

Oral presentation

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## Effect of external loading on in vitro measured muscle induced calcaneal and talar motion

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### Introduction

Several foot deformities (e.g. pes planus, pes cavus) result from muscular force imbalance across the joints of the ankle and foot. The use of in vitro measurements is required to explore the causal relation between muscle forces, individual foot bone movement and resulting foot deformities. This study quantified the effect of muscle action of the pretibial muscle groups, Mm. peronei as well as the Gastro-soleus on the three dimensional rotation of calcaneus and talus using in vitro measurements with a gait simulator consisting of pneumatic actuators. Furthermore, we tested the effect of altered load bearing conditions of the foot on the observed relations.

### Methods

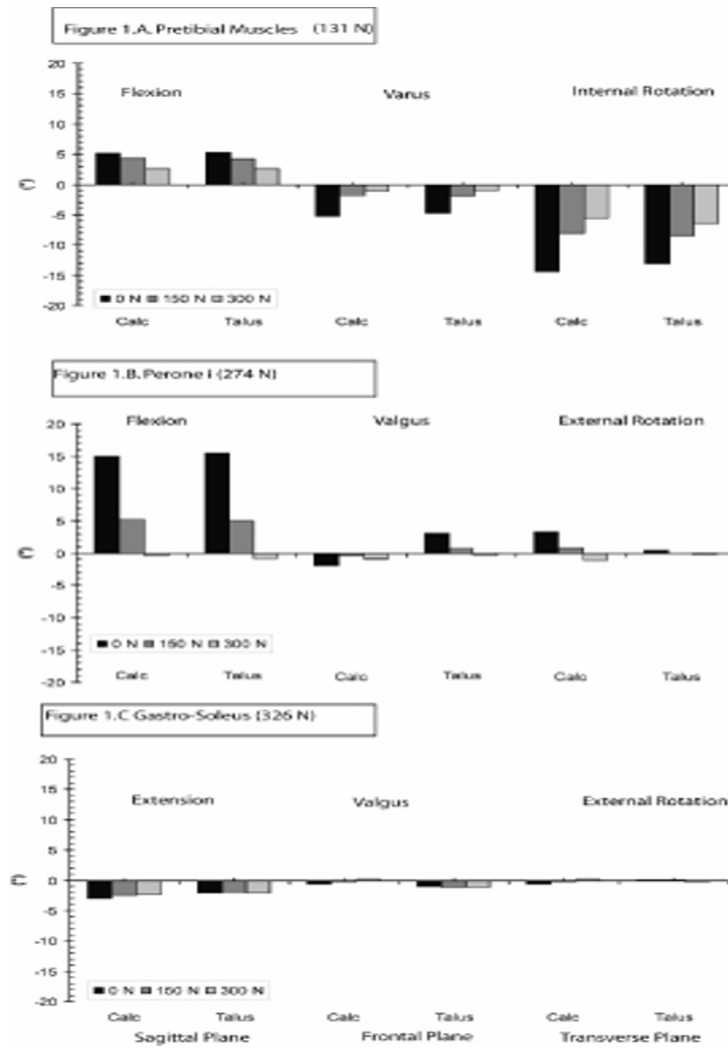
Pneumatic actuators exerted forces with increasing magnitude onto the tendons of the pretibial muscles (M. tibialis anterior, M. extensor hallucis and M. extensor digitorum longus), the tendons of both M. peronei and the Achilles tendon of a cadaver foot, placed in an anatomical position (neutral, upright standing). The resulting motion of bone embedded LEDs was tracked using an opto-electronic system (Krypton, Metris) and the resulting three-dimensional rotation of calcaneus and talus was quantified. Changes in ground reaction forces were measured using a Kistler force platform. These tests were repeated for loading of the foot of 0 N, 150 N and 300 N.

### Results

Figure 1 presents the main muscle function as derived from the three dimensional movement of the talus and calcaneus for forces applied onto the tendons of the pretibial muscles (Figure 1A), onto the tendons of Mm. peronei (Figure 1B) and onto the Achilles tendon (Figure 1C) for the three loading conditions. A pronounced effect of the load bearing condition on the bone motion is found for the pretibial muscles and Mm. peronei. Whereas for the latter, mainly sagittal plane rotations were affected, a pronounced effect in all three planes was found for the pretibial muscles.

### Conclusion

The load bearing condition of the foot needs to be accounted for when defining the causal relation between three-dimensional rotations of calcaneus and talus and forces exerted on muscle tendons through pneumatic actuators.



**Figure 1**  
Positive values indicate flexion, valgus and external rotation.

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