

CENTER OF MASS AND ANKLE INCLINATION ANGLES DURING WALKING: AN ALTERNATIVE DETECTION OF GAIT INSTABILITY

Chu-Jui Chen and Li-Shan Chou

Department of Human Physiology, University of Oregon, Eugene, Oregon USA
E-mail: chou@uoregon.edu, Web: biomechanics.uoregon.edu/MAL/index.html

INTRODUCTION

Instantaneous inclination angles between the whole body center of mass (COM) and center of pressure (COP) during gait were reported to detect gait instability in the elderly [1]. Accurate calculation of the COP requires a single foot placement on each force plate. However, many studies indicated that older adults, especially fallers, walk with a significantly smaller step than young adults [2,3]. Such gait modification and inter-trial inconsistency of this population greatly increase difficulty in obtaining a clean foot placement on the force plate, which will hinder the calculation of COM-COP inclination angles. Therefore, the purpose of this study was to find an alternative parameter, similar to COM-COP inclination angles, for assessing instantaneous alignment between COM and base of support during gait without the concern of the subject's ability in making proper foot contacts with the force plate. Effectiveness to identify patients with imbalance using the inclination angle formed by the lateral ankle marker and COM during gait was assessed in this study.

METHODS

Eight elderly patients with gait imbalance (mean age = 78.3 ± 5.8) and eight healthy elderly controls (mean age = 77.5 ± 6.2) were recruited for this study. Subjects were asked to walk on a level surface with self-selected pace while barefoot. Whole body motion was captured with an 8-camera motion analysis system (Motion Analysis

Corp., Santa Rosa, CA). A total of 29 markers were placed on the subject's bony landmarks [4]. Two force plates (AMTI, Watertown, MA) were used to collect ground reaction forces for the calculation of COP. Inclination angles of the lines formed by the COM and lateral ankle marker as well as by the COM and COP were computed for each frame during the single stance phase of gait. The effect of subject group on the average medial and peak anterior inclination angles during the time period were assessed using the *t*-test with an α level of 0.05.

RESULTS AND DISCUSSION

Representative profiles of the medial and anterior-posterior inclination angles during the single support phase from a patient and a healthy subject were shown in Fig. 1 and Fig. 2. COM-Ankle medial inclination angles were consistently greater than COM-COP inclination angles. Average medial COM-Ankle and COM-COP inclination angles of imbalance patients were $6.4^\circ \pm 0.8^\circ$ and $4.4^\circ \pm 0.9^\circ$, respectively. Average medial COM-Ankle and COM-COP inclination angles of healthy individuals were $5.3^\circ \pm 0.8^\circ$, and $2.6^\circ \pm 0.9^\circ$. Imbalance patients were found to display a significantly greater medial inclination angle than healthy elderly ($p=0.025$ for COM-Ankle angle; $p=0.002$ for COM-COP angle; Fig.3).

Compared to the medial COM-COP inclination angle, it is reasonable to expect the medial COM-Ankle inclination angle to be greater due to the lateral ankle marker's locations.

Peak anterior COM-Ankle and COM-COP inclination angles of imbalance patients were $18.7^\circ \pm 3.6^\circ$ and $9.2^\circ \pm 1.8^\circ$. Peak anterior COM-Ankle and COM-COP inclination angles of healthy individuals were $23.4^\circ \pm 2.4^\circ$, and $11.6^\circ \pm 2.9^\circ$. Healthy individuals were found to have significantly greater peak anterior inclination angles than patients ($p \leq 0.001$ for COM-Ankle angle; $p=0.002$ for COM-COP angle).

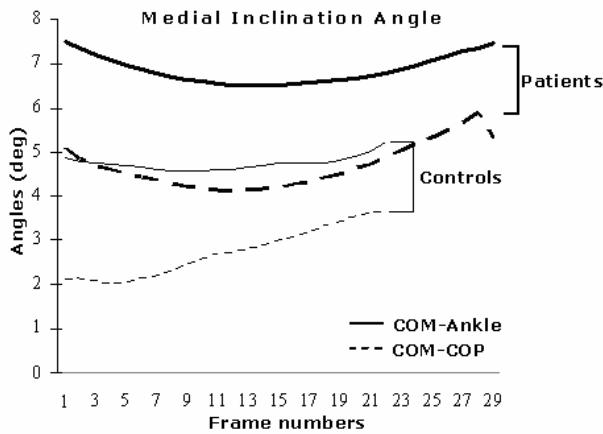


Figure1. Medial inclination angles during the single stance phase.

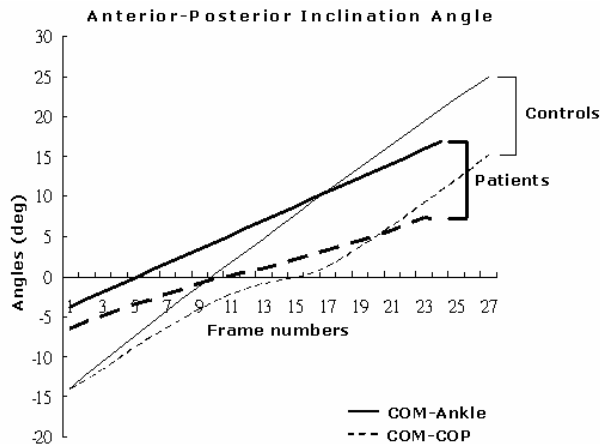


Figure2. Anterior-posterior inclination angles during the single stance phase.

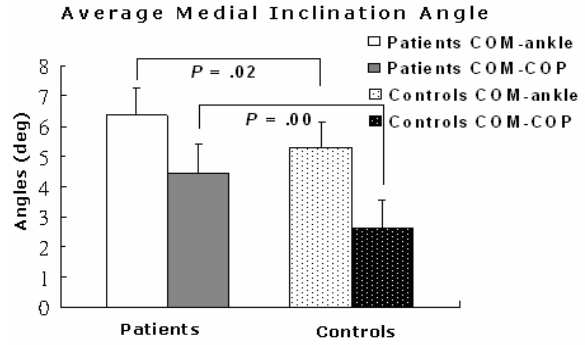


Figure3. Mean medial inclination angles during the single stance phase.

Findings from this study demonstrated that COM-Ankle inclination angles during the single stance phase, similar to the COM-COP inclination angles, could successfully distinguish patients with gait imbalance. Calculation of the COM-Ankle inclination angle will not require the subject's proper foot placement on the force plate, which could be a more suitable assessment to clinical populations.

SUMMARY/CONCLUSIONS

The COM-Ankle inclination angles during single stance phase are effectiveness to identify patients with imbalance.

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