# POSTURAL RESPONSES TO DYNAMIC PERTURBATIONS IN TRANSTIBIAL AMPUTEE FALLERS VS. NON-FALLERS

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## INTRODUCTION

People who have had a transtibial amputation exhibit similar characteristics when compared with the elderly, such as muscle weakness and postural instability, that predispose them towards an increased risk of falling [1]. Computerized dynamic posturography (CDP) is an objective measure of postural control [2]. Previous research has found kinetic and joint power differences between amputee fallers and non-fallers during level walking [1]. However, it is unclear whether dynamic posturography could also be used to distinguish between these groups. The aim of the current study was to investigate whether CDP could be used to differentiate between amputee fallers and non-fallers and control fallers and non-fallers using the NeuroCom® Smart Equitest® system.

## METHODS

Nine transtibial amputees (mean ± SD: age 59 ± 14 yrs; height 172 ± 14 cm; mass 76 ± 16 kg), and nine age-matched controls (mean ± SD: age 61 ± 16 yrs; height 173 ± 14 cm; mass 80 ± 13 kg) took part in this study. All participants wore a safety harness that permitted postural sway beyond their limits of stability but prevented falling. Participants were classified according to their falls history in the previous 9 months.

Postural responses to dynamic perturbations were measured in the Sensory Organization Test (SOT) and Motor Control Test (MCT) using the Smart Equitest® system (NeuroCom International Inc., Clackamas, OR, USA). A dual force plate system measured vertical and shear forces at 100 Hz. Participants were instructed to stand upright, arms at their side, facing the visual surround and to maintain their balance throughout the tests. The SOT consisted of six conditions that measured postural sway in conditions with and without vision and with inaccurate visual and/or somatosensory input (equilibrium score). A score of 100 indicated perfect balance; a score of 0 indicated a loss of balance. The MCT measured automatic postural reactions (msec) in response to graded (medium and large) support surface translations (backwards and forwards).

In order to compare participants in different age groups, the values were normalized and expressed relative to Neurocom® normative age-matched data. Measured scores that were greater than the normative data were positive, whereas lower scores were negative. A One-way ANOVA, with the LSD post-hoc test, was used to determine if falls' history had an effect on postural variables ($p < 0.05$).

## RESULTS AND DISCUSSION

The equilibrium scores for the SOT were greater than the age-matched normative value for all the groups, indicating overall good balance (Table 1). In condition 6 (inaccurate visual and somatosensory input), the amputee fallers scored significantly higher than the non-fallers suggesting that the non-fallers may rely more heavily on visual cues even if they are inaccurate. No significant differences were found between the control fallers and non-fallers.

**Table 1**: Mean (±SD) SOT relative equilibrium scores and relative response latency (msec) of the intact limb (for amputee groups) to support surface translations in the MCT. * indicates significantly greater than amputee non-fallers

| SOT (score) | Amputee Non-Faller | Amputee Faller | Control Non-Faller | Control Faller |
|---|---|---|---|---|
| Condition 1 | 12 (12) | 9 (10) | 9 (8) | 17 (8) |
| Condition 2 | 14 (12) | 11 (8) | 12 (10) | 18 (10) |
| Condition 3 | 6 (3) | 9 (2) | 5 (5) | 6 (5) |
| Condition 4 | 13 (3) | 13 (7) | 13 (7) | 12 (7) |
| Condition 5 | 17 (2) | 25 (9) | 10 (6) | 17 (13) |
| Condition 6 | 25 (13) | *** 36 (13)** | 18 (9) | 14 (23) |
| Composite | 10 (3) | 15 (5) | 7 (2) | 7 (5) |
| **MCT (msec)** | | | | |
| Medium Backwards | 10 (14) | 12 (8) | 11 (8) | 14 (10) |
| Large Backwards | 10 (22) | 14 (11) | 6 (11) | 15 (18) |
| Medium Forwards | -3 (10) | 14 (5) | 20 (6) | 18 (23) |
| Large Forwards | 0 (8) | 16 (9) | 16 (16) | 11 (15) |

No one experienced a loss of balance during the MCT. No significant differences were found for medium and large relative latency scores in the backwards or forwards direction during the MCT. As evidenced by the large SD, variability of latency scores was high. In the majority of amputee participants, the prosthetic limb did not generate a sufficiently large active force response needed to measure latencies. The results suggest the MCT is not a suitable test to understand response latencies in transtibial amputees.

Weight symmetry results revealed that the amputee fallers bore significantly more weight through the prosthetic limb during all four translation conditions ($p < 0.05$). The findings suggest that the fallers were relying too heavily on the prosthetic limb to correct for postural disturbances during rapid, dynamic movements.

## CONCLUSIONS

Although the results were based on a small sample size, we have shown that the SOT and MCT on the NeuroCom® Equitest® may be population specific and therefore may not be suitable diagnostic tests for reliably identifying fallers among transtibial amputees. However, a loss of balance during the SOT and MCT may identify amputee and control fallers who have difficulty in performing more challenging postural and locomotor tasks, but who are otherwise independent.

## REFERENCES

1. Vanicek N, et al. *Gait Posture*. In press, 2008.
2. Wallmann HW. *J Gerontol*. **56A:** M580-3, 2001.