences between mean baseline motor speed, reaction time, and total symptom scores between those with both LD/ADHD with no LD or ADHD (p&lt;.001).</td>
</tr>
<tr>
<td>- Controls</td>
<td>With ADHD/LD/ADHD reported more symptoms at baseline than control (SD=4.45)</td>
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<tr>
<td>Level of Evidence</td>
<td>Ib</td>
<td>Ib</td>
<td>Ib</td>
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<tr>
<td>Conclusions</td>
<td>ADHD is associated with lower scores on ImPACT domains and more symptoms.</td>
<td>Separate normative data for athletes with LD, ADHD, and LD/ADHD should be used when evaluating concussions.</td>
<td>ADHD is linked to lower neurocognitive test scores and higher risk of sustaining a head injury.</td>
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</tbody>
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