# Developing mathematical models to analyse postural stability data from Deep Brain Stimulation of the Pedunculopontine nucleus for treatment of Parkinson's disease

## Final Progress Report

The muscles in the upper body act to keep balance and prevent falls when standing or performing tasks such as walking. The brain receives information from the visual and vestibular (spatial orientation) systems about balance – then it commands the muscles to perform corrective actions. This process happens continuously without any forethought.

Sometimes the brain loses the ability to keep perfect balance (e.g. alcohol intoxication or neurological disorder). This causes the body to sway from side to side – the brain is too slow to respond to postural variations. The amount of sway can be used as a measure of postural stability. In our study, we did this by asking patients with Parkinson's disease to stand on a measurement platform for 30 seconds per trial. The recorded data were then analysed by computer algorithms to calculate sway distance and velocity.

We found that sway velocities increased in patients treated with Deep Brain Stimulation (DBS) of the Pedunculopontine nucleus (PPN), when compared to both healthy subjects and control subjects (who had Parkinson's but no DBS). This means that DBS therapy is helping to speed up the process of balance control and helping to improve postural stability. This is true when the patient is standing and maintaining balance, but in reality they would be faced with other day-to-day postural challenges.

Our research further examined dynamic postural stability: what happens when the patient is faced with an unexpected challenge? At present, this question is answered by using the *Neurophysiological Pull Test*. During the Pull Test, the neurologist pulls the patient backwards and subjectively grades the corrective response. In the worst-case scenario, the patient is unable to keep balance and falls backwards (the patient is caught to prevent injury). Unfortunately the subjective rating used in the Pull Test does not have enough sensitivity to show small changes in stability.

We plan to place electronic sensors on the patient to quantify the Pull Test response. We now have a custom-made hardware/software system that can measure the pull force, knee angle, muscle activity and upper body acceleration. Ethics approval was received recently to enrol suitable patients into this study.



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We plan on completing the study within the next six months and publish our findings from both the standing test and the pull test in a relevant medical journal. We will be presenting our interim results at the Asia-Pacific Centre for Neuromodulation DBS Symposium held on the 8th of November 2013. It is hoped that our in-house developed Pull Test response measurement system will be used in further studies that investigate postural stability in Parkinson's patients.

Furthermore, based on our findings, this system can be translated into routine clinical assessment to provided objective measures used for fine-tuning DBS parameters or dose of medications, thereby providing added benefits to patient's suffering from Parkinson's disease.

Dr Perera performing the neurophysiological pull test.