

## **Kinematic Effects of Sloped Surfaces on Shank Angle for Persons with Drop Foot**

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### **Abstract**

Functional Electrical Stimulation (FES) was introduced in 1961 by Liberson as an alternative to the Ankle Foot Orthosis (AFO) for treating drop foot. The common peroneal nerve can be stimulated to create dorsiflexion in the swing phase of walking and allow toe clearance of the affected limb. The most difficult aspect of this concept for functional use has been the control of stimulation timing. Dai introduced the concept of incorporating a tilt sensor in 1996. The tilt sensor can be calibrated so that a stimulation of the peroneal nerve will occur when the shank angle has reached its most positive value, which occurs at toe off. The stimulation can be reliably attained in this way if the shank angle at toe off is relatively consistent. On a flat surface, this has proven to work well (Stein 2006, Kim 2004, Weiler 1999) in devices with tilt sensors, such as the Walk Aide (Innovative Neurotronics). This study will examine the impact of a sloped surface on the shank angle and therefore on the reliability of the tilt sensor for stimulation control. If this maximum shank angle is reduced on an inclined or declined surface, a stimulation may not occur based on the tilt sensor input. The hypothesis is that a significant difference will exist between shank angle at toe off on inclined and declined surfaces when compared to the shank angle at toe off on a flat surface. Seven subjects were recruited from the Atlanta area who have unilateral drop foot and currently utilize a Walk Aide device. Shank angle at toe off was measured for each subject on three different surfaces using kinematic data from the Vicon motion analysis system. The three surfaces were flat, a 4.8 degree ramp, and a 9.6 degree ramp. Results indicate that the shank angle at toe off was significantly lower when walking up both ramps compared to the shank angle at toe off on the flat surface ( $p < 0.05$ ). No significant differences were found when walking down the ramps. When wearing the Walk Aide, preliminary observations indicate that a stimulation is less likely to occur on the inclined surfaces when compared to the flat or declined surfaces.

### **References**

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