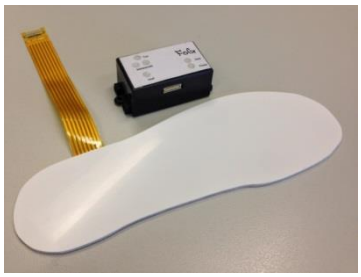
Author: Dr Wesley Thevathasan
Qualification: Neurologist, PhD
Institution: Royal Melbourne Hospital, Parkville, Victoria
Date: 12/09/2016

Title of Project: Improving Walking Disorders in Parkinson's Patients using Cueing

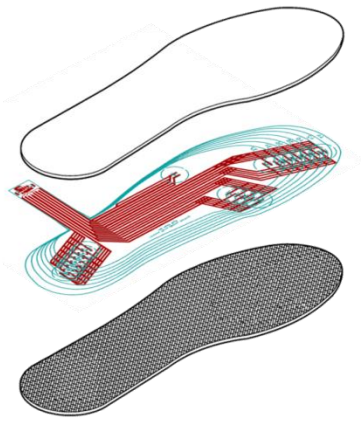
Freezing of gait (FoG) is a debilitating symptom of Parkinson's disease (PD) associated with a heightened risk of falls, which is a prevalent cause for morbidity and mortality. Individuals describe it as the feeling that their feet are glued to the ground leaving them frozen and unable to move their legs when trying to walk. These freezing episodes can last from a few seconds to several minutes. FoG is usually associated with reduced gait (walking) speed and step length. It occurs during gait initiation, turning or when encountering obstacles.

An estimated 10 million people worldwide are living with PD and the prevalence of FoG ranges between 20 and 60% of this population. It is an incapacitating motor symptom, as it significantly affects patients' quality of life and levels of activity. Total loss of movement can also leave patients wheelchair-bound. Furthermore, psychological conditions such as depression and anxiety are common in patients with FoG.

FoG is a progressive condition, and at its onset is usually treatable with oral medications. As the disease worsens, more invasive therapies such as deep brain stimulation (DBS) are required. However, DBS does not improve FoG in many patients and therefore a novel intervention is required to treat this disabling symptom. Previous studies have demonstrated that auditory, visual and vibratory cueing can improve the gait of PD patients. While visual cueing has been shown to take advantage of pre-marked step intervals, its effectiveness diminishes over time. Auditory feedback employs a metronome or verbal cueing, neither of which is practical for everyday use. Therefore, neither visual nor auditory cueing techniques are particularly practical for use in the community environment. Recently, more attention has been directed towards vibration as a treatment and intervention for reducing FoG severity.



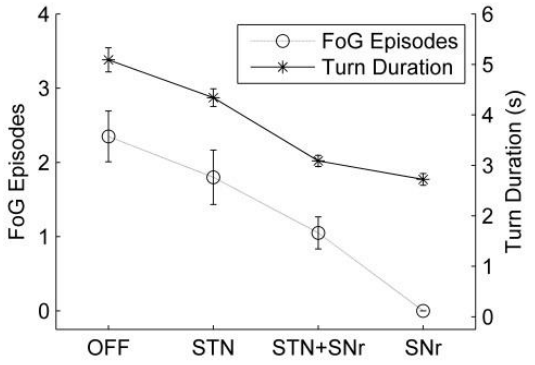
In our previous work, we used on-the-spot-turn task duration and cadence (steps per minute) as clinical measures of FoG severity. We believe these metrics provided more sensitivity compared to the standard and popular timed-up-and-go (TUG) test because straight line walking rarely provokes freezing. In the past, these measures were manually recorded using a stopwatch – a technique which gave inconsistent results.



Accurate and precise FoG assessment is crucial to guide effective treatment. Current clinical assessment involves subjective observation of patient gait during timed exercises in addition to self-reporting questionnaires, which are imprecise. Instrumented walkways and full-body motion tracking can improve precision and accuracy; however, these systems require a dedicated space, are not portable and the cost can be prohibitive to most clinics. To overcome these problems, a wireless instrumented shoe-insole was developed at the Bionics Institute.

Using our insoles to measure turn duration, we planned to compare the three cueing modalities (visual, auditory, vibratory) and determine which was most effective at reducing FoG severity.

Validation studies conducted during August 2015 showed promising results with the instrumented insoles being able to differentiate therapeutic states. We trialled DBS of two brain structures: subthalamic nucleus (STN) and substantia nigra reticulata (SNr). Unfortunately, our insoles were not robust and many failed due to stresses on mechanical components. We have spent the past year re-designing the system into an anklet-style wearable sensor.



The new hardware iteration is robust and removes the compounding limitation of footwear. We have received human research ethics committee approval to trial these sensors to detect FoG and investigate cueing as a therapeutic means. The clinical study is set to begin in December 2016. While unforeseen circumstances prevented us from completing the study as per the original timeline, we continue to make progress and will inform you of the study outcomes in the near future.