

Use of the Equilibrate System as a Diagnostic Tool for Concussion; and for Tracking Recovery after Incident

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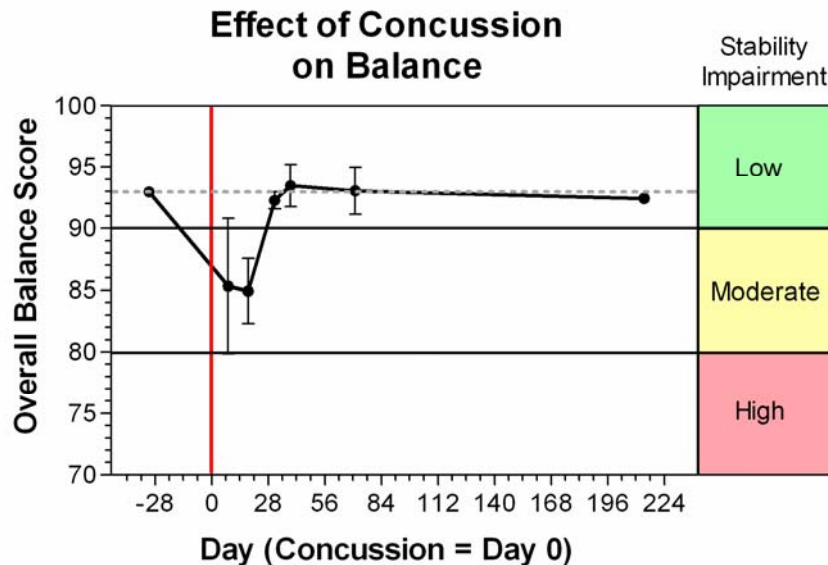
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Case Brief

Female subject (Beth S., born 1990; proficiency in figure skating, running, self-defense, and motocross) suffered mild traumatic brain injury (mTBI or 'concussion') in June 2010. Incident involved subject's helmeted head striking a tree while riding a motorcycle off-road. Subject suffered no loss of consciousness or amnesia, but did experience rapid and severe headache. CT scan revealed no internal bleeding; however significant headache persisted for weeks, and was exacerbated by any physical activity (Subject: "even walking around the house"). Slight movement or mental activity ("any thinking at all") increased headache pain. Approximately one month following mTBI, persistent headache was mostly diminished, but would re-emerge upon physical activity. After one month, subject felt comfortable enough to resume a normal running and work-out schedule.

Balance Assessment

Both prior to and following the accident, Beth S. (at 20 years of age) had her physical balance measured using the Equilibrate System, a non-invasive and comprehensive device for objective, whole-body assessment of postural control and degree of stability impairment (Balance Engineering LLC, Henrietta, NY). Beth S. was subjected to a variety of balance tests that ranged from measurement of overall balance during simple standing, to perturbatory equilibrium testing in which weights were worn to facilitate instability. The figure below illustrates quantitative output from the Equilibrate System measuring Beth S.'s overall balance score before mTBI and during recovery:



Notes: Overall Balance Score on the Equilibrate System (Balance Engineering, LLC) is based on a scale of 0-100, with a higher score reflecting superior postural control. Equilibrate data shown is for 'test type 1' which measures postural control during quiet standing on two feet with eyes open for 15 seconds. Time points are relative to concussion on day 0 (vertical red line) and represent the average of tests per session (typically three, but ranging from two to six). Colors indicate degree of stability impairment: Green = low, Yellow = moderate, Orange = high. Gray dashed line represents pre-concussion baseline value (92.96). Bars indicate standard error of the mean.

Results

Prior to accidental concussion, the average balance score for Beth S. on the Equilibrate System was comparable to the average for similar-aged peers (subject score 92.96, versus 94.03 for peers) and greater than the average score for the general population (90.98). Additionally, Beth S. showed relatively low variation in her scores prior to concussion (typical).

Upon blunt trauma to the helmeted head while motocrossing, Beth S. suffered a decrease in her balance score of approximately eight points, as measured one week following concussion. The decrease was sufficient to increase her estimated stability impairment from 'low' to 'moderate.' Further, there was a significant increase in the variance of her scoring. As we will see, variance will be a subtle yet important feature of Equilibrate's sensitive balance assessment that may have significant influence on the determination of 'recovery' from mTBI.

Eighteen days following concussion, Beth S.'s balance score remained eight points below baseline, however variability of her test scores began to decrease. At 31 days following concussion Beth S. had nearly recovered to pre-incident baseline levels. Based on overall balance score alone, she achieved recovery to pre-concussion baseline level by 39 days.

Interestingly, while recovery to pre-concussion balance score levels occurred within 4-5 weeks following mTBI, variation in balance scoring continued through her assessment at 71 days. At a balance assessment 7 months later, variability in Beth S.'s scoring had returned to minimal levels, suggesting that full balance recovery from concussion may require at least 10 weeks and perhaps up to 30 weeks.

Conclusion

Beth S.'s balance assessment on the Equilibrate System quantitatively reveals the degree of deleterious effect on her balance as a result of concussion suffered from head trauma. Also revealed is the time for recovery to pre-concussion balance score (approximately 30 days), as well as a persistent variation in balance ability that required a longer time to normalize (between 72 and 213 days). *The results also highlight the capability of the Equilibrate System for objective and sensitive detection of the vestibular effects of mTBI.*

For additional information regarding the EQUILIBRATE System of objective human balance testing and balance function therapy visit www.balanceengineering.com

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