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Evaluation of optimal electrode configurations for epidural spinal cord stimulation in cervical spinal cord injured rats

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HIGHLIGHTS

- Dorsal funiculi were injured at C4 spinal cord in adult female rats.
- Epidural stimulation electrodes were implanted chronically at C6 and C8.
- Potentials evoked in forelimb muscles by cervical spinal stimulation were examined.
- Evoked potentials were dependent on electrode configuration and current intensity.
- Evoked potentials are useful biomarkers to identify optimal stimulation parameters.

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ABSTRACT

Background: Epidural spinal cord stimulation is a promising technique for modulating the level of excitability and reactivation of dormant spinal neuronal circuits after spinal cord injury (SCI). We examined the ability of chronically implanted epidural stimulation electrodes within the cervical spinal cord to (1) directly elicit spinal motor evoked potentials (sMEPs) in forelimb muscles and (2) determine whether these sMEPs can serve as a biomarker of forelimb motor function after SCI.
New method: We implanted EMG electrodes in forelimb muscles and epidural stimulation electrodes at C6 and C8 in adult rats. After recovering from a dorsal funiculi crush (C4), rats were tested with different stimulation configurations and current intensities to elicit sMEPs and determined forelimb grip strength.
Results: sMEPs were evoked in all muscles tested and their characteristics were dependent on electrode configurations and current intensities. C6(−) stimulation elicited more robust sMEPs than stimulation at C8(−). Stimulating C6 and C8 simultaneously produced better muscle recruitment and higher grip strengths than stimulation at one site.
Comparison with existing method(s): Classical method to select the most optimal stimulation configuration is to empirically test each combination individually for every subject and relate to functional improvements. This approach is impractical, requiring extensively long experimental time to determine the more effective stimulation parameters. Our proposed method is fast and physiologically sound.
Conclusions: Results suggest that sMEPs from forelimb muscles can be useful biomarkers for identifying optimal parameters for epidural stimulation of the cervical spinal cord after SCI.

1. Introduction

Epidural electrical stimulation of the spinal cord, i.e., electrical enabling motor control (eEmc), is a promising therapy for the rehabilitation of sensorimotor function after spinal cord injury (SCI) (Edgerton and Roy, 2012; Alam and He, 2014; Dietz and Fouad,

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