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LITERATURE REVIEW

Tai Chi for Stroke Rehabilitation

A Focused Review

ABSTRACT

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This focused review summarizes and critically evaluates clinical trial evidence for the effectiveness of Tai Chi as a supportive therapy for stroke rehabilitation. All prospective, controlled clinical trials published in English or Chinese and involving the use of Tai Chi by survivors of stroke were searched in eight electronic databases. Information from the included studies was extracted and synthesized. The methodological quality of all studies was assessed with the Jadad score. Five randomized controlled trials, four in English and one in Chinese, met the inclusion criteria and were reviewed. The methodological quality of the trials was moderate (Jadad score, range, 1–4; average score, 2.6). Meta-analysis was not performed because of the heterogeneity of the study conditions and outcome measures. Three studies reported benefits of Tai Chi with respect to improved balance in participants who have had a stroke. Three studies assessed mobility function and reported no improvement after Tai Chi intervention in survivors of stroke. Improvements in quality-of-life and mental health were reported in three trials. This focused review suggests that Tai Chi exercise might be beneficial with respect to balance, quality-of-life, and mental health in survivors of stroke. More rigorous randomized controlled trials are required to determine whether Tai Chi is effective in stroke rehabilitation.

Key Words: Rehabilitation, Stroke, Review, Tai Chi

Anually, 15 million people have a stroke worldwide. Of these, 5 million die and another 5 million are left with permanent disability, placing a burden on the family and the community.¹ In the United States, approximately 759,000 people have a new or recurrent stroke each year.² Stroke remains the third leading cause of death in China, with total stroke incidence³ increasing 6.7% annually from 1984 to 2004.

Stroke leaves many survivors with mental and/or physical disabilities. Rehabilitation aims to hasten and maximize recovery from stroke by treating the disabilities caused by stroke and attempts to help patients regain freedom of movement and functional independence and to reintegrate into community life as fully as possible.⁴

Physical activity is an important component of a comprehensive stroke rehabilitation program to reduce disabilities. Tai Chi, as a form of physical activity, may favor the rehabilitation of stroke. Tai Chi is an ancient form of exercise,

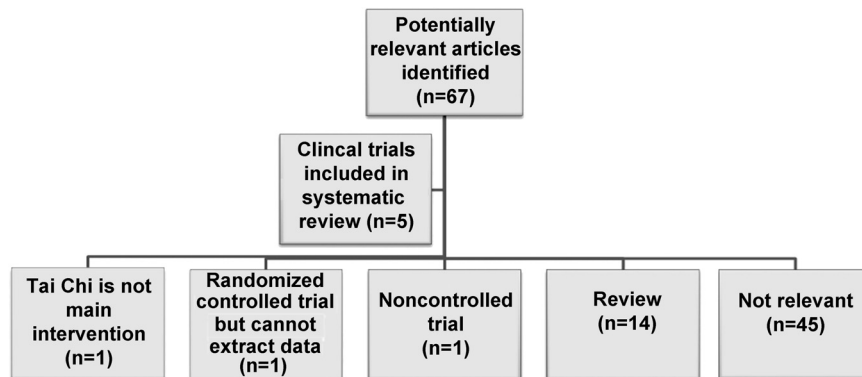


FIGURE 1 Flow chart demonstrating selection of studies for inclusion in the review.

meditation, and self-defense widely practiced in China for thousands of years.⁵⁻⁹ As a low-impact, moderate-intensity exercise, Tai Chi has been practiced widely in recent decades to promote mental and physical health and to prevent chronic disease among individuals of all ages. A recent review claims that Tai Chi is associated with benefits with respect to several risk factors for subsequent stroke or disability, including better balance, lower blood pressure, and improved mood. However, that review discussed only the potential benefit of Tai Chi for stroke rehabilitation and included only one clinical trial of Tai Chi in survivors of stroke. The aim of the present study was to perform a comprehensive literature review to summarize and critically evaluate clinical trial evidence for the effectiveness of Tai Chi as a supportive therapy for stroke rehabilitation.

METHODS

Data Sources

The following databases were searched from their respective inception through November 2011: PubMed, EMBASE, Cumulative Index to Nursing and Allied Health, Allied and Complementary Medicine Database (AMED), China National Knowledge Infrastructure, Chinese Medical Database, Taiwan Academic Online, and the Cochrane Library. The following search terms were used: *Tai Chi*, *Taiji*, or *Tai Chi Chuan* and *stroke* or *cerebrovascular accident*.

Inclusion Criteria

All prospective, controlled clinical trials investigating patients who have had a stroke and published in English or Chinese were included. Trials in which there was a comparison between a treatment group that received Tai Chi exercise as a main intervention and a control or comparison group that received either an alternative form of intervention

or no treatment were included. Observational studies, case series, and case reports were excluded.

Data Extraction and Analysis

All studies were reviewed independently by two investigators. For each eligible publication, the following information was extracted and recorded: (1) name(s) of author(s), (2) year of publication, (3) study design including intervention and control group information, (4) Tai Chi style, (5) duration of intervention, (6) sample size, (7) participant demographic characteristics, (8) primary and all other outcome measures, and (9) results. Meta-analysis was not performed because of the heterogeneity of the study conditions and outcome measures used.

Quality Assessment

The methodological quality of all studies was assessed according to Jadad score.¹⁰ The Jadad score was calculated by assessing the following three criteria: description of randomization, blinding, and withdrawals. The score ranged from 0 to 5 points. Taking into account that patients could not be blinded to the treatment, 1 point was assigned for blinding if the outcome assessor was blinded. The study with a higher Jadad score had a higher methodological quality.

RESULTS

Search Results

The database searches identified 67 potentially relevant studies. A total of 62 studies were excluded (Fig. 1). Five randomized controlled trials, four published in English and one published in Chinese, met the inclusion criteria and were reviewed.

TABLE 1 Features of the five studies included in this systematic review

Author (Year)	Patients and Control Subjects, Age, Mean \pm SD, Yrs (If Reported)	Jadad Score	Experimental Intervention	Control Intervention	Outcomes	Intergroup Difference
Au-Yeung (2009)	136 subjects: Tai Chi, 74 (61.7 \pm 10.5); control, 62 (65.9 \pm 10.7); history of stroke, >6 mos	4	(A) Short-form Tai Chi, 1 hr weekly for 12 wks, plus approximately 3 hrs of self-practice per week	(B) Breathing and stretching exercises	Limit of Stability Test: (1) Nonaffected side (2) Affected side (3) Backward (4) Forward Sensory Organization Test: Equilibrium score: (5) Condition 1 (6) Condition 2 (7) Condition 3 (8) Condition 4 (9) Condition 5 (10) Condition 6 (11) Somatosensory ratio (12) Visual ratio (13) Vestibular ratio (14) Timed Up and Go Test (1) Duke Health Profile (2) Romberg Test of Standing Balance (3) Standing on one leg (4) Walking speed Short Physical Performance Battery (1) Balance (2) Gait speed (3) Strength (2-min step-in-place test) (4) Endurance (5) Medical Outcomes Study Short Form-36 (6) Center for Epidemiological Studies Depression Scale (7) Pittsburgh Sleep Quality Index (1) Global Sleep Quality (2) General Health Questionnaire (1) Berg Balance Scale (2) Hamilton Anxiety Meter (3) Somatic anxiety (4) Psychic anxiety (5) General Quality of Life Inventory-74 (6) Physical domain (7) Psychologic domain (8) Social domain (9) Material domain	(1) RT: (A) shorter than (B), $P < 0.05$; (2-4) RT: NS; (1), (2) LS: (A) greater than (B), $P < 0.005$; (3), (4) LS: (A) greater than (B), $P < 0.05$; (5-8), (10-12): NS; (9): (A) greater than (B), $P = 0.040$; (13): (A) greater than (B), $P = 0.038$; (14): NS
Hart (2004)	18 participants: Tai Chi, 9; control, 9; mean age, 54.77 yrs; have independence in gait and activities of daily living and have intact visual acuity	2	(A) Tai Chi practice for 1 hr twice weekly	(B) Group exercises focusing on improvement in balance, 1 hr twice weekly		(1-4): NR
Taylor-Piliae (2011)	28 subjects: Tai Chi, 16 (72.8 \pm 10.1); control, 12 (64.5 \pm 10.9); community-dwelling men and women; ≥ 50 yrs old and at ≥ 3 mos after stroke	4	(A) A 60-min Tai Chi class three times a week for 12 wks	(B) Written materials and resources for participating in community-based physical activity suitable for older adults		(1), (4), (5-7): favor of (A); (2), (3): (B) greater, NS
Wang (2010)	34 participants: Tai Chi, 17; control, 17; ≥ 50 yrs old; those with cerebrovascular disorder were eligible to participate	3	(A) 50-min Tai Chi sessions conducted once a week for 12 wks	(B) Walking and/or standing and resistance training, 80 mins of rehabilitation sessions carried out once a week for 12 wks		(1), (2): NS
Zhou (2010)	68 participants: Tai Chi, 34; control, 34 (65.2 \pm 8.5); post stroke, myodynamia in 4-5 degrees	1	(A) Twice weekly for 4 wks	(B) Conventional rehabilitation for 4 wks		(1): (A) higher than (B), $P < 0.01$; (2): (A) lower than (B), $P < 0.01$; (3): (A) lower than (B), $P < 0.05$; (4): (A) higher than (B), $P < 0.05$; (5-7): (A) higher than (B), $P < 0.01$

RT, reaction time; LS, limitation of stability; NS, no significant difference; NR, not reported.

Study Characteristics

The trials were conducted between 2004 and 2011 in China, Israel, Japan, and the United States. In total, there were 284 participants, whose average age was older than 50 yrs. Only one study had more than 100 participants. Three studies had fewer than 20 participants in one or more of the study groups.^{11–13} The participants were recruited from local community or day-care centers or hospitals. The Tai Chi exercise varied from 50 to 240 mins, one to three times per week, for 4–12 wks. Home practice was required in one study. The control groups performed various exercises, such as breathing and stretching exercises, balance exercises, walking, standing, and resistance training, or received education. The features of the included studies are listed in Table 1.

Study Quality

The methodological quality of the trials was moderate (Jadad score, range, 1–4; average score, 2.8). Two randomized controlled trials described the methods of randomization,^{12,13} and one reported details on allocation concealment.¹² Three trials described assessor blinding.^{11,13,14} Details regarding dropouts and withdrawals were described in three trials.^{11–13} One study had a high risk for bias.¹⁵

Outcomes

Physical Performance

Balance. Four studies assessed balance with a variety of tests or scales. One study assessed standing balance with the Limit of Stability Test and the Sensory Organization Test and reported a significant effect of Tai Chi on standing balance compared with the control intervention.¹² One study of low quality reported a more significant effect, according to the Berg Balance Scale, of Tai Chi intervention on balance compared with conventional rehabilitation.¹⁵ In addition, one study reported a favorable change in balance after Tai Chi intervention, although this change was not statistically significant.¹³ Finally, one study reported no changes in balance, as measured by the Romberg Test of Standing Balance and by standing on one leg, in the Tai Chi group but showed improvement in balance in the control group¹⁴; however, the significance of the intergroup difference was not reported.

Mobility function. Three studies assessed mobility function via the Timed Up and Go Test,^{12–14} assessment of walking speed, and assessment of gait speed, and all reported no improvement in mobility function after Tai Chi intervention.^{13,14} However,

two of the three studies showed improvements in mobility function after intervention in the control groups.^{13,14}

Strength and endurance. One study reported an effect of Tai Chi on strength and endurance compared with usual care intervention.¹³ The results showed improvement in endurance after Tai Chi intervention and improvement in strength after usual care, but these improvements did not reach statistical significance with regard to group difference or intergroup difference.

Quality-of-Life and Mental Health

Four studies assessed quality-of-life with various self-report questionnaires. One study reported that the Tai Chi group showed improvement in general functioning (t test = 0.08) and social functioning (t test = 0.012) at endpoint via the Duke Health Profile.¹⁴ Another study reported that Tai Chi exercise tended to improve physical health, mental health, depression, and sleep quality.¹³ A low-quality study reported higher scores in the General Quality of Life Inventory–74 and lower scores in the Hamilton Anxiety Meter after Tai Chi intervention compared with control intervention.¹⁵ One study evaluated quality-of-life with the General Health Questionnaire and Global Sleep Quality questionnaire, which revealed no significant difference between the Tai Chi group and the control group in either questionnaire scores at start point or endpoint.¹¹

DISCUSSIONS

Many clinical studies have indicated the effectiveness of Tai Chi in enhancing balance and preventing falls among elder participants with or without chronic disease.^{16–20} Gatts and Woollacott^{21,22} investigated neural and biomechanical mechanisms of Tai Chi on balance and suggested that Tai Chi enhances neuromuscular responses, controlling the ankle joint of the perturbed leg, and enhances balance responses via efficacious use of mechanisms, controlling the stepping strategies of the swing leg.

In the present review, most of the included studies reported that Tai Chi exercise can improve balance after stroke despite study limitations, including few rigorously conducted studies, various balance measures, and different styles and durations of Tai Chi exercise.^{12,13,15} One study reported improved balance after an exercise focusing on balance but not after Tai Chi; however, that study had a small sample size (nine participants each in the Tai Chi and control groups). Therefore, it is necessary to conduct trials with larger sample sizes to detect any advantage of

Tai Chi for balance compared with other treatments in patients who have had a stroke.

Some studies indicated no improvement in mobility function with Tai Chi but indicated improvement with the control intervention in patients who have had a stroke. However, the author could not draw the conclusion that Tai Chi had no effect on mobility function for stroke rehabilitation, given the lack of or unclear significant intergroup difference and small sample size in those studies.

Only one trial tested the effects of Tai Chi on strength and endurance in patients who have had a stroke. Therefore, it is difficult to conclude that Tai Chi is beneficial for strength and endurance in patients who have had a stroke. However, a recent systematic review reported that a meta-analysis favored Tai Chi exercise for improving lower-limb muscle strength in older people,²³ and one study reported that muscle endurance of the knee extensors was more pronounced in older persons who practiced long-term Tai Chi compared with control participants. Rigorous and long-term trials should be conducted to determine the effectiveness of Tai Chi on strength and endurance for stroke rehabilitation.²⁴

Physical activity has a positive impact on quality-of-life and mental health. Tai Chi, as a type of physical activity, should have similar benefits. In addition to the physical component, Tai Chi also has socio-cultural and meditative components that are believed to contribute to overall well-being.²⁵ Furthermore, specialized breathing that accompanies motion of the extremities, such as in qigong exercise, is helpful for reducing stress and anxiety. Most of the studies in the present review reported that Tai Chi has positive effects with respect to quality-of-life, sleep, depression, and anxiety among patients who have had a stroke.

Stroke is an important cause of cognitive impairment. Treatment for improving cognition and preventing cognitive decline should be an element of stroke rehabilitation. Unfortunately, none of the studies included in the present review assessed cognitive function after Tai Chi intervention in survivors of stroke. A recent cross-sectional study and a randomized controlled trial showed that Tai Chi exercise might offer specific benefits with respect to cognition.^{26,27} Therefore, Tai Chi might have potential benefits with respect to cognitive function in persons who have had a stroke. Additional randomized controlled trials are needed to examine this possibility.

Limitations

This review has several limitations that pertain to the potential incompleteness of the evidence

reviewed. Because Tai Chi is popular in Japan and Korea, some relevant studies may be published in Japanese or Korean literature. However, the author did not search databases in Japan or Korea. In addition, given that the substantial majority of studies reported positive results of Tai Chi, a possibility of publication bias exists. Furthermore, the insufficient quality of the included studies might affect the strength of the evidence. For example, a poor-quality study reported positive results for all outcomes. In addition, meta-analysis was not performed, owing to study heterogeneity (differences in design, selection of control, intervention protocol, and outcomes). Despite these limitations, the present review provides a valuable synthesis of information of literature both in the English and Chinese language on the use of Tai Chi in stroke rehabilitation.

CONCLUSIONS

Tai Chi exercise might be beneficial with respect to balance, quality-of-life, and mental health in survivors of stroke; however, the number of trials and total sample size were too small to draw a firm conclusion. More rigorous randomized controlled trials with larger sample sizes and longer treatment periods are required to determine whether Tai Chi is effective in stroke rehabilitation.

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