Clinically-Feasible Ankle Proprioception Testing Apparatus

Proprioception is the sensation of body segment position and movement. This sensation is integral to coordinated human movement including basic functional tasks such as maintaining standing balance. While proprioceptive deficits may involve various regions of the body, the interest of this project is specific to the ankle, as impaired ankle proprioception has been associated with decreased function and increased risk of falling in populations such as those with diabetic peripheral neuropathy. The reliance on this sensory information for basic functional tasks motivates the need to be able to quantify an individual’s proprioceptive function in order to identify potential deficits and/or objectively document effects of interventions.

Several procedures exist for evaluating proprioception including a joint reposition task, where patients attempt to match a target ankle joint angle that they previously learned. The error in this task is taken as an estimate of proprioceptive ability in this case. Testing is done either blindfolded or with eyes closed and can be done upright, or laying supine. For this project, the intent is to develop a device that can be utilized as patients lay supine on a table.

Existing means to quantify proprioception utilize bulky, expensive equipment (e.g., Figure 1) or custom-developed testing setups (e.g., Figure 2) that typically lack the feasibility to incorporate into many clinical settings. Therefore, the deliverable for this project is a device that aims to meet these unmet needs and decrease the barrier for clinicians to objectively evaluate ankle proprioception in their clinics. Specifically, the device should:

1. Be comfortable for the patient and flexible to test either ankle (patient safety is a paramount design requirement)
2. Allow for active (patient controls ankle movement) and passive (device moves patient’s ankle) proprioception analyses
3. Quantify the error in patients’ ability to match a given ankle joint target position
4. Demonstrate validity in assessing ankle joint angular positions with documented accuracy specifications
5. Flexibility to allow for various ankle joint target positions
6. Allow for various angular velocity set points for movement speed during trials
7. Allow for patient input to indicate when they believe they have matched a given ankle joint set point
8. Be designed for clinical use (e.g., portable and able to be testing on a table top, easy to operate, etc.)
Figure 1. Biodex System 4 dynamometer. (http://www.biodex.com/physical-medicine/products/dynamometers/system-4-pro)

Figure 2. Custom-built research setup to evaluate ankle proprioception. (Deshpande, Nandini, et al. "Reliability and validity of ankle proprioceptive measures." *Archives of Physical Medicine and Rehabilitation* 84.6 (2003): 883-889.)