

Figure-of-Eight Test to Determine Balance Impairments After Stroke.

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Summary

This study evaluated the ability of the figure-of-eight test (F8T) to detect balance impairments in individuals after stroke based on discriminatory ability, independence of gait speed, and differences in turning performance with the paretic vs. non-paretic leg placed inwards. Sixteen individuals with self-reported balance impairments after unilateral stroke and 20 healthy controls completed a modified F8T at a comfortable speed. The F8T effectively distinguished individuals post-stroke from healthy controls with Longer time to complete the F8T, larger CoM trajectory length, and a larger minimum MoS during turning. Notably, turning difficulty was independent of the direction. Finally, the F8T showed added value over the evaluation of gait speed, as indicated by remaining group differences after correction for gait speed.

Introduction

Dynamic balance impairments after stroke increase fall risk. The figure-of-eight test (F8T) [1], which combines straight and curved walking, may be a valuable tool for assessing dynamic balance. Its complexity could expose deficits not seen during regular walking. This study examined the F8T's ability to detect balance impairments in stroke survivors by assessing 1) its discriminatory power, 2) independence from gait speed, and 3) differences in turning performance when the paretic vs. non-paretic leg is placed inwards.

Methods

Individuals with self-reported balance problems after unilateral stroke (n=16) and healthy controls (n=20) completed a modified figure-of-eight test (F8T) at a comfortable speed. The task involved four laps around two hula hoops (0.95m diameter) placed 3m apart. Performance was assessed via 3D motion capture, extracting the following parameters: (1) completion time, (2) center of mass (CoM) trajectory length, (3) minimum mediolateral margin of stability (MoS) during turning [2], (4) turn duration, and (5) CoM trajectory length ratio between turns with the paretic/non-dominant leg vs. the non-paretic/dominant leg placed inwards. Straight-line gait speed was measured with a 2-minute walk test. Discriminatory ability was analyzed using linear models with and without gait speed as a covariate, with effect sizes reported as mean differences (95% CI) and Cohen's d.

Results and Discussion

CoM trajectories during the F8T are shown in Figure 1A for a representative healthy individual and an individual after

stroke. Compared to controls, individuals after stroke demonstrated a longer F8T completion time (mean difference: 17.2 s [11.8, 22.7], d=2.1), greater CoM trajectory length (mean difference: 4.5 m [3.4, 5.7], d=2.8), and prolonged turn duration (mean difference: 1.4 s [1.0, 1.8], d=2.4) (all p<0.001). Minimum mediolateral MoS during turning was higher in individuals after stroke group by 0.07 m [0.05, 0.10] (p<0.001, d=2.2). Between-group differences remained significant (p<0.012) after adjusting for gait speed (Figure 1B). There was no difference between groups in the CoM trajectory length ratio between turns with the paretic vs. non-paretic leg inwards (mean difference: -0.00 [-0.03, 0.03], p=0.909).

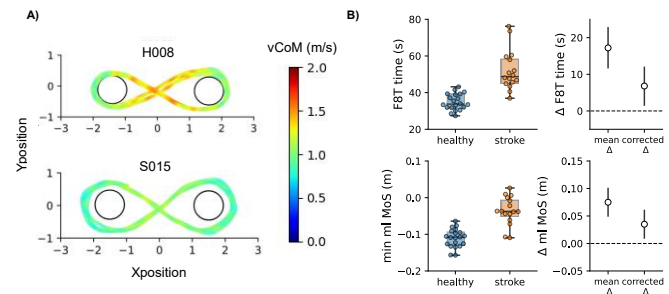


Figure 1 A) example of CoM trajectories during the F8T, colored according to the CoM speed (vCoM). Trajectories are provided for a representative healthy individual (H008) and individual after stroke (S015). B) Group differences on F8T time and minimum mediolateral margin of stability. Differences between healthy individuals and individuals after stroke are presented as mean difference with 95% confidence intervals for the models without (left) and with (right) gait speed as covariate.

Conclusions

The F8T effectively distinguished individuals after stroke from healthy controls. Longer completion time, increased CoM trajectory length, and greater minimum MoS during turning suggest a more cautious walking strategy to prevent instability. Notably, turning difficulty was not direction-dependent. Furthermore, the F8T provided added value over the evaluation of gait speed, as group differences remained significant after adjusting for speed.

References

- [1] Hess RJ, et al. (2010). *Phys Ther.* 90(1):89-99.
- [2] Ho TK, et al. (2023). *J Biomech.* 151: 111544.