INTRODUCTION: Combination of measurement and mathematical modeling has provided a powerful tool for investigating the complicated behavior of human joints [2, 6]. In the previous studies the ankle joint complex was usually modeled as ideal hinge joints with fixed rotation axes or spherical joints [3, 7]. These models ignored some important kinematic features of the joints. In this study, a three-dimensional ankle joint complex model is proposed.

STATEMENT OF CLINICAL SIGNIFICANCE: The ankle joint complex is modeled as consisting of two rigid bodies — the tibia-fibula and the talus-calcaneus, which undergo three-dimensional motion. Six major ankle ligaments bind the tibia-fibula and the talus-calcaneus together: anterior tibiotalar ligament (ATT), posterior tibiotalar ligament (PTT), and tibiocalcaneal ligament (TiC) on the medial side; anterior and posterior talofibular ligaments (ATaF and PTaF) and calcaneofibular ligament (CF) on the lateral side. One-point frictionless contact is assumed at the articulation between the talus and the tibia and at the articulation between the talus and the fibula respectively.

METHODOLOGY: Geometric data of the ligaments and articular surfaces were collected from a foot cadaver specimen by using a ‘Flock of Birds’ tracking system (Ascension Technology Inc., Burlington, Vermont, USA). The movement of dorsiflexion-plantarflexion was simulated. The geometry of articular surfaces is modeled using thin-plate splines [1].

RESULTS: Figure 1 shows the rotational parameters as a function of flexion-extension angles of the talus-calcaneus. Figure 2 shows the strains in the ligaments varying with the flexion-extension angle of the talus-calcaneus. A negative strain (dotted line) indicates a tensionless state of the ligament.

DISCUSSION: The results indicate that the ligaments CF and TiC are always tightly during dorsiflexion-plantarflexion. From dorsiflexion to plantarflexion, the ligaments PTT and PTaF, which
locate posteriorly, vary from tension to relax while the ligaments ATaF and ATT, which locate anteriorly, from relax to tension. It can also been seen that strains in the ligaments ATaF increase when the ankle joint complex is plantarflexed while stains in the ligaments PTT and PTaF increase when the ankle joint complex is dorsiflexed. The calculation results are in reasonable agreement with what reported in the literature and observed in the *in vitro* experiment [5].

**Related Publication:**


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