Novel Method for Wireless Ventral Epidural Functional Electrical Stimulation of the Rat Spinal Cord
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Disclosures

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Recovery of hand function is the number one priority for those living with cervical spinal cord injury.

While intraparenchymal spinal cord stimulation with penetrating electrodes has shown beneficial in several small animal models of cervical spinal cord injury, the negative aspects of spinal penetration (e.g. gliosis) obviate many potential benefits.

Furthermore, the need for tethering of implanted electrodes to external power and monitoring devices hinders training and normal animal behavior. We designed and tested a wireless, fully implantable spinal cord stimulator capable of eliciting focused motor activity in the upper limb over an extended period of time.

Methods

An amplifier, power source and radiofrequency (RF) antenna are contained within a sterile capsule implanted subcutaneously and attached to a surface electrode with 8 circular contacts.

Each contact may be independently selected for stimulation, and stimulation parameters may be wirelessly modified after implantation.

The electrodes are situated on thin, flexible PCB which can be threaded ventral to the spinal cord through a midthoracic laminectomy approach into the cervical spine with relative ease.

A) A fully implantable wireless ventral spinal stimulator  B) Diagram of the electrode tip and size  C) Schematic of wireless cervical stimulation in a rat
Evoked potential analysis of 5 rats undergoing stimulation revealed a maximal activation of:

- trapezius muscles (8.7 mV) at C3
- infraspinatus muscle (11.9 mV) at C6
- tricep (8.4 mV) at C7
- bicep (7.3 mV) at C6
- wrist flexors (11.3 mV) at C8
- wrist extensors (10.1 mV) at C6
- hand intrinsics (11.8 mV) at T1/C8.
This novel method of wireless, fully implantable ventral epidural cervical spinal cord stimulation has proven to be feasible in a rat model of chronic cervical spinal cord injury.

Future efforts will focus on establishing the device's suitability for long-term stimulation and evaluating the role of ventral surface stimulation on synaptic plasticity, stem cell integration and functional recovery in a rat model of chronic cervical spinal cord injury.
Summary Points

- We have developed and tested a novel method for performing epidural functional electrical stimulation in a rat model of spinal cord injury

- This method is wireless and thus allows the rat to move around the cage without the need for tethering

- Further research into the relationship between functional electrical stimulation and functional recovery in spinal cord injury is ongoing