

## RELATIONSHIP BETWEEN GAIT BIOMECHANICS AND INVERSION SPRAINS

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### INTRODUCTION

In order to increase knowledge of the aetiology of ankle sprains, a few prospective studies have investigated the underlying risk factors. Knowledge of the variables influencing and contributing to the risk of ankle sprains is important for the development of effective preventive strategies. Most probably, the aetiology of inversion sprains is multifactorial, in which intrinsic and extrinsic risk factors play their part. One of the causes that has been assumed, is biomechanical abnormalities in gait(1). Therefore, the purpose of our study was to prospectively determine gait related risk factors for inversion sprains.

### MATERIALS AND METHOD

Plantar pressure data and alignment were collected from 93 (October 2001) and 130 (October 2002) healthy undergraduate physical education students without lower extremity injuries. 3D-kinematic data were collected from the first group (n=93). A footscan pressure plate (RsScan nv., 2m x 0.4m, 16384 sensors, 480 Hz, dynamic calibration with AMTI) was mounted in the middle of a 16.5m long wooden running track. Video data were collected at 240 Hz using 7 infrared cameras (Proreflex) and Qualisys software. Retroreflective markers were placed on the upper leg, the lower leg and the rearfoot. A multi-segment model was developed to investigate the three-dimensional motions of the knee and the ankle: rearfoot with respect to a laboratory frame, rearfoot to shank and shank with respect to thigh (Visual 3D, S.Selbie, USA). The subjects were asked to run barefoot at a speed of 3.3m/s (+/- 0.17m/s). Prior to the measurements, all subjects performed habituation trials. Three valid left and three valid right stance phases were measured. After testing, the same observer placed 8 regions (medial heel, lateral heel, metatarsal heads I to V and hallux) on the footprints for all trials. Temporal data (i.e. time to peak pressure, instants on which the regions make contact and instants on which the regions end foot contact), peak pressure data and relative and absolute impulses were calculated for all 8 regions. Medio-lateral ratio's were calculated at five instants of the foot contact, namely initial contact (IC), midstance (Mst) i.e. contact of one of the metatarsal heads, foot flat (FF) i.e. contact of all metatarsal heads, heel off (HO) and last contact (LC). Excursion ranges of these ratio's were calculated over four intervals (IC-Mst, Mst-FF, FF-HO, and HO-LC). The X-component (medio-lateral) and Y-component (anterior-posterior) of the centre of pressure (COP) scaled to the foot width and foot length, were analysed. The positioning and displacements of the components were calculated at the five instants and in the intervals. From the kinematic data, initial position at heel-strike, position at push-off, maximal position, time to maximal position, excursion, maximal and mean velocity and time to maximal velocity were identified for rearfoot with respect to a laboratory frame, rearfoot to shank and shank with respect to thigh.

Sports injuries were registered during a year and a half for the first group and a half year for the second group by the same sports physician.

### RESULTS

During this one year and a half, of the 93 subjects, 15 subjects had an inversion sprain of whom one subject bilaterally, and during half a year 6 subjects of the 130 had an inversion sprain (group 1, n=22, 12 left and 10 right). As control group (group 0), 36 subjects were selected out of the first group who were followed during a year and a half. None of these subjects had injuries at the lower extremities. Statistical analyses revealed that total contact time is significant longer in subjects who sustained an inversion sprain compared to the non-injured subjects. In addition, the impulse underneath M1 is significantly higher in group 1 and the impulse underneath M5 is significantly lower. Relative contact time of M1 is earlier in group 1. Medio-lateral ratio's show that pressure distribution is more medially directed at midstance, footflat and heel off in subjects who sustain an inversion sprain. In addition, in the intervals of IC-Mst and Mst-FF, there is less displacement of the pressure from lateral to medial. From heel off until last foot contact, there is significantly less pressure displacement from lateral to medial. The X-component of the COP is situated significantly more laterally at last foot contact in subjects who sustained an inversion sprain. Although not significant (p=0.062), but clinically relevant, the X-component is situated more laterally at first heel contact in group 1. Kinematic data show a significantly higher maximal pronation of the rearfoot with respect to the ground and the instant of maximal resupination velocity occurs significantly later in group 1. Time of maximal knee flexion is significantly later in these subjects, through which the flexion velocity is significantly lower. Alignment measurements show that subjects who sustain an inversion sprain, have a significantly higher metatarsophalangeal I extension range of motion.

### DISCUSSION AND CONCLUSION

Our results reveal that the gait of subjects who will sustain an inversion sprain has typical characteristics of a laterally situated COP at initial contact, which implies that the trust needed to invert the ankle is smaller in these subjects. In addition, at midstance, footflat, and heel off, these subjects show a mobile foot type, which is more pronated and accompanied with more pressure underneath the medial side of the foot and maximal knee flexion is later. Resupination starts later and the roll off does not happen across the hallux, but more laterally, probably because of the diminished support at the metatarsophalangeal I joint. Total foot contact time is also longer than in normal subjects. The findings of this study suggests that effective prevention and rehabilitation of inversion sprains should include attention for gait patterns and adjustments of the foot biomechanics.

(1) Willems T., Witvrouw E., Verstuyft J., et al. *Journal of Athletic Training* 2002, October-December: 487-93.