Activation of the expiratory muscles via lower thoracic high frequency spinal cord stimulation (HF-SCS) in intact non-anesthetized animals.

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Introduction: Lower thoracic SCS been shown to restore an effective cough mechanism in subjects with complete spinal cord injury. Unfortunately, the high stimulus amplitude requirements and potential activation of pain fibers significantly limits this application in subjects with intact sensation. Recent studies have shown that the expiratory muscles can also be effectively activated via low stimulus currents (1mA) but with high stimulus frequencies (500Hz) in anesthetized animals.

Objective: To assess the response to HF-SCS, in intact, non-anesthetized animals (pigs).

Material and Methods: During an initial surgical procedure performed under sterile conditions, a stimulating disc electrode was placed on the dorsal surface of the spinal cord at the T9 level. 10-14 days post-operatively, electrical stimulation was applied 2-3 times a day to activate the expiratory muscles. While awake, expiratory muscle contraction was assessed during HF-SCS via abdominal muscle EMG and inductance plethysmography (IP) via bands positioned over the abdominal wall. Electrocardiogram and heart rate were also monitored. While anesthetized during a terminal procedure, airway pressure generation and abdominal movement were assessed.

Results: During HF-SCS in the awake state, there was marked movement of the abdominal wall as assessed by IP and electrical activation of the external oblique muscles, which was positively correlated with stimulus amplitude (correlation coefficients greater than 0.95 for both). HF-SCS was not associated with any changes in heart rate or vocalization. During a terminal procedure under general anesthesia, mean airway pressure generation during HF-SCS at 0.8, 1 and 1.5mA were 31±6, 46±2 and 65±2 cmH_2O respectively. The positive correlation between stimulus amplitude and excursion of the abdominal wall was not significantly different compared to the awake state.

Conclusions: HF-SCS applied to awake, non-anesthetized animals results in contraction of the abdominal muscles similar to that observed in anesthetized animals. The lack of changes in heart rate and vocalization suggests that HF-SCS was well tolerated and not painful. Lower thoracic HF-SCS may be a useful method to restore an effective cough in patients with intact sensation.

Keywords: Expiratory muscles, spinal cord stimulation, animal, non-anesthetized animals

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