Force Plate Measurement of Postural Control in Division I Football Players

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Introduction

• A Division I College football player sustains a concussion in practice.

• Two weeks after the concussion he is cleared to return to play.

• During a game approximately two weeks later, he sustains a second concussion.

• Rather than mild symptoms such as experienced with his first concussion, he is momentarily unconscious following the hit.

• He is combative upon awakening, and then collapses on the field.
Introduction

• The second concussion and the events that followed ultimately leave him with persistent cognitive and speech impairments requiring 24-hour care.

• His family files a lawsuit against the university and the medical and training staff for improper management.

• The university settles the case one day before the trial was to begin, without any admission of wrongdoing, for $7.5 million.¹

¹ http://www.nytimes.com/2009/12/01/sports/ncaafootball/01lasalle.html
Introduction

- The appropriate management of sport-related concussion, specifically determining better objective determinants for return to play, is critical and constantly evolving.
Introduction

• Assessment Protocol:
  – Detailed Neurological Examination
  – Symptom Inventory
  – Neuropsychological Tests
    • Remain the cornerstone of the assessment and provide objective data to enhance return to play decisions.²

Introduction

- Assessment protocol also requires:

- Objective evaluation of postural control.³

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Objective Measures of Postural Control

- Force Plate Technology
  - Various measures previously studied\textsuperscript{4,5}
    - Center of Pressure (COP)
    - COP travel – Total, X, Y
    - %COP


Objective Measures of Postural Control

• Balance Error Scoring System (BESS)
  – Inexpensive alternative to force plate measurements
  – Quantifiable method to objectively assess balance in athletes.⁶

Objective Measures of Postural Control

• **Balance Error Scoring System (BESS)**
  
  – Comparison studies showed significant correlation between the BESS and force plate measures of postural control.\(^7,8,9\)
  
  – More recently however, the reliability of the test has been questioned.\(^10,11\)

Study Objectives

• To examine the relationship of height, weight, position of play, and history of concussion to force plate measured postural control in Division I college football players.

• The components of postural control were also evaluated to determine another reliable measure that could compliment %COP and be used in the clinical setting.
Methods

• Data collection

  – 103 Division I College football players were recruited into the study

  – Collection was prior to the start of contact drills during the Fall 2009 training camp at Virginia Tech
Methods

• Data collection

  – IsoBALANCE ® 2.0 Force Plate measurements:
    • True Center of Pressure (COP)
    • Center of Pressure (%COP\textsubscript{0.6})
    • Total Travel of COP (COP\textsubscript{TT})
    • Lateral side to side travel (COP\textsubscript{TTx})
    • Anterior-posterior travel (COP\textsubscript{TTY})
Methods

• Data collection

  – Two trials were recorded:

    • 1 – Eyes open
    • 2 – Eyes closed

    • Athletes wore only socks, athletic shorts, and t-shirts.
Methods

• Data Analysis
  – Divided into two height classes:
    • ≤ 72 inches
    • > 72 inches
  – Stratified into four weight classes:
    • Class 1: 170-210 lbs
    • Class 2: 211-250 lbs
    • Class 3: 251-290 lbs
    • Class 4: 291-330 lbs
  – Grouped based on position of play:
    • Offensive line (OL)
    • Offensive non-line (ONL)
    • Defensive line (DL)
    • Defensive non-line (DNL)
  – History of prior concussion
    • Yes
    • No
Table 1: Baseline Characteristics of Virginia Tech Football Players by Position of Play

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Offensive Line (OL) n=17 (16.5%)</th>
<th>Offensive Non-Line (ONL) n=41 (40%)</th>
<th>Defensive Line (DL) n=16 (15.5%)</th>
<th>Defensive Non-Line (DNL) n=29 (28%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight (Mean ± SD)</td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>Class 1: 170-210 lbs.</td>
<td>34 (33%) N/A</td>
<td>193.7 ± 11.3</td>
<td>N/A</td>
<td>191.7 ± 12.4</td>
</tr>
<tr>
<td>Class 2: 211-250 lbs.</td>
<td>42 (41%) 239.9 ± 3.5</td>
<td>226.4 ± 11.6</td>
<td>283.5 ± 7.9</td>
<td>223.9 ± 8.9</td>
</tr>
<tr>
<td>Class 3: 250-290 lbs.</td>
<td>15 (15%) 283 ± 4.9</td>
<td>226.1 ± 12.8</td>
<td>274.4 ± 9.6</td>
<td>N/A</td>
</tr>
<tr>
<td>Class 4: 291-330 lbs.</td>
<td>12 (12%) 306.9 ± 7.5</td>
<td>N/A</td>
<td>306.0 ± 5.7</td>
<td>N/A</td>
</tr>
<tr>
<td>Height (Mean ± SD)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Class 1: ≤ 72 inches</td>
<td>39 (38%) N/A</td>
<td>71.1 ± 0.8</td>
<td>N/A</td>
<td>71.0 ± 0.9</td>
</tr>
<tr>
<td>Class 2: &gt; 72 inches</td>
<td>64 (62%) 76.3 ± 1.9</td>
<td>75.3 ± 1.5</td>
<td>74.6 ± 1.0</td>
<td>73.7 ± 0.9</td>
</tr>
<tr>
<td>History of Concussion</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>No</td>
<td>76 (74%) 12 (11.7%)</td>
<td>30 (29.1%)</td>
<td>13 (12.6%)</td>
<td>21 (20.4%)</td>
</tr>
<tr>
<td>Yes</td>
<td>27 (26%) 5 (4.9%)</td>
<td>11 (10.7%)</td>
<td>3 (2.9%)</td>
<td>8 (7.8%)</td>
</tr>
</tbody>
</table>
Methods

• Data Analysis

  – Primary components of balance examined:
    • COP\textsubscript{TT}
    • COP\textsubscript{TTx}
    • COP\textsubscript{TTy}
    • %COP\textsubscript{0.6}

  – One-way analysis of variance (ANOVA) was used to compare the four primary components of balance as a function of height, weight and position of play
Results – Height

[Bar chart showing the mean travel of the center of pressure (COP) in inches for different conditions and height categories.]
Results – Height

- Eyes Open:
  - No significant differences

- Eyes Closed:
  - Players ≤ 72 inches demonstrated significant less travel as measured by \( \text{COP}_{TT} \) and \( \text{COP}_{TTx} \) (\( p < 0.05 \))
Results – Weight

The graph shows the mean travel of the center of pressure (COP) in inches for different weights and conditions. The x-axis represents the weight categories (170-210 lbs, 211-250 lbs, 251-290 lbs, 291-330 lbs), and the y-axis represents the mean travel of the COP in inches. The graph includes data for different conditions such as Eyes Opened and Eyes Closed, as well as side to side travel (COP(TT)) and anterior-posterior travel (COP(TTY)).
Results – Weight

• Eyes Open:
  – Group 4 (291-330 lbs) had significantly worse balance than group 3 for COP_{TTy} (p < 0.005)

• Eyes Closed:
  – Group 4 had significantly worse balance than groups 1, 2, and 3 for COP_{TTy} (p < 0.006)
Results – Player Position
Results – Player Position

• Eyes Open:
  – No significant differences between groups

• Eyes Closed:
  – Better balance of ONL vs. OL (p < 0.05)
    • As measured by $\text{COP}_{TT}$, $\text{COP}_{TTy}$, and $\%\text{COP}_{0.6}$
  
  – Better balance of DNL vs. OL (p < 0.05)
    • As measured by $\text{COP}_{TT}$ and $\text{COP}_{TTy}$

  – Better balance of ONL vs. DNL (p<0.05)
    • As measured by $\%\text{COP}_{0.6}$
Results – Prior Concussion

[Bar chart showing the mean of travel from the center of pressure (COD) inches for different conditions: Total Travel (COP(TT)), Eyes Opened and Eyes Closed, Lateral Side to Side Travel (COP(TTX)) Eyes Opened and Eyes Closed, Anterior-Posterior Travel (COP(TTY)) Eyes Opened and Eyes Closed, for a history of concussion (NO and YES).]
Conclusions

- An athlete’s height, weight, and position of play significantly influence the components of postural control.

- COP_{TTy} (heel to toe travel) showed significant differences across the categories of weight and position.
  - Also showed a trend towards significance for the category of height.

- %COP_{0.6} did show significant differences, but only in relation to player position
  - Offensive non-line players having comparatively better postural control than offensive and defensive line players.
Conclusions

• Based on these findings, it would suggest that COP$_{TTy}$ could be used along with %COP$_{0.6}$ as another reliable and objective measure of postural control.

• Potentially, this measure of postural control may be useful in the clinical evaluation of concussed athletes.

• The obvious limitation in proving this hypothesis is the collection of an adequate number of trials performed on concussed athletes.
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References


12. Hokie athletics pictures courtesy of www.pbase.com/jfleming/hokie_sports