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Selective neural activation by field sculpting: results from a new computer model for spinal cord stimulation

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Background

Technical advancement in computational models can provide not only theoretical tools to improve understanding of the mechanism of electrical stimulation, but also evaluations of new stimulation technologies, such as novel electrode designs, optimal polarity configurations, and stimulation pulse waveforms for neurostimulators.

We report on our development and use of a new computer model [1] to study the effect of various electrode configurations on activation of dorsal column (DC) and dorsal root (DR) neurons in spinal cord stimulation (SCS).

Method

A volume conductor model of a low-thoracic spinal cord with single and multiple epidurally-positioned cylindrical percutaneous leads was created using the finite element model tool ANSYS from which the electric field was calculated. The electric field results were then coupled with the NEURON simulator to determine the activated region of spinal cord DC and DR fibers [2]. DC and DR fiber models were adopted from double-cable axon model [3] with various fiber sizes (5.7–15 um diameter).

Using the model, we studied the capability to "sculpt" the electric field using constant current pulse delivery fractionalized across various contacts from multiple leads.

Results

In a longitudinal tripolar configuration (anodes placed rostro-caudally around a cathode), a single percutaneous lead on midline had deeper penetration of DC fibers than similar polarity configurations on multiple leads. In contrast, dual leads had mediolateral steering capability to selectively stimulate left vs. right DC fibers. For three leads placed in a symmetric, parallel mediolateral arrangement, anodes can be placed laterally to the cathode with a variable anode-cathode separation and still prevent DR fibers from being stimulated by cathode.

Conclusion

Our computational model was able to quantify and provide visualizations of the volumes of activated spinal cord fibers for multiple lead orientations and contact polarities. The ability to determine the neural selectivity of a given electrode configuration and fractionalization of current can provide insight into the therapeutic possibilities of lead placement and programming in SCS.

References

1. Moffitt M, Bradley K, Pete D: **Incremental movement of the volume of activation in spinal cord stimulation via fractionalization of current between contacts.** *Neuromodulation* 2006, **9(1):**17.
2. Holsheimer J, Struijk J: **How do geometric factors influence epidural spinal cord stimulation?** *Stereotact Funct Neurosurg* 1991, **56:**234-249.
3. McIntyre CC, Richardson AG, Grill WM: **Modeling the excitability of mammalian nerve fibers: Influence of afterpotentials on the recovery cycle.** *J Neurophysiol* 2002, **87(2):**995-1006.