The Effects of Time and Direction on Single Leg Balance

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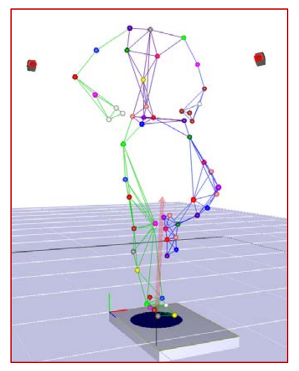


ABSTRACT

Single Leg Stance (SLS) testing is used in clinical assessments of balance, but little is known about the temporal structure of sway parameters during this test. SLS research is equivocal on the effects of sway over time and the direction of balance initiation. Sway data in a healthy young population may provide insight on how balance is initiated and maintained in relation to the initial step direction. This may lead to novel approaches to help healthy elderly populations decrease fall risk and fall-related mortality.
The purpose of the study was to examine the temporal and directional dependencies of sway parameters during 10 seconds of SLS in young, healthy adults.
Thirteen healthy, young college students (7 male, 6 female) performed 10 seconds of SLS on their dominant leg, stepping from a frontward and sideward direction. Ground reaction forces measured with a force platform were used to calculate the sway parameters: sway area, sway velocity, anterior-posterior and medio-lateral sway, and sway path.
Sway parameters decreased over time, with stabilized values similar to baseline after the 4 seconds of SLS. The forward direction exhibits elevated sway parameters compared to the sideward direction in the first two seconds of single leg stance.

INTRODUCTION

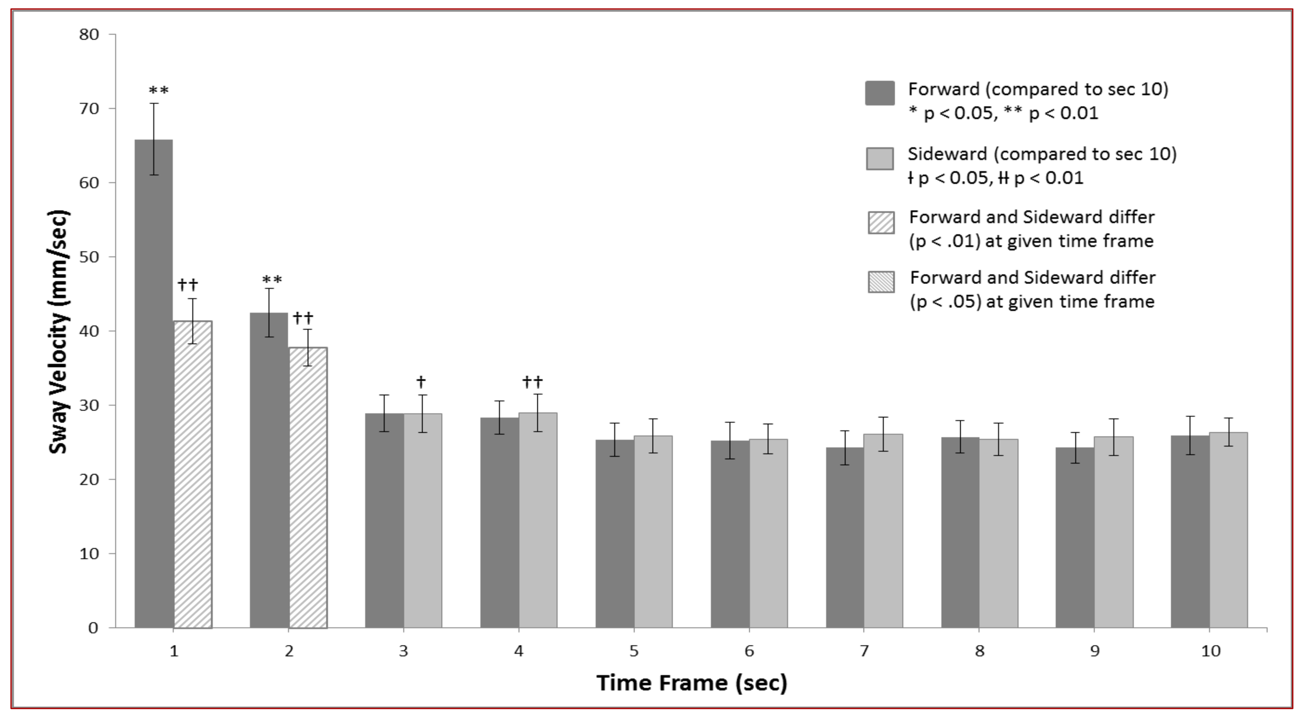
Single Leg Stance (SLS) is used in a clinical setting for the assessment of balance and fall risk (Yelnik & Bonan, 2008). Initiating SLS involves a shift of the center of mass (COM) to the standing leg. Maintaining SLS requires slight postural corrections to align the center of mass over the base of support (Carpenter, 2010). This shift in the center of mass results in sway.

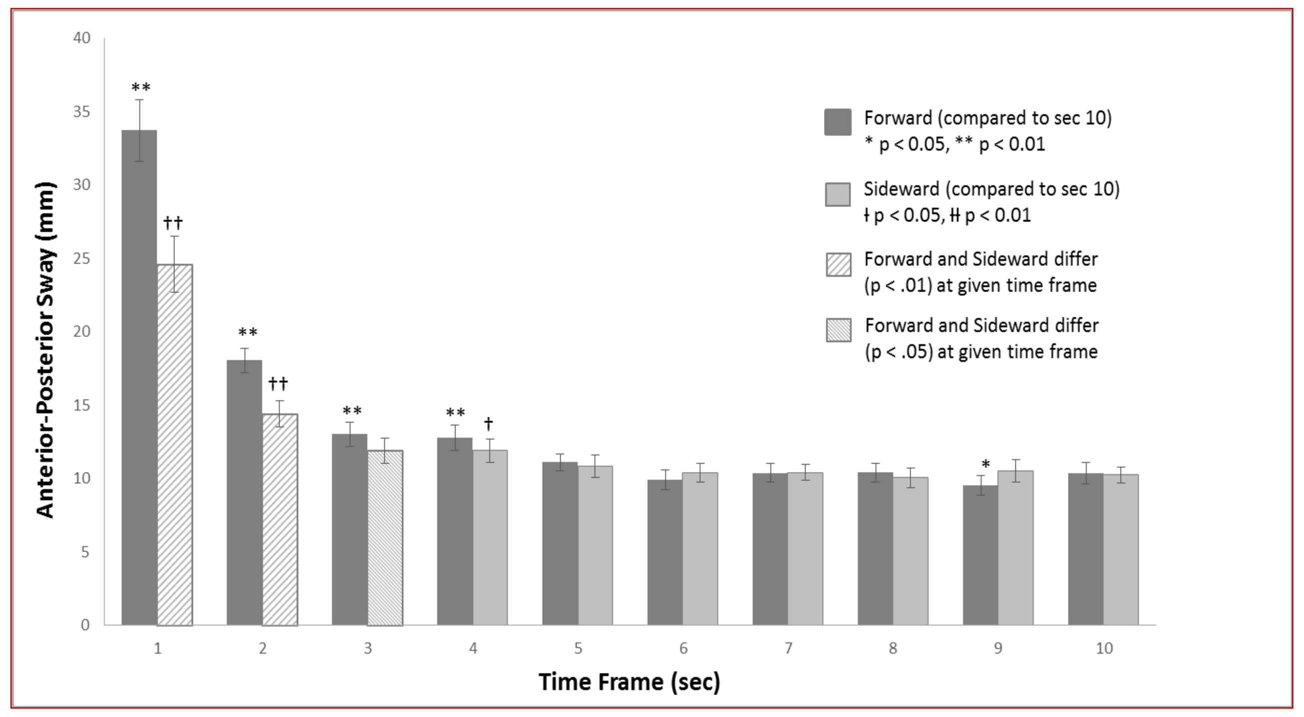
Detriments in balance are measured by an increased amplitude in sway parameters such as sway velocity, anterior-posterior sway, medio-lateral sway, and sway area (Hwang 2009). SLS can be initiated from the sideward direction during activities of daily living or from the forward direction during initiation of gait. The direction of balance initiation may have an effect on sway parameters over time (Roemer & Raisbeck, 2015).

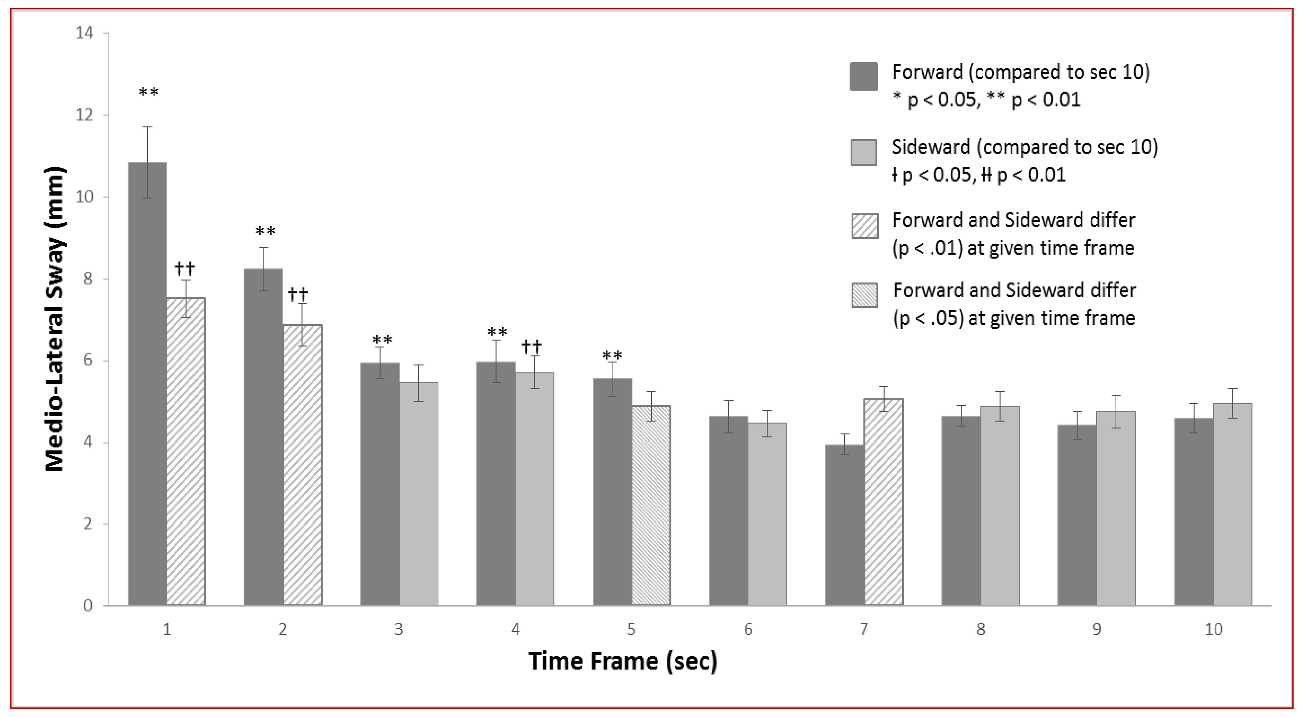
Research is needed on the impact of step direction on the temporal structure of sway during a balance test, given the importance of balance initiation during activities of daily living.

The purpose of this study was to examine the temporal and directional dependencies of sway parameters during 10 seconds of SLS in young, healthy adults. It was hypothesized that sway would decrease rapidly within the first four seconds, and thereafter sway would stabilize compared to the 10 second baseline. It was also hypothesized that there would be differences in the two directions of balance initiation within these first four seconds.

RESULTS







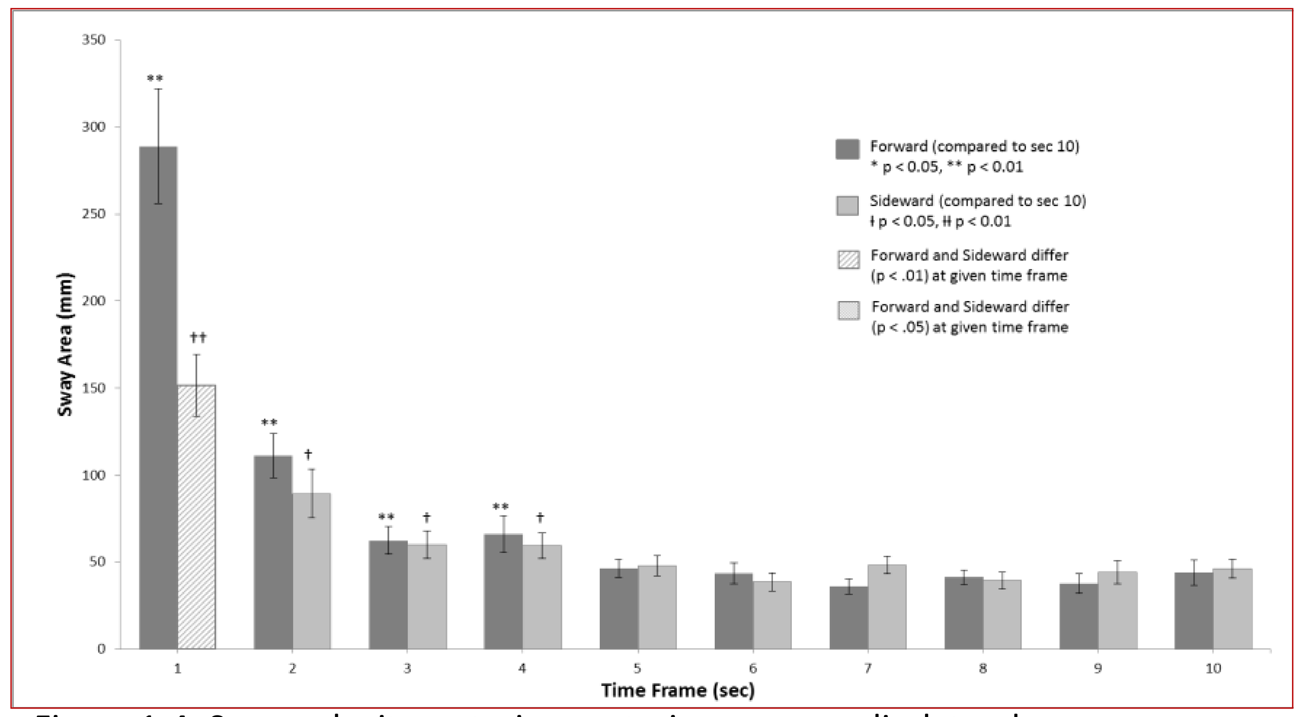


Figure 1-4: Sway velocity, anterior-posterior sway, medio-lateral sway, and sway area during 10 seconds of single leg stance.

METHODS

Subjects: Thirteen subjects (age: 23 ±1.9 yr, height: 174 ± 9.5 cm, weight: 73.7 ± 15.7 kg) with no previous injuries or history of falls.

Protocol: Subjects stepped on to a 40x40 AMTI force platform from a forward and sideward direction to initiate SLS on their dominant leg and maintained it for 10 seconds. The direction of balance initiation (forward or sideward) was randomly assigned.

Dependent variables: Sway velocity, sway area, anterior-posterior and medio-lateral sway.

RESULTS

The data was analyzed with a generalized linear mixed model design using time frame and direction as fixed effects with simple contrasts. Second 10 and sideward direction were used as baseline for the simple contrasts respectively.

- Subjects showed a significant decrease ($p < 0.05$) in sway velocity, anterior-posterior sway, and sway area over time, with similar values to baseline balance past the fourth second.
- The forward direction exhibited higher sway parameters ($p < 0.05$) in the first second of balance compared to the sideward direction.
- Medio-lateral sway was higher in the forward step than the sideward step, despite the fact that the shift in center of mass in the sideward condition occurs in the medio-lateral axis.

DISCUSSION

- Both directions showed significantly elevated sway parameters during the initial phase (first 4 seconds) compared to the maintenance phase (remaining 6 seconds) which matches previous studies using SLS (Hernandez, 2012; Roemer & Raisbeck, 2013; Jonsson, 2004).
- Step direction impacts sway parameters during the early phase of SLS. Initiating balance from a forward direction increased sway during the first two seconds of single leg stance compared to the sideward direction. However, balance is stabilized by the fourth second in both conditions. These results are in agreement with previous studies that suggest healthy young subjects rapidly achieve stable balance during SLS (Parreira; 2013).
- In this study each time frame was one second in length. Further research should experiment with the temporal structure of sway by manipulating the selected length of each time frame to see if differences in sway are seen in shorter or longer time intervals.

A limitation of the study is that the subjects were allowed to select their own step speed when switching to their stance limb for SLS. Future studies should control for step speed because it may influence the temporal structure of sway.

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