

Spinal Cord Microstimulation Boosts Voluntary Contractions

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Spinal cord microstimulation (SC μ stim) may help restore movement in people with spinal cord injury (SCI) [1]. We found previously that in cats implanted with SC μ stim electrodes, sensory input evoked by muscle stretch tends to reduce the activation threshold of muscles to SC μ stim [1]. We now report a related finding that may have important clinical implications. The basic observation was that electromyogram (EMG) responses in some muscles to SC μ stim pulses of constant intensity were enhanced when background activity in the muscles was elevated.

In 12 cats, 6 to 20 microwires (17–50 μ m dia., 30–100 μ m exposed tips) were chronically implanted in the spinal cord lumbar enlargement. EMG electrodes were implanted in key muscles of the hindlimb. Muscles were activated by delivering stimulus pulses (50–300 μ A, 2/s or 50/s) through the implanted electrodes. The stimulation was apparently completely painless, as evidenced by a lack of aversive reactions and an uninterrupted continuation of normal motor activities such as feeding, grooming or locomotion [1].

Testing was performed with the cats lying in the experimenter's lap, or standing quietly on a table surface. It was noticed in all cats that as stimulus amplitude was gradually increased, responses in muscles varied with background contractions and posture. We analyzed this systematically in 3 cats, by plotting the size of EMG responses to stimulus pulses set just above threshold for muscle activation in the resting animal. In 25 of 31 electrodes, responses significantly increased with increasing background EMG. One way of showing this clearly was to lower the cat to the

support surface and then to allow gradually increasing weight-bearing. In 6 electrodes there was no clear relationship between background EMG and SC μ stim-evoked responses [2].

Several mechanisms could account for the relationship between background EMG and SC μ stim response. Motoneurons depolarized by background drive would be closer to firing threshold and so would be more responsive to nearby SC μ stim. Interneurons contributing to the background drive would also be more excitable. Stimulation of sensory afferents with excitatory action on motoneurons could also contribute. Given that over half of the implanted electrodes evoked larger responses with increased background EMG and given that this significantly tensed the muscles, we speculate that if low-level, tonic stimulation were delivered through SC μ stim electrodes in people with incomplete SCI, their residual voluntary contractions could be boosted. In some cases this could significantly improve motor control. Similarly, boosting voluntary contractions may improve the outcome of spinal cord regeneration when this eventually succeeds in humans with SCI [2].

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REFERENCES

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