The effect of chronic ankle instability on gait dynamics and muscle activation patterns during planned and unplanned changes-of-direction during normal, level-ground walking

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Methods Procedures

Participant selection: Seventeen subjects (ages 23-41) participated in the study, and all were included in the healthy ankle group (Mean CAIT score = 7.7%). Protocol: Each subject’s mass and height were recorded, and body mass index (BMI) was calculated. Subjects then completed the CAIT. All subjects walked barefoot on a level walkway instrumented with two AMTI tri-axial force plates to capture ground reactive forces (GRF) during the testing step or natural walking speed. They were given instructions, via quasi-random turn order, to either walk straight or make 45° or 90° degree turns indicated by the numbered turns as shown in Figure 1. In addition, three trials of normal gait were also randomly collected in the session. In planned turns, subjects walked to an instructed target number. In unplanned turns, the number was revealed mid-trial at the step immediately before the evaluated foot made contact with the force plate. Subjects’ movements were recorded using a 6-camera Qualisys 3D motion capture system marking retro-reflective markers placed at standardized locations on the trunk and upper and lower extremities according to the Helen Hayes model. These markers were used to create a model of joint kinematics. Additionally, muscle activation for 6 pairs of lower extremity muscles was assessed using a telemetered electromyography (EMG) system (DelSys Trigno).

Outcome measures: Data were collected on relative kinematic joint angular displacement, moments of force, and power generation/absorption to determine if significant differences exist between planned and unplanned turns. In the portion of the study, data were analyzed only regarding angles of the ankle in the sagittal, transverse, and frontal planes.

Akleic kinetic data comparisons (planned vs. unplanned, turns vs. no turn) were assessed via Pearson product moments (r). The range of values for r in the planned vs. unplanned turns ranged from 0.90 to 0.98. Planned turns compared to normal gait ranged from 0.85 to 0.95. The range of values below 0.90 was observed in the frontal and transverse planes. Similarly, comparison between unplanned and no turns ranged from 0.95 to 0.98, again due to low correlations in the frontal and transverse planes.

Literature Review

Ankle sprains make up approximately one-third of all sports injuries, with up to 34% of patients experiencing re-sprains within 3 years. Up to 40% develop symptomatic chronic ankle instability.1-2 Hertel et al. estimated that more than 23,000 ankle sprains occur per day in the United States. This equates to 1 sprain per 10,000 people daily.3 Chronic ankle instability (CAI) is a term that encompasses deficiencies of the ankle joint complex following an acute ankle injury. Patients subjectively receive a “given way” of the ankle joint.4 CAI has been traditionally attributed to mechanical instability (e.g., pathologic laxity) and/or functional instability (e.g., proprioceptive and neuromuscular deficits, postural control, or strength).1,5 Mechanical and functional instability together lead to recurrent ankle sprains, the third component of CAI.4

Analysis & Discussion

The original aim of this study was to investigate the effect of CAI on angles of the ankle in the sagittal, transverse, and frontal plane when comparing 45° or 90° planned versus unplanned turns at heel contact. In this pilot study, based on the results of the CAIT questionnaire, all 17 subjects were assigned to the healthy ankle group. The results demonstrated no significant difference between angles of the ankle in the planned versus unplanned turns at heel contact. There were, however, considerable differences in both frontal and transverse plane ankle angles comparing planned or unplanned turns and normal walking. This is reasonable in one sense would assume that making turns whilst walking involves a shift from the sagittal to the frontal plane, and that motion in the transverse plane would also be necessary to achieve a successful turn.

There were no apparent differences in the ankle kinematics of turns whether the subject knew ahead of time or was told just prior to making the turn. Once the protocol of uncertainty was clear to the subjects, it is possible that subjects were already compensating for unplanned turns at the ankle, knee, and hip joints during swing phase prior to heel contact. It would be interesting to further evaluate these angles at points during gait other than at heel contact.

For the next stage of this study, the study should include subjects that must criteria for CAI based on the CAIT questionnaire. Comparing subjects with CAI to the healthy ankle control group described in this study, or a similar healthy ankle control group, could demonstrate greater differences in angles of the ankle in planned versus unplanned turns. In this study, data was also collected regarding knee and hip kinematics that has yet to be analyzed; possibly subjects made angular adjustments at joints instead of the ankle to compensate during unplanned turns. EMG data was also collected from the healthy ankle subjects that has yet to be analyzed. Perhaps different muscle groups are recruited in planned versus unplanned turns when faced with unexpected changes.

In this healthy ankle group, subjects demonstrated no significant difference in angles of the ankle at heel contact during planned versus unplanned turns, suggesting intact compensation mechanisms present at the ankle joint or at the ankle joint prior to heel contact.

Acknowledgement

Thanks to Drew Smith PhD and Steven Hill PhD for their assistance and support.

References