INTRODUCTION

Optimized Magnetic Resonance Imaging (MRI) protocol is identified and successfully used to obtain the shape of the residual-limb. In a subsequent step MRI data of the residual limb are imported into Mimics medical imaging software. Utilizing Mimics digital CAD capabilities MRI slices are transformed into three-dimensional volumetric geometry representing major tissues, i.e. bone, tendon, muscle and fat. This research provides the detailed framework required to perform Finite Element Analysis (FEA) to simulate residual limb prosthetic socket interaction. Patient-specific requirement of the analysis entailed two major challenges, namely, its repeatability and general applicability. Therefore, the FEA is designed based on the principals of computational anatomy in order to attain these requirements.

METHOD

Subjects: The analysis framework is universal and need not to be adapted to a sub-class of trans-tibial amputees.

Apparatus: Three commercial software packages are involved, namely Mimics and 3matic medical CAD by Materialise and Abaqus FEA.

Procedures: Import anatomical entities into Abaqus FEA software from medical CAD. Identify material models to be assigned to different tissue type and create contact behaviour between the residual limb and the prosthetic socket.

Data Analysis: Pressure distribution over the residual limb is captured and used to identify (1) the goodness of fit or degree of comfort for the wearer, and (2) further rectifications needed to optimize the socket shape.

RESULTS

Pressure distributions are obtained over the gel liner and the skin (residual limb). The essential pressure distribution being the one over the skin is optimized to minimize/eliminate excessive pressure points, i.e. maintain a uniform pressure distribution over the skin.

Comparison of the pressure distribution, anterior view, over the gel liner and the skin (Figure 1) is used to optimize the Patellar Tendon Bearing (PTB) pressure. Similarly the pressure distributions in the posterior view (Figure 2) are for used to optimize the pressure distribution over the fibula’s head.

DISCUSSION & CONCLUSION

Pressure distribution predicted by the current FEA framework has proven to be an effective parameter to optimize socket shape. The current technique mainly depends on attaining uniform pressure distribution through socket rectifications. Future work will incorporate design factors such the threshold of pain combined with pressure measurement instrumented socket.

REFERENCES