High Frequency Spinal Cord Stimulation (HF-SCS) in a Sub-Acute Animal Model of Spinal Cord Injury (SCI)

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Introduction: In previous studies, HF-SCS applied at the T2 spinal level was shown to result in physiologic activation of the both the diaphragm and inspiratory intercostal muscles in C2 spinal sectioned dogs. While the bulbo-spinal fibers were cut, they likely survived given the short duration of the day long acute experiments and that the mechanism of inspiratory muscle activation may have involved stimulation of these fibers. Since these fibers would not be viable in patients with chronic ventilator dependent SCI.

Objective: To determine if HF-SCS is effective following degeneration of these fibers.

Material and Methods: In 2 anesthetized, C2 paralyzed, intubated and mechanically ventilated dogs, an electrode lead was positioned on the ventral epidural surface of the spinal cord at the T2 level to activate the inspiratory muscles. Animal temperature, end-tidal PCO_2 and oxygen saturation were continuously monitored. The effectiveness of HF-SCS in generating inspired volume (V) and negative airway pressures (P) was evaluated over a period of 5 days during which time the bulbo-spinal fibers would have degenerated. Since the effectiveness of HF-SCS may be adversely affected by deterioration in the condition of the animal, low frequency (50Hz) SCS (LF-SCS) was also performed and served as a control.

Results: All vital signs, oxygen saturation and end-tidal PCO_2 remained stable over the 5-day period. V and P also remained stable over the study period. For example, V and P were 771±25ml and 64±1cmH_2O with HF-SCS (3mA, 300Hz) during the initial and 674±59ml and 63±5cmH_2O and final 6 hours on day 5. Comparable values during LF-SCS (8mA, 50Hz) were 467±12ml and 48±1cmH_2O during the initial and 397±16ml and 40±1cmH_2O final 6 hours on day 5.

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Conclusions: Since V and P in response to HF-SCS remained stable over a 5-day period following which the bulbo-spinal fibers would have degenerated, the mechanism of HF-SCS does not depend upon the viability of these tracts. HF-SCS therefore may be a useful method to restore ventilation in ventilator dependent tetraplegics.

Keywords: High frequency spinal cord stimulation, animal model, spinal cord injury

Support: NIH-R01NS105785 and MetroHeath Foundation

Disclosure: Drs. DiMarco and Kowalski hold the U.S. patents for technology related to the content of this abstract: Respiratory Muscle Activation by Spinal Cord Stimulation (8,352,036)

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