The Effect of Systematically Varying the Prosthetic Foot Keel and Ankle Joint Stiffness on Standing and Walking in Persons with Unilateral Transtibial Amputations

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ABSTRACT

One of the main objectives for the prosthesis fitting process is to provide the amputee with the optimal configuration that would produce the best possible long-term rehabilitation outcome. It is desirable to provide prosthetic users with components that can replicate the functional capabilities of their anatomical counterparts. For transtibial prosthetic users, two critical components are the foot keel and ankle joint. The anatomical foot-ankle complex performs a significant role for walking and standing performance on able-bodied individuals. Consequently, it is reasonable to think that the variation of the mechanical properties of the prosthetic feet could influence the outcome.

In the present study, we address the question of how systemically varying the prosthetic foot keel stiffness and prosthetic ankle joint stiffness affects standing and walking in persons with unilateral, transtibial amputations. To accomplish this, we performed a gait analysis and quiet standing evaluations where five different combinations of foot-ankle stiffness were tested and among them an optimal condition was identified.

Results of the gait analysis suggested that the highest stiffness condition best replicated the anatomical ankle range of motion and ankle-foot Roll-over Shape (ROS) radius of able-bodied individuals, thus enabling smoother forward progression between the prosthetic side and sound side and offering greater stability during prosthetic stance phase. Results of quiet standing evaluations also pointed to the high stiffness condition as optimal for standing. The results also showed the influence of walking speed on the geometry of ROS.