LOCAL DYNAMIC STABILITY IN SINGLE AND DUAL-TASK CONCUSSED GAIT: PRELIMINARY RESULTS
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Introduction: While most symptoms from concussions recover in 7-10 days [1], challenging motor control tasks can be affected longer. Concussed athletes have shown prolonged changes in challenging motor control tasks such as dual-task gait [2], but only traditional stability measures such as medio-lateral (ML) sway have been investigated thus far. The current investigation compared the local dynamic stability (LDS) of recently concussed athletes to matched controls to identify lasting motor control abnormalities, even after the concussed athletes returned to competition.

Materials and Methods: Five recently concussed collegiate athletes and four matched teammates (controls) were longitudinally tested for up to six weeks following each concussion. Not all participants were tested every week because of scheduling difficulties. All protocols were approved by the Virginia Tech IRB. Participants gave written consent and walked around a marked course featuring an 18 m long straight section for 14 laps without a cognitive task (single-task, ST) and again while serially subtracting by sevens (dual-task, DT). Short-term LDS was estimated using the maximum Lyapunov exponent ($\lambda_S$) from a 9D state space constructed using twice time-delayed data from a tri-axial accelerometer located over the xiphoid process. The middle eight strides of each straight gait section were time normalized. Stability was calculated with 13 short bouts of 8 strides [3], where the slope between 0 and 0.5 strides on the log mean divergence curve represented the local dynamic stability. The exponent $\lambda_S$ was calculated for ST and DT conditions. To remove the effect of gait speed [4], $\lambda_S$ was normalized to individual gait speeds measured with a stopwatch. Group differences in $\lambda_S$ were compared using a GEE model, involving a compound symmetric covariance structure with group, week, and task as a covariates and group*task, week*task interactions, and with a 0.05 significance level.

Results and Discussion: No significant main effects were found, but there was a significant interaction of group*task ($p < 0.01$). A plot of the difference between DT and ST for each group is shown in Figure 1. Mean (SD) $\lambda_S$ in the ST condition for the C and H groups were 0.41 (0.05) and 0.41 (0.07), respectively, agreeing with data from healthy young adults [3]. The group * task interaction indicates that DT decreased the LDS (increased $\lambda_S$) of the C group but did not change the LDS of the H group with respect to ST.

Conclusions: These results suggest that concussed athletes may exhibit healthy locomotion in normal conditions, but are more influenced by distractions than healthy individuals, with greater stride-to-stride variability during demanding tasks. This finding is particularly important given the high cognitive demand that is often present during athletic competitions. Future research should examine LDS in larger samples of concussed populations and explore whether this decrease in dual-task LDS correlates to increased injury risk [5] or declined performance [6].

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