

Identifying Falls Risk using an Instrumented Four-Square Stepping Test for Persons with Parkinson's Disease*

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Problem:

Although several assessments are available to document balance, only a limited number can sufficiently document multi-directional decline in dynamic balance in persons with Parkinson's Disease (PPD).^{1,2}

Purpose:

Identify clinical metrics to track changes in motor coordination over time using an instrumented Four-Square Stepping Test (iFSST) to document decomposition variables of performance for PPD.³

Study Design:

Exploratory Case - Control

Methods:

Participants were PPD at least 18 years of age, with a Hoehn & Yahr stage 1 - 3, and able to walk at least 10 meters with/without an assistive device.

Performance of the test involved a four-square stepping task using forward, sideways and backwards stepping into squares 1,2,3,4,1,4,3,2,1 on a computerized pressure mat while timed using the Prokinetic Zeno mat for 2 trials every 6 – 8 weeks up to 7 sessions.

Statistical analysis was performed using SPSS (vs. 26.0, IBM, Inc.) for descriptive statistical analysis including Chi Square for frequency analysis while a repeated measures MANOVA was used to explore group difference over time at $p=0.05$

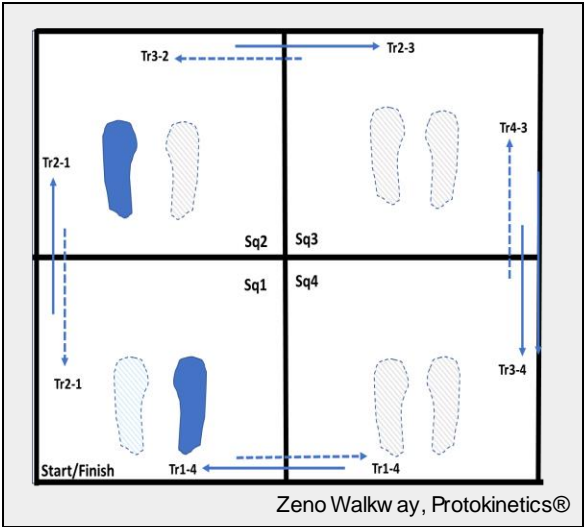


Figure 1

Instrumented Four Square Stepping Test

Description of test and explanation of picture below (Figure 1 & 2)

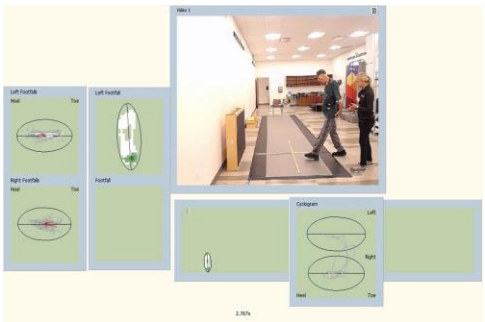
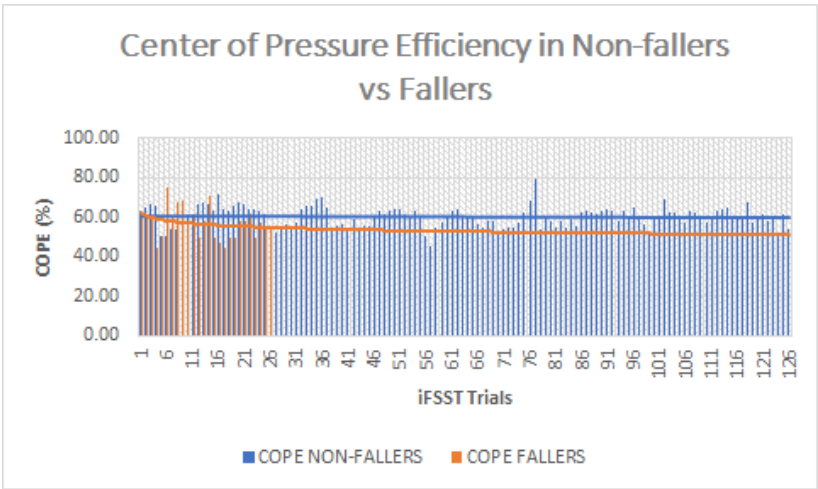


Figure 2

Participants perform the instrumented four-square stepping test on the Prokinetic Zeno mat which tracks pressure distribution from movement in real time.



Graph 1

Trials performed by PPD with a history of falls (orange) demonstrated a difference in center of pressure efficiency (COPE) compared to those without a history of falls (blue).

Preliminary Results:

44 participants (F/M = 9/35) contributed to 244 completed iFSST trials over 18 months. Timed trials averaged 8.79 +/- 2.02 sec., Backward Transition times (sq3 - sq4) and (sq2 - sq1) indicated a significantly different strategy between fallers & non-fallers ($p=0.028$) with decreased efficiency (COPE) scores (< 50%).

Conclusions:

Preliminary results indicate a significant deficit in backwards stepping transitions for PPD with an identified history of falls compared to PPD without a history of falls.

Clinical Relevance:

Project results suggest that a decomposition of directional step performance can yield early detection of fall risk in persons with degenerative motor disorders like PD.

References:

1. Winsor SJ, Kannan P, Bello UM & Whitney SL. "Measures of balance and falls risk prediction in people with Parkinson's disease: a systematic review of the psychometric properties." Clinical Rehabilitation, 2019, Vol. 33(12) 1949 - 1962.
2. Kim J, Kim I, Kim YE, Koh SB. "The Four-Square Step Test for Assessing Cognitively Demanding Dynamic Balance in Parkinson's Disease Patient." J Mov Disord 2021;14(3):208- 213. pISSN 2005-940X / eISSN 2093-4939. <https://doi.org/10.14802/jmd.20146>.
3. Gouelle A & Highsmith MJ. "Instrumented Four Square Step Test in Adults with Transfemoral Amputation: Test-Retest Reliability and Discriminant Validity Between Two Types of Microprocessor Knees", Sensors 2020, 20, 4782; <http://doi:10.3390/s20174782>