TACSM Abstract

A Method of Altering Coronal Plane Prosthetic Foot Stiffness for Studying its Effect on Amputee Gait

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Category: Masters

ABSTRACT

In an effort to understand the effects of prosthetic foot stiffness on amputee gait and mobility, it is useful to produce prototype prosthetic feet that differ in stiffness. While many commercial prosthetic feet are made out of carbon fiber, the manufacturing process is ill-suited to design experimentation as it is expensive, time consuming and requires tooling modifications to produce design changes. In order to facilitate a study of the effects of coronal plane prosthetic foot stiffness on amputee maneuvering gait, we are manufacturing custom prosthetic feet using a form of additive manufacturing, selective laser sintering (SLS), that was developed at the University of Texas at Austin [1]. We have previously used SLS technology to create functional transtibial prosthetic sockets, ankle-foot orthoses, and prosthetic foot prototypes [2-5]. To manufacture prosthetic feet with different stiffnesses, we first measured the stiffness profile of a commercially available carbon fiber prosthetic foot on an Instron 3345 (Norwood, MA) in two configurations where the foot was loaded to 114 kg in foot flat at 0° eversion and toe-only at 5° eversion positions. A computer aided design model of an SLS prosthetic foot was developed and adjusted to match the stiffness profile of the carbon fiber foot. Finite element analysis (SolidWorks Corp.; Waltham, MA) was then used to verify that the desired stiffness level was achieved. This process was repeated to create three prosthetic feet with altered coronal plane stiffness profiles (25% greater, 50% greater, and 25% less) while sagittal stiffness was held constant. The prototype feet were fabricated using selective laser sintering in a Vanguard HiQ/HS SLS Machine (3D Systems Corp.; Rock Hill, SC). Finally, the feet were mechanically tested in the same configurations as the carbon fiber foot to confirm that they had the desired stiffness profiles. Prototype feet closely matched the sagittal stiffness of the chosen prosthetic foot while coronal plane stiffnesses were approximately the same, 30% greater and 30% less than the carbon fiber foot. Future work will be to use these feet to observe the influence of coronal plane stiffness on amputee gait.