UNIVERSITY of HOUSTON | ENGINEERING

Department of Biomedical Engineering

Tuesday, December 8th, 2020

3:00 PM

Defense held online via Zoom

Nicholas C. Dias

PhD Dissertation Defense

Dr. Yingchun Zhang, Faculty Advisor

"Assessment of Pelvic Floor Dysfunction Using High Density Surface EMG"

Abstract

This dissertation aims to develop a reliable, non-invasive technique for assessing pelvic floor muscle (PFM) overactivity and determining patient-specific innervation zone (IZ) distributions. Existing techniques for evaluating PFM activity include magnetic resonance imaging, ultrasound, and digital palpation. All the previous techniques provide qualitative information about the length and pressure generated by the PFMs, but do not provide any information about the neuromuscular activity or the IZ. Digital palpation is completely subjective and relies on the examiner's experience. High density surface EMG provides a non-invasive, quantitative technique to assess muscle activity, yet has seldom been applied to the PFMs. In this dissertation, I aim to develop techniques to 1) map PFM hypertonicity at rest, and 2) help personalize treatment by guiding therapeutic neurotoxin towards the IZ. The goal of my PhD study is to noninvasively, objective and quantitatively assess the neuromuscular activity related to PFM dysfunction using a novel intravaginal high-density surface EMG probe. Surface interference EMG and decomposed MUAP information were used to elucidate PFM overactivity and define PFM IZ distributions. Specifically, in collaboration with Baylor College of Medicine I:

- Mapped hypertonicity severity in women with and without confirmed PFM hypertonicity
- Developed a novel IZ mapping technique that can guide the location and dosage of BoNT towards the hypertonic muscle.

In collaboration with Washington University School of Medicine I:

- Determined that a significant increase in normalized intravaginal EMG at rest in women with IC/BPS exists.
- Mapped patient specific IZ's in thirty women
- Mapped hypertonicity severity in women with IC/BPS and healthy controls.

The enhanced spatiotemporal information afforded by intravaginal HD-sEMG greatly enhances the ability to assess PFM activity in women. In this dissertation, I developed a novel hypertonicity mapping technique, and for the first time, mapped the spatial distribution of PFM hypertonicity in women with IC/BPS. Further, I developed a novel PFM IZ mapping technique, which can be used in the clinic to personalize the treatment of PFM hypertonicity. Finally, the developed techniques can be adapted to assess PFM activity in many pelvic floor dysfunctions, including stress urinary incontinence, fecal incontinence, and pudendal neuropathy.

Zoom ID: https://uofh.zoom.us/j/7065078826