

**BIOMECHANICAL AND ENERGY ANALYSIS
OF THE ISCHIAL CONTAINMENT
AND QUADRILATERAL SOCKETS
FOR THE TRANS-FEMORAL AMPUTEE**

by

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*For Misbah, Natasha
and their family and friends*

Dr Hall died tragically on 3rd January 1999. After the thesis had been reviewed by the examiners it was prepared for final submission by Mr DJ Maxwell and Dr MJ Dolan.

Prof. JP Paul

ABSTRACT

This longitudinal study aimed to investigate the biomechanics and energetics of four trans-femoral amputees walking on prostheses incorporating Quadrilateral (Quad) and Ischial containment (IC) sockets. A new 11-segment model of the body was developed to allow the calculation of three-dimensional inter-segmental joint forces, moments and power transfers. Metabolic energy measures of heart rate and oxygen consumption were also made.

A new procedure for calibrating force plates 'in situ' was developed and the resulting cross-sensitivity matrix allowed measured forces and moments to be predicted within 0.3% of the true value. Different models for predicting segmental mass properties were considered and were found to give widely differing values of these for the same subject. In stance the effect of this was negligible, but in swing they had a significant effect. Error analysis showed that inter-segmental moments could be calculated to within a range of accuracy 2.5 to 6.5%. A portable oxygen consumption measuring device was designed and constructed for the experiments. This was found to be accurate whilst allowing less restrictive metabolic energy measurement than standard techniques.

The gait of the amputees differed on the two sockets. Differences observed in measured parameters varied among amputees, indicating the individualistic nature of gait. Some general trends however were observed. On the IC, a greater self-selected velocity and cadence was seen. Some evidence for increased dynamic stability on the IC was also seen in the medio-lateral plane. Metabolic energy measures showed a decreased energy cost per unit distance walked on the IC socket. The results of the study point to a biomechanical and energetic favourability of the IC over the Quad socket.

Two of the amputees tested showed an interesting trend of lacking a moment tending to extend the sound hip in late stance. It was suggested that this is speed adaptive behaviour, resulting from a lack of power generation of the prosthetic side and a higher than normal push-off force.

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