

Selection of an Optimal Muscle Set for a 16-Channel Standing Functional Electrical Stimulation System

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Abstract

The CWRU/VA 8-channel standing neuroprosthesis can restore standing to selected individuals with paraplegia by application of functional electrical stimulation (FES) to the otherwise paralyzed hip, knee, and trunk extensor muscles [1][2]. However, due to the limited number of available stimulation channels and an open-loop control scheme, users are required to provide upper body effort to stabilize themselves and maintain balance. The second generation of this system will include an additional 8 channels of stimulation and a feedback control system to provide automatic postural corrections, with the intention of reducing the upper body requirements. This study utilized a musculoskeletal model of the legs and trunk to determine which muscles to target with the new system in order to maximize the range of postures that can be statically maintained, both in the coronal and sagittal planes. The results show that the semimembranosus, gluteus medius, and adductor magnus are the primary hip muscles required for postures in the coronal plane, with the gluteus maximus and rectus femoris also generating significant moments. In forward leaning postures, the plantarflexors, primarily the medial gastrocnemius, generate the required moments at the ankle and assist in preventing hyperextension at the knee. In backward leaning postures, the vastus intermedius provides the largest contribution to knee extension moment.

References

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- [2] Triolo RJ, Bieri C, Uhlir J, *et al.* Implanted functional neuromuscular stimulation systems for individuals with cervical spinal cord injuries: clinical case report *Arch. Phys. Med. Rehab.*, 77: 1119-1128, 1996.

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