



Concepts and Application of Tai Ji in Stroke Rehabilitation: A Narrative Review

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Abstract

Stroke remains a leading cause of adult disability, and it decreases the health-related quality of life due to functional disability and poor functional recovery in stroke. Tai Ji has been recently introduced to overcome disabilities. This review aims to explain the effects of Tai Ji on functional recovery in stroke patients, linking it to current approaches, concepts and therapies such as Bobath and proprioceptive neuromuscular facilitation techniques. A compilation of recent literature on Tai Ji's use in stroke rehabilitation from Google scholar and PubMed Central (2018 to 2022). The benefits of Tai Ji in stroke functional recovery were studied and explained based on its similarity in concepts to current conventional stroke rehabilitation approaches. There were few randomized controlled trials on Tai Ji in functional recovery among stroke patients. However, all literature identified Tai Ji as beneficial in stroke rehabilitation. However, there was no literature on explaining the Tai Ji movement based on current conventional stroke rehabilitation approaches. Tai Ji carries similar theories to the current neurorehabilitation approach. Tai Ji can be modified and incorporated into stroke rehabilitation programs based on patients' needs to produce promising outcomes.

Keywords: Tai Ji; Stroke rehabilitation; Review

Introduction

Stroke is the second leading cause of death (11.6% of total death globally) and the major cause of disability globally, affecting >80 million survivors (1–3). Functional disability and poor functional recovery in stroke were associated with decreased health-related quality of life, leading to an increased public health burden (4). A recent review on trunk electromyographic (EMG) activity following stroke reported that individuals with stroke

demonstrated differences in the trunk EMG recruitment timing, magnitude, and symmetry when comparing the paretic and non-paretic sides (5). While functional disability such as poor postural control and gait performance in stroke is associated with trunk control disability commonly occurring after a stroke, the trunk component should not be neglected when developing a stroke rehabilitation program (6).



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Tai Ji (A.K.A Tai Chi) is a famous intangible cultural heritage originating from China as a martial art centuries ago that has recently become popular in the western world (7,8). It comprises various styles and forms using bare hands or weapons such as sword, sabre, spear, and fan that have been used for self-defense, mindful nurturing of well-being, and fitness enhancement (9). Today, the art has been expanded to more contemporary applications focusing on physical and mental health promotion, enhancement of wellbeing, physical rehabilitation and disease prevention. It is a safe form of gentle physical exercise integrating meditation and breathing components to promote relaxation and tranquility of the mind besides improving postural stability, postural control, movement coordination, strength, and flexibility. Up to date, a substantial number of studies and reviews conducted on the clinical use of Tai Ji in stroke rehabilitation, and most of the studies reported Tai Ji to yield positive results (10–13). As different styles of Tai Ji may have different focus which may affect the rehabilitation outcomes, not all these studies present specify the style used.

Tai Ji had been reported to improve postural stability and physical function (10,11,13–16), cardiorespiratory function (17,18), and mental health (11,13,15,18–20), which is beneficial when incorporated into stroke rehabilitation. This article is the first to review and explain the effects of Tai Ji on functional recovery in stroke patients, linking it to current approaches, concepts and therapies such as Bobath and proprioceptive neuromuscular facilitation techniques.

Methods

This review studies the effects of Tai Ji on functional recovery in stroke patients and seeks to explain it based on the currently available theories and approaches to neurorehabilitation. The review authors searched on Google scholar and PubMed Central to find recent literature from 2018 to 2022 supporting or against Tai Ji for functional recovery among stroke patients. The different styles, methods and Tai Ji movements were studied and linked

to the basic concepts. The primary outcome studied was functional ability in activities of daily living, and secondary outcomes were: Cognitive function and cardiovascular fitness, which may affect the primary outcome.

Results

The review includes 45 literatures relating to Tai Ji in stroke rehabilitation, where 11 were randomized control trials. All articles favored Tai Ji to be beneficial in stroke rehabilitation however, it should also be practiced with precaution. As such, two works of literature have reported that the wrong practice of Tai Ji could be detrimental, causing knee pain. According to this literature, practicing the movement wrongly increases stress on the knee ligaments causing pain. To date, there is no literature on Tai Ji movements concerning the current approaches to stroke rehabilitation such as motor relearning program (MRP), proprioceptive neuromuscular facilitation (PNF) and the Bobath concept.

Principles of Tai Ji in relation to conventional stroke rehabilitation

Several Tai Ji styles are practiced globally, including Chen, Yang, Sun and Wu (21,22). Although these styles may have slight differences in focus, they carry the same basic principles of slow, circular, continuous movements combined with deep diaphragmatic breathing and maintenance of an upright posture (23–25). These principles are adopted in conventional rehabilitation strategies such as MRP, PNF, constrain-induced movement therapy, and the Bobath concept, which relays on neuroplasticity.

Neuroplasticity involves adaptive structural and functional changes to the brain in response to intrinsic or extrinsic stimuli (26). As such conventional rehabilitation strategies aim to stimulate the central and peripheral nervous system through electrical stimulation and movements through functional training and exercises (27–31). Exercise and motor training promote dendrites arborizations and neuronal growth leading to new synaptic

formation, which is the key to reorganizing neural function (32). Conventional therapies such as constrain-induced movement therapy, which involves restraining the unaffected side while forcing the use of the affected side, had been reported to increase dendritic arborization (33). Similarly, other task-specific programs such as motor relearning also increase dendrites arborizations leading to functional reorganization (34). The authors also state that repetition of movement, which is not helpful, is insufficient to produce increased motor cortical representations. Tai Ji movements are mainly martial arts based, unlike constrained induced therapy and motor relearning programs that focus on daily tasks (30,33). Despite that, some studies reported Tai Ji promotes neuroplasticity (24,35).

To explain how Tai Ji promotes neuroplasticity, it is essential to understand that, functional movement to perform a particular task, does not depend solely on single plane movement but, rather, a more complex movement involving the activation and inhibition of certain muscle groups (36,37). As such, PNF involves a series of diagonal movement patterns that resembles components of normal functional movements and has been reported to produce greater adaptive plasticity through the increase of neural recruitment of the dorsolateral prefrontal cortex, and the primary motor cortex as compared to the single plane movement (6,38). Although Tai Ji movements are martial art based and do not specifically focus on daily tasks, circular movement in Tai Ji carries similar concepts of PNF diagonal and spiral movement. As an example, the 'single whip' movement in Chen Style Tai Ji requires trunk rotation along with both forearm supination, flexion of right and extension of left elbow, followed by trunk rotation, flexion of left and extension of the right elbow and then, abduction of both shoulders with right elbow, wrist, and flexion of fingers, after that adduction and internal rotation of left shoulder followed by, horizontal extension and external rotation of the left shoulder, with wrist extension. Although the movement patterns differ between Tai Ji and PNF, they are diagonal and resemble components of normal

functional movement. In addition, Tai Ji movements are driven from the waist, known as 'Dan Tian' (25).

Similarly, Bobath concepts developed by Berta Bobath highlight the interaction of postural control involving the trunk and head to the movement (39,40). Bobath exercise improves walking ability and reduces spasticity (41). In Tai Ji, all body movements are directed by the waist, which serves as an axis for limb movements (25,42). Since trunk control is commonly reduced post-stroke, electromyography (EMG) study reported that the paretic side demonstrated slower, lower EMG recruitment timing and magnitude (43). Hence, we believe that the focus on the trunk in Tai Ji movement may stimulate some extent of adaptive plasticity, which aids in the recovery of postural control. Postural control determines static and dynamic postural stability through the ability to maintain the line of gravity within the base of support; therefore, good postural control is one of the main components for good static and dynamic postural stability (44–46). In addition, trunk rotation and pelvic movements emphasized in Tai Ji are also essential components of human gait (47,48).

One major key to successful neurorehabilitation is emphasizing movement quality while minimizing compensatory behaviors (49). Thus, slow movement is the key to the awareness that minimizes compensatory behavior, leading to learning that stimulates neuroplasticity and reinnervation. Besides, it enables the therapist to capture those compensatory behaviors and provide verbal and (or) tactile cues for movement correction. Slow training has a better effect on upper limb motor function than fast training (50). In Tai Ji, movements are usually done at a slow pace which may also alternate with some fast explosive movement known as 'fa jin' such as in Chen style Tai Ji (24,25). In addition, the slow movements in Tai Ji are also reported to promote brain function and improve cognitive flexibility, which is more holistic and focuses on the patient's biopsychosocial model as compared to conventional therapy; therefore, Tai Ji is known as the moving meditation (51,52). Since Tai Ji is an art, the practitioner

may also choose to perform them at a faster pace once the practitioner is familiar with the movements or during 'Tui Shou' (Tai Ji Sparring), which carries different benefits such as cardiovascular health (53,54). Besides, the fundamental stance in Tai Ji, known as horse-riding stance or horse-riding posture 'ma bu', requires eccentric contraction of the lower limb muscles, particularly the quadriceps, and strengthens the lower limb, which is vital in static and dynamic balance (55,56).

Incorporating Tai Ji in stroke rehabilitation

Tai Ji is a very versatile art that can be modified to suit patients' needs. For instant, it had been done in a sitting position (13,57,58), and mainly focused on performing a single and particular movement (59,60) or creating a new form consisting of movements which suit the patient's needs. Even when performing the movement, the therapist can incorporate them with PNF concepts such as rhythmic initiation. In performing that, the therapist will be positioned behind the patient, initiate the desired Tai Ji movement passively and gradually progress into the active assisted, active resisted, and finally allow the patient to perform the movement actively (61).

Performing Tai Ji in a sitting position benefits those who cannot stand and ambulate due to poor trunk control. Participants who performed 12 weeks Tai Ji exercise demonstrated improved upper limb function based on Fugl-Meyer Assessment Upper Extremity and Wolf Motor Function Test, balance control based on Berg Balance Scale, and sitting balance control based on Trunk Impairment Scale (13). In addition, the Tai Ji group also demonstrated improved shoulder range of motion, activities of daily living and quality of life. Although there are not many recent randomized control trials on this aspect, we believed this concept was similar to that of Bobath, where movements such as 'Yun Shou' focus greatly on trunk motion (40). Moreover, movements such as 'Yun Shou' have been reported to improve balance ability and functional mobility (59).

Apart from 'Yun Shou', we also believe 'Chan Shi' (also known as silk reeling), one of the movements emphasized by Chen style Tai Ji, can be beneficial

for hemiplegic patient who does not have control of their affected upper limb (62). The therapist can start by educating the patient on single hand silk reeling using the non-affected side. Once the patient is familiar with the movement, the therapist can incorporate rhythmic initiation into that movement on the affected upper limb. As this movement requires waist and circular movement of the shoulder and wrist with some flexion extension of the elbow joint and relaxation, we are optimistic that such movements can activate muscle groups leading to neuroplasticity. However, we are unable to identify any related articles using silk reeling on stroke rehabilitation in Google scholar using the following sets of keywords: 1) 'silk reeling' and 'tai chi' and 'neurorehabilitation' and 'stroke', and 2) 'Chan Shi' and 'tai chi' and 'neurorehabilitation' and 'stroke'. Hence, there is room for further studies in this aspect.

For those with fair to good trunk control, however, poor balance due to lower limb weakness, we would recommend 'Ma Bu', 'Chan Chuang' and 'Qi shi'. According to a randomized control study involving 72 subacute stroke inpatients, 'Chan Chuang' had been reported to demonstrate improvement in muscle strength and quality of life as compared to those receiving standard care (63). In addition, due to its meditative nature when performing the stance, many studies have reported it to improve cognitive and mental function (64–66). The justification where this movement improves the lower limb muscle strength leading to better static postural stability can be seen through its form, where it puts the quadriceps in eccentric contraction. According to a randomized controlled trial on hemiparesis patients, eccentric contraction of the quadriceps promotes lower limb strength based on one repetition maximum and gait performance based on six-minute-walk-test (67), although six-minute-walk-test incorporated with cognitive behavioral-based therapy has promising outcomes in pain (68). Besides, it was reported that eccentric muscle contractions were more effective for improving neuromuscular activation, strength, and walking speed than concentric contractions (69). The reason for that is explained where eccentric muscle contraction leads

to the generation of greater force while requiring less motor unit activation, and consumes less oxygen and energy for a given muscle force compared to concentric and isometric contractions leading to adaptations (69,70). Hence, it is beneficial in gaining strength with less energy cost compared to other resistive training such as concentric or isometric contractions (71). The authors also believed that eccentric contractions followed by a concentric contraction of the lower limb, such as during 'Qi Shi' (also known as the opening move), could generate more force which can be used in stroke rehabilitation to reduce deficits in the concentric contraction. For patients who have yet to have good postural stability and lower limb strength, these movements can be done by leaning against the wall.

Discussion

Challenges in incorporating Tai Ji into stroke rehabilitation

Tai Ji was proven beneficial in stroke rehabilitation based on current concepts and studies. In addition, a systematic review reported that Tai Ji had the most substantial evidence in improving aerobic endurance, reduced falls, functional reach, dynamic gait, walking speed, and static and dynamic balance compared to Pilates and yoga (72). However, incorporating Tai Ji into stroke rehabilitation also comes with a challenge. One of the main challenges is the lack of physiotherapists who are also professional Tai Ji coaches. At the same time, some who taught Tai Ji do not undergo proper training, but online sources such as YouTube and books result in incorrect postures, particularly the knee position (25). Incorrect Tai Ji posture has been reported to increase stress on the knee ligaments, resulting in knee pain which is detrimental to the patient's quality of life and functional recovery (73–75). In addition, there were no regulatory bodies for Tai Ji, and patients are in the dark about their therapist's capabilities in delivering and educating them on the proper effective Tai Ji move for stroke rehabilitation. Future studies could be conducted to validate Tai Ji with the incorporation

within the mobile health development and evaluation framework for better usability and acceptability in stroke rehabilitation (76).

Implications in neurorehabilitation

There are not many recent studies on Tai Ji regarding functional recovery among stroke patients, moreover, most studies were conducted mainly on one region. However, all studies available reported the beneficial effects of Tai Ji in stroke rehabilitation. In addition, this review also studies some of the important and commonly used forms of Tai Ji, and explains the movement based on current conventional concepts and approaches for stroke rehabilitation. This review also provides insights on how Tai Ji can be modified, carried out, and incorporated into neurorehabilitation on stroke patients.

Conclusion

The essence of Tai Ji carries similar theories to the current neurorehabilitation approach. Hence, incorporating Tai Ji into stroke rehabilitation programs can yield promising outcomes. In addition to the meditative part of Tai Ji, which improves the patient's cognitive function, Tai Ji is a more holistic approach when compared to the current neurorehabilitation model. Besides, it is versatile because its form and style can be modified based on each patient's needs. While Chen style Tai Ji is the parent for all Tai Ji styles, Sun style is the gentlest form and hence, more manageable for a functionally compromised stroke patient to complete the entire form. However, single movements, regardless of Tai Ji styles, can be adopted from any style and be modified in sitting, leaning, or standing positions based on the patient's needs. The major challenge in implementing Tai Ji into stroke rehabilitation is the lack of regulatory bodies to screen out those incapable of delivering the art effectively for stroke rehabilitation.

Journalism Ethics considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

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Declaration of interest

The authors declare no conflicts of interest.

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