NUMERICAL INVESTIGATION OF HEEL-SHOE INTERACTION IN RUNNING

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INTRODUCTION: Human heel sensitivity to mechanical loading, which is associated with the strain/stress state around the sensory receptors, is an important body function for sport, exercise and other daily activities (Lake & Lafortune, 1998; Patritti, 2002). The sensory receptors within the heel transmit the mechanical signals (e.g. strains) into neural signals and enable human body to sense and adapt to changes of external loadings. To improve the understanding of the mechanics of this process, a realistic numerical model was developed in this work to establish quantitative relationships between the external loads and the state of stresses/strains at sensory receptor locations in running.

METHOD & RESULTS: A finite element (FE) model was developed to simulate the heel-shoe interaction and the strain distribution around the sensory receptors in running. The bone was modelled as a rigid body and a first order Ogden strain-energy function was used to describe the hyperelastic material behaviour of the soft tissues. A typical running shoe was sectioned and the measured dimensions of the insole, midsole and outsole were used in the FE model. Mechanical tests were conducted to characterise the insole and midsole to obtain the material properties. Using a parametric method, the dimensions and mechanical properties of the insole and midsole were systematically altered in the model and the effect on the strain/stress around the sensory receptors within the heel pad was analysed. The ratios of stiffness of the heel pad, the insole and the midsole of the shoe showed significant effect on the strain distribution (Figure 1).

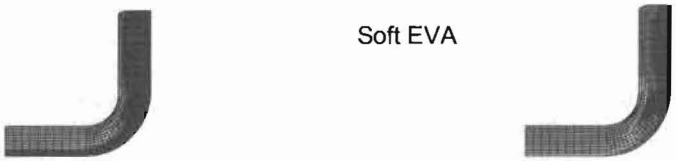

Figure 1 Effect of the midsole hardness on the strain distribution within the heal pad.

CONCLUSION: A parametric numerical model has been developed to simulate the heel-shoe interaction in running and the strain/stress around sensory receptors within the heel. The results suggest the human heel sensitivity to the impact loading in running is associated with ratios of the mechanical properties of the heel pad, the insole and the midsole.

REFERENCES:

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