

¹Shinichi Amano, ²Joe Nocera, ³Srikant Vallabhajosula, and ¹Chris J. Hass

¹University of Florida, Gainesville, Florida, ² VA Rehabilitation R&D Center of Excellence, Atlanta VAMC,

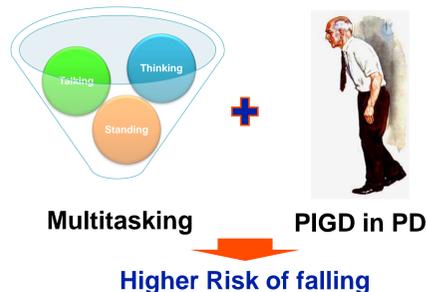
³University of Nebraska at Omaha, Omaha, Nebraska

Abstract

Balance dysfunction is a disabling feature of idiopathic Parkinson's disease (PD). Postural control in PD worsens when attention is averted, such as when performing a concurrent cognitive or motor task. Tai Chi (TC) exercise interventions, which have a dual-task component, have resulted in increased physical fitness and postural stability and reduced risk of falling in older adults. However, few studies have quantified the improvements in motor coordination after TC in persons with PD, particularly when examined during a dual task paradigm. **PURPOSE:** To determine whether TC training can improve postural control under secondary cognitive/motor task conditions in persons with PD. **METHODS:** Sixteen persons with idiopathic PD (65.4±9.7 yrs, 167.0±10.1 cm, 74.8±12.7 kg) participated. Randomly selected 11 participants (TC) were provided with the 16-week TC training, and five participants (Control) were assigned to a non-exercising control group. During baseline testing, each participant was asked to stand for 10 seconds on a force platform, holding a set of two cylinder-shaped objects stacked together. The center of pressure excursion under the feet was collected at 360Hz under three task conditions: static (holding objects with precision grip), secondary cognitive (a digit subtraction while holding objects), and secondary motor (pulling the top cylinder apart). All participants underwent the same tests following the 16-week period. The change score after 16 weeks in Approximate Entropy (ApEn) on anteroposterior (A/P) and mediolateral (M/L) directions and 95% confidence ellipse (Area95) were evaluated using independent t-test in each of three secondary task conditions. The level of significance was set at $\alpha=0.05$. **RESULTS:** In the static condition, TC reduced their Area95 (-.05±.57cm²) when compared to Control (+.73±.78cm², $p<.05$). On the other hand, change in ApEn in TC (A/P: +.12±.35, M/L: -.01±.23) did not significantly differ from Control (A/P: +.07±.23, M/L: +.10±.23). No significant differences were observed in any of two secondary task conditions. **CONCLUSION:** TC appears to be effective in improving postural stability for persons with PD under less cognitively challenging condition. However, this benefit could not be reflected in postural control while performing a more demanding secondary task.

Background

Postural instability and risk of falling are increased in persons with PD

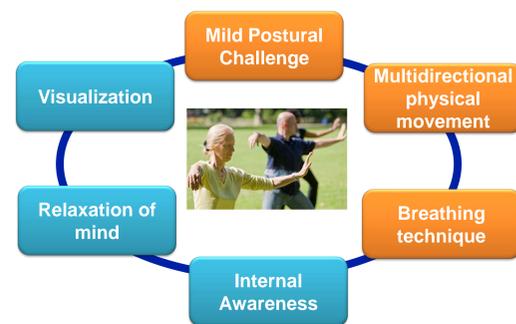


Falls are one of the most serious consequences of postural instability and gait disturbances (PIGD) in persons with PD.

Persons with PD are vulnerable to fall during multi-tasking while standing.

Interventions that involve multi-task components are needed

Tai Chi training reduces postural instability and fall risk



TC participants have to perform many different tasks simultaneously.

Purpose

- The purpose of this study is to determine whether Tai Chi training can improve postural control under secondary cognitive/motor task condition in persons with PD.
- We hypothesized that Tai Chi training improves postural control in PD under both single task and dual task conditions.

Methods

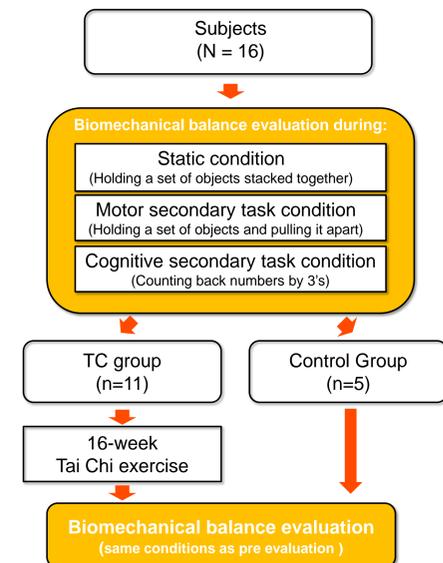
Study participants

Group	TC	Control
N	11	5
Age (yrs)	66(11)	66(7)
Height (cm)	166.7(10.5)	168.8(8.4)
Mass (kg)	76.2(14.3)	74.2(7.2)
Disease Duration (yrs)	8(5)	5(3)
HY scale	2.4(0.6)	2.4(0.4)
UPDRS Motor	22.6(6.2)	23.1(4.8)

All participants were randomly assigned to either of 2 groups:

- TC group (n=11): underwent 1-hour, 3 x/week, 16-week TC intervention
- Non-exercise control group (n=5)

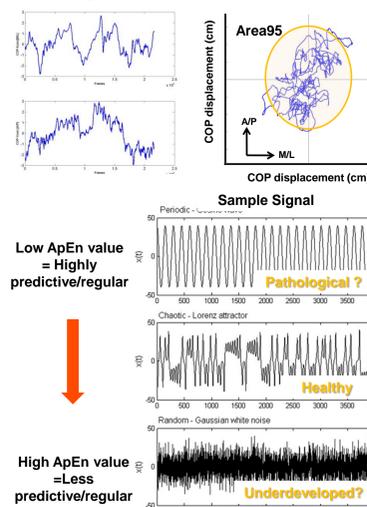
Study design and experimental protocol



- All participants visited Biomechanics Laboratory before and after a 16-week intervention period for balance evaluation.
- Center of pressure (COP) excursion under feet was measured for 10 seconds at 360Hz using a force platform.
- Collected under 3 Conditions (Static, Secondary Cognitive and Secondary Motor).
- 3 trials were collected for each condition.

Outcome measures

Change scores (Post – Pre) of spatial & time-dependent COP variability :



Spatial COP variability:

95% confidence ellipse area (Area95) : a bivariate confidence ellipse that enclosed 95% of the COP trajectory

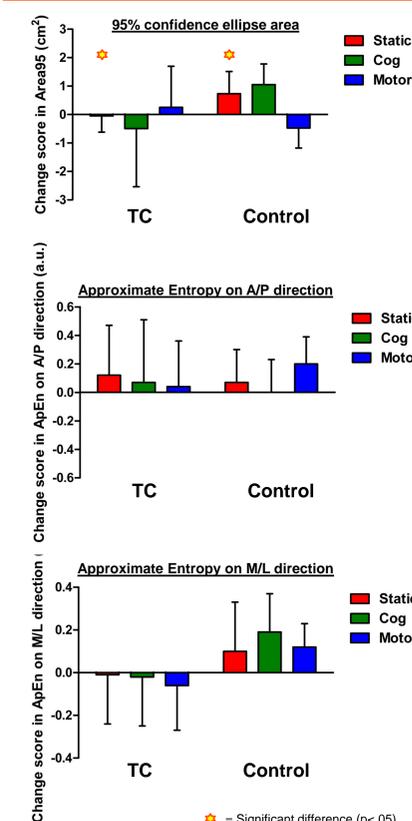
Time-dependent COP variability:

Approximate entropy (ApEn): Higher ApEn values reflect an irregular time-series (more unpredictable time-dependent structure)

Statistical Analysis

An independent t-test was used in each of three single/secondary task conditions to evaluate the difference between groups. The level of significance was set at $\alpha=0.05$

Results



TC participants reduced magnitude of COP variability in Static condition.

In static condition, TC participants reduced their Area95 (-.05±.57cm²) when compared to their counterparts (0.73±.78cm², $p<.05$). On the other hand, change in ApEn in TC participants (A/P: 0.12±.35, M/L: -.01±.23) did not significantly differ from Control group (A/P: +.07±.23, M/L: 0.10±.23, $p>.05$ on both directions).

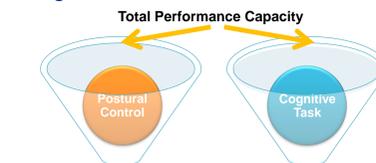
No significant improvements were observed in secondary task conditions.

Regarding COP variability under dual task conditions, no significant difference in change score of Area95 was observed under either Cog (TC: -.49±2.05cm², Control: 1.05±.73cm², $p>.05$) or Motor (TC: .25±1.45cm², Control: -.47±.71cm², $p>.05$) secondary task condition. The same can be said for ApEn on both directions under secondary task conditions.

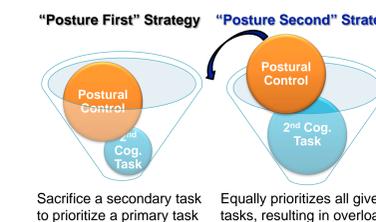
Discussions

Improvement cannot be observed in secondary task conditions. Why?

Single Task



Dual Task



"Posture second" strategy in persons with PD (Bloem et al., 2006)

- Healthy young and elderly adults sacrifice performance on the cognitive secondary task to maintain the primary task. = "Posture first" strategy
- Persons with PD use a "posture second" strategy and treat all elements of given tasks with same priority.
- Even if Tai Chi improves postural control under the single-task condition, persons with PD might have used their resources MORE for the cognitive component of dual task.

Conclusion

Tai Chi intervention appears to be effective for persons with PD to improve their postural control under less challenging condition. However, this benefit was limited and could not be reflected in postural control while performing a secondary task. This might be because persons with PD treat both tasks with same priority ("posture second" strategy), which can result in retaining risks of falling while performing multiple tasks in their activities of daily living.