Title: Positive force feedback may ameliorate muscle weakness

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Abstract: Functional electrical stimulation has been used to activate weakened or paralyzed muscles during locomotion using kinematic signals to control the stimulator. Evidence for the effectiveness of positive force feedback from Golgi tendon organs in load-bearing tasks such as locomotion (Prochazka et al, 1997, J. Neurophysiol 77: 3226) suggested to us that an engineered feedback controlled stimulation system could be used to increase muscle force in patients with muscle weakness. By amplifying the weak signals recorded by the muscle, the time course of muscle activation could be determined voluntarily. We tested this approach using the unanesthetized decerebrate cat preparation by recording muscular force during muscle stretch. The force signal was then fed back to electrically stimulate the muscle through intramuscular electrodes and increase force output over that due to the stretch reflex. Stretches and releases of the medial gastrocnemius muscle were imposed by a linear motor and used to initiate and terminate the electrical stimulation of the muscle, respectively. Thresholds and gains of the feedback could be selected in the computer interface and were varied to determine the limits of the system's stability in order to controllably activate the muscle. It was found that intramuscular stimulation remained stable through a wide range of these parameters. During stable behavior, the stimulation terminated when the muscle was returned to its original length. At higher gains and lower thresholds than within the stable range, stimulation outlasted the return to the starting length, causing an undesirably prolonged muscle contraction. In a clinical setting, the feedback signal could be obtained from electromyographic recordings, and stimulation could be delivered by intramuscular or surface electrodes.

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Poster

231. Posture and Gait: Afferent Control

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