BTrackS Balance Test for Concussion Management is Resistant to Practice Effects

Mason C. Hearn, BSc, Susan S. Levy, PhD, Harsimran S. Baweja, PT, PhD, and Daniel J. Goble PhD

Abstract

Objective: Recent guidelines advocate for ongoing balance testing in the assessment of management of concussion injuries. This study sought to determine whether the Balance Tracking System (BTrackS) provides stable balance results over repeated administration and, thus, is a reliable tool for concussion management. **Design:** Repeated measures and test–retest reliability. **Setting:** University Biomechanics Laboratory. **Participants:** Random sample of 20 healthy young adults. **Interventions:** Force plate balance testing using BTrackS on days 1, 3, 8, and 15. **Main Outcome Measures:** Practice-induced changes in the average center of pressure excursion over 4 repeated administrations of the BTrackS Balance Test (BBT). Test–retest reliability of center of pressure excursion from day 1 to day 15. **Results:** No significant practice-induced balance differences were found across testing days ($P > 0.4$), and test–retest reliability of the BBT was excellent from day 1 to day 15 (R 0.92). **Conclusions:** These findings indicate that the BBT does not elicit a practice effect over repeat administrations. BTrackS provides excellent reliability and objectivity, which can increase clinician accuracy when monitoring sport-related concussions.

Key Words: BTrackS, practice effects, balance, postural sway, concussion, force plate

(*Clin J Sport Med* 2017;0:1–3)

INTRODUCTION

Concussions are garnering increased attention in the field of sports medicine because of greater knowledge of their prevalence and long-term health effects. These injuries result from direct or indirect forces translated to the brain during a sports activity and are variable in nature. The most recent guidelines for concussion management advocate for the measuring balance as a key component of a concussion protocol.[1] This recommendation is based on studies showing reduced balance after concussion.[2–4]

The most common means of balance measurement for concussion protocols is the Balance Error Scoring System (BESS). This approach subjectively quantifies balance errors during double-leg, tandem, and single-leg stance conditions. Although popular, the BESS approach has typically, but not always,[3] been shown to improve over repeated administrations.[5–7] This "practice effect" is hypothesized to be driven by a strategy-dependent enhancement in performance on the single-leg stance condition, whereas double-leg and tandem stances do not improve over repeated administrations.[5,6] Because most concussion protocols rely on repeat testing, these findings suggest that BESS-related practice effects could mask balance deficits after a concussion, possibly leading to underdiagnosis. This could place concussed athletes at increased risk for second-impact syndrome.[8]

A relatively new force plate device called the Balance Tracking System (BTrackS) was recently shown to be more sensitive than the BESS for concussion diagnosis.[4] Specifically, balance declines measured by BTrackS were found in 64% of concussed athletes tested, compared with ~30% with the BESS. BTrackS measures balance by objectively quantifying the total center of pressure (COP) excursion from foot forces created during standing, which are a proxy for body sway control and balance. Despite its promise, and low cost compared with many other force plates, the effect of practice on BTrackS results has not yet been examined. The aim of this study was, therefore, to determine if BTrackS provides stable balance results over time and is resistant to practice effects. It was hypothesized that the BTrackS would show practice effect resistance because of the use of a double-leg stance testing condition, as has been shown previously for the BESS methodology.[5,6]

METHODS

Participants

Based on a power analysis, 20 healthy young adult (mean age = 22.8 ± 2.9 years; age range 18-29 years; 11 males, 9 females) volunteers were solicited to participate in this study. Participants were screened for health status and balance-related issues using the Physical Activity Readiness Questionnaire (PAR-Q) of the National Academy of Sports Medicine, and no exclusions were necessary. The local university institutional review board approved all protocols, and subjects provided informed consent before participation.

Submitted for publication April 7, 2016; accepted February 14, 2017.

From the School of Exercise and Nutritional Sciences, San Diego State University, San Diego, California.

D. J. Goble holds an equity stake in the parent company for the BTrackS Balance Plate. This conflict of interest was strictly managed by San Diego State University through a mitigation plan that limited his involvement in all primary aspects of data collection and analysis. The remaining authors report no conflicts of interest.

Corresponding Author: Daniel J. Goble, PhD, School of Exercise and Nutritional Sciences, San Diego State University, 5500 Campanile Dr, San Diego, CA 92182-7251 (dgoble@mail.sdsu.edu).

http://dx.doi.org/10.1097/JSM.0000000000000435

Figure 1. The BTrackS Sport Balance package, consisting of the BTrackS Balance Plate (left) and the BTrackS Sport Balance software (right) running on a tablet computing device. Photograph from https://balancetrackingsystems.com/—used with permission.

Experimental Setup

The BTrackS Balance Plate and Sport Balance Software (Balance Tracking Systems Inc, San Diego, CA) were used for all data collection (Figure 1). The BTrackS Balance Plate is a lightweight (<7 Kg) force plate with a 0.4-m by 0.6-m surface that is FDA-registered medical device for the determination of COP excursion during standing. This device was placed on a firm, level surface, as per the manufacturer's specifications. The BTrackS Sport Balance software is an application-based program used for test administration, which was loaded onto a desktop computer (Precision T3500; Dell Computer Corp, Round Rock, TX).

Figure 2. A depiction of the typical BBT administration. The athlete quietly stands wearing socks, on the BTrackS Balance Plate with eyes closed, feet shoulder width apart, and hands on hips while the tester collects COP information on a connected computing device running the BTrackS Sport Balance software. Photograph from http://balancetrackingsystems.com/sport-balance—used with permission.

Experimental Procedure

The BTrackS Balance Test (BBT) was performed at approximately the same time of day on days 1, 3, 8, and 15 of a 15-day testing period. This protocol was based on the typical concussion return-to-play period.[9] The BBT consists of four, 20-second trials with minimal intertrial delay (<10 s). As instructed by the BTrackS Sport Balance software, participants wore socks, stood as still as possible with eyes closed, had their hands on hips, and placed their feet shoulder width apart (Figure 2). The first trial conducted was for familiarization purposes, whereas the remaining trials were used to determine the BBT result. The BBT results were calculated by the Sport Balance software based on the average COP excursion (ie, COP path length) across testing trials.

Data Analysis

To test the hypothesis that no practice effects exist for the BBT, a 1-way repeated measures analysis of variance was performed with test day (1, 3, 8, and 15) serving as the repeated measures factor. Test–retest reliability of the BBT from day 1 to day 15 was also calculated using intraclass correlation coefficients [ICCs (2, 1)] to confirm the stability of testing results.

RESULTS

The average BBT across participants on each day of testing is shown in Figure 3. Results show that BBT performance did not differ across testing days ($F_{3,57} = 0.97$, $P > 0.4$). In addition, test–retest reliability of the BBT results was found to be excellent with an ICC = 0.92 (95% confidence interval, 0.84-0.97) from day 1 to day 15. This indicates

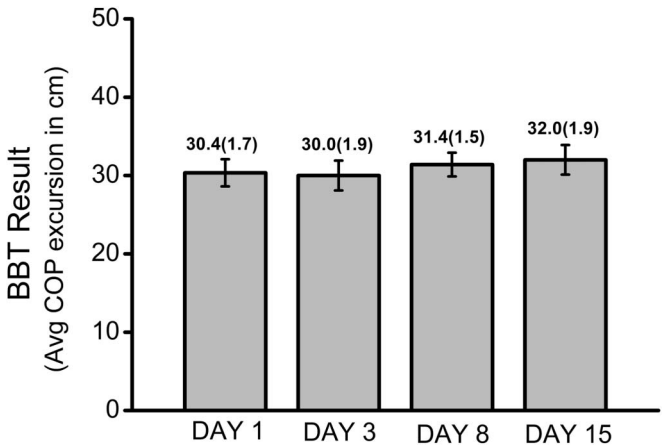

Figure 3. Mean (+/− between subjects' standard error) BBT results across participants on each test day.

robust test–retest reliability across the testing period for each participant tested.

DISCUSSION

There is a clear need for more effective testing tools to determine the presence of, and/or recovery from, a concussion after a sport-related head injury. Currently, the BESS is the most widely used assessment of balance for concussion management, but most previous research suggests that it is susceptible to practice effects.[5–7] This study examined a new, force plate system called BTrackS. It was shown that BTrackS was resistant to practice effects across a typical return-to-play period and had a high test–retest reliability.

The absence of a BTrackS practice effect may stem from differences in stance condition tested versus the BESS. The BBT implements only simple double-leg standing trials, whereas the BESS includes multiple stance conditions (double leg, single leg, and tandem) on two surfaces (firm and foam). As shown previously, it is single-leg stance condition in the BESS test that is prone to practice effects, and not the double-leg or tandem stance conditions.[5,6]

Data in this study were collected from healthy adults and not athletes. Despite this limitation, a previous study noted that performance on double-leg balance conditions does not differ between athletes and nonathletes.[10] Thus, although unproven, it is unlikely that athletes would have been more prone to practice effects than nonathletes.

ACKNOWLEDGMENTS

The authors thank Sean Williard for his role in the data collection phase of this study.

References

1. McCrory P, Meeuwisse W, Aubry M, et al. Consensus statement on concussion in sport: the 4th International Conference on concussion in sport held in Zurich. *Clin J Sports Med*. 2013;23:89–117.
2. Riemann BL, Guskiewicz K, Shields EW. Relationship between clinical and force plate measures of postural stability. *J Sport Rehabil*. 1999;8:71–82.
3. McCrea M, Guskiewicz K, Marshall S, et al. Acute effects and recovery time following concussion in collegiate football players: the NCAA concussion study. *JAMA*. 2003;290:2556–2563.
4. Goble DJ, Manyak KA, Abdenour TE, et al. An initial evaluation of the BTrackS balance plate and sports balance software for concussion diagnosis. *Int J Sports Phys Ther*. 2016;11:149–155.
5. Valovich T, Perrin D, Gansneder B. Repeat administration elicits a practice effect with the balance error scoring system but not with the standardized assessment of concussion in high school athletes. *J Athl Train*. 2003;38:51–56.
6. Wilkins JC, Valovich McLeod TC, Perrin DH, et al. Performance on the balance error scoring system decreases after fatigue. *J Athl Train*. 2004;39:156–161.
7. Susco TM, Valovich McLeod TC, Gansneder BM, et al. Balance recovers within 20 minutes after exertion as measured by the balance error scoring system. *J Athl Train*. 2004;39:241–246.
8. Byard R, Vink R. The second impact syndrome. *Forensic Sci Med Pathol*. 2009;5:36–38.
9. Covassin T, Elbin RJ, Parker T, et al. Depression and neurocognitive performance after concussion among male and female high school and collegiate athletes. *Arch Phys Med Rehabil*. 2012;93:1751–1756.
10. Williams D, Murray N, Powell D. Athletes who train on unstable compared to stable surfaces exhibit unique postural control strategies in response to balance perturbations. *J Sport Health Sci*. 2016;5:70–76.