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Current trends in tai chi for stroke rehabilitation

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Abstract *Background:* There are an increasing number of studies focusing on the effect of tai chi for different diseases. As a special form of physical activity, tai chi may be beneficial for the rehabilitation of stroke, a leading cause of disability worldwide.

Objective: This review summarizes the existing literature on the potential benefits of tai chi for stroke rehabilitation and offers recommendations for future research.

Methods: Studies on the biomechanics and physiology of tai chi for stroke rehabilitation are reviewed. Research on tai chi for stroke rehabilitation and related diseases are summarized. Finally, the shortcomings of existing studies and recommendations for future studies are discussed.

Conclusions: Tai chi appears to be beneficial for stroke rehabilitation. But reporting quality of existing studies are sub-optimal. Future trials should define tai chi style, apply rigorous methodology to sample size calculation, randomization, recruiting criteria, and outcome measures. To avoid inadequacies during the research and reporting processes, investigators may wish to follow CONSORT guidelines and refer to well-conducted clinical studies on tai chi.

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Introduction

Stroke is the second most common cause of death and a major cause of disability worldwide.¹ Stroke greatly impacts quality of life of survivors and is an immense public health burden.² With the population aging and lifestyle changing, the burden is projected to increase markedly during the next 20 years, especially in developing countries.³ An epidemiologic study published in 2007 indicated that China had over 7 million stroke survivors, approximately 70% of whom experienced functional disabilities.⁴ This reality is a powerful impetus to search for effective modalities of treatment for stroke rehabilitation.

Tai chi (also known as tai ji or tai chi chuan) is a form of physical activity that is widely practiced in China and throughout the world. Tai chi originated in China as a martial art hundreds of years ago.⁵ Based on the mind-body connection, tai chi combines breathing control, meditation, and physical movement, to settle and relax the mind, with the aim of enhancing balance, strength, posture, coordination, and flexibility.⁶ Numerous studies have been conducted on the clinical application of tai chi,^{7,8} and have validated its effect in improving symptoms of conditions such as fibromyalgia and Parkinson disease.^{9,10}

Physical activity is an important component of stroke rehabilitation to reduce disability. Thus, tai chi has been incorporated into stroke rehabilitation programs.^{11–13} The objective of this review is to summarize the literature on the potential benefits of tai chi for stroke rehabilitation and to offer recommendations for future research.

Current trends in tai chi for stroke rehabilitation

The biomechanics and physiology of tai chi for stroke rehabilitation

Tai chi is a blend of slow, gentle, helical movements and meditation, deep breathing, and full-body relaxation. It is a unique intervention that integrates physiology, psychology, physiologic, psychological, emotional, spiritual, and behavioral components.⁹ The core of tai chi practice is similar to that of the Bobath and proprioceptive neuromuscular facilitation (PNF) stroke rehabilitation techniques, making tai chi to stroke rehabilitation.^{13,14} A previous review also suggested that tai chi is safe and viable for persons with disabilities and may serve as an additional exercise modality of rehabilitation among stroke survivors.¹¹

The helical nature of most tai chi movements are aimed at strengthening the limbs and core muscles of the abdomen and back.¹⁵ This corresponds with conventional stroke rehabilitation techniques, which also focus on strength exercises for the limbs and the trunk. Since tai chi is practiced while on the feet, it is also a weight-bearing exercise that improves balance similar to conventional rehabilitation.¹⁴ Research by Matjacic et al demonstrated that helical movements increase stimulation of neuronal excitability of motor neurons in stroke patients.¹⁶ The requirement of deep breathing and relaxation of the body

and mind when practicing tai chi is consistent with stroke rehabilitation therapies that encourage patients to relax and stay calm to achieve a better recovery. One of the most important principles of tai chi is “conquering the unyielding with the yielding,” which corresponds with physiotherapy treatment of spasticity with gentle manipulation.

Clinical studies on tai chi for stroke rehabilitation

Our original intention was to conduct a systematic review of tai chi for stroke rehabilitation. However, after meticulous literature retrieval in databases that included the Cochrane Library, PubMed, EMBASE, Chinese Biomedical Database, Wanfang Database, and China National Knowledge Infrastructure up to March 2015, we found only a limited number of studies that applied tai chi for stroke rehabilitation.¹⁷ Thus, instead of a systematic review, we present a general review of results of the studies below.

Taylor-Piliae et al. conducted a prospective pilot study in which 28 stroke survivors attended a community-based Yang-style tai chi program. Outcome measures included safety, program adherence, falls or adverse events, and participant satisfaction. Results indicated that tai chi was well tolerated with an adherence rate of 92% with no falls or other adverse events. Participants were highly satisfied. Thus, Yang-style tai chi is safe and achievable as a community-based rehabilitation program for stroke patients.¹⁸ A single-blind, randomized controlled trial also by Taylor-Piliae et al. examined how tai chi affected physical function, including fall rates and quality of life in stroke patients.¹⁹ There were 145 participants who were 50 years of age or older and 3 or more months post-stroke. Participants were randomized to 3 groups: short-form tai chi, strength and range of movement exercises (SS), and usual care. During the 12-week study, the tai chi and SS groups attended a 1-h class 3 times a week, and the usual care group received written materials and resources on physical activity and had weekly phone calls provide individual attention and monitor their health. Results showed that tai chi intervention reduced fall rates more effectively than SS or usual care interventions.

Researchers in Hong Kong carried out a randomized controlled trial to investigate whether short-form tai chi improved standing balance in stroke survivors.²⁰ Adapted from Sun-style tai chi, short-form tai chi consists of 12 postures that require concentration to perform whole-body movements in continuous sequence. Patients with a history of stroke longer than 6 months after onset and the ability to walk at least 6 m were included in the study. A total of 136 patients were randomly assigned to a tai chi group or a general exercise group. Scores of dynamic standing balance, standing equilibrium, and time-up-and-go were evaluated at 6 weeks (mid-program), 12 weeks (end-program), and 18 weeks (follow-up). Results indicated that the tai chi group demonstrated significantly better improvements over the general exercise group in standing balance and equilibrium at the end-program and follow-up assessments but not in the timed-up-and-go scores.

A study by Zhou et al. investigated the effect of tai chi on balance, anxiety, and general quality of life in stroke

survivors.²¹ Sixty-eight stroke patients with stable vital signs and muscle strength grades 4 and 5 (Medical Research Council Muscle Strength Grading System) were recruited to participate in either 24-form tai chi or standard rehabilitation. The tai chi group practiced twice a week for 1 month. Compared with standard rehabilitation, tai chi significantly improved Berg balance, Hamilton anxiety, and quality of life scores.

In a recent prospective randomized controlled study by Zheng et al., stroke survivors participated in tai chi or conventional rehabilitation for 1 year.²² Results indicated that tai chi improved activities of daily living and emotional status. But the authors failed to provide details of the tai chi exercise.

HY Li et al. compared a modified tai chi program with conventional rehabilitation for stroke survivors who were unable to stand or walk.²³ The tai chi program consisted of sequential elements over the 6-week study period: tai chi visual imagery training while lying in bed, bedside tai chi standing exercises, and basic tai chi movements away from the bed. The daily tai chi sessions were followed by proprioception training using a Technobody Pro-Kin apparatus. Results showed that this type of sequential tai chi program combined with proprioception training improved standing balance and equilibrium in stroke patients.

X Li et al. also investigated tai chi visual imagery training as a supplemental rehabilitation technique for bedridden stroke survivors.²⁴ In the study, 32 patients in the control group received conventional rehabilitation while 35 patients received tai chi visual imagery training plus conventional therapy. Results indicated that tai chi visual imagery training was effective in enhancing pinch strength, motor function, and activities of daily living of the stroke-affected upper limbs.

In research by YL Li et al., 68 post-stroke depression patients were randomly assigned to receive either sitting tai chi plus conventional rehabilitation or rehabilitation alone.²⁵ After the 5-week study period, patients in the tai chi group had significantly higher scores on the Hamilton Depression Rating Scale than patients who received only conventional rehabilitation, indicating that sitting tai chi improved symptoms of post-stroke depression.

Studies on tai chi for stroke-related diseases

Hypertension and atrial fibrillation are the primary risk factors for stroke.²⁶ Results of many studies have shown the beneficial effects of tai chi for various cardiovascular diseases and their secondary prevention.^{27–30} There is encouraging evidence that tai chi is effective in lowering blood pressure in hypertensive patients.^{31,32} Tai chi has also been shown to improve quality of life in persons with cardiovascular disease.^{30,32}

Depression, anxiety, and other emotional and behavioral disorders are common in stroke survivors.³³ The slow, moderate movements of tai chi are ideal not only for improving physical balance and symptoms such as high blood pressure, but also for enhancing psychological well-being.^{34,35} Research indicates that tai chi helps improve mood problems, reduces levels of emotions such as anger and sadness, and enhances happiness and even sleep quality.^{6,35}

Recommendations for future studies on tai chi for stroke rehabilitation

Application of tai chi for stroke rehabilitation is based on well-founded theory,¹⁴ and studies have shown that tai chi appears to be beneficial for stroke rehabilitation.³⁶ However, the reporting quality of existing studies is below standard and considerable improvements are warranted to meet the Consolidated Standards for Reporting Trials (CONSORT) guidelines.^{7,36,37} Generally, the most poorly reported items were associated with inadequate details of tai chi intervention, statement of randomization and blinding, recruitment criteria, and sample size determination. These issues are discussed next.

Tai chi intervention

In a clinical trial, the intervention should be described clearly and concisely to facilitate comparison and replication of the treatment by other researchers. Tai chi is a complex mind-body practice comprised of many components. Thus, stressing different components can impact estimation of the results differently.⁷ There are numerous styles of tai chi, such as Yang, Chen, and Sun, each having short and long forms (form refers to number of movements). The movements vary from style to style. The studies on tai chi for stroke rehabilitation or other diseases that we reviewed failed to describe clearly the tai chi intervention or only indicated the style of tai chi. Therefore, questions that should be addressed in future studies and reported include: tai chi training – such as description of the style, length of each session, frequency of sessions, length of tai chi rehabilitation and study period, as well as certification or other credentials of tai chi instructors. Li et al. recommended a 10-item mini-checklist adapted from previous reviews to assess the quality of studies reporting the clinical effect of tai chi.⁷ To improve the quality of future studies, we recommend that investigators refer to this checklist to avoid potential problems in describing details of their tai chi intervention.

Novel modifications of tai chi have been developed for stroke survivors with ambulatory dysfunction such as inability to stand or walk. Tai chi imagery is similar to motor imagery for stroke rehabilitation,³⁸ and has been studied in stroke patients who are bedridden.²⁴ However, because of the complexities of tai chi imagery, further rigorous studies are needed to confirm its effects. Wheelchair tai chi, invented by Li in the 1990s is popular in China,^{39,40} but its effects also warrant further study.

Eligibility criteria

Previous research has demonstrated that post-stroke rehabilitation should be initiated as early as possible when a patient's vital signs are stable.^{41,42} However, inclusion criteria of stroke patients in existing studies were 3–6 months or even longer after stroke onset. This was acceptable to assess the feasibility of tai chi for stroke rehabilitation but cannot be regarded as assessment of the overall effect of tai chi for stroke rehabilitation because no

studies have explored the rehabilitative effect of tai chi for stroke within 3 months of onset.

Argument exists that tai chi is only suitable for stroke survivors who are ambulatory. For this reason, past studies did not recruit participants within 3 months post-stroke to ensure that participants were capable of practicing tai chi on their own. For example, eligibility criteria applied in the Taylor-Piliae et al. study were screening patients for safety using standardized tests to assess functional disability, overall physical function, and cognitive impairment.^{18,19} Au-Yeung et al. restricted recruitment to stroke patients with the ability to walk at least 6 m,²⁰ and Zhou et al. recruited only stroke patients with stable vital signs and muscle strength grades 4 and 5.²¹ Thus, future studies should include stroke patients of varying degrees of disability to better appraise the comprehensive effect of tai chi for stroke rehabilitation.

Outcome measures

The Fugl-Meyer Assessment (FMA), National Institutes of Health Stroke Scale (NIHSS), Barthel Index (BI), and modified Rankin Scale (mRS) are widely used in large-scale stroke trials to document baseline and outcome severity of motor impairment, stroke severity, quality of life, and disability, respectively.^{43–45} Other assessment tools, such as the Berg Balance Scale, have been used to evaluate the effect of tai chi for stroke rehabilitation.⁴⁶ However, the aforementioned tools share the common shortcoming of appraiser bias. Thus, adding an objective outcome measurement would improve reliability and scientific authenticity of the results of studies on tai chi for stroke rehabilitation. Tools such as plantar pressure measurement and DNA methylation profiling may serve as unbiased assessments to better understand the physiologic mechanisms of tai chi.^{47,48}

Sample size

To detect statistically significant differences between interventions, large enough sample sizes are required in clinical trials. In some instances, an insignificant finding is not only because the intervention was not effective but also because of small sample size.⁷ In our review of the literature, we found that nearly none of the existing studies on tai chi for stroke rehabilitation reported how sample size was determined. Only the study by Taylor-Piliae et al. indicated that a sample size of 52 subjects in each group was needed to detect statistical significance between interventions.¹⁸ Investigators of future studies may wish refer to Taylor's paper to understand how to determine sample size.

Randomization and blinding

The purpose of randomization and blinding is to reduce reporting and measurement bias and ensure the validity of the study results. However, we found few studies that detailed their randomization process. In reality, it is not feasible to blind participants and investigators in a clinical trial on tai chi. Thus, every effort should be made to ensure that statisticians who assess outcome measures are blinded from the group assignment to eliminate measurement bias.

Additional recommendations

The long-term effects of tai chi for stroke rehabilitation have not been well studied. We highly recommend that a multi-center study be undertaken to validate the effects of tai chi for stroke patients with different levels of impairment. Adverse events have also not been well documented in existing studies. Future studies should provide clear reporting of adverse events to evaluate the risks of tai chi rehabilitation programs. Post-stroke rehabilitation is a heavy financial burden for both patients' families and the healthcare system. Therefore, attention should also be paid to the efficacy and cost-effectiveness of tai chi rehabilitation for stroke. Rigorous clinical studies have been published on tai chi for fibromyalgia and Parkinson disease.^{9,10} Investigators designing studies on tai chi for stroke rehabilitation may wish to refer to these papers.

Conclusions

Our review of the current literature suggests that tai chi appears to be beneficial for stroke rehabilitation. However, the reporting quality of existing studies is sub-optimal and substantial improvements are required to validate the effects of tai chi and its underlying mechanisms.

Conflict of interests

The authors declare that they have no competing interests.

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