UPDATE ON AN ANKLE-FOOT PROSTHESIS THAT SELF-ALIGNS TO SLOPED SURFACES
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INTRODUCTION
Lower limb systems of able-bodied humans adapt for walking on different surface slopes. Lower limb roll-over shapes are “dorsiflexed” for uphill slopes and “plantarflexed” for downhill slopes, suggesting that a prosthetic component could improve gait on slopes by self-aligning for the user (Hansen et al., 2004a). The anatomical ankle also displays a torque versus angle characteristic for normal walking speeds (~1.2 m/s) that could be mimicked using two sets of springs (Hansen et al, 2004b). Based on this information, Williams et al (2009) developed a working prototype of a prosthetic ankle-foot system that could adapt to different surface slopes without the use of motors or batteries (see Figure 1A). The purpose of this abstract is to provide an update on this project including changes that have been made to the design to make it more clinically and commercially viable.

INITIAL PROTOTYPE
Persons using the initial prototype displayed ankle torque versus ankle angle curves that shifted toward dorsiflexion for uphill walking and toward plantarflexion for downhill walking, suggesting an adaptation to the surface slope (Williams et al, 2009). However, the initial prototype had problems that required a redesign, including:
(1) The weight activation system was composed of a plate that telescoped on four bolts. This system was not durable or rotationally stable.
(2) The cam-locking system included two knurled surfaces that could grip, but that also created a loud clicking noise and wear during unlocking.
(3) The neutralizing elements (dark blue in Figure 1A) were positioned laterally to the cam locking component, causing a large width for the device.

REVISED PROTOTYPE
The telescoping weight-activation system for the initial prototype was replaced by a simple hinge mechanism in the revised prototype (see Figure 1B). The cam surfaces in the revised prototype are currently made of non-knurled D2 tool steel. Also, the larger cam of the initial design was changed to a ring to reduce weight and height of the revised prototype. The neutralizing element (light blue block in Figure 1B) was moved to a position posterior to the cam locking system, creating a narrower design. The stiffer triceps surae spring element in the initial prototype has now been replaced by a flexible foot plate. The entire revised design now fits inside a College Park Venture foot shell (see inset in Figure 1B). The revised prosthetic ankle-foot prototype is currently being tested.

This design has the potential to automatically adapt to surface slopes on every step of walking. The design should also provide late stance plantarflexion followed by dorsiflexion of the ankle in early swing phase after the cam-locking system releases.

REFERENCES

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