# THREE-DIMENSIONAL BONE KINEMATICS IN AN ANTERIOR DRAWER TEST OF THE ANKLE JOINT

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## INTRODUCTION

For evaluating the function of the anterolateral ligaments in the ankle joint an anterior drawer test can be performed [1]. The heel is forced forward relative to the shank. The anterior displacement of the calcaneus relative to the tibia is a measure for the anterior laxity of the ankle joint, which actually should represent the displacement between the talus and tibia. The assumption is that the calcaneus moves with the talus for the intact ligaments as well as for the ruptured ligaments [2]. The motions between the talus and calcaneus may affect the measurement in a newly designed instrumented tester. This study addressed the question to what extent the talus and calcaneus move as one in a test that is aimed at quantifying anterior ankle joint laxity.

## METHODS

Five fresh-frozen cadaveric tibia-foot specimens were used. Simultaneous measurements were made with an instrumented anterior ankle laxity tester and a three-dimensional kinematic analysis system (Optotrak). Tracking LEDs were fixated to tibia, fibula, talus and calcaneus. From the continuous motion data, the three-dimensional translations and rotations of those bones were determined for anterior drawer forces up to maximally 150 N. The translations were calculated for a point at the center of the talocrural joint as marked after finalization of the drawer experiments. This point moved either with the talus or with the calcaneus. The drawer test was repeated after sequential cutting of the anterior talofibular ligament (ATFL), the calcaneofibular ligament (CFL) and the posterior talofibular ligament (PTFL).

## RESULTS AND DISCUSSION

In one specimen, a luxation of the ankle joint was observed. This specimen was excluded from further analyses. For the remaining four specimens, the major motion was an anterior translation. The other translations and rotations were small and variable as illustrated by the data at 100 N anterior force (Figure 2). The anterior translation of talus and calcaneus showed a significant increase with increasing ligament damage and with increasing loads (ANOVA; $p<0.05$). On average, the motion differences between the talus and calcaneus were small, i.e. less than 1.5 mm and 2 degrees at 100 N (Figure 2). Surprisingly, the effect of cutting the ATFL was greater for the talus anterior translation than for the calcaneus anterior translation due to the altered kinematics in the subtalar joint after ligament cutting. In all 4 joints the motion coupling was mainly affected after cutting the ATFL.

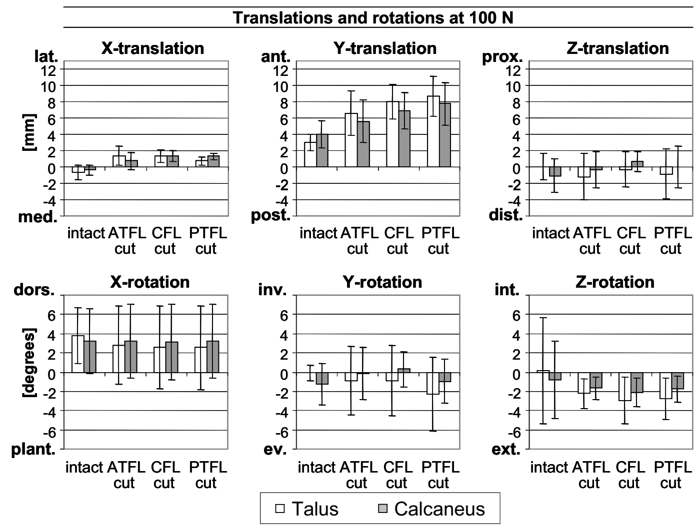


**Figure 1**: The translations and rotations at 100 N (average +/- s.d.) of the intact specimens (N=4) and after sequential cutting of the ATFL, CFL and PTFL. The translations are calculated for a point in the center of the talocrural joint that moves with the talus and for the same point that is virtually attached to the calcaneus and moves with the calcaneus. The motion data are calculated relative to the translation- or rotation readings at 0 N. Explanation of the abbreviations: lat. = lateral; med. = medial; ant. = anterior; post. = posterior; prox. = proximal; dist. = distal; dors. = dorsal; plant. = plantar; inv. = inversion; ev. = eversion; int. = internal; ext. = external.

## CONCLUSIONS

If testing the anterior drawer of the ankle joint by evaluating the motions between the calcaneus and the tibia, then the actual translation measurement is affected by the motions between the calcaneus and the talus. This effect is small relative to the measured anterior translation. The motion coupling between the calcaneus and the talus is changed after sectioning the anterior talofibular ligament.

## REFERENCES

1. Kannus P & Renstrom P. *J Bone Joint Surg (A)* **73**, 305-312, 1991.
2. Tohyama H, et al. *Am J Sports Med* **31**, 226-232, 2003.