INTRODUCTION.
The biomechanical mechanisms through which foot orthoses derive their clinical benefit are not clearly understood, although changes in some characteristics of rearfoot and knee kinematics and kinetics have been reported. We have found no reports of the effects of foot orthoses on the hip or pelvis. The purpose of this study was to describe the effects of medially wedged foot orthoses (MWO) and laterally wedged foot orthoses (LWO) on joint kinematics and moments, and ground reaction forces.

METHOD.
Fifteen subjects were recruited into this study (8 male). Each subject performed 10 gait cycles in each of three conditions: shod; shod with MWO; and shod with LWO, walking at a controlled cadence of 108 steps/minute and wore their own footwear. The MWO comprised a 3mm base with a 10° wedge under the medial aspect of the insole, and an arch filler. The LWO comprised a 3mm base with a 10° wedge under the lateral aspect of the insole.

Kinematic data were acquired using the Kadaba et al (1989) marker set and five infrared cameras. Following calculation of joint centres and a local co-ordinate system for each segment, rotations at the pelvis, hip, knee and rearfoot complex were calculated using Euler angles.

Kinetic data were collected using two Kistler force plates. Calculated segment masses, moments of inertia, and segment velocities and accelerations were combined with the positions of the joint centres and the kinetic data, to derive the three dimensional moments at the rearfoot complex, knee and hip using inverse dynamics.

Data for each subject was derived by averaging the ten gait cycles. Discrete parameters describing the key characteristics of the joint and ground reaction force data were derived from each subject’s data. The discrete data values were found to be suitable for parametric statistical testing, and were compared across the sample using standard paired t-tests (sig. level p< 0.05).

RESULTS.
The peaks in the transverse plane rearfoot complex motion and moment data were significantly affected by both orthoses (p<0.01) (Fig 1a). Changes in the knee kinematics were negligible (<1.3°). The peaks in the frontal and transverse plane knee moments were only affected by the MWO (p <0.009) (Fig 1b). All angular changes at the hip and pelvis were negligible (<1.2°) and hip moments were only minimally affected.

Both orthoses changed the initial peak in the lateral ground reaction force (Fig 1c) (p=0.001 in both cases) and the second peak of the medial ground reaction force (p< 0.02 for both).

DISCUSSION.
The greatest effect of the orthoses was on the rearfoot complex. The magnitude of the changes suggests that a wide range of structures within the foot will be affected by each orthosis, which may explain why such a wide range of foot pathology are successfully resolved using foot orthoses.
The minimal effect of the orthoses on knee kinematics is consistent with the conclusions of Lafortune et al (1994), although they studied running gait. However, their proposition that because the knee was not affected, compensation for the effects of the orthoses on the foot must occur at the hip is not supported by our results, since the effect on hip kinematics was also minimal. The increase in the knee varus moment with the MWO, may influence the distribution of load between the medial and lateral femoral-tibial compartments, and consequently the development of osteoarthritic changes.

If, as our results suggest, the kinematics of the pelvis, hip and knee are minimally affected by either orthosis, the question remains as to where within the limb the significant transverse plane angular changes at the rearfoot complex are referred. As opposed to producing significant changes in the kinematics of proximal joints, foot orthoses may act by altering the stresses within passive structures, or the action of musculature. Some muscular effects of foot orthoses have been reported (Nawoczenski and Ludewig 1999).

Changes in foot pronation/supination due to the orthoses would be expected to change the shock absorption capabilities of the foot. This perhaps explains the increase and decrease in the lateral force during the contact phase in the MWO and LWO conditions respectively (Fig 1c).

In conclusion, both the MWO and LWO had greatest effect on the kinematics and moments of the rearfoot complex, with some effects on the moments at the knee. The kinematics of the knee, hip and pelvis were minimally affected. It may be that the effects of foot orthoses that are extrinsic to the foot, occur in the passive and active soft tissues of the lower limb.

REFERENCES:

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