An Implantable Actuator for Musculotendon Force Assistance in a Bipedal Animal Model

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Abstract: Mobility, a key metric for quality of life, is often rehabilitated by using basic aids (e.g. walkers). Even complex solutions such as exoskeletons are difficult and cumbersome to use every day for mobility-impaired individuals which often leads to underuse [1]. Here, using a bipedal animal model (Numida meleagris), we present a concept for a fully implantable assistive limb actuator that can provide assistive torque at the ankle and reduce muscular demand at no additional energy cost. We emulate the in vivo mechanics of isometrically functioning leg muscles that use tendons to store and release mechanical power [2], similar to the externally worn synthetic Achilles tendon used to reduce metabolic costs in humans [3]. We have developed a variable length actuator based on the concept of 'strutlike' biological muscle function (measuring 9 x 30 mm) that can be fully implanted within the leg via a bone anchor and tendon fixation, replacing the lateral gastrocnemius muscle. The actuator can generate isometric forces similar to the in vivo forces of the native muscle during gait ($\sim$ 40N). The stroke characteristics permits rapid clutching (disengaging when needed) and a tunable slack length to modulate the timing and level of assistive force during gait. Surgical viability has been established using survival surgeries (n = 3), which show no signs of device rejection.

References

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