Modeling Vagal Nerve Compound Action Potential Parameters to Control Specific Nerve Fiber Pathways

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Neuromodulation of the peripheral nervous system has shown potential as an effective targeted therapy for conditions such as Parkinson's disease, chronic pain and gastroparesis. Stimulation of the vagus nerve is of particular interest since the nerve stretches from the brain to the colon, and parasympathetically controls nearly every organ in between. Thus, a detailed understanding of the vagus nerve morphologies and their stimulation parameters is vital to delivering effective neuromodulation therapy with predictable and reproducible outcomes. The primary goal of this project is to utilize a recently developed compound action potential (CAP) modeling tool to characterize the interplay between four key parameters for bipolar vagal nerve recordings: stimulus pulse shape, cuff length, conduction distance, and peak amplitude of the resulting CAP volley. Sample data from the model's optimization tool is shown in Figures 1-2 below, indicating that the optimal cuff length and conduction distance for maximizing the CAP peak amplitude from bipolar recordings in the vagal ventral gastric branch ranges from 1-4 mm and 0-2 mm, respectively. This data was collected from a CAP model that corresponds to particular subsets of nerve fibers within the vagus nerve that supply individual organs, in this case the ventral gastric branch of the stomach. Further research will break down this CAP feedback to identify individual vagal nerve fiber pathways and their effect on linked organs, ultimately helping create more functional and targeted stimulation therapies.

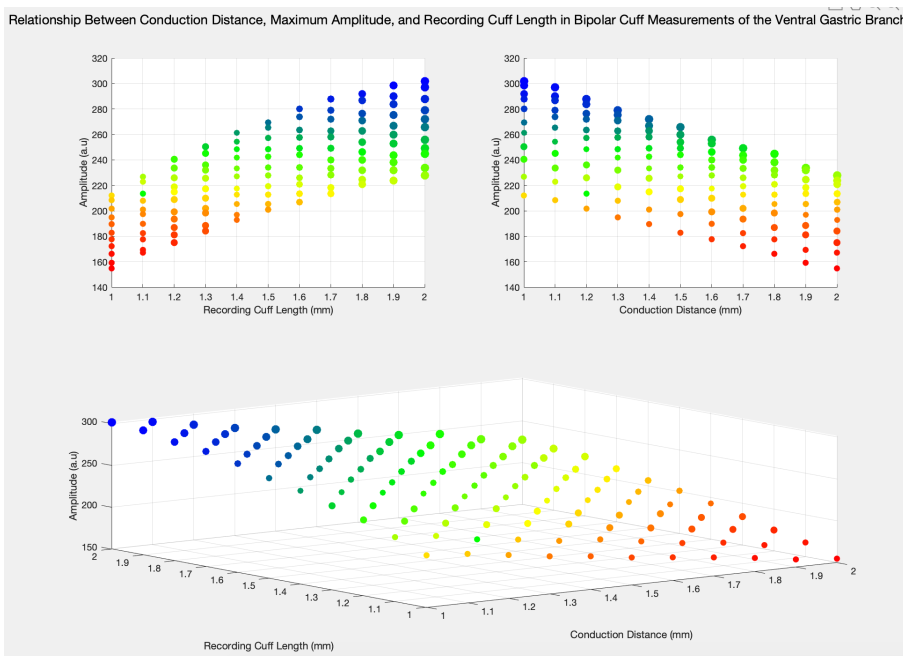

Figure 1. Relationship between bipolar recording cuff length and conduction distances ranging from 1-2 mm to peak amplitude of the resulting compound action potential. The color gradient from red to blue indicates increasing maximum peak-to-peak amplitude. Increasing marker size corresponds to increasing recording cuff length.

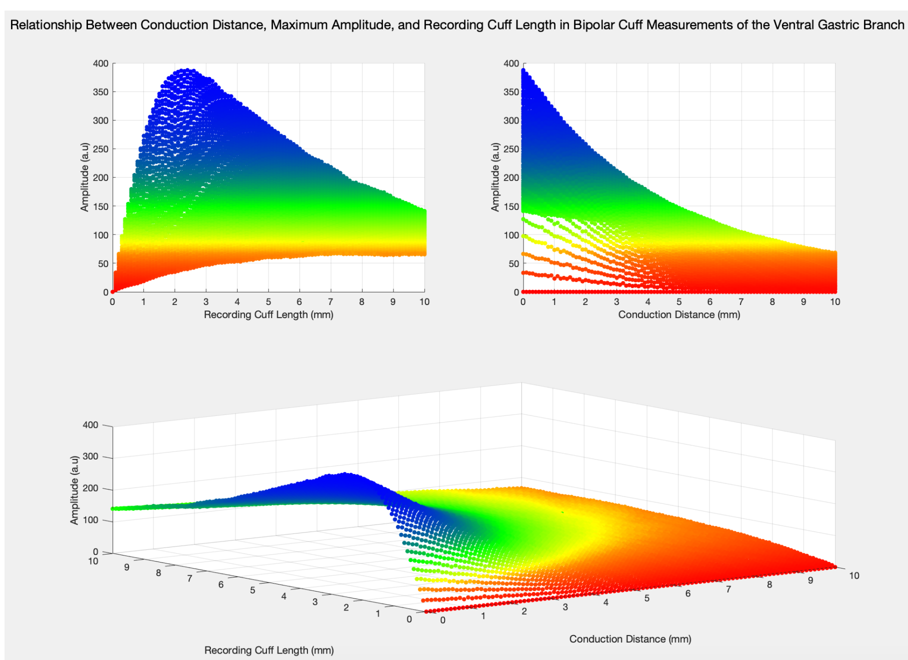

Figure 2. Relationship between bipolar recording cuff length and conduction distances ranging from 0-10 mm to peak amplitude of the resulting compound action potential. The color gradient from red to blue indicates increasing maximum peak-to-peak amplitude

References
1. Ward, M.P., Pelot, N.A., Biscola, N.P., Pena, E., Jaffey, D., Havton, L.A., Grill, W.M. and Powley, T.L. (2020), SPARC: A Hybrid Computational Approach to Classify Vagal C Fiber Functions. The FASEB Journal, 34: 1-1. https://doi.org/10.1096/fasebj.2020.34.s1.09657.

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