**Static Measures of Prosthetic Shoe Materials for Transtibial Amputees**

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**BACKGROUND/OBJECTIVES:** Patients with lower limb transtibial amputations frequently report lower limb and back pain with the use of prosthetic devices. The increased transient forces produced by the prosthetic device during walking puts these patients at a high risk of developing degenerative joint conditions in the knees, hips, and lower back. Commercially available shock-absorbing insoles show promising evidence in reducing these forces; however, they are not currently recommended for transtibial amputees due to the high degree of compression leading to feelings of instability. This concern highlights the need for innovative, low-cost solutions to improve the functional outcomes of passive prosthetic devices by mitigating pain and the risk of injury. Thermoplastic polyurethane (TPU) material shows a promising use as insole or heel material for this population due to its shock-absorbing capabilities. The purpose of this research was to analyze the material properties of TPU and conventional prosthetic shoe materials by statically testing the energy absorption capabilities of each material.

**METHOD:** Several materials underwent static compression testing using a Chatillon force tester and AMTI force plates to analyze the energy absorption capabilities. The samples tested included TPU material arranged to form a heel lift or thin insole, a conventional prosthetic heel lift, and each heel lift type (TPU or conventional) combined with a foam insole commonly used with prosthetic heel lifts. The samples were compressed for 15 trials at a speed of 25 mm per minute to ensure that the testing could be considered static, and the force tester was modified to allow the materials to be compressed at a 30° angle, resulting in both compressive and shear forces being applied. The compression, shear, and total energy absorption was found for each material tested and the means of each were compared.

**RESULTS:** When comparing the conventional heel lift with the TPU heel lift, the TPU heel lift absorbed the highest meant percent of shear (M=37.8%), compressive (M=54.6%) and total (M=48.2%) energy (see Figure 1). When comparing the conventional heel lift combined with a foam insole and the conventional heel lift combined with a TPU insole, the conventional heel with the TPU insole absorbed the highest mean percent of shear (M=27.2%), compressive (M=35.7%) and total (M=32.4%) energy (see Figure 2). When comparing the conventional heel lift combined with a foam insole and the TPU heel lift combined with a foam insole, the TPU heel with the foam insole absorbed the highest mean percent of shear (M=26.1%), compressive (M=32.3%) and total (M=30.1%) energy (see Figure 3).

*Figure 1.* Mean energy absorption for a TPU heel versus a conventional heel

*Figure 2.* Mean (%) energy absorption for a conventional heel with a conventional insole versus a conventional heel with a TPU insole

*Figure 3.* Mean (%) energy absorption for a conventional heel with a conventional insole versus a TPU heel combined with a conventional insole

**CONCLUSION:** The results of this preliminary research show that the TPU material has the potential to replace either a conventional heel lift or conventional foam insole that are commonly used by amputees with their prosthetic devices. More specifically, this outcome highlights the potential use of the TPU material for future research with humans to examine its capability to absorb energy and attenuate transient forces in amputee populations to decrease the risk of injury without disrupting their gait mechanics. This information will allow clinicians to provide solutions for transtibial amputees that are low cost and improve their walking symmetry.