The effect of Tai Chi intervention on balance in older males

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Abstract

Purpose: The purpose of the present study was to examine the effects of a 24-week Tai Chi exercise intervention on balance and other physical changes such as flexibility and reaction time (RT) among healthy older males.

Methods: Thirty-eight male subjects aged 55–65 years without prior Tai Chi experience were recruited from a local community in Shanghai, China. A 60-min Tai Chi exercise session was performed three times a week for 24 weeks. Changes in RT, sit-and-reach flexibility and balance (static balance with eyes open and closed respectively) were measured before and after the Tai Chi intervention.

Results: After the 24-week Tai Chi intervention, the choice RT ($p < 0.05$) decreased, and sit-and-reach flexibility improved ($p < 0.01$) over the pre-test (7.8 ± 6.2 vs. 7.1 ± 3.0 cm). Sway length, area, X-axis deviation amplitude and Y-axis deviation amplitude performance decreased significantly after the intervention with a double-foot stance with eyes open ($p < 0.05$). Sway length, area and average sway speed showed a statistically significant decrease after the intervention with the double-foot stance with eyes closed. In the single-foot stance with eyes open condition, sway length and average sway speed showed a statistically significant decrease ($p < 0.05$).

Conclusion: The 24-week Tai Chi exercise intervention had a positive influence on balance control in older males.

Keywords: Balance; Exercise intervention; Older males; Tai Chi

1. Introduction

Falls are defined as an individual “inadvertently coming to rest on the ground, floor or other lower level, excluding intentional change in position to rest in furniture, wall or other objects”.1 The direct consequences of falls include devastating injuries and fractures that may lead to decreased mobility, functional decline, depressive symptoms, decreased social activity, and a decline in the quality of life.2 Decreases in balance function are intrinsic factors that can cause falls.3 Many factors contribute to poor balance, including reduced strength, flexibility, and sensorimotor coordination as well as delayed information processing. Oakley et al.4 collected information confirming that physical exercise reduces the risk of falls and may be a significant element in a more extensive program of preventive activities. One method of fall prevention consists of increasing muscular strength and improving body balance.5 Tai Chi, a Chinese martial art, has been used for centuries as a fitness exercise and is particularly popular among the elderly. It offers substantial potential benefits by reducing the incidence of falls among the elderly population.6 A number of cross-sectional and longitudinal studies have shown that Tai Chi practitioners exhibit better balance control than matched older adults from the general population.7,8 In 2001, Wong et al.9 compared the postural stability of older Tai Chi practitioners whose experience ranged from 2 to 35 years with that of healthy non-practitioners of similar ages. They found that elderly Tai Chi practitioners had better postural
stability than non-practitioners when faced with disturbed somatosensory and visual input. Li et al. found that the Tai Chi group performed significantly better than the non-practitioner group on all functional balance measures. Both groups exhibited deterioration in functional balance measures during post-intervention follow-up. However, the Tai Chi group showed a significantly slower decrease. The results of more recent studies suggest that Tai Chi training may improve strength and flexibility, balance, blood pressure, and cardiorespiratory function in older adults. These findings support the benefits of Tai Chi as an exercise form for elderly men and women. Studies have focused on balance tests, in spite of other physical changes, such as impairments to reaction time (RT) and flexibility due to aging, may affect balance.

The purpose of this study was to assess the effect of a 24-week Tai Chi training program on RT, sit-and-reach flexibility and static balance among older males. We hypothesised that the 24-week Tai Chi intervention, conducted three times a week for 60 min per session, was sufficient to produce positive changes in balance, RT and flexibility.

2. Methods

2.1. Subjects and study design

Thirty-eight sedentary male subjects aged 55–65 years (mean age, 59.7 ± 5.6 years; height, 171.2 ± 4.5 cm; weight, 68.3 ± 5.9 kg) were recruited through an advertisement at the Yang Pu Culture Community Center in Shanghai, China. None of the subjects had previous Tai Chi experience. All of the subjects were asked to avoid changing their lifestyles except for their participation in the Tai Chi intervention. The inclusion criteria included the presence of severe cognitive impairments, symptomatic cardiovascular diseases at moderate exertion levels, poorly controlled hypertension or symptomatic orthostatic hypotension, other neurological disorders, peripheral neuropathy of the lower extremities, crippling arthritis, and metastatic cancers. The procedures were fully explained, and written informed consents were obtained from all of the subjects.

All of the subjects participated in a 24-week exercise class that was held three times a week (Monday, Wednesday, and Friday) in the morning. Each exercise session lasted 60 min and was led by a certified Tai Chi instructor. The session included 10 min of warm-up exercise (including stretching and balancing exercises), 40 min of Tai Chi practice, and 10 min of cool-down exercises. The simplified 24-form and 42-form Tai Chi movements were used in this study. During the sessions, the instructor constantly monitored the subjects and corrected their body positions, joint angles and form-to-form transitions.

2.2. Outcome measures

Three physical variables were measured at the beginning and the end of the Tai Chi intervention. These variables included (1) RT, (2) sit-and-reach flexibility, which have been identified as important factors associated with the increased risk of falls, and (3) static balance. Every subject was fully informed about the nature and procedure of the test prior to the experiment.

2.2.1. Reaction time

Finger choice RT test: the visual choice RT apparatus was used to measure the four-choice RT of finger response. Subjects were asked to respond to a light stimulus by pressing a corresponding key as quickly as possible. Using each finger three times, subjects completed a total of 12 test trials, which were conducted in a predetermined random order. Choice RT was recorded after each of the trials, and the best score for each subject was used for the data analysis.

2.2.2. Sit-and-reach flexibility

Sit-and-reach flexibility was measured using a sit-and-reach apparatus. All of the participants were asked to sit on the floor with their legs stretched out forward and their shoes removed. Both knees were locked and pressed flat to the floor (the tester assisted by holding them down). With the palms facing downward, the subjects reached forward along the measuring line as far as possible and held that position for one or two seconds while the distance was recorded in centimetres. The subjects were tested twice, and the better results were used.

2.2.3. Static balance

The instrument used in this study was the Balance System, a computerised-force platform system (Medicapteurs, Balma, French) to assess balance. The Balance System measures the fluctuation of weight displacement. The sway index in centimetres was used in all of the analyses. We achieved static balance conditions by asking the participants to stand on the force platform on their right feet (with their eyes open and closed) and on both feet (with their eyes open and closed). The following posturographic parameters were considered: (1) sway length (SL); (2) area (A); (3) unit area sway length (SL/A); (4) average sway speed (SS); (5) X-axis deviation amplitude (X-DA); (6) Y-axis deviation amplitude (Y-DA). SL represented the sum total of the movement route length of the centre of gravity. A was the surface area covered by the movement route of the centre of gravity and reflected the degree of the balance disorders. SL/A reflected the proprioception of postural control. SS was the movement speed of the centre of gravity, which reflected balance stability. X-DA and Y-DA amplitude represented horizontal and vertical of the centre of gravity, respectively.

2.3. Statistical analysis

For each outcome employed, descriptive statistics (such as mean ± SD values) were calculated for the subjects for both pre- and post-test measures. One-way repeated measures analysis of variance (ANOVA) was conducted to examine the overall effect of the Tai Chi intervention. When F values were statistically significant, paired t tests were employed to determine the effects of the intervention at a specific outcome measure, and a post hoc test was used to identify the effects of Tai Chi exercise. Statistical significance was set at p < 0.05.
3. Results

Table 1 presents the means ± SD of the outcome measures pre- and post-intervention. After the intervention, the choice RT was statistically significantly improved (p = 0.027), indicating that the subjects experienced better brain function. The data obtained from the sit-and-reach test indicate that long-term regular Tai Chi practitioners had better flexibility (p < 0.01) than they experienced in their former sedentary lifestyles (7.8 ± 6.3 vs. 7.1 ± 3.0 cm).

The data analysis in Tables 2 and 3 summarises the static balance performance for four conditions: the single-foot stance with eyes open and closed; the double-foot stance with eyes open and closed. The results indicated that SL, A, X-DA and Y-DA performance decreased significantly after the 24-week Tai Chi intervention for the double-foot stance with eyes open. SL, A, and SS showed a significant decrease after the intervention for the double-foot stance with eyes closed. In the single-foot stance with eyes open, SL and SS were statistically decrease, however, they did not decrease in the single-foot stance with eyes closed.

Table 2
Comparison of measures in the double-foot stance before and after the 24-week Tai Chi intervention (mean ± SD).

<table>
<thead>
<tr>
<th></th>
<th>Eyes open Before</th>
<th>Eyes open After</th>
<th>p value</th>
<th>Eyes closed Before</th>
<th>Eyes closed After</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>SL (mm)</td>
<td>292.4 ± 77.8</td>
<td>261.3 ± 92.3</td>
<td>0.050</td>
<td>391.0 ± 177.3</td>
<td>349.8 ± 141.3</td>
<td>0.048</td>
</tr>
<tr>
<td>A (mm²)</td>
<td>252.0 ± 104.0</td>
<td>205.5 ± 108.0</td>
<td>0.050</td>
<td>321.2 ± 219.0</td>
<td>250.2 ± 128.3</td>
<td>0.047</td>
</tr>
<tr>
<td>SL/A (mm)</td>
<td>1.3 ± 0.3</td>
<td>1.5 ± 0.5</td>
<td>0.081</td>
<td>1.4 ± 0.5</td>
<td>1.6 ± 0.5</td>
<td>0.136</td>
</tr>
<tr>
<td>SS (mm/s)</td>
<td>8.9 ± 2.3</td>
<td>8.0 ± 2.8</td>
<td>0.060</td>
<td>12.0 ± 5.4</td>
<td>10.6 ± 4.3</td>
<td>0.045</td>
</tr>
<tr>
<td>X-DA (mm)</td>
<td>4.6 ± 1.5</td>
<td>3.9 ± 1.3</td>
<td>0.031</td>
<td>4.6 ± 1.9</td>
<td>4.1 ± 1.5</td>
<td>0.218</td>
</tr>
<tr>
<td>Y-DA (mm)</td>
<td>5.3 ± 1.7</td>
<td>4.4 ± 1.5</td>
<td>0.024</td>
<td>6.1 ± 3.0</td>
<td>5.1 ± 1.9</td>
<td>0.072</td>
</tr>
</tbody>
</table>

Abbreviations: SL = sway length; A = area; SL/A = unit area sway length; SS = average sway speed; X-DA = X-axis deviation amplitude; Y-DA = Y-axis deviation amplitude.

4. Discussion

Balance is a required component in the execution of postural control. The capacity to maintain balance decreases with age which results in an increased risk of falls and fractures among the elderly. This study shows that Tai Chi offers potential benefits to the elderly in terms of balance and other physical functions. Improvements were evident in flexibility, RT, and the index of static balance in different conditions. Our results are consistent with the results of a previous randomised trial of the effect of Tai Chi on balance as well as the findings of another study that showed the benefits of Tai Chi with respect to physical functions and quality of life. Previous studies found that Tai Chi had beneficial effects on balance in older adults through comparisons of experienced Tai Chi practitioners with non-practitioners in a test involving single-foot standing with eyes open. However, there was no significant difference between Tai Chi practitioners and sedentary subjects in single-foot standing with eyes closed. The present study identified an improvement in balance after a 24-week Tai Chi exercise intervention for single-foot standing with eyes open. With eyes open in both double-foot stance and single-foot, SL decreased significantly after the intervention (Tables 2 and 3). This decrease also occurred for A, X-DA, and Y-DA in the double-foot stance, and SS in the single-foot stance. This finding suggests that maintaining of balance with occluded vision is not a normal life experience.

The maintenance and development of levels of flexibility closely related to balance are important components of a general health enhancement program during the aging...
process.\textsuperscript{12} This study shows that practitioners of Tai Chi for 24 weeks possessed better trunk and hamstring flexibility than they experienced during their previous sedentary lifestyles. This finding is confirmed by the findings of Lan et al.,\textsuperscript{24} who reported significantly superior performance among older Tai Chi practitioners with more than 10 years of experience than their sedentary counterparts with respect to hip joint flexibility, as measured by their stand and reach test scores. The RT of the subjects decreased significantly after the 24-week Tai Chi exercise intervention. These findings suggest that Tai Chi exercise may positively influence balance abilities among older males during the course of 24 weeks of training. Furthermore, flexibility and RT are important factors in maintaining balance. One possible explanation for this finding is that Tai Chi is a mind-body practice that combines meditation with slow, gentle, graceful movements. It is considered a complex, multicomponent intervention that integrates physical, psycho-social, emotional, spiritual, and behavioural elements\textsuperscript{25} and features constant swinging, shifting, and turning in all directions, including left, right, forward, and backward. This activity requires a high degree of concentration and coordination between mind and body and among the different body parts. The motor system, the nervous system and the proprioceptive systems are all mobilised during Tai Chi exercise.

Given the large number of comparisons, some statistically significant differences in this study may have occurred by chance. Another limitation of this study is the lack of a control group. Therefore, the outcome pre-test is used as the baseline, and further studies are needed to understand the mechanisms of the effect of Tai Chi on balance.

5. Conclusion

Our preliminary findings indicate that Tai Chi may be a positive method for improving balance and other physical functions, such as RT and flexibility, among the older males. Longer-term studies involving additional factors related to balance are needed to improve our understanding of the biological mechanisms by which Tai Chi affects balance.

Acknowledgments

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References