Effect of Concussion History on Neurocognition and Neuromuscular Function of College Football Players

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BACKGROUND AND PURPOSE

- Sport-related concussions are a growing concern, the vast majority of which result from participation in football
- Post-concussion recovery of cognitive function, postural balance, and reaction time slow with concussion history
- Recent evidence suggests long-term impairments, and risk for concussion recurrence and musculoskeletal injury
- Improvement in speed of peripheral motor responses to visual stimuli associated with decreased concussion rate
- The purpose of our research was to identify any associations between concussion history, neuropsychological function, neuromuscular control, and core or lower extremity (Core/LE) sprain or strain among college football players

PARTICIPANT CHARACTERISTICS AND PROCEDURES

- 34 NCAA Division I-FCS football players: 17 cases with concussion history and 17 matched controls
- Cases: Age 20.2 ± 1.3 yrs, Mass 100.72 ± 22.72 kg, Height 183.03 ± 7.05 cm
- Controls: Age 19.5 ± 1.1 yrs, Mass 101.92 ± 19.31 kg, Height 185.27 ± 5.54 cm
- Neuropsychological composite scores obtained from computerized test (Neuropsychological Assessment Resource [NARP], Pittsburgh, PA)
- Verbal Memory: attention processes, learning, and memory
- Visual Memory: visual attention and scanning, learning, and memory
- Visual Motor Speed: visual processing, learning and memory, and visual-motor response speed
- Central Reaction Time (CRT): reaction time (ms)
- Visual detection time (VDT) quantified by visual reaction time testing system (Dynavision International, West Chester, OH)
- Elapsed time (ms) between target illumination and initial motor response (release of depressed button)
- Central and peripheral VDT assessed for right and left tests (Figure 1 A-D)
- Unilateral Squat Hold (USH): knee maintained in 45° flexion with heel elevated – 2.5 cm for 60 s (Figure 2)
- Time to loss of postural balance recorded; balance quickly re-established for completion of test
- USH-postural balance also quantified by electronic tablet accelerometer system (SwayMed, Tulsa, OK)
- Occurrence of Core/LE sprain or strain documented throughout pre-season practice sessions and 14-game season
- Injury defined as any acute Core/LE sprain or strain that required evaluation and received treatment
- Receiver operating characteristic (ROC) analyses used to identify cut-points for dichotomization of variables
- Cross-tabulation analyses performed to assess associations between concussion history and dichotomous variables
- Logistic regression analyses identified models that provided maximum discrimination between cases and controls

RESULTS

- ROC and cross-tabulation analyses identified 7 variables strongly associated with concussion history (Table 1)
- Fisher’s exact 1-sided P-value reported for categorizations created by cut-points derived from ROC analyses
- Multivariable 4-factor model:
  - USH (ORadj = 5.68), Peripheral VDT (ORadj = 3.23), Visual Memory (ORadj = 3.11), and CRT (ORadj = 2.27)
- Model (ORadj = 11.04, P = .026; Nagelkerke R² = .370)
- Multivariable 3-factor model:
  - USH (ORadj = 7.31), Peripheral VDT (ORadj = 3.35), and Visual Memory (ORadj = 3.41)
- Model (ORadj = 10.59, P = .014; Nagelkerke R² = .357)
- ROC analysis provided comparison of simplified 4-factor and 3-factor models (Figure 2)
- Model comparisons: 4-factor ≥ 3 positive, 4-factor ≥ 2 positive, and 3-factor ≥ 2 positive (Figure 2)
- Concussion history was strongly associated with the occurrence of Core/LE strain or strain
- Fisher’s exact 1-sided P = .007; Sensitivity 79%; Specificity 70%; OR = 8.56 (95% CI: 2.24 – 32.63)

TABLE 1

<table>
<thead>
<tr>
<th>Variable</th>
<th>Cut-Point</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>Odds Ratio</th>
<th>90% CI</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual Memory Score (0-100)</td>
<td>77.5</td>
<td>65%</td>
<td>71%</td>
<td>4.40</td>
<td>1.31 - 14.75</td>
<td>.042</td>
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<tr>
<td>Composite Reaction Time (ms)</td>
<td>≥ 0.075</td>
<td>30%</td>
<td>94%</td>
<td>6.67</td>
<td>0.99 - 44.94</td>
<td>.087</td>
</tr>
<tr>
<td>Impulse Control Score (0-100)</td>
<td>≥ 0.0</td>
<td>53%</td>
<td>60%</td>
<td>2.06</td>
<td>0.46 - 6.03</td>
<td>.129</td>
</tr>
<tr>
<td>Peripheral VDT (ms)</td>
<td>≥ 2.700</td>
<td>82%</td>
<td>43%</td>
<td>3.27</td>
<td>0.87 - 12.27</td>
<td>.129</td>
</tr>
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<td>Peripheral VDT (ms)</td>
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<td>82%</td>
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</tr>
</tbody>
</table>

CLINICAL RELEVANCE

- The results of our prospective case-control analysis suggest that concussion may have long-lasting effects
- Alternatively, pre-existing deficiencies in neural function may increase susceptibility to concussion occurrence
- The results of our prospective case-control analysis suggest that concussion history is a Core/LE injury risk factor
- Whether a cause or an effect of concussion, deficiencies in neural function appear to be important to assess
- Neuropsychological processes relating to detection, interpretation, and generation of responses to visual stimuli
- Neuromuscular processes relating to maintenance of postural stability during single-leg support
- The potential for injury risk reduction through administration of screening tests and implementation of training activities for development of specific neuropsychological and neuromuscular adaptations needs thorough investigation

REFERENCES