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# Neuro-mechanical interaction during an imitated ankle sprain mechanism

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## INTRODUCTION

Lateral ankle sprains are among the most common sport injuries potentially resulting in pain, swelling and recurrent sprains[1]. So far, the musculus peroneus longus being an evertor of the ankle has been in the limelight of research but its actual function and relevance during lateral ankle sprains is poorly understood[2]. To gain new insights into the control of the ankle, complex methods addressing the neuromuscular activation as well as the mechanical behaviour of the muscle are needed. Accordingly, the present studied evaluated the neuro-mechanical interaction in the course of injury-like situations combining electromyography (EMG), three-dimensional joint kinematics and ultrasound.

## METHODS

In the current experiment, ankle sprain mechanisms were imitated in the standing subject using a custom built platform inducing a deflection of 24° inversion and 15° plantarflexion (Figure 1) in 10 healthy subjects (21.9±2.3 years, 74.4±7.8kg, 180.1±8.0cm).

Retro-reflective markers were recorded with a three-dimensional motion analysis system at 240Hz (Vicon Motion Systems, Oxford, UK). Using a Joint Coordinate System approach plantar/dorsiflexion and inversion/eversion of the ankle joint complex were calculated. Joint angles before tilting the platform, maximal joint angles and maximal angular velocities were extracted. Additionally, muscular activity of the m. tibialis anterior and the m. peroneus longus were determined with wireless surface electromyography at 2400Hz (myon RFTD-E08, myon AG, Baar, Switzerland). Finally, ultrasound images from the m. tibialis anterior and the m. peroneus longus were taken. Muscle fascicle length was recorded applying a flat shaped ultrasound probe tightly strapped to the muscle bellies. A 96-element, linear, multifrequency probe (LV7.5/60/96, Telemed, Vilnius, Lithuania) which was attached to a PC-based ultrasound system (Echoblaster 128, UAB, Telemed) and a running software (EchoWaveII,Telemed) for recordings at a frame rate of 80 frames/s.

Joint kinematics, muscular activities and muscle fascicle lengthening characteristics were compared in a time window from 100ms before until 300 ms after tilting the platform.

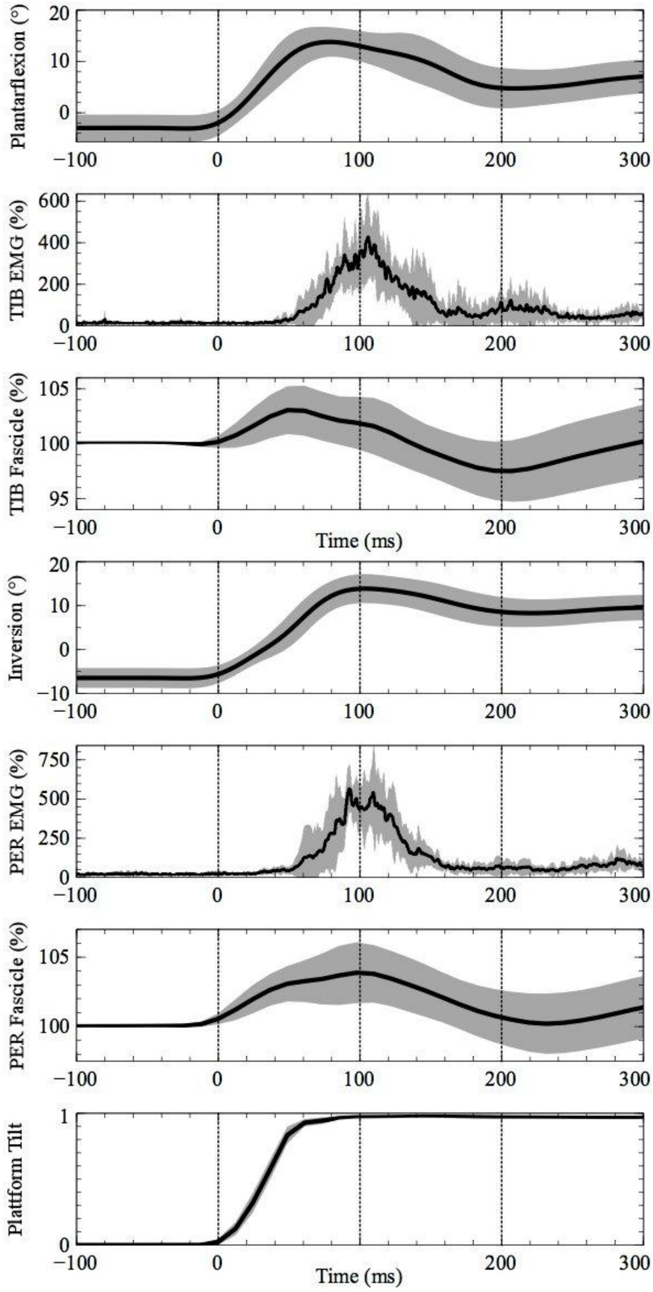


**Figure 1**: Interaction of ankle joint kinematics, neuromuscular activation pattern and muscle fascicle length when imitation the ankle sprain mechanism (grand mean±SD).

## RESULTS AND DISCUSSION

The sudden platform tilt resulted in a maximal plantarflexion of 12.6±4.7° and a maximal ankle inversion of 13.8±3.3°. Maximal joint excursion was reached after 75.0ms for the plantarflexion and 104.2ms for the inversion. The onset of the neuromuscular activity for the m. peroneus longus was apparent after 76.7±42.5ms and for the m. tibialis anterior after 51.3±32.3ms. Muscle fascicle length of the m. peroneus longus increased by 3.9±2.1% and reached its maximum after 85.2±19.7ms The muscle fascicle length of the m. tibialis anterior increased by 3.1±2.2% with its maximal length after 50.4±16.1ms.

The results of the present study show that the fascicles of the m. tibialis anterior and the m. peroneus longus are stretched right after the initial platform tilt. While the fascicles of the m. tibialis anterior start to shorten with the onset of the muscular activity, the fascicles of the m. peroneus longus continue to be stretched even after the onset of the muscular activity. The reason for this might lie in a different potential of the two muscles to contract. While the m. tibialis anterior seems to react much faster under the given conditions enabling a fast “counter reaction” against the supination, the m. peroneus longus, however, needs considerable more time.

Moreover, the present results show that the shortening of the muscle fascicles precedes the maximal joint excursions. This indicates an ‘active’ shortening of the muscle and highlights that even under purely reactive conditions the neuro-mechanical contribution of the ankle joint muscles might be fast enough to counteract fast ankle inversions.

## CONCLUSIONS

The present study shows that the ankle joint muscles might not be to be fast enough to be actively involved in ankle joint stabilization during ankle sprains counteracting an externally induced supination of the ankle joint. Furthermore, the combination of ultrasonography, kinematics and electromyography might provide new insight into ankle joint control in close to injury situations.

## REFERENCES


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