An alternative surgical architecture to broaden accessibility of the Agonist-antagonist Myoneural Interface (AMI)

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Background and Motivation

The AMI has emerged as a methodology to reflect proprioceptive sensations of joint position, speed, and force from a neurally controlled prosthesis onto the nervous system. It is designed on the principle that native physiological mechanotransducers provide the best means of communicating proprioceptive information from a prosthesis to the nervous system. The fundamental AMI paradigm is shown above. One AMI is surgically constructed in the residuum for each prosthetic joint, by 1) rerouting native musculature, 2) connecting neurovascular island flaps, or 3) creating free muscle grafts.

Agonist-antagonist Myoneural Interface (AMI)

Methods

Alloderm as a Pulley

In a large goat model, one AMI was created at the time of primary transtibial amputation. The distal tendon of the medial gastrocnemius was passed through a rolled piece of Alloderm, and coapted to the distal tibialis cranialis. The Alloderm pulley was then sutured closed, and affixed directly to the surficial fascia via five sutures. Placement of the pulley was selected to preserve biological levels of tension in each muscle. Leads were routed percutaneously through a custom-designed, 3D printed port in the animal's back. Sonomicrometer crystals and intramuscular electrodes were placed within each muscle to measure fascicle strain, and electromyography, respectively.

Results

AMI Function

Sonomicrometry data showing stretch in the medial gastrocnemius during artificial stimulation of the tibialis cranialis. This antagonistic stretch is indicative of AMI excursion. Gray shading shows that stimulation is on (9mA, 400us, 30Hz).

Conclusion and Future Directions

These findings demonstrate that Alloderm may be used as a substitute for tarsal tunnels in the construction of native AMIs. This new architecture has the potential to broaden the patient population that would benefit from the AMI to include those with limited availability of distal tissues, including persons who have already undergone amputation.