

# A MATHEMATICAL MODEL ANALYSING THE MOTION OF THE CALCANEUS FROM PRESSURE PLATE MEASUREMENTS

Friso Hagman<sup>1,2</sup>, Stef van Eijndhoven<sup>2</sup>, and Fons van de Ven<sup>2</sup>

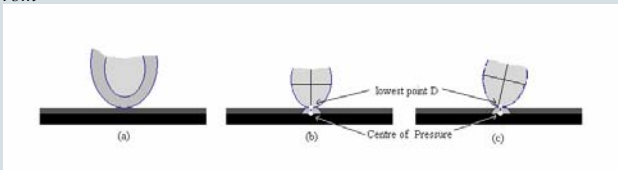
<sup>1</sup>Human Biometry and Biomechanics Laboratory; Brussel, <sup>2</sup>Applied Mathematics, Eindhoven

## INTRODUCTION

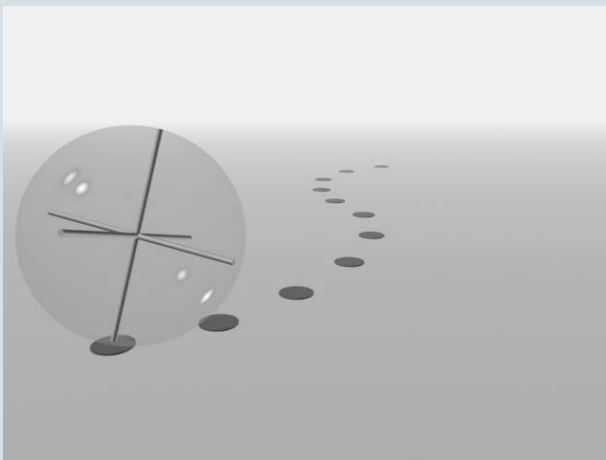
In the last decennia of the previous century, extensive studies on the lower extremity have been carried out based on data obtained from high-speed cinematography (review: McClay et al., 2000). From these studies, it has been concluded that excessive subtalar pronation is linked to running-related injuries, and that the eversion of the calcaneus is a reliable predictor of the amount of pronation. The present analysis of rearfoot motion is not based on cinematography, but instead on data obtained from a pressure measurement system. To accomplish this the pressure distribution should be linked to rearfoot motion according to a mathematical model. Thus, three-dimensional rearfoot kinematics can be simulated during heel contact.

## MODEL

From



To



Using

- assumptions about the interaction of the heel with the pressure plate,
- the model parameters: radius of the sphere and initial orientation,
- the model input variable: the centre of pressure path,
- a difference scheme of the fundamental law of kinematics,

Result

Simulation of the motion of the calcaneus.

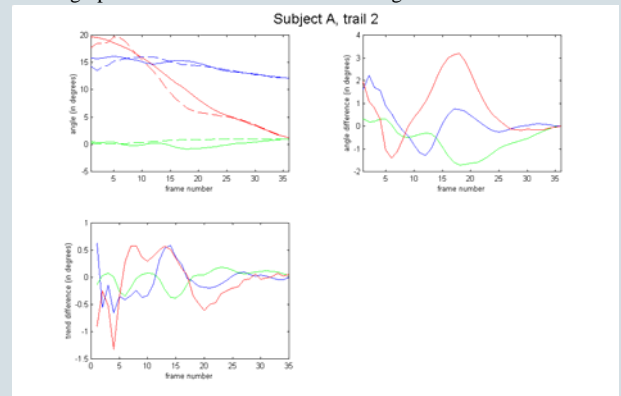
## VALIDATION

To validate the output of the mathematical model, Cardan angles describing the kinematics are calculated and compared with the corresponding Cardan angles obtained from cinematographical measurements.

The measurements set-up consists of six MCU240 cameras constructed by Qualisys, a footscan pressure plate of 200cm by 40cm constructed by RSscan International, a force plate of 200cm by 40cm constructed by Amti, and a 3D data box constructed by RSscan International. Five subjects were measured

Camera measurements were analysed with Move3D, a software package from the National Institutes for Health.

A typical comparison between simulated model motion and cinematographical measurements is found in figure 1



**Figure 1:** red is associated with dorsal flexion / plantar flexion, blue is associated with inversion / eversion, green is associated with abduction / adduction. In A, the solid curves denote the model curves and the dashed curves denote the cinematographical curves.

## CONCLUSION, STATE OF THE ART, AND FURTHER RESEARCH

- A kinematic model has been designed to simulate reliably the motion of the calcaneus from heel impact until forefoot contact. Input to the model is data from a pressure measurement system. The kinematic model uses the simplifying assumption that the surface geometry of the calcaneus is a sphere locally.
- The validation procedure is currently being extended
  - by including 60-70 subjects (both left and right feet, three trails each).
  - by including determination of the radius and the orientation of the sphere directly from the pressure measurement.
  - by including the complete heel contact time.
- The model is extended to forefoot motion

## REFERENCES

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