



UNC CHARLOTTE

College of Health and Human Services

Department of Kinesiology

GAIT TERMINATION IDENTIFIES LINGERING POSTURAL INSTABILITY IN CONCUSSED ATHLETES

Jessie Oldham*, Kelsey Evans,† Barry Munkasy,† Erik Wikstrom,* Thomas Buckley†

*University of North Carolina at Charlotte, Charlotte, NC †Georgia Southern University, Statesboro, GA.



INTRODUCTION

- According to The 4th International conference on Concussion in Sport, a concussion is a brain injury and is defined as a complex pathophysiological process affecting the brain, induced by biomechanical forces.
- One of the major issues surrounding concussions is when to safely return an athlete to full sports participation.
- Returning to physical activity prematurely, it can increase the risk of subsequent concussions and detrimental long-term effects.
- Clinical concussion assessments, such as the Balance Error Scoring System (BESS), Standard Assessment of Concussion (SAC) and self-reported symptoms (SS) are highly sensitive to acute diagnosis; however, there is increasing concern that these assessments might miss lingering impairments in postural control.

PURPOSE

- To evaluate the effectiveness of a dynamic task, gait termination (GT), at identifying lingering postural instability in concussed athletes at the time when clinical assessments (BESS, SAC, SS) return to their respective baseline values.

METHODS

- 50 NCAA Division 1 student-athletes (age= 19.28 ± 1.14 years, height= 173.68 ± 11.73 cm, weight = 80.54 ± 22.96 kg), with diagnosed concussions, were compared to 17 physically active NCAA Division 1 uninjured control student-athletes (Age= 19 ± 1.17 years, Height =178.38 ± 8.71 cm, Weight= 88.6 ± 20.26 kg).
- Each concussed participant underwent repeated trials of BESS, SAC and SS assessments until each returned to baseline.
- GT trials were performed on a 4.9-meter Gaitrite portable walkway system that culminated with four 0.4 x 0.6-meter force plates. The protocol consisted of 2 standard gait trials and 5 planned GT trials.
- During the standard gait trials, the participant walked down the portable system, struck the force plates, and continued walking. Conversely, during the GT trials, the individual walked down the portable walkway and terminated their gait cycle on the force plates. (See Figure 1)

METHODS

- The main outcomes included center of pressure (CoP) excursion and velocity in the anteroposterior and mediolateral directions during the three distinct phases (S1, S2, S3) of the CoP displacement, along with the measures of GT strategy (gait velocity, and the propulsive force and braking force change relative to standard gait).
- Group differences between the control group and the days that traditional assessments returned to baseline were determined by separate one-way ANOVAs. Post-hoc testing was performed, when needed, to locate the location of the specific group differences. The p-value was set at .05.

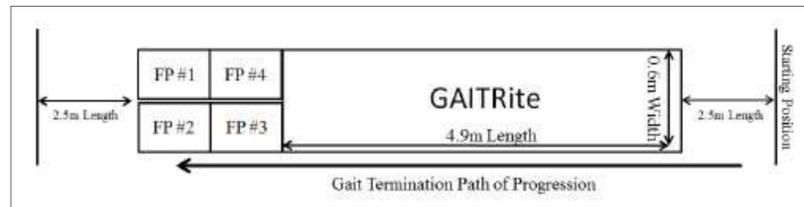


Figure 1: Participants began all trials at the starting position. For standard gait, participants walked across the GAITRite and force plates until reaching the end of the walkway. For GT, participants walked across the GAITRite and terminated gait with the penultimate step occurring on force plate #3 or #4 and the termination step occurring on force plate #1 or #2 depending on natural footfall.

RESULTS

- Group differences were identified in 6 of the 12 CoP outcomes, as well as the change in propulsive force. No differences were noted for gait velocity or braking force change.

Outcomes	Control (n=17)	BESS (n=26)	SAC (n=27)	SS (n=28)	RTP (n=15)
Gait Velocity (m/s)	1.37±.19	1.31±.19	1.30±.18	1.33±.15	1.38±.15
Propulsive Force Change (%)	.63±.15	.46±.14*	.49±.18*	.48±.10*	.52±.10
Braking Force Change (%)	-.02±.31	.15±.22	.12±.21	.14±.21	.15±.25
S1 AP Excursion (cm)	60.96±8.86	35.67±25.55*	38.67±23.1*	40.01±22.38*	49.15±22.4
S1 ML Excursion (cm)	17.27±7.35	10.03±8.43	9.82±7.99	9.45±6.77*	15.32±9.36
S2 AP Excursion (cm)	6.14±4.84	28.12±20.13*	27.65±18.69	27.59±18.38*	15.32±9.36
S1 AP Velocity (cm/s)	811.72±171.87	575.17±214.52*	582.95±165.58*	639.79±220.87	721.36±155.89
S1 ML Velocity (cm/s)	225.91±88.88	146.29±83.78	138.36±72.67*	145.43±95.85	211.60±106.09
S2 AP Velocity (cm/s)	119.38±117.37	649.08±469.95*	612.69±432.76*	656.81±489.27*	462.23±528.5

Table 1: Motor Control Strategy and Center of Pressure Outcomes (Mean±SD) during Gait Termination among the Control, BESS, SAC, SS, and RTP Groups. * Indicates a significant difference (p≤0.05) from the Control group.

RESULTS

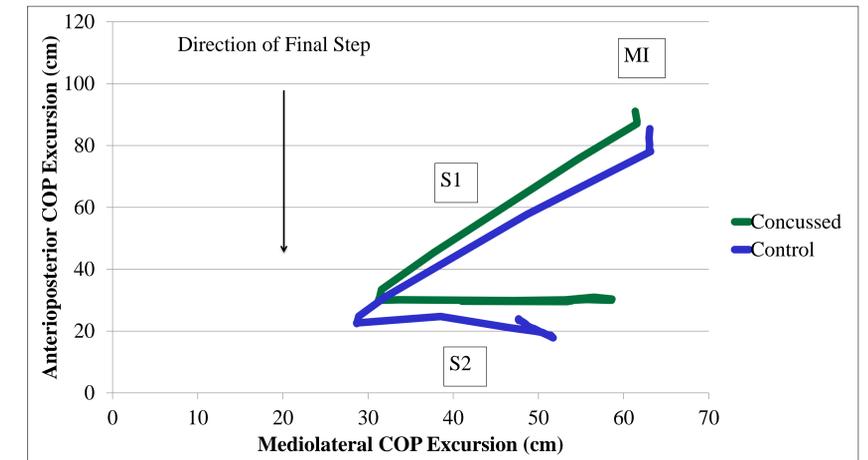


Figure 2: An exemplar trace of the CoP, which demonstrates excursions in the frontal and sagittal planes during planned GT. Movement initiation (MI) begins with the contact phase of penultimate step on force plate #3 (see Figure 1). The first phase of GT (S1) represents the CoP excursion during the swing and contact phases of the leading limb with force plate #1 and ends with toe off of the trailing limb from force plate #3. The second phase of GT (S2) represents the COP excursion that occurs while the trailing limb is in its swing phase and ends when the trailing limb strikes force plate #2 and the participant is in a double limb stance.

CONCLUSIONS

- Lingering impairments in postural stability were identified by a planned GT task on the days when traditional concussion assessment tools (BESS< SAC< SS) returned to their baseline values.
- Failure of the concussed individuals to reduce their propulsive forces during planned GT to the same extent as the controls, illustrates the lingering impairments and suggests the adoption of a compensatory altered GT strategy that allowed them to stop without falling.
- The volume of sagittal plane CoP alterations also illustrates lingering postural stability impairments and highlights the need to conduct a kinematic analysis to explore the nature of the compensatory strategy adopted during planned GT post-concussion.
- These findings are significant because an individual is traditionally considered to have recovered from a concussion when the clinical concussion assessments return to baseline.

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