2024 Multidisciplinary Research Program in Medicine Project*: Characterizing pudendal nerve function in adults with chronic spinal cord injury and able-bodied controls*

Hypothesis or Research Question(s): The objective of this research is to evaluate pudendal nerve function in adults with chronic spinal cord injury (SCI) and able-bodied controls. We will evaluate both the motor and sensory function of this nerve via pelvic floor muscle ultrasound and somatosensory evoked potentials assessments, respectively. We hypothesize individuals with SCI will demonstrate impaired pudendal nerve function after injury, and the degree of impairment will be associated both with the severity of their injury and symptoms of urogenital dysfunction.

PROJECT BACKGROUND & SUMMARY

The pudendal nerve is a mixed sensory and motor nerve that innervates key structures in the pelvis. Importantly, the pudendal nerve carries sensory information about the urogenital and bowel systems to the sensory centers in the brain, and carries motor commands from the movement centers of the brain to the pelvic floor muscles. A healthy pudendal nerve is crucial for proper urogenital and bowel function (e.g. urination, defecation, sexual arousal), and any impairments to this nerve can result in symptoms such as urinary/bowel incontinence, pelvic pain, or sexual dysfunctions.

Following a spinal cord injury, the pudendal nerve itself is typically uninjured, but it may have a diminished or a complete loss of communication with sensory and motor centres in the brain. This means that while the pudendal nerve can still collect sensory information, it is unable to transmit that information to the brain. Similarly, the brain can still attempt to send movement commands to the pudendal nerve, but these signals never arrive. We can assess the extent to which the pudendal nerve can communicate with the brain after injury by using two assessments: pudendal somatosensory evoked potential, and pelvic floor muscle ultrasound.

In pudendal nerve somatosensory evoked potential (SEP) assessments, a non-painful electrical current is applied on the skin over top of the pudendal nerve, and recordings are taken from the brain using electroencephalography (EEG). Information extracted from the EEG signals can inform clinicians and researchers if there is an impairment in the signals transmitted to the brain from the pudendal nerve. In pelvic floor muscle (PFM) ultrasound, we can place an ultrasound probe on the skin over the PFM and ask the participant to attempt to contract their muscles. Information extracted from the ultrasound images can inform clinicians and researchers if the person was able to move their PFM voluntarily, and which muscles were able to move.

Working with members of our laboratories, the students will be responsible for collecting and analyzing pudendal SEP recordings and PFM ultrasound images from a number of individuals with spinal cord injury and able-bodied controls. The questions addressed in this study are at the cross-roads of neurophysiological and clinical research. The SEP assessments will be supported by members of the Faculty of Medicine laboratory who have extensive experience in EEG and sensory assessments. The ultrasound component of this study will be supported by members of the non-Faculty of Medicine laboratory who have years of experience investigating pelvic floor muscle function. Both laboratories have a strong interest in spinal cord injury rehabilitation and are eager to work together to combine techniques from our fields to answer these questions. Moreover, our laboratories have a long-standing collaborative relationship and, together, bring the necessary equipment, techniques, and expertise required to execute this project.

BENEFIT TO THE STUDENTS

We are looking to take on 3 students who will be involved in all aspects of the research process. Prior to these students joining our laboratory, we will have completed UBC Clinical Research Ethics Board application and Vancouver Coastal Health Research Institute Operational Approval requirements so that the students can begin work on the project immediately. Senior laboratory members will train the students on how to conduct the SEP and ultrasound assessments using techniques and protocols that have already been established in our laboratories. The students will have ample time to practice these skills and using relevant equipment, including an electrical stimulator (DS7 Stimulator, Digitimer Ltd, UK), 32-channel electroencephalography (EEG) system (BrainVision, USA), and ultrasound system.

Two students will be responsible for collecting the SEP data from individuals with SCI and able-bodied controls. Based on our experience, this type of data collection requires two research team members. Both students will have support from the lab coordinators to recruit participants from pre-existing participant databases, and will have the opportunity to recruit more widely as well. While both students will collect the data simultaneously, the analysis will be divided between the students so they may each investigate unique elements of the data set. To this end, students will also be taught how to analyze these data to extract outcomes of interest (e.g. time from stimulation to response in brain; size of brain signals) using custom software (MATLAB, MathWorks, USA) and conduct basic statistical analyses. Finally, students will be expected to prepare scientific posters describing their project and results using a graphic design program (Adobe Illustrator, Adobe, USA).

One student will be responsible for collecting ultrasound data. This individual will work with the research team to further develop protocols related to PFM ultrasound and will first be asked to collect data from able-bodied controls. Once the techniques are established in control participants, they will have the opportunity to collect preliminary data from SCI participants. The student will have support from the lab coordinators to recruit participants from pre-existing participant databases, and will have the opportunity to recruit more widely as well. The student will be taught how to analyze these data to extract outcomes of interest (e.g. muscle thickness, urethral displacement) using custom software (MATLAB, MathWorks, USA) and relevant open source software. The student will also be instructed on conducting basic statistical analyses and will be expected to prepare a scientific poster describing their project and results using a graphic design program (Adobe Illustrator, Adobe, USA).

Through their involvement in all aspects of this research study, from data collection and analysis, to statistical analysis and results preparation and interpretation, the students will gain insight into the execution of high-quality research programs. The students will have the opportunity to work alongside a variety of laboratory members including laboratory managers, coordinators, undergraduate students, graduate students, postdoctoral fellows, principal investigators, physical therapists, and research technicians. They will also have regular, weekly contact with both faculty members involved in this project, and will be supervised day-to-day by the Postgraduate Student Advisor and other senior members of the laboratories as appropriate.

This project will provide students with a unique opportunity to engage with equipment and protocols that may otherwise only be accessible in specialized neurophysiological or clinical settings. The students will be interacting directly with research participants and will have the opportunity to develop skills around communication and knowledge translation. Students will also be exposed to basic data analysis and computer programming techniques to conduct these analyses, which may translate to other

practical future applications. While the students will always have the support of our laboratory personnel, we also expect the students will be able to independently conduct aspects of this research after enough practice, giving them professional development opportunities around leadership, critical thinking, and decision making.

The institution that houses our laboratories provides excellent professional development opportunities for students including monthly lectures from other students across a diverse range of faculties, regular 'lunch-and-learn' seminars, and frequent social events. The students involved in this project will not only be exposed to the research being conducted in our laboratories, but across many different departments at the university. We expect they will be able to interact and network with a variety of individuals including clinicians, primary investigators, research staff, and fellow students.

We expect that the results from these two projects will produce at least one peer-reviewed publication. There will be opportunities for the students to become co-authors on these publications/abstracts, as well as present their findings at local academic conferences.