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Effects of a 60 Minute on Ice Game Simulation on the Balance Error Scoring System

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ABSTRACT

International Journal of Exercise Science 11(6): 462-467, 2018. Mild traumatic brain injuries (mTBIs) are common in contact sports. There is an association between mTBIs and altered motor function. BioSway technology measures individuals' balance using the Balance Error Scoring System (BESS). Prior to incorporating BESS testing in concussion protocol, other variables that influence the BESS test require review. The objective of this study is to determine if game fatigue in hockey players also influences the BESS score. 23 male (21.08 ± 1.09) National Collegiate Athletic Association (NCAA) athletes were tested using the BioSway™ (Biodex, USA). The BESS test measures the Sway Index (SI) - a calculation of deviation from the center of mass. Balance errors were counted according to BESS standard testing protocol. Baseline and post BESS scores were completed at rest and following exertion in a standard non-contact practice setting. Heart rate and rate of perceived exertion (RPE) were recorded to document fatigue during a 60 minute non contact game simulation. Statistical analysis was performed using SPSS v.25. A paired sample t-test comparing sway index in the single, double, and tandem pre and post stances demonstrated no significance (p=.567, .666, .098) respectively. A paired sample t-test demonstrated a significant increase in balance errors in the single leg stance following 60 minutes on ice (p=.006). While mTBIs influence balance, this study demonstrates that game-like exertion also influences single leg stance balance as measured by the BioSway technology and BESS testing protocol. Athlete fatigue should be considered a confounding variable in measure of balance as an indicator of mTBI.

KEY WORDS: mTBIs, BioSway, concussion

INTRODUCTION

A concussion is a form of mild traumatic brain injury that is induced by transmission of force to the brain from either a direct or indirect impact to the head, face, neck or elsewhere along the body (2). The number of concussions and other head injuries are increasing dramatically across athletics - especially in the National Hockey League. Ice hockey has been identified as a sport with a high risk for concussions. Concussions occur at all skill and age levels in ice hockey, and have been reported to account for 2-14% of all hockey injuries (2). This poses a serious threat to the health of the players and the game itself. Given the health implications associated with concussions, a great deal of attention has been placed on its diagnosis, management and return-to-play protocols.

Balance testing is a widely accepted evaluation tool within a multitude of concussion diagnosis protocols - including mid game concussion testing. It is also widely accepted that fatigue affects balance. One study suggested that muscle fatigue of the hip extensors is associated with a decline in balance function of the lower limbs of healthy young adults. Fatigue of Hip Extensors, which are important for maintaining a standing position, has an impact on balance function (1). Results of another study reported that fatigue of the hip and knee joint muscles due to exercise had a larger impact on balance function than fatigue of ankle joint muscles (3). Lastly, recent research has shown that in-game fatigue is an important, and often overlooked, factor when evaluating concussions (4).

Amongst all of these findings, and considering that hockey players experience a great deal of lower body fatigue through a variety of lower extremity movements, one may assume that players will experience fatigue in their hip and knee joint muscles like mentioned above. This may suggest that using balance testing to diagnose a concussion in the middle of a game after individuals have undergone acute neuromuscular fatigue is a skewed approach, and may lead to false positives. Prior to incorporating the BioSway BESS test into mid game concussion testing protocol, other variables like balance, that influence the BESS test results, require review.

METHODS

Participants

23 male NCAA division III hockey players from Bethel University in Saint Paul, MN volunteered to participate in the study. The participants were between 18 and 24 years old (21.08 ± 1.09). It was already Bethel University protocol for players to perform concussion baseline testing prior to starting the season. As a result, any individual that was on the Bethel University NCAA hockey team, performed the pre season concussion testing protocols, was not injured, and was willing to undergo the BioSway BESS Test Protocol was admitted to participate in the study. Participants were excluded from the study if they weren't on the hockey team or had an injury preventing them from participating in on ice activity or concussion testing protocol. On the first day of testing, study participants were given a right to privacy through an informed consent and a health history and risk stratification.

Protocol

Within the study, each participant completed two separate testing sessions, lasting approximately 5-10 minutes. Each testing session was completed in groups of 5-7 individuals at a time. A pre-fatigue balance score was found in the first session and an immediate post on-ice game simulation balance score was found during the second session. These results were evaluated to further review if fatigue from a game simulation affected balance scores. The results of this help understand if balance should be considered a confounding variable in mid game concussion testing protocol.

Session 1: The first session was completed 5-7 days prior to partaking in the on ice game simulations. Individuals were evaluated before any participation to ensure they could partake in the study. Those that could participate signed an informed consent and completed the health history stratification. Immediately following, individuals were able to complete their pre fatigue balance test on the BioSway and receive their balance scores.

The BioSway balance protocol used was the Balance Error Scoring System Test (BESS Test). The test involves three different stances in which balance is assessed; the tandem stance, single leg stance, and the double leg stance. Participants stand at each position with their eyes closed, hands on hips, and feet in the listed position. The participant attempts to hold each position for 30 seconds with as little movement as possible. After completing each stance, the BioSway calculates the Sway Index, a calculation of deviation from the individual's center of mass. This is a number to represent the individual's balance performance in each stance. While testing, the researcher also recorded the number of errors made according to the BESS Testing Error Protocol. Each individual concluded the first session with the sway index and errors calculated for the single leg stance, double leg stance, tandem stance and totals of the stances.

Session 2: Athletes do not perform baseline concussion testing on the same day as competition. In order to ensure external validity, there was an intentional gap in time between session 1 and session 2. The post test was conducted within 5 to 7 days of each individual performing the pre test. To start the post testing, the athletes performed a 60 minute non-contact game simulation at the Schwan Super Rink in Blaine, MN. The goal was to reprise an actual game without the risk of individuals acquiring a concussion. Consequently, if there was a significant change in balance scores from the pre test results, it would conclude altered performance from game fatigue. Coaching staff enforced non-contact regulations and would ensure players involved in contact eject the game. Players ejected from the game because of contact would be removed from the study. During the game simulation, athletes also wore heart rate monitors to quantify fatigue. Researchers collected the average heart rate directly after the athletes finished the game simulation. Researchers also collected each individual's rate of perceived exertion (RPE) directly after coming off the ice. Descriptives were performed on the heart rates and RPEs. Lastly, under the direction of Bethel University Hockey athletic trainer Justin Byers, the players were told to remove their skates and as little gear as necessary to perform the post game simulation BESS Test. This was due to the standard protocol of mid game concussion testing that focused on testing individuals quickly to get them back onto the ice faster. The BioSway Bess Test Protocol was the same protocol that athletes performed in the first session.

Statistical Analysis

Within subjects, a paired sample t-test comparing total Sway Index scores was conducted using SPSS v.25. The first t-test compared Sway Index scores in each stance from the first session with the Sway Index scores in each stance from the second session. It also compared the averages of all three stances Sway Index scores between the two sessions. A second paired sample t-test was completed that compared the number of errors committed during the pre test in each stance with the number of errors committed during the post test in each stance. It also compared the total errors committed in the first session with the total errors committed in the second session. In both t-tests, the level of significance was set at 0.05.

RESULTS

No significance was noted in the initial t-test comparing sway scores in the three stances (p= 0.567, 0.666, 0.098; see table 1) Single pre-post 0.149 ± SD 1.226, Double pre-post 0.034 ± SD 0.371, Tandem -0.679 ± SD 1.928. (figure 1). However, the second paired samples t-test comparing errors showed significance in the pre and post single stance error scores (P=0.006). There was not a significant change seen in errors with the double leg stance and tandem stance (P=NA, .665) (figure 2). There was not significance noted in the total error measurements.

Table 1. Significant values pertaining to the Sway Index and Error scores.

	Single Leg Stance	Double Leg Stance	Tandem Stance
Sway Index Significance	0.567	0.666	0.098
Errors Significance	0.006	NA	0.665

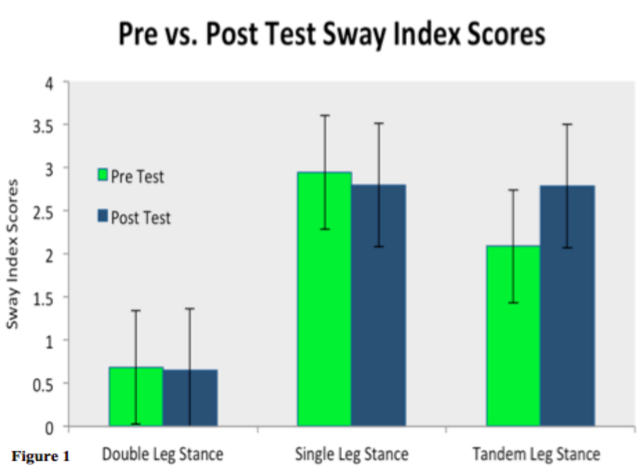

Figure 1. The BioSway scores for double, single and tandem stances.

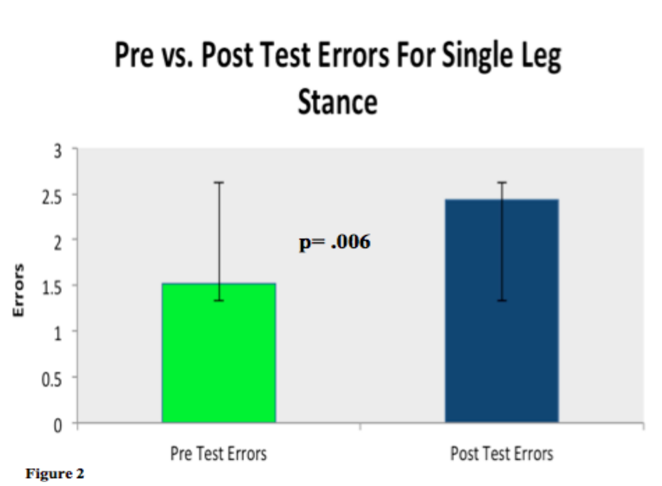

Figure 2. The errors for pre and post single leg stance.

DISCUSSION

The data indicated no significant change in any Sway Index between the pre BESS testing and post game simulation BESS testing. However, the data did show that there was a significant change in the number of errors committed by the athletes in regards to the single leg stance protocol. The results indicate that neuromuscular fatigue in a non-contact game simulation does not significantly affect the sway scores for division III hockey players. However, the significant change in errors during the single leg stance may represent why we didn't evoke a significant change in the Sway Index scores. The significant increase in errors potentially represents athletes overcompensating to correct their balance due to muscle fatigue. Due to the fact that the BioSway is not commonly used for in game testing, athletic trainers rely on visual error scores to recognize balance issues related to balance. The change in errors still represents a decline in their balance scores that was separate to that of other variables - like a concussion. Athlete fatigue should be considered a confounding variable in measure of balance as an indicator of mTBI.

After hockey players undergo on ice in game fatigue, a multitude of physiological changes take place. Peripheral fatigue escalates through an accumulation of metabolic by-products in the muscle fiber, a depletion of neurotransmitters, creatine phosphate and glycogen and a change in muscle membrane potential. These biochemical changes alter the frequency, amplitude, and rate coding of the neurons at work. This, along with higher body temperature, micro tears, and no time for the lymphatic system or neurotransmitters to rejuvenate explain why individuals may see altered performance their balance after completing an on ice game simulation (5).

Further research could be used to explicate more internally valid neurophysiological mechanisms that explore the effects of neuromuscular fatigue in other activities. Focusing more on internally valid measurements may give more detailed results. However, this wouldn't be as externally applicable to a real game scenario as the game simulation was. Also, a larger sample size and smaller groups in each session would allow for a faster turnover rate during the post test and allow for less recovery time - this is more likely what individuals would see if they were being tested during a real game. Lastly, it would be beneficial to test this hypothesis in other sports.

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