BAREFOOT-, SHOD, PLATE AND INSOLE PRESSURE MEASUREMENT COMPARISONS DURING 4-4.5 m/s RUNNING IN RELATIONSHIPS TO LOWER LIMBS MOVEMENTS

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In order to know the different between insole and ground pressure measurements, or which information is given by a pressure platform and which by an pressure insole – system, We compare them for some specific parameters against the relationship of lower limbs movement. The methods we used are collected plantar pressure data from 30 males (in different conditions we controlled). A six-degrees of freedom, midfoot and forefoot segments along with motion of the tibia. Kinematic data (Qualisis, Sweden) was collected simultaneously with high speed pressure plate (footscan RSSCAN International, Belgium) data. At last we found Highly good correlation were found in the barefoot (heel and total foot, Figure 5) and shod data for the pressure plate (footscan). And the two different pressure measurement systems produce different results for the TIR. Etc

KEY WORDS: pressure platform-system, pressure insole-system, tibea (TIR)

INTRODUCTION: In many clinical or scientific applications, such as gait analysis, pressure measurements, either from a pressure platform or a pressure insole-system, are used. Rarely both systems are used synchronised. Which information is given by a pressure platform and which by a pressure insole – system?
The purpose of this study is therefore to compare insole and ground pressure measurements for some specific parameters against the relationship of lower limbs movement.
The kinematics of barefoot (BF) and shod (SH) running have been examined in the literature (e.g. Stacoff et and DeWit et al 2000) and movement adaptations such as foot/lower leg posture atground contact, and coupled movement behaviour of the rearfoot and tibea have been investigated. McClay and Manal (1997) found good relationships between the internal rotation of the tibea (TIR) and inversion/eversion of the rearfoot. This rapid lower limb movements that contribute to the bodies natural load and mechanical movements during locomotion, are not easy to quantify (Digby et al, 2005). Plantar pressure measurements systems are now able to record plantar loading transition at high data acquisition, related to rearfoot motion (Hagman, 2002), and therefore have the potential of using a relatively simple measurement approach (footscan pressure mat) to estimate movement transients during running that may be associated with the risk of running overuse injury.
This Study's examined how the medial and lateral foot and heel pressures taken from a pressure plate and pressure insole were associated with TIR.

METHODS: Plantar pressure data was collected from 30 male subjects (Digby C, barefoot/tibea rotation), 15 trails collected, and 7 male subjects, and Shod running 7 male subjects all with size 9 feet participated and completed 10 trails of barefoot and shod (neutral cushioned running shoe) running between 4 and 4.5 m/s (Robinson M).
A six-degree of freedom, multi-segment foot model was produced with heel, midfoot and forefoot segments along with motion of the tibia. Kinematic data (Qualisis, Sweden) was collected simultaneously with high speed pressure plate (footscan RSSCAN International, Belgium) data.

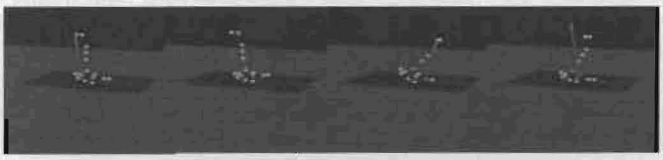
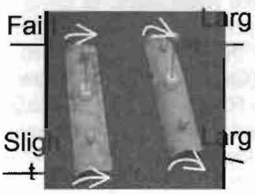


Figure 1 Test protocol: tibea kinematics.

In the shod condition a pressure insole (footscan RSSCAN International, Belgium) was also worn. The equipment was triggered by TTL from the 3D box (footscan RSSCAN International, Belgium) and sampled at 500 Hz (footscan, polymer sensors of size 7mm to 5mm, linear calibrated) ore 1000 Hz (Qualisis).

Methodological Development

Large difference in curvature of plates
Skin pre-stretch
Plate glued and taped



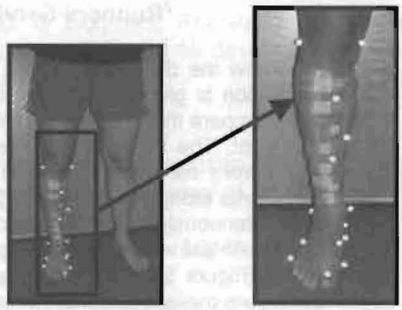


Figure 2 Test protocol: tibea kinematics.

8 ProReflex
1000 Hz cameras

footscan Platform and
insole 500 Hz

30 subjects

15 trials

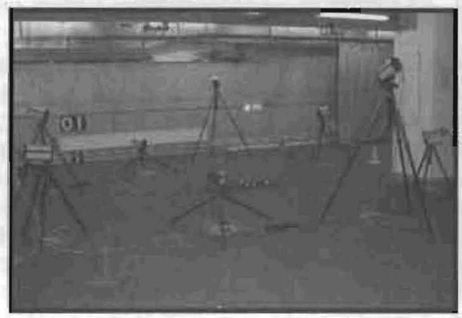


Figure 3 Setup footscan/Qualisis.

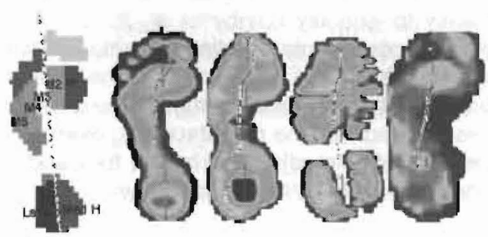
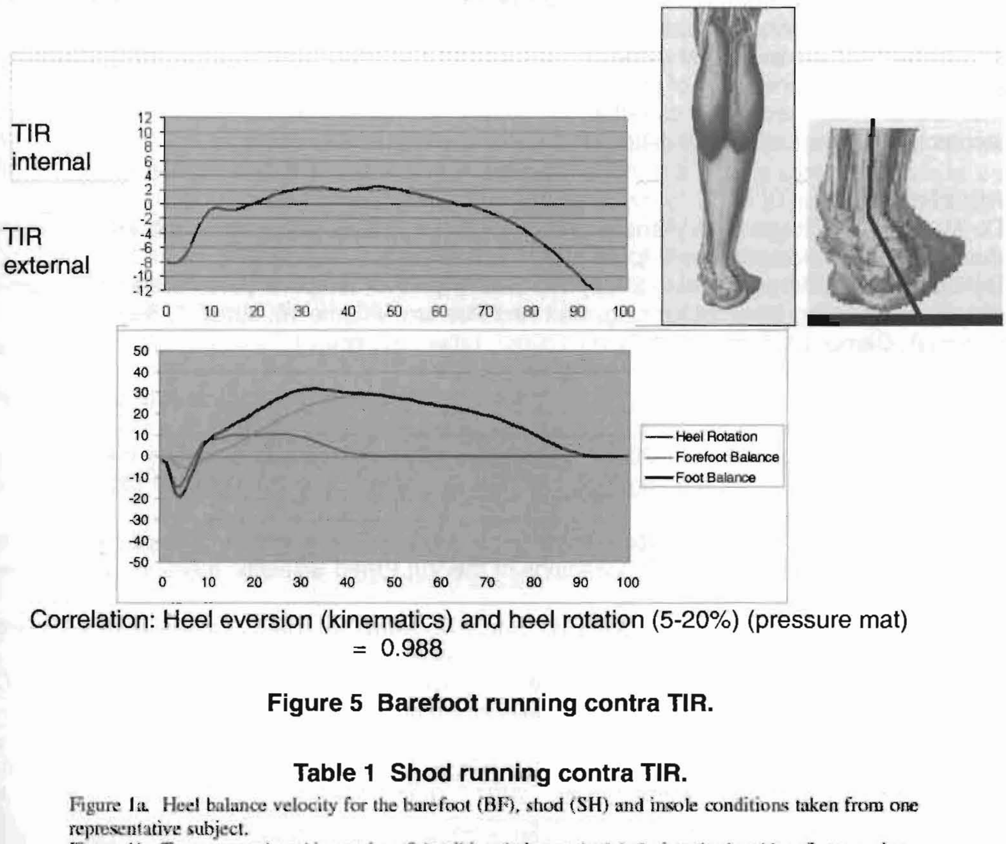


Figure 4 Dynamical Region. Analysis by footscan gait software 7.

Localized areas of pressures (Figure 4) under the medial and lateral heel and metatarsals were used to give accurate indications of of the rapid transitions in pressures throughout stance.
Each data were normalized to the average Fz Force of the trail allowing comparison between subjects. A Pearson's correlation was performed on the barefoot and shot tibial internal rotation kinematics and barefoot, shod and insole pressure heel medio-lateral loading (heel balance) curves. The average velocity of the increase in intern rotation after contact was related to corresponding 'heel balance' velocities.

RESULTS AND DISCUSSION: Highly good correlation were found in the barefoot (heel and total foot, Figure 5) and shod data for the pressure plate (Footscan), but no significant correlation was found for the insole (Table 1a & 1b).

This indicates that as TIR increases, medial pressure under the heel increases (Figure 1a) and would support previous research demonstrating that eversion of the heel increase is closely related to tibia internal rotation (DeLeo et al, 2004). The best correlation of foot ore heel pressure transition velocity results to TIR velocity was obtained for the pressure information at the barefoot and shoe ground interface (Footscanplate) rather than the foot-shoe interface (Footscan insole was collected simultaneously). This can be explained by the constant orientation of the pressure insole flat against the heel and perhaps it is not surprising that movements aspects of the foot-ankle complex are not predicted.



Correlation: Heel eversion (kinematics) and heel rotation (5-20%) (pressure mat) = 0.988

Figure 5 Barefoot running contra TIR.

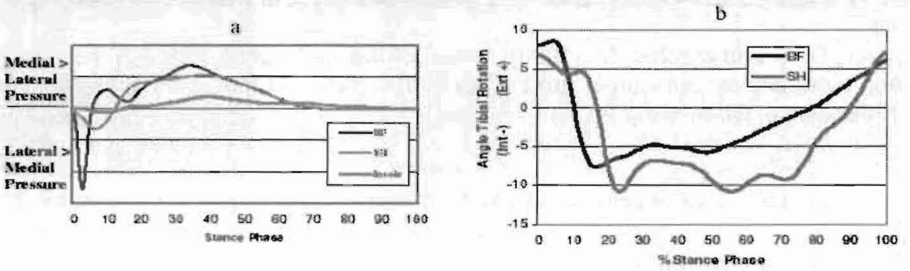
Table 1 Shod running contra TIR.

Figure 1a. Heel balance velocity for the barefoot (BF), shod (SH) and insole conditions taken from one representative subject.

Figure 1b. Transverse plane kinematics of the tibia relative to the lab during shod and barefoot running

Table 1. The correlation coefficients and corresponding p-values for the three correlations performed.

	Correlation coefficient	P –value
Barefoot TIR velocity vs Barefoot Heel Balance velocity	-0.812	**0.026**
Shod TIR velocity vs Shod Heel Balance velocity	-0.891	**0.007**
Shod TIR velocity vs Insole Heel Balance velocity	-0.324	0.478



It is established that the pressure insoles provide important information regarding the localized loading of the plantar tissues inside the shoe but the insole loading transitions do not appear to be well linked to movement kinematics in this investigation.

CONCLUSION: The two different pressure measurement systems produce different results for the TIR. One of the reasons for this difference is that the insoles translocate and bend with the shoes. Another aspect is that the pressure platform measure the shoe-to-ground interaction, where an insole measure a foot-to-shoe interaction.
In conclusion, clinicians had to be careful when evaluating plantar pressure data of different systems, different conditions and different patients.
The high-speed pressure mat measures of barefoot and shod running (shoe-ground interface) were shown to be predictive of tibial internal rotation velocity. This suggests that the pressure mat alone may have the potential to predict important movements transients during locomotion that are otherwise difficult to measure using traditional methods.

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