

# ESTIMATING CENTER OF PRESSURE AND CENTER OF MASS PATTERNS IN STROKE SUBJECTS DURING DAILY LIFE ACTIVITIES USING FORCE SENSING SHOES

Fokke B. van Meulen<sup>1\*</sup>, Jasper Reenalda<sup>1,2</sup>, Corien D.M. Nikamp<sup>1,2</sup> Jaap H. Buurke<sup>1,2</sup>  
Peter H. Veltink<sup>1</sup>

<sup>1</sup>University of Twente

Drienerlolaan 5, 7522 NB, Enschede, the Netherlands

<sup>2</sup>Roessingh Research and Development

Roessinghsbleekweg 33b, 7522 AH, Enschede, the Netherlands

e-mail: [f.b.vanmeulen@utwente.nl](mailto:f.b.vanmeulen@utwente.nl)

## ABSTRACT

### Background and aim

Stroke is associated with impaired balance control, which may decrease the performance of activities of daily living (ADL). Up till now, balance control often is assessed in the clinical setting using standardized clinical tests (like the Berg Balance Scale (BBS)) or using force plates in the laboratory setting. However, these tests provide limited information about the performance of stroke patients during ADL.

Recent developments in sensor technology enable the measurement of relevant balance parameters like center of pressure (CoP) and center of mass (CoM) using special shoes containing force sensors and inertial sensors. This way, balance parameters can be assessed while performing ADL without the restrictions of a lab environment.

The aim of this study is to evaluate CoP and CoM movement patterns in stroke patients, during activities of daily living while wearing instrumented shoes containing force sensors and inertial sensors.

### Methods

Currently, nine of a planned total of twenty individuals with a history of stroke have been included. Subjects walked in a straight line over 10 meters and performed a predefined ADL task while wearing the instrumented shoes. The ADL task was defined as a sequence of the following activities: sitting, rising up from a chair, walking to another room, opening a door, manipulating an object while standing and finally returning to the start position.

The instrumented shoes included two force sensors and two inertial sensors per shoe (ForceShoes™ - Xsens, Enschede, the Netherlands). The position of the CoP, relative to the position of both feet (in the frontal plane) was measured at a rate of 50 samples per second. The position of the CoM was estimated by low-pass filtering the CoP position at a cut-off frequency of 0.4 Hz.

### Results

The CoP patterns vary per individual and per task. During stance and walking in a straight line, individuals generally show a small shift of the mean CoP position and CoM position to their non-affected side. While performing the more difficult predefined ADL task, the mean CoP position and the CoM position shifts more towards the individual's non-affected side.

**Conclusion**

The use of force shoes enables the measurement of balance parameters during ADL tasks without being restricted to a laboratory environment. CoP and CoM movement patterns measured during ADL tasks can give more insight in balance control of individuals than current clinical tests or lab measurements with force plates. Results indicate that in more demanding tasks, the mean CoP and CoM position shifts more towards the non-affected side compared to walking in a straight line.

**ACKNOWLEDGEMENT**

This study is part of the INTERACTION project, which is partially funded by the European Commission under the 7th Framework Programme (FP7-ICT-2011-7-287351)