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Exploring the Adaptability of Tai Chi to Stroke Rehabilitation

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Abstract

Purpose—To assess the feasibility, safety, and preliminary estimates of effectiveness of Tai Chi on functional outcomes in stroke survivors.

Design—A mixed-method study with a single-group repeated-measure design and in-depth interviews.

Methods—Fourteen stroke survivors with hemiplegia were recruited to participate in a Tai Chi program, twice weekly for 12 months. Outcomes included physical function, self-efficacy, and activity of daily living measured at 3 month intervals for 12 months.

Findings—Ten participants (mean age 68.5 years) completed all assessments with significantly improved balance ($X^2=14.08$, $p=.007$), flexibility ($X^2=11.70$, $p=.020$), and self-efficacy ($X^2=21.84$, $p<.001$) over 12 months. Qualitative results highlighted the positive impact on physical improvement, psychological wellbeing, social support, and improved confidence in performing activities of daily living.

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Declaration of Interest

Peter Wayne is the founder and sole owner of the Tree of Life Tai Chi Center. Peter Wayne's interests were reviewed and managed by the Brigham and Women's Hospital and Partner's HealthCare in accordance with their conflict of interest policies. For remaining authors, none were declared.

Conclusion—An adapted Tai Chi program was safe, feasible, and well-received in community dwelling stroke survivors.

Clinical Relevance—The Tai Chi based rehabilitation program shows promise for improving function and balance outcomes related to fall prevention in stroke survivors.

Keywords

stroke; Tai Chi; rehabilitation; activities of daily living; self-efficacy; physical functioning

Introduction

Stroke is one of the leading causes of persistent disability and premature death in adults in Korea and worldwide (Hong et al., 2013; Office, 2015). Most stroke survivors experience persistent difficulties in performing activities of daily living (ADL) (Winstein et al., 2016), and when present, chronic paralysis and motor control deficits contribute to significant limitations in physical and social functioning (Michael, 2002; Sunnerhagen, 2007).

In Korea, stroke patients receive intensive treatment during the acute recovery stage, but relatively few patients are referred to rehabilitation programs, mainly due to limited access to rehabilitation hospitals and financial costs to patients (Min, 2002). For those who do participate in rehabilitation programs, various exercise-related symptoms such as shortness of breath, fatigue, pain, and fear of falling can pose significant barriers to compliance (Kim, Kwon, Hur, Roh, & Shin, 2012; Simpson, Eng, & Tawashy, 2011). Consequently, functional gains are not commonly achieved, leading most stroke patients to feel discouraged and to discontinue treatment (Association, 2010; Dobkin, 2004). Even for those who complete the rehabilitation program, increased risk of falling remains a significant concern, with approximately 70% of individuals experiencing a fall during the first 6 months after hospital discharge (Winstein et al., 2016).

Tai Chi is a popular Asian mind-body exercise shown to be effective in improving balance, mobility, muscle strength, and reduction of falls in older adults (Huang & Liu, 2015; Logghe et al., 2010). A handful of smaller trials have specifically reported benefits of Tai Chi to physical function, falls, and quality of life in stroke survivors (Ding, 2012; Hart et al., 2004; Kim, Kim, & Lee, 2015; Taylor-Piliae et al., 2014). However, to the best of our knowledge, no previous study has explored the beneficial effects of Tai Chi for stroke rehabilitation among community dwelling stroke survivors in South Korea.

Building on the success of previous clinical trials in Korea evaluating Tai Chi for other health conditions (e.g. arthritis, diabetes, and cardiovascular disease) (Kim, So, & Song, 2010; Park & Song, 2013), the purpose of this study was to assess the feasibility and safety of a clinical trial evaluating the effects of Tai Chi based rehabilitation program on physical function and ADL in stroke survivors. Employing a mixed-methods approach, we evaluated feasibility of participant recruitment and safety and adherence to a Sun-style Tai Chi for health program (Lam, 2011) adapted for a nurse-led stroke rehabilitation setting. We characterized preliminary pre-post estimates of effectiveness on physical function, self-efficacy, and ADL. We also reported results of qualitative interviews to characterize

participants' experiences with the Tai Chi program. Findings are discussed with respect to lessons learned relevant to designing a phase II clinical trial.

Methods

Study design

A mixed-method design was employed; including a prospective single-arm study with repeated measures and in-depth semi-structured interviews for those completing the study. A battery of physical function outcomes was assessed at baseline and at 3 month intervals over a 12-month period. The study was approved by the Institutional Review Board at the university where the lead author was affiliated (No2-1046881-AN01201505-HR-020-01-04).

Study participants and flow

Recruitment relied on placement of study posters in community health centers and in the common areas of residential buildings. After screening potential participants who initially contacted the research nurse, 14 stroke survivors were recruited from the community of D district in Seoul, Korea. Participant inclusion criteria included: 1) self-reported diagnosis of hemiplegic stroke more than one year prior to enrollment; 2) 40 to 80 years of age; 3) no longer hospitalized; 4) ambulatory skills (with or without mobility aids) sufficient to attend and participate in Tai Chi program twice weekly for 12 months; and 5) ability to communicate and understand the questionnaires. Exclusion criteria included: 1) prior participation in long-term rehabilitation program before hospital discharge; 2) current involvement in formal exercise or rehabilitation program; 2) mobility dysfunction caused by brain injury or vestibular problems; and 3) severe medical conditions such as heart, lung, or renal disease. Interested participants were instructed to contact the research assistant for an in-person interview. During the interview, the purpose of study was explained, and participants were screened for eligibility. Interested and eligible participants signed a consent form, and were scheduled for baseline assessment before the class. Participant flow through the study is shown in Figure 1.

Intervention: Tai Chi based stroke rehabilitation program

The Tai Chi program was delivered in 60 minute classes, twice per week for 12 months with progressive increases in duration and intensity. The Tai Chi for health program developed for arthritis patients (Lam & Horstman, 2002) was adapted for stroke survivors. The original program consisted of 21 Sun-style Tai Chi movements, employing qigong breathing, meditative music, and safety features for individuals with arthritis. This program has been reported to be safe to apply to various vulnerable populations including arthritic and fall-prone elderly, with relatively low dropout rate and no serious adverse effect (Choi, Moon, & Song, 2005; Kim et al., 2010; Song, Lee, Lam, & Bae, 2003). The Tai Chi based stroke rehabilitation program used in the present study was further adapted and modified based on the following principles (Kim & Park, 2004; Lam, 2011; Lam & Horstman, 2002) (Figure 2):

- Movement control: Slow and gentle movements were applied at a constant speed from the beginning to the end. The participants used motor-imagery based

visualization to enhance kinesthetic and motor outcomes in both the healthy and hemiplegic limbs.

- **Body posture:** While seated, standing, or walking, the participants were encouraged to maintain an upright posture with a lowered center of gravity. Tai Chi specific elements of gait dynamics (Tai Chi walking steps) include foot placement and weight transference in both standing and seated instruction (i.e., plantar pressure changes while seated).
- **Psychological components:** The participants were encouraged to relax during the movements to loosen the joints and muscles. Meditative music was used during the program to release body tension and help the participants achieve mental quietness.

A team of 3 certified Tai Chi instructors with formal nursing training, who also had experience in the teaching older adults with chronic illness guided the program twice weekly for 12 months in an auditorium within the community health center. Each session consisted of warm-up exercises (10 minutes), Tai Chi walking steps with empty stance and weight transference (5 minutes), qigong breathing (5 minutes), formal Tai Chi movements (30 minutes), and cool-down exercise (5 minutes).

Training in Tai Chi movements progressively increased in duration and intensity over the 12-month program. All participants were seated during the warm-up exercises and the practice of weight shifting. Over time, those who were able to stand were encouraged to do so while practicing walking steps with weight transference and Tai Chi movements. A stepwise progressive teaching strategy (Lam, 2011) was applied to teach Tai Chi movements by separately teaching the upper body and the lower body movements so that the participants could follow them easily in sitting or standing positions.

Safety monitoring

The safety of the program was monitored by asking participants at the beginning of each class if they experienced any exercise related symptoms since the previous class. Participants were also encouraged to report any adverse event, during classes, which were also monitored by instructors and nurses at the community health center.

Outcome assessments

All assessments at baseline and follow-up were made by a single team (n=4) of trained research assistants. A small room attached to the auditorium was reserved for outcome assessments. The assessment lasted approximately 30 minutes per person. To avoid fatigue of the participants and to insure the reliability of the assessment, we limited testing to 2–3 persons per day, taking 3–4 days to complete all assessments at each follow-up time.

Physical function—Grip strength was measured using a digital hand dynamometer (0–90 kg; Labisen KS-301) for both the healthy and hemiplegic hand. The higher score of two repeated measures was recorded for each hand. Flexibility was measured with the standard sit-and-reach (SAR) test (Holt, Pelham, & Burke, 1999). Participants sat on the floor with the legs fully extended and feet touching a wall panel while slowly bending forward to reach

as far as possible, holding this position for at least 2 seconds. The distance between the participant's finger tips and the wall panel was recorded, with higher scores indicating better flexibility. Balance was measured using the 14-item Berg Balance Scale (Berg, Wood-Dauphinee, & Williams, 1995) to assess static standing balance. The maximum total score was 56, with a high score indicating better balance. This scale has been validated in stroke patients (Heinemann, 2010). Mobility was measured by the Timed-Up-and-Go (TUG) test. Time (in seconds) was measured for the participants to stand up from a chair, walk to a line 3 meters away on the floor at normal pace, turn around, and walk back to the chair and sit down (Podsiadlo & Richardson, 1991). The test-retest reliability and inter-rater reliability of this test among stroke patients were 0.98 or higher (Podsiadlo & Richardson, 1991).

Self-efficacy—Self-efficacy was measured with the 17-item Self-efficacy Scale developed for hemiplegic patients, with each item scored using 4 points, from 1 point for “not confident at all” to 4 points for “fully confident”(Lee, 1998). Higher scores indicate higher self-efficacy. The internal consistency was established to be 0.94 in individuals with hemiplegia (Lee, 1998).

Activities of daily living—The performance of ADL was measured with the Korean version of the modified Barthel Index (Jung et al., 2007), consisting of seven items for self-care and four items for mobility, with a maximum score of 100. The internal consistency was reported to be 0.84 in a stroke population in Korea (Jung et al., 2007).

Data analysis

Quantitative analysis—IBM SPSS Statistics (version 22.0) was used for data entry and analysis. Descriptive statistics were used to describe the sociodemographic and health-related characteristics of the participants. The quantitative effects of the program were analyzed with nonparametric statistics including the Friedman test and the Wilcoxon test for post-hoc comparisons of repeated measures.

Qualitative analysis—At the completion of the program, an in-depth semi-structured interview was conducted with each participant by a member of our research team (ML) with formal training in qualitative methods. Interviews were conducted in a quiet office at a community health center. The following broad questions were asked: (1) What is the reason you enrolled in this study and its associated Tai Chi program? (2) How did stroke affect your daily life before the program? (3) Were there any features you most liked about this program? (4) Were there any difficulties you experienced during this program? and (5) What changes do you perceive in yourself as a result of participating in this program? Each interview took between 30 to 60 minutes to complete and was recorded on audiotape with the permission of the subject, and then later transcribed verbatim. Qualitative analyses was guided by a Grounded Theory approach (Foley & Timonen, 2015; Patton, 1990).

Results

Study participants and patient flow

After screening 18 stroke survivors who initially contacted study staff, a total of 14 participants were enrolled over approximately a one-month period. The fourteen participants had a mean age of 68.5 years (range 58 to 76 years), and 60% of them were women (Table 1). All participants were married, with 70% of them living with a spouse or family member. Most of the participants did not smoke or drink alcohol, and 90% of them reported doing some type of exercise. The most common co-morbidities were hypertension (80%), osteoarthritis (60%), heart disease (40%), and diabetes (10%).

During the 12-month study, 4 of the 14 (28.5%) enrolled participants dropped out of the program. The reasons for dropout were as follows: 1 died; 1 was admitted to a hospital for surgery; and 2 could not come to the class due to transportation problems. The remaining 10 participants maintained an average class attendance rate of 72 % over the 12-month period. General characteristics of the 4 drop-outs were not markedly different than remaining 10 in term of age, gender, disease duration, and the baseline outcomes.

Safety

No falls or adverse events related to the intervention were reported by the Tai Chi instructors, research nurses, or by the participants during the study period.

Functioning, self-efficacy, and Activities of Daily Living (ADL)

The effects of the program on physical functioning are summarized in Table 2. Grip strength did not change significantly over time on either the affected side ($\chi^2=4.87$, $p=.300$) or the unaffected side ($\chi^2=0.93$, $p=.920$). Flexibility in bending forward did not change significantly from baseline (-4.80 cm) through to 6 months (-5.70 cm), but significantly improved by 9 months ($\chi^2=11.70$, $p=.020$). Balance assessed with the Berg Balance Scale improved steadily from baseline (mean= 46.20) to 12 months (mean= 51.10), with a significant change noted at 6 months which was maintained through to 12 months ($\chi^2=14.08$, $p=.007$). Mobility assessed with TUG did not improve significantly over time ($\chi^2=5.87$, $p=.209$).

Self-efficacy for ADL significantly improved over time from baseline (50.20 ± 13.91 , mean $\pm$ SD) to 3 months (58.10 ± 10.67), with improved changes remaining significant up to 12 months ($\chi^2=21.84$, $p<.001$). The ability to perform ADLs tended to improve over time from baseline (84.60 ± 25.17) to 3 months (88.60 ± 15.31) and then remained similar up to 12 months, but these changes were not statistically significant ($\chi^2=2.04$, $p=.727$).

Qualitative findings

Analysis of transcribed interviews identified 49 meaningful statements (Table 3). The coded logs were classified and categorized into 4 main themes with 14 sub-themes. The main themes included physical improvement, psychological well-being, social support, and improved independence in ADL.

Theme 1: Physical improvement—Four sub-themes with 9 statements in this category emerged from the analysis. The stroke survivors described that the most important subjective benefits of the Tai Chi program were functional improvements in walking, coordination, and standing (n=4), along with improved balance (n=2), strength (n=1), and flexibility (n=2).

“I used to have a cane when I come to the class, but I don’t need it anymore. I am walking alone. This is what makes me keep coming to the class.”

Theme 2: Psychological well-being—Four sub-themes with 9 statements emerged from the analysis. The stroke survivors reported that they found the Tai Chi program to be enjoyable (n=3), giving a boost to their self-esteem (n=1) and self-confidence (n=1), and most importantly lead to less depressed feelings (n=4).

“I always feel good about myself after the class. I used to stay behind of other people, never stood up since I had a stroke. But I don’t feel depressed anymore. I can talk to other people.”

Theme 3: Social support—Three sub-themes with 25 statements emerged from the analysis. The participants increasingly relied on each other in a small group to exchange their experiences about the same difficulties they faced in their daily lives (n=8). They expressed that they were having fun (n=7), and frequently mentioned the instructors as the critical factor that made them feel comfortable and safe in the program (n=10). The positive class climate and social interaction was frequently mentioned.

“It’s like family here. We come to the class, laughing together, singing together, and doing exercise together. People look at me differently outside because of my disability, but I don’t feel that way. I get up early even on a rainy day to prepare to come here. It’s not hard at all because I feel happy with my friends here.”

Theme 4: Perceived independence in ADL—Three sub-themes with 3 statements emerged from the analysis. The stroke survivors perceived that they could express themselves easily (n=1), and had more control over their ADL despite of their disability (n=2).

“I couldn’t put on my clothes by myself before. I couldn’t wear a swimming suit without help. But look at me, I can now do those things, and I feel good about it.”

Discussion

This pilot study aimed to evaluate the feasibility, safety, and effectiveness of a Tai Chi based rehabilitation program in community-dwelling stroke survivors in Korea. A standardized form of Tai Chi (Lam & Horstman, 2002) was adapted for stroke survivors so that participants could practice Tai Chi either sitting or standing, as well as with hemiplegic limitations, according to their health conditions. The adapted Tai Chi program was well-received by stroke survivors in our study. Average class attendance rate was 72.12% over the 12-month intervention period. Loss to follow-up was modest (4 participants, 28.5%), comparable with other long-term stroke programs (Pollock et al., 2014), and mainly due to non-intervention related reasons such as illness-related death, hospitalization for planned

surgery, and loss of transportation. The intervention also was found to be safe with no serious intervention-related adverse events reported.

Participants' qualitative reports further support the feasibility and the value of a more definitive trial evaluating Tai Chi for stroke rehabilitation in this population. Participants consistently reported that they were satisfied with the program and that they were able to do things that they had not found possible before, which translated into improved confidence in performing ADLs. Most of the participants perceived physical improvement in the early stages of the program, which served as a source of motivation for sustained adherence to the program. Additionally, a number of psychosocial benefits were also reported, including lower levels of depression and increased levels of social support from peers and instructors. The positive effect of Tai Chi, as a form of meditative exercise, on psychological wellbeing such as depression and anxiety, has been recognized in previous reviews (Jahnke, Larkey, Rogers, Etnier, & Lin, 2010; Payne & Crane-Godreau, 2013). The perceived benefits of a Tai Chi-based stroke rehabilitation program along with psychosocial support inherent in integrative mind-body interventions could encourage stroke survivors to participate in such rehabilitation programs more actively and consistently (Yang et al., 2011). This is critical given the low levels of utilization of such programs and the high dropout rates for those who do begin (Min, 2002).

While our clinical findings are based on a small sample using an uncontrolled study design, the quantitative findings suggest that our program is beneficial to stroke survivors' physical function. The participants in our study improved both balance and flexibility with significant within-group effects found following 6 months and 9 months of Tai Chi training respectively. The previous Korean study also reported positive effects of Tai Chi on physical function, balance and quality of life when provided to inpatients diagnosed with stroke (Kim et al., 2015). Previous individual studies, however, reported mixed results on balance when Tai Chi was used with community-dwelling chronic stroke survivors for 6 to 12 weeks (Au-Yeung, Hui-Chan, & Tang, 2009; Hart et al., 2004; Taylor-Piliae et al., 2014). These inconsistent results regarding the impact of Tai Chi on balance may be partly due to the relatively short duration of Tai Chi programs used in prior studies. In our study, significant changes in balance and flexibility were found only after 6–9 months after practicing Tai Chi. Considering the typical features of stroke as a chronic disease, community dwelling stroke survivors may require longer periods of Tai Chi training to show significant changes in physical functioning. A meta-analysis of 8 randomized trials including a total of 820 stroke patients also generally supports a favorable effect of Tai Chi on balance (Chen et al., 2015), but more clinical studies are needed due to methodological heterogeneity in studies, relatively short durations of intervention and follow-up, and lack of studies in Korea stroke survivors.

Our findings support the proposed hypothesis that a Tai Chi program can be used while seated or standing to improve balance and functional outcomes in stroke patients with hemiplegia. Improvement in balance and flexibility is critical for stroke survivors to be able to perform ADL and prevent falls (Chen et al., 2015). A functional feature of Tai Chi includes a greater commitment to single leg stance time during average gait cycles (Wu, Liu, Hitt, & Millon, 2004), along with heightened awareness of body position and center of

gravity control. Of note, improved balance and center of pressure control has been reported following practicing Tai Chi in a seated position (Leung & Tsang, 2008). We hypothesize that our methods of weight transfer training while seated, along with our use of motor imagery based visualization when targeting the hemiplegic limb (Hackney, Lee, Battisto, Crosson, & McGregor, 2015), may have contributed to overall improved balance and motor function (Ridderinkhof & Brass, 2015). The potential underlying mechanisms of the adapted form of Tai Chi warrant further studies.

Study Limitations

A main limitation of this study is that it is based on a single group design with a small sample size. A larger scale randomized controlled study will be needed to draw more definitive conclusions. Another limitation is the heterogeneity of our study population with possible selection bias as participants self-referred to the program.

Implications for Nursing Practice and Research

This pilot study confirmed the feasibility and safety of a 12-month Tai Chi applied stroke rehabilitation program delivered by trained nurses. Sun-style Tai Chi was adapted to a 12-month post-stroke rehabilitation program, which was well-received by stroke survivors with a moderate level of impairment without any adverse effect. The objective effects began to show in 3 months for self-efficacy and in 6 months for balance and flexibility which remained significant up to 12 months. The participants also experienced improved self-efficacy to perform ADL, more control over their disabilities, and reported that they enjoyed the program.

This feasibility study showed that further studies are warranted to examine objective outcomes of the mind and body components of the program with randomized trial. The program response from stroke survivors would vary according to their post-stroke phase, therefore future studies should explicitly evaluate the benefits to stroke survivors at different stages of stroke recovery and with varying levels of functional ability.

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Key Practice Points

- Tai Chi was adapted to a 12-month nurse-led stroke rehabilitation program, which was well-received by community dwelling stroke survivors with a moderate level of impairment without any adverse effect.
- The adapted Tai Chi based rehabilitation program led to improved function and balance outcomes related to potential effects on fall prevention in stroke survivors.
- These preliminary findings support the value of a more definitive trial evaluating Tai Chi for stroke rehabilitation in stroke survivors.

Figure 1.
Study flow diagram

Figure 2.
Features of the Tai Chi-based stroke rehabilitation program

Table 1

Sociodemographic characteristics of the participants

(N=10)		
Characteristic	Categories	Freq (%)
Age	< 60 years	1 (10.0)
	60–70 years	4 (40.0)
	71 years	5 (50.0)
Sex	Male	4 (40.0)
	Female	6 (60.0)
Education	6 years	5 (50.0)
	7–12 years	2 (20.0)
	13 years	3 (30.0)
Living situation	Alone	3 (30.0)
	With spouse	4 (40.0)
	With family	3 (30.0)
Duration of stroke	< 3 years	5 (50.0)
	3–6 years	2 (20.0)
	> 6 years	3 (30.0)
Health habits *	Currently smoking	2 (20.0)
	Currently drinking	2 (20.0)
	Regular exercise	9 (90.0)
Hemiplegic side	Right	4 (40.0)
	Left	6 (60.0)
Chronic disease *	Osteoarthritis	6 (60.0)
	Hypertension	8 (80.0)
	Heart disease	4 (40.0)
	Diabetes	1 (10.0)

* Multiple responses possible; Data are *N*(%) values

Table 2

Effects of the program on physical functioning, self-efficacy, and activities of daily living

Variables	Baseline	3 months	6 months	9 months	12 months	χ^2	<i>p</i>
(N=10)							
Grip strength							
Affected	15.46(12.13)	16.57(13.93)	16.67(13.13)	17.04(13.50)	16.51(14.66)	4.87	.300
Unaffected	23.61(6.49)	23.88(5.03)	23.43(5.71)	23.87(5.53)	23.65(4.26)	0.93	.920
Flexibility	-4.80(7.85)	-4.90(6.57)	-5.70(5.81)	-1.70(6.16)*	-0.30(4.34)*	11.70	.020
Balance	46.20(8.65)	47.70(6.79)	49.70(5.61)*	50.50(4.99)*	51.10(4.04)*	14.08	.007
Mobility	16.70(12.97)	15.60(11.83)	17.20(14.20)	17.20(14.20)	18.80(14.28)	5.87	.209
Self-efficacy	50.20(13.91)	58.10(10.67)*	53.70(12.53)*	56.30(12.14)*	56.30(12.05)*	21.84	<.001
ADL	84.60(25.17)	88.60(15.31)	87.20(14.95)	86.10(15.19)	85.00(16.20)	2.04	.727

Note. ADL, activities of daily living; Data are mean±SD values

* significant at post hoc comparisons

Table 3

Content analysis on subjective benefits of the program

Themes	Freq	Sub-themes	Interviewee ID
Physical improvement	9	Improved functional movements (walking, standing, or coordinating)	12 32 38 42
		Improved balance	30 38
		Improved strength	31
		Improved flexibility	26 43
Psychological well-being	9	Mental wellness	8 25 36
		Decreased depressive feeling	3 6 7 40
		Self-confidence	4
		Self-esteem	46
Social support	25	Support from peers	2 9 24 29 35 37 39 47
		Support from Instructors	5 10 11 13 15 20 23 33 41 48
		Enjoy as a group	1 16 18 19 34 45 49
Perceived independence in activities of daily living	3	Dress up without help	27
		Improved spoon use	44
		Language (mechanics)	28