EFFECT OF WALKING POLES ON DYNAMIC GAIT STABILITY

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INTRODUCTION

Decreased balance is a major contributor to accidental falls in the elderly. Ninety percent of hip fractures are caused by these falls and 12% to 20% of the fractures are fatal (Carter et al., 2001).

Gait stability is affected by mechanical factors such as mass, size of the base of support (BOS) and the relative position of the center of mass (COM) to the boundary of the BOS. Age-related adaptations occur in walking to create a more stable, but less efficient walking pattern (Cromwell & Newton, 2004) due to diminished balance. Methods used to assess stability and/or balance include COM trajectory, BOS size, limits of stability (LOS), and gait stability ratio.

Falls can be prevented by improving balance and increasing stability. Although exercise can improve balance, physical weakness and fear of fall prevents the frail elderly from exercising. Assistive walking devices are often prescribed for these individuals to increase stability and to provide a sense of safety. Telescope-style walking poles (T-poles) (Yoon et al., 2005) are an assistive device intended to provide additional support and a wider BOS, thus increasing stability. The purpose of this study was to examine the effect of T-poles on dynamic gait stability parameters. It was hypothesized that T-poles would significantly alter gait stability parameters, increasing gait stability.

METHODS

A total of ten healthy elderly volunteers (65+ years old) participated in this study (5 male and 5 female; 67.1 ± 6.1 yrs.; 169.8 ± 7.4 cm; 78.2 ± 13.8 kg). All participants were required to enroll in a 2-month long pole walking program using telescope-style walking poles (Martin Van Breems, Inc., Norwalk, CT). The walking program consisted of mandatory weekly pole training sessions (1 hr/wk) and a minimum of 120-min/wk voluntary pole walking. Participants were tested at the end of the walking program.

Three-dimensional video motion analysis (DLT method) was performed to obtain the whole body COM position and the positions of the toe and heel markers. Hand drawn footprints marked with the locations of the toe and heel markers were videotaped and the contour was then digitized to obtain the real-life coordinates of the contour based on the 2-D DLT. In dynamic BOS computation, the heel and toe markers from the footprint were matched to the actual heel and toe marker positions at heel-strike and toe-off, respectively, obtained through motion analysis.

Participants performed gait trials in 4 different conditions: 2 pole conditions
(with/without poles) x 2 walking speeds (preferred and 15% faster). The COM trajectory was projected to the ground in computing dynamic gait stability parameters. The gait cycle was divided into phases based on the support types (normal walking: 4 phases, single to double supports; pole walking: 8 phases, double to quadruple supports) and the location of the COM with respect to the BOS (in-phase and out-phase). The computed stability parameters included max attainable BOS (MABOS), in-phase time (T), minimum COM distance to the closest inner edge of the MABOS during the in-phase ($D_{\text{min}}$), and maximum COM distance to the closest outer edge during the out-phase ($D_{\text{max}}$). In the MABOS computation, it was assumed that the entire foot is in contact with the ground in each phase.

Two-way (2 pole conditions x 2 speed conditions) RM ANOVA ($p < .05$) was performed for statistical analysis followed by post-hoc comparisons (Sidak adjustment), if necessary.

**RESULTS AND DISCUSSION**

Pole walking resulted in significantly larger mean MABOS than normal walking in both speed conditions (Table 1). T-poles also increased $D_{\text{min}}$ significantly with no effect on $D_{\text{max}}$. T significantly increased due to the use of the T-poles.

MABOS almost tripled on the average by the use of the T-poles. Pole walking was also characterized by an increased in-phase time. $D_{\text{min}}$ reflects the magnitude of the gravitational torque that helps maintaining the equilibrium during the in-phase, while $D_{\text{max}}$ reflects the magnitude of the gravitational torque that facilitates loss of equilibrium (forward motion of the COM) during the out-phase. T-poles increased $D_{\text{min}}$ while not affecting $D_{\text{max}}$.

**SUMMARY AND CONCLUSIONS**

The T-poles provided increased gait stability at both preferred and fast speeds in general by mainly increasing MABOS, T, and $D_{\text{min}}$.

**REFERENCES**


| Table 1. Comparison of the Dynamic Gait Stability Parameters (p < .05) |
|-------------------|-------|-------|-------|-------|-------|-------|-------|
| **Pole** | **Speed** | **Pole-Speed** |
|            | W/O | W | P | F | W/O-P | W/O-F | W-P | W-F |
| Mean MABOS (cm$^2$)$^1$ | M | 493.6 | 1,448.1 | 927.5 | 1,014.2 | 496.3 | 490.8 | 1,358.6* | 1,537.6*† |
| | SEM | 14.1 | 53.4 | 31.8 | 31.1 | 15.1 | 14.4 | 56.1 | 54.5 |
| $D_{\text{min}}$ (cm) | M | 2.8 | 4.5* | 3.7 | 3.7 | 3.0 | 2.7 | 4.4 | 4.7 |
| | SEM | 0.4 | 0.6 | 0.5 | 0.5 | 0.3 | 0.5 | 0.8 | 0.6 |
| $D_{\text{max}}$ (cm) | M | 20.4 | 20.7 | 18.8 | 22.2$^2$ | 19.3 | 21.4 | 18.3 | 23.0 |
| | SEM | 0.9 | 1.6 | 1.1 | 1.3 | 2.2 | 1.5 | 1.6 | 2.6 |
| T (%) | M | 39.4 | 61.2* | 53.2 | 47.4$^3$ | 41.7 | 37.1 | 64.8 | 57.6 |
| | SEM | 3.2 | 2.0 | 2.1 | 2.3 | 2.7 | 4.0 | 2.2 | 2.1 |

* Significantly different from the matching normal walking condition
† Significantly different from the matching preferred walking speed condition
‡ Significant interaction