Pre- and Post-Season Physical and Cognitive Testing of College Athletes Susceptible to the Effects of Concussion

Audrey Berning, Elsa Klump, Hannah Burkhart, Jeneca Thomas, Stephanie Cahill, & Chris Koch, PhD.

George Fox University

Introduction

Concussions are considered a common occurrence in all contact sports, during practice as well as in games.[9] Quarterbacks and wide receivers have the highest concussion rates in professional football while offensive and defensive linemen and linebackers have among the lowest concussion rates.[3] Concussions account for approximately 6% of all injuries in college football.[4] Every player is impacted by a concussion differently.[7] As a result, athletes are at risk for returning to play too soon and potentially struggling on the field and in the classroom.[2] In worse cases, players are at risk for second-impact syndrome which can have a fatal impact on the athlete.[1]

The ImPACT is commonly used in both high school and collegiate athletics to identify athletes with concussions. However, research validating the ImPACT used with other psychological measures is limited. Studies have shown the ImPACT is more effective at diagnosing a concussion when combined with other tests that take into account factors such as balance.[5] Therefore, we included the SCAT 2 and BESS, in addition to the ImPACT, in attempt to more accurately identify concussed athletes.

Objectives & Hypothesis

The purpose of this study was to:

- Compare baseline and end of season measures between players with and without a previous concussion
- Analyze player's pre-season and post-season scores to determine any statistically significant differences
- Identify any underreported concussions based on pre- and post-test scores

We hypothesize that if a player experiences a concussion, they will report increased symptoms and perform poorly during post-season testing compared to pre-season test scores, allowing us to identify athletes with undiagnosed concussions during the course of the season.

Participants

This study included 48 male student athletes in their freshman or sophomore year ranging in age from 18-21. The athletes competed in Division III football and completed a season of nine games. Approximately 33% of participants were offensive linemen, 28% were defensive linemen and 39% were linebackers. Only 19 of the 48 players (40%) completed all two testing sessions and were the subjects of this study. Thirteen of the 48 athletes self-reported one or more concussions before the test season.

Methods

Data from all participants was collected pre-season (before the first full-pads practice) and post-season (within 2 weeks of the last game). The test battery included the ImPACT (Immediate Post-Concussion Assessment and Cognitive Test) which takes about 25 minutes to complete and has a sensitivity of 81.9% and specificity of 89.4%,[10] the SCAT 2 (Standardized Concussion Assessment Tool 2) which takes 15-20 minutes with a sensitivity of 96% and specificity of 81% when compared to baseline measurements in season,[9] and the BESS (Balance Error Scoring System) which takes 5-10 minutes and has a sensitivity of 34-64% and specificity of 91%.[5] The tests were administered and/or proctored through the University's Athletic Training, Physical Therapy, and Psychology Departments.

The **ImPACT** measures concussions through:

- 6 neuropsychological tests- Each designed to target different aspects of cognitive functioning including *attention, memory, processing speed, and reaction time.*
- 4 separate subtest composite scores are generated: *verbal memory, visual memory, motor speed, and reaction time.*
- Outcome of 5 final composite scores: verbal memory, visual memory, processing speed, reaction time, and impulse control

The **SCAT 2** assesses signs/symptoms, memory, cognition, and has a neurological screen for example:

***I am going to test your memory**. I will read you a list of words and when I am done, repeat back as many words as you can remember, in any order:*

Elbow, Apple, Carpet, Saddle, Bubble

The **BESS** measures static postural stability; 6 conditions are performed on a firm and foam surface, all with eyes closed, and accounts for errors made. The maximum number of errors for any single condition is ten.

BESS Test performs the following on the ground then on a foam pad:

- Double leg stance
- Single leg stance
- Tandem Stance

The same test battery was re-administered at the end of season and analyzed for any significant differences. Each individual's playing time and position was also recorded to assess whether playing time correlates with increased risk of concussion.

Results

After conducting a statistical analysis using Systat, our results are as follows:

- There was no significant difference between players with a previous concussion (n=13) and those without a previous concussion (n=35) in regards to pre-season and post-season scores for the ImPACT, BESS and SCAT 2 tests.
- There was no significant difference between pre-season and post-season ImPACT scores overall.
  - However, a sign test revealed a significant increase in reaction time composite scores from baseline to end-of-season (as shown in Figure 3).
    - Increased reaction time is a potential marker for malingering .[11] However, malingering at end-of-season testing is not advantageous to the athlete.
- There were no significant differences between pre-season and post-season BESS and SCAT 2 scores overall (as shown in Figures 1 and 4).
- There was a significant increase in self-reported concussion related symptoms from baseline (M=.80) to end of season (M=6. 60; t(14)=2.24; p<.05) (as shown in Figure 2).

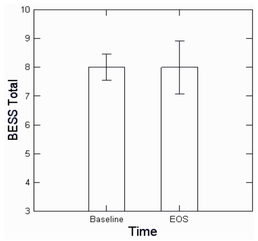

Figure 1

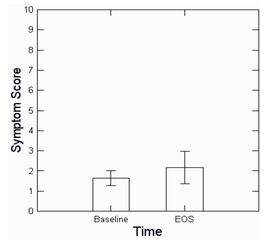

Figure 2

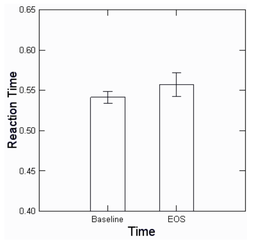

Figure 3

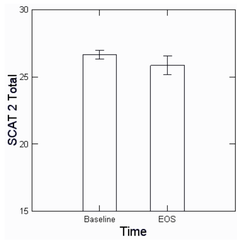

Figure 4

Discussion

Our study demonstrated no significant differences between pre-season and post-season ImPACT, BESS and SCAT 2 scores. There was also no significant difference with the pre-season and post-season scores between players with and without a previous concussion. These athletes most likely experienced many repetitive, high impact hits throughout the season both in practice and in games.

Since there was an increase in concussion-related symptoms from baseline to end-of-season, a correlation was conducted between end-of-season symptoms and the difference between the baseline and end-of-season reaction time composite scores. The resulting correlation was positive but not significant (r = .14). A positive correlation indicates that the increase in reaction time over the course of the season may be due to increased concussion symptomatology whereas a negative correlation may indicate malingering. This finding suggests that either malingering was not a factor in testing or that the reaction time composite score from the ImPACT is not a useful measure of malingering.[11] Additional research is required to clarify this issue.

The lack of controlled testing conditions could have also affected the results, which include; high attrition rate, psychological tests included at baseline, different testing environments and test administrators pre-season vs. post-season.

Further research is required to determine if testing should be conducted post-season, as well as which tests create an appropriate test battery to detect concussions.

Declarative Statement

There is no significant difference in baseline and post-season testing amongst uninjured players with and without a previous concussion. Also, there is no significant difference between the uninjured athlete's baseline and post-season test results. Lastly, it is inconclusive whether the composite scores of the ImPACT can be used to detect sandbagging or malingering in college football players post-season.

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