Comparison of Active Stimulating Electrodes of Sacral Neuromodulation

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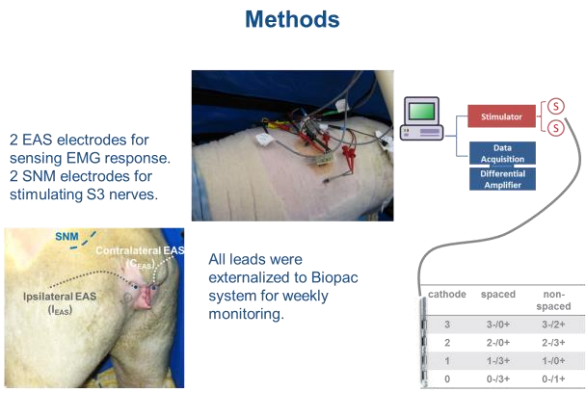
Hypothesis / aims of study: The programming of sacral neuromodulation (SNM) therapy, assigning one contact of the quadripolar electrode as cathode (-) and one as anode (+), is done manually and repeatedly to ensure the accuracy of stimulation location and intensity. In this preclinical study, we have compared motor response threshold and myotome response to SNM with different pairs of stimulating electrodes. Data from this preclinical work suggest that there are several principles that may be referenced to simplify and expedite the programing process in clinical practice.

Study design, materials and methods:
Stimulation leads were implanted bilaterally at S3. Two sensing electrodes were implanted into the external anal sphincter (EAS) at the 3 and 9 o'clock positions. Post implantation, weekly monitors were initiated, consisting of variable intensity stimulation (0-10V, 10 Hz, 210 µs pulse width) unilaterally delivered with a Biopac. Four responding zones were assigned as P (the perineum, tail, or bellows), G (gluteal region), T (thigh region), and F (femoral region).



Results:

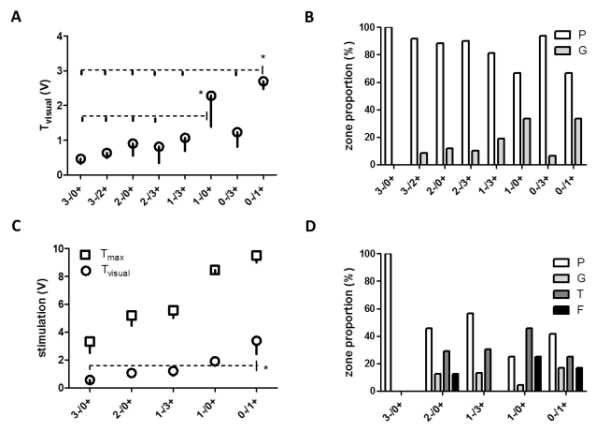


Figure 1. Visual motor responses in anesthetized condition (A, B) and conscious condition (C, D). A and C. Summary of the visual threshold to trigger motor responses (T_{visual}). The significance of differences between tests was demonstrated by repeated test. n=6, * p<0.05, ANOVA, Bonferroni post test. B and D. Histogram of myotome zone distribution to different configurations of nerve stimulation.

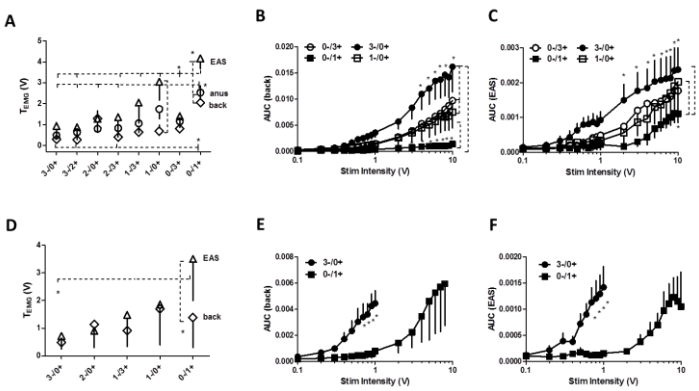


Figure 2. EMG activities sensed from contralateral tined quadripolar (back), ipsilateral external sphincter (EAS), and/or the anus using anal sensor in anesthetized condition (A, B, C) and conscious condition (D, E, F). A and D. Summary of the threshold to trigger EMG signals (T_{EMG}). n=6, * p<0.05, ANOVA, Bonferroni post test. B, C, E, and F. Summary data of stimulus-response functions of increased EMG activities (area under the curve, AUC) from contralateral tined quadripolar (back, B, E) and ipsilateral external sphincter (EAS, C, F) to different configurations of electrical stimulation (10 Hz) to graded intensity of the sacral neuromodulation. n=6, * p<0.05, ANOVA, Bonferroni post test.

Concluding message: Comparing motor response threshold and myotome recruitment to SNM with different pairs of stimulating electrodes, there was significantly lower voltage required to evoke an EMG response when stimulating with 3-/0+ versus 0-/1+ and electrode 3 always triggered contractions at perineal area, an "on-target" response. In contrast, electrode 1 or 0 stimulations most likely trigger "off-target" responses. Future studies are needed, however, to determine if the therapeutic efficacy of SNM is associated with electrode pair combinations.

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