

Tai Chi and Chronic Pain

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Abstract: In the last 2 decades, a growing body of research aimed at investigating the health benefits of Tai Chi in various chronic health conditions has been recognized in the literature. This article reviewed the history, the philosophy, and the evidence for the role of Tai Chi in a few selected chronic pain conditions. The ancient health art of Tai Chi contributes to chronic pain management in 3 major areas: adaptive exercise, mind-body interaction, and meditation. Trials examining the health benefit of Tai Chi in chronic pain conditions are mostly low quality. Only 5 pain conditions were reviewed: osteoarthritis, fibromyalgia, rheumatoid arthritis, low back pain, and headache. Of these, Tai Chi seems to be an effective intervention in osteoarthritis, low back pain, and fibromyalgia. The limitations of the Tai Chi study design and suggestions for the direction of future research are also discussed.

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Long-term noncancer pain is prevalent in industrial nations with a median point prevalence of 15%.¹ In the United States, the National Center for Health Statistics estimates that 1 of 4 Americans has chronic or recurrent pain, and 40% of Americans say that pain has a moderate or severe impact on their lives.² The estimated total cost (direct and indirect) of chronic pain exceeds US \$150 billion annually.³ Despite that, many patients experience poor treatment outcomes from traditional medical therapies.⁴ Complementary and alternative medicine (CAM) has emerged as a popular alternative, especially among chronic pain patients.⁵ Complementary and alternative medicine practices are often grouped into broad categories, such as natural products, mind-body medicine, and manipulative and body-based practices.⁶ Tai Chi is an example of mind-body medicine.

In the United States, approximately 2.5 million individuals have practiced Tai Chi for health reasons, and this number is increasing.⁷ In the last 2 decades, a number of investigators have examined the role of Tai Chi in pain and various chronic health conditions. The objectives of this review are to examine the health benefits of Tai Chi in pain patients and to assess the evidence of therapeutic benefits of Tai Chi in a few selected pain conditions.

METHODS

We performed computerized searches of the medical literature in the following databases: MEDLINE (from 1970 to

November 2011), HealthSTAR (from 1970 to November 2011), PsycINFO (from 1970 to November 2011), EMBASE (from 1970 to November 2011), AMED (from 1985 to November 2011), CAB (from 1973 to November 2011), and the Cochrane Library (from 1993 to November 2011). In addition, manual searches of the reference lists of selected articles were performed. Keywords used in the literature search included “pain,” “hyperalgesia,” “neuralgia,” “tai chi,” “tai ji,” and “tai qi.” Inclusion criteria were randomized controlled trials (RCTs) examining the use of Tai Chi as the main intervention for a certain well-defined chronic pain condition. The search result is presented in Figure 1. The study scientific quality was evaluated using Jadad score, a validated tool assessing the study design and quality of reporting⁸ (Table 1). In addition, studies with outcome assessment by a blind assessor are specifically pointed out in the tables because it is impossible to have a double-blind design with Tai Chi intervention. The strength of evidence and grades of recommendation were determined using the schema developed by the US Development of Health and Human Services Agency for Health Care Policy and Research⁹ (Table 2).

PHILOSOPHY, HISTORY, AND DEVELOPMENT OF TAI CHI

Tai Chi—also referred as Tai Chi Chuan, Taiji, or Taiji Quan (both Chuan and Quan mean “fist”)—literally means “ultimate supreme.” In this article, we will use the term *Tai Chi* to represent Tai Chi Chuan. The concept of the term *Tai Chi* appears in both Taoist and Confucian Chinese philosophy, which considered Tai Chi the driving force of the universe.¹⁰ In this regard, Tai Chi is believed to generate 2 opposing forces, the yin and yang, which form the symbol of Tai Chi. This Taoist philosophy suggests that the world is full of contrast or conflicts and that harmony can be reached by balancing these contrasts or conflicts. The symbol of Tai Chi (Fig. 2) conveys the 2 opposing forces, yin and yang, which are not absolute and are capable of changing each other’s direction. Tai Chi exercise itself teaches “stillness in movement” and constant transfer of body weight, reflecting the simultaneous separation and merging of yin and yang energy in the form of “qi.”^{11,12} In Chinese belief, “qi” is the internal energy of the body.

Tai Chi is an ancient martial and health art that was developed a few hundred years ago. It involves gentle, flowing circular movement of the upper limbs, constant weight shifting of lower limbs, meditation, breathing, moving of qi (the internal energy in Chinese belief), and various techniques to train mind-body control. Although many Chinese believe that Master Zhang San Feng, a Taoist priest, developed Tai Chi, the history literature attributed the origin of Tai Chi to Master Chen Wang Ting, who lived at the end of the Ming Dynasty (1597–1664 AD). From him, Tai Chi was passed on through many generations in the Chen family until the martial art was disseminated outside the family by Yang Lu Chan.¹³ There are 5 major styles of Tai Chi, each named after the Chinese families from which each style originated: Chen, Yang, Wu, Sun, and Wu/Hao. Chen is generally accepted as the oldest style. The major family styles share much underlying theory but differ in their approaches to training: postures, forms, pace, and order of movements.¹⁴ There

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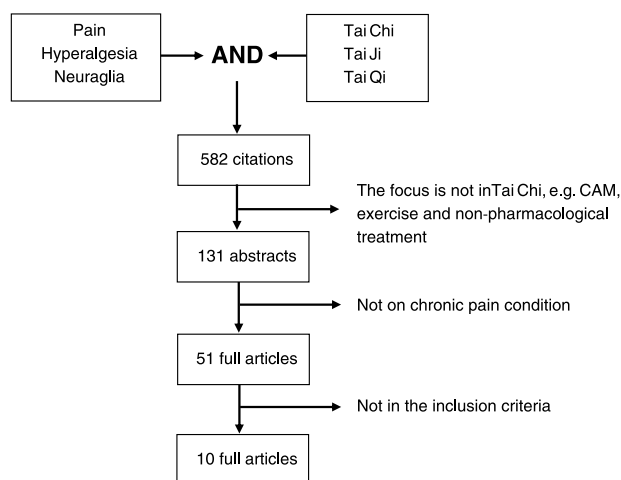


FIGURE 1. Flow diagram of screened, excluded, and analyzed studies.

are now dozens of new styles, hybrid styles, and offshoots of the main styles. However, these 5 family schools are recognized by the international community as being the orthodox styles.

In 1956, the government of the People’s Republic of China sponsored the Chinese Sports Committee, which brought together 4 Tai Chi teachers to create a simplified form of Tai Chi as exercise for the masses. They truncated and abbreviated the traditional Yang family-style Tai Chi forms to 24 postures, taking 4 to 5 minutes to perform.^{13,15} Tai Chi can be practiced everywhere, indoors and outdoors, alone, or as a group. No special equipment is required. All that is needed is a small flat area of approximately 4 m², loose clothing, and flat-heeled shoes.¹⁴ Because of the official promotion, Tai Chi has become a very popular exercise in China.¹⁵

HEALTH BENEFITS

Improvement in Physical Fitness

Adaptive Exercise

Tai Chi is an exercise of mild-to-moderate intensity, depending on the duration, pace, experience, and time spent practicing.¹⁶ The metabolic equivalent of task (MET) for Tai Chi ranges from 2.5 to 6.5. One MET is defined as the ratio of work

TABLE 2. Key to Evidence Statements and Grades of Recommendations

Statements of Evidence	
Ia	Evidence obtained from meta-analysis of RCTs
Ib	Evidence obtained from at least 1 RCT
IIa	Evidence obtained from at least 1 well-designed controlled study without randomization
IIb	Evidence obtained from at least 1 other type of well-designed quasiexperimental study
III	Evidence obtained from well-designed nonexperimental descriptive studies, such as comparative studies, correlation studies, and case reports
IV	Evidence obtained from expert committee reports or opinions and/or clinical experiences of respected authorities
Grades of Recommendations	
A	Requires at least 1 prospective, randomized controlled trial as part of a body of literature of overall good quality and consistency addressing the specific recommendation (evidence levels Ia and Ib)
B	Requires the availability of well-conducted clinical studies, but no prospective, randomized clinical trials on the topic of recommendation (evidence levels IIa, IIb, III)
C	Requires evidence obtained from expert committee reports or opinions and/or clinical experiences of respected authorities; indicates an absence of directly applicable clinical studies of good quality (evidence level IV)

Source: US Department of Health and Human Services Agency for Health Care Policy and Research.⁹

metabolic rate to a standard resting metabolic rate of 1 kcal/kg per hour.¹⁷ The MET in the range of 3 to 6 is equivalent to exercise of moderate intensity, such as dancing or brisk walking.¹⁷ The peak oxygen uptake (VO_{2peak}), defined as the highest attained oxygen uptake (VO₂) during exercise testing, is commonly used to measure aerobic capacity and thus physical fitness or endurance.¹⁸ Long-term Tai Chi training has been shown to enhance aerobic capacity (VO_{2peak}) by 16% to 27% and by 16% to 21% in a cross-sectional study and a longitudinal study, respectively.^{19,20} However, a systematic review examining the controlled trials failed to support the superiority of Tai Chi over sedentary control.²¹ The lack of effects may be due to the “dose” effect (duration, frequency, and intensity).²² If the training goal

TABLE 1. Jadad Score

Study Characteristic	Score
• Was the study described as randomized (this includes words such as randomly, random, and randomization)?	0/1
• Was the method used to generate the sequence of randomization described and appropriate (table of random numbers, computer generated, etc)?	0/1
• Was the study described as double-blind?	0/1
• Was the method of double-blinding described and appropriate (identical placebo, active placebo, dummy, etc)?	0/1
• Was there a description of withdrawals and dropouts?	0/1
• Deduct 1 point if the method used to generate the sequence of randomization was described and it was inappropriate (patients were allocated alternately or according to date of birth, hospital number, etc).	0/−1
• Deduct 1 point if the study was described as double-blind but the method of blinding was inappropriate (eg, comparison of tablet vs injection with no double dummy).	0/−1

The first 5 items are indications of good study quality; a point is added for each criteria met. The last 2 items indicate poor study quality; a point is subtracted for each criteria met. The Jadad score⁸ therefore ranges from 0 to 5.

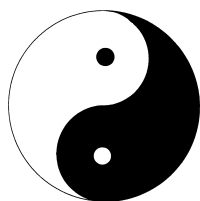


FIGURE 2. The symbol of Tai Chi, depicting the close relationship of yin and yang.

is to increase aerobic capacity or muscular strength, a complete set of classic Tai Chi is recommended.

Improvement in Musculoskeletal Strength and Balance

The slow exercise speed and constant weight shifting associated with Tai Chi increase the load on the lower limbs. Tai Chi training has been shown to improve musculoskeletal strength and balance.^{23–25} Twelve-week Tai Chi intervention was shown to result in significant improvements in the isometric strength of knee extensors.²³ Long-term (≥ 12 months) Tai Chi practice was effective in enhancing the strength of the knee joints, with a 20.3% improvement for extensors and a 15.9% improvement for flexors²⁶ as well as improving torque in the ankle dorsiflexors.²⁷

This improved musculoskeletal strength can contribute to improvement in balance.²⁴ The integration of cognitive and physical components in Tai Chi could represent additional value of Tai Chi over other exercise programs that mainly focus on physical aspects only. Tai Chi enhances self-awareness of balance and thereby decreases the fear of falling.^{28–30} Prevention of falls among the elderly is an important health issue because approximately 30% of community-living persons aged 65 years and older experience a fall at some point in their lives.³¹ Of these falls, 55% to 70% result in physical injury, of which one fifth require medical attention.^{32,33} Two recent reviews examined the role of Tai Chi in the prevention of falls. One suggested that Tai Chi had the potential to reduce falls or the risks of falling among the elderly, provided that they were “relatively” young (ie, in their 60s and 70s) and nonfrail (such as living in the community).³⁴ The other review found that Tai Chi reduced the incidence of falls by 49% and 21% versus exercise and nonexercise control, respectively, although the difference was not statistically significant in the latter. The fear of falling was also lower in the Tai Chi group.³⁵ The dose of Tai Chi exercise programs was heterogeneous, ranging from 16 to 120 hours. Although the authors of this review³⁵ concluded that there was insufficient evidence for fall prevention with Tai Chi, they also remarked that the presence of a positive dose-effect relation in Tai Chi was highly likely. They suggested future research on the role of patient characteristics (eg, living setting, activity level), intervention dose, and effect maintenance on the measured outcomes.

Other Health Benefits

Low bone mineral density (BMD), either in the form of osteoporosis or osteopenia, is a risk factor for fracture after a fall.³⁶ Tai Chi is recommended to osteoporotic women as a safe and effective exercise for bone density maintenance.³⁷ The 2004 US Surgeon General’s report on osteoporosis specifically recommends Tai Chi as a good exercise for fall prevention.³⁸ Tai Chi also addresses other risk factors associated with osteoporosis and osteopenia, such as poor balance, decreased muscle strength, and diminished agility.³⁷

A review of the controlled trials and observation studies provides preliminary evidence that Tai Chi exercise is beneficial to patients with coronary artery disease and congestive heart failure.³⁹ In a RCT, the patients recovering from an acute myocardial infarction were randomized to 1 of 3 groups: mixed Tai Chi/Qigong intervention, conventional aerobic exercise, or to a cardiac support group for 8 weeks. Both the aerobic exercise and Tai Chi groups were associated with significant reductions in systolic, diastolic blood pressure, as well as resting heart rate.⁴⁰ Moreover, the adherence rate with Tai Chi was superior. This is important because utilization and adherence of conventional cardiac rehabilitation programs is an issue.⁴¹ In patients with congestive heart failure, 12 weeks of Tai Chi exercise was shown to increase exercise capacity and improve B-type natriuretic peptide and disease-specific quality of life, using the Minnesota Living with Heart Failure Questionnaire to compare with the control group.⁴² Tai Chi exercise was also consistently shown to reduce the blood pressure in patients with hypertension, a known risk factor for coronary artery disease.⁴³

Conclusions

In conclusion, Tai Chi is a mild to moderate aerobic exercise, depending on the intensity, pace, frequency, and duration of the practice. Because the movement is slow and gentle, an individual with chronic illness and pain can pace according to their physical fitness. The constant shifting of body weight helps to improve the balance, minimize the risk of falling, maintain BMD, reduce blood pressure, and improve exercise capacity in patients with cardiovascular disease.

Mind Body Control

It is now well supported by current scientific literature that the relationship between nociceptive information and pain perception is profoundly affected by affective and cognitive factors.⁴⁴ Higher centers play an important role in pain perception. Of particular importance are the roles of *attention* and *expectation*.

Attention is a mechanism by which sensory events, including nociceptive information, are selected and enter awareness. Two modes of attention selection are conceptualized in a neurocognitive model.^{45,46} One is “top-down selection,” which is an intentional and goal-directed process that prioritizes information relevant for current action. This is achieved by modifying the sensitivity of the relevant signals relative to the noise. The signal, which is the stimulus-specific neural response, is enhanced by amplifying the activity of neurons that respond to relevant stimuli. The noise represented by the irrelevant stimuli is dampened by inhibiting the activity of the neurons that respond to it. Simply put, this refers to the concentration and staying focus of one’s mind. “Bottom-up selection” corresponds to an unintentional, stimulus-driven capture of attention by the events themselves. Noxious input is a good example of unintentional stimuli that can act as a source of distraction. Although the bottom-up attention is unintentional, it is influenced by the top-down processes.⁴⁵ Clinically, these concepts help one explore the possibility for an individual to exercise *executive* control over nociceptive interference, either improving the top-down or bottom-up selection, through training with mind-body interaction exercise like Tai Chi. The concept of attention helps us understand why many patients with chronic pain display cognitive deficits, which can be attributed to anxiety or a specific construct of “hypervigilance” to pain, that is, a tendency to increase attentional allocation to pain-related information.⁴⁷

The complex function of the human brain also allows us to anticipate a multitude of future scenarios, including upcoming

pain and discomfort (expectation). This capability, in turn, invokes coping strategies, such as behaviors to avoid pain and/or an activation of the different inhibitory mechanisms for pain relief.⁴⁸ Activation of the descending pain control system through the anticipation of pain relief is well exemplified by the placebo response.⁴⁹ The descending inhibitory network involves a constellation of areas in the higher centers, such as the rostral anterior cingulate cortex, the periaqueductal gray, and the rostral ventromedial medulla. The network influences the ascending nociceptive input through endogenous opioids and nonopioids pathways.^{50,51} Again, these concepts help one to explore the possibility for an individual to exercise *executive* control over nociceptive input, by anticipating the forthcoming pain⁵² and using imagery techniques⁵³ and meditation⁵⁴ to cope.

Tai Chi is an excellent exercise for training the mind body interaction. The traditional and fundamental teaching of Tai Chi is to emphasize the interrelationship of the mind and body: consciousness or mind (yi) leads to the movement of energy (qi), which in turn leads to the movement of the body.^{11,55,56} Each style involves movement of the whole body in fluidity and harmony. Without concentration, focus, and attention directed either to the body or to the environment, the movement will be disorganized, and it will not be Tai Chi.⁵⁷ Furthermore, the styles and movements of Tai Chi are full of metaphors, such as “grasp the bird’s tail,” “white crane spreads its wing,” and the famous “cloud hands.” The practitioner is required to feel the chi or internal energy flowing like water across the body. This “mind” component has been shown to have various beneficial effects. Concentration and mindfulness meditation itself may modulate multiple aspects of health, including mood, pain, and functions of the immune and peripheral autonomic nervous systems.^{58–61} Encouraging control through the use of visual imagery and managing beliefs and expectations can also influence our physiology and health.^{62–64}

In summary, the role of higher centers in pain modulation is well supported by an abundance of literature. Tai Chi helps individuals focus and improve their body-mind control. The central belief of Tai Chi—“the mind moves the qi and the qi moves the body”—helps people optimize their coping mechanisms.

Meditation/Breathing Effects on Psychological Well-Being

Chronic pain has a profound effect on patients’ psychological well-being, social relationships, and quality of life.^{65,66} Individuals who experience pain are associated with a much higher risk of depression, suicidal ideation, anxiety disorders, increased tendency to catastrophize, poor anger control, emotional distress, and sleep disturbance, especially for those who experience significant limitations in their daily activities due to pain.^{65,67} These psychological comorbidities pose significant economic burdens to those involved, reduce productivity, and increase health care costs.^{68,69}

Tai Chi offers appealing management modalities because of its relatively low cost, the low physical and emotional risk involved, and because of the way it encourages patients to take a more active role in their treatment. The effectiveness of Tai Chi in psychological well-being was recently examined in a systematic review.⁷⁰ This review included 40 studies (17 RCTs, 16 nonrandomized comparison studies, and 7 observational studies) published between 1980 and 2009 and involving approximately 3800 patients or healthy individuals from 6 countries. The conclusion was that Tai Chi was associated with favorable effects on mood, improved stress levels and self-esteem, and reduction in anxiety and depression. The effects on stress,

anxiety, and depression were of moderate effect sizes using bias-corrected Hedges *g* score. Although definitive conclusions were limited because of variation in designs, comparisons, heterogeneous outcomes, and inadequate controls, similar conclusions were drawn by another review around the same time.⁷¹

The improvement in psychological well-being can be associated with the “mind” or physical components of Tai Chi. As discussed earlier, practitioners of Tai Chi depend on the mind to direct the inner energy. In doing so, they must keep their mind peaceful and placid. Internal peace of mind and coordinated breathing are the important components of mindful stress reduction.^{72,73} In addition, physical activity/exercise is well supported by the literature in association with better psychological health.^{74–77} One review demonstrated the causal link between physical activity and a reduction in clinically defined depression. This review also showed that exercise is associated with the strongest anxiety-reduction effects.⁷⁸

In summary, meditation, breathing, and visual imagery are essential components of Tai Chi, help control mood, and are associated with improvements in psychological well-being, including reduced stress, anxiety, depression, and mood disturbance as well as increased self-esteem.

SPECIFIC PAIN CONDITION

Osteoarthritis

Background

Among the different types of arthritis, osteoarthritis is the most common.⁷⁹ Treatment includes pharmacologic, nonpharmacologic, and surgical modalities. Common nonpharmacologic options like weight loss,⁸⁰ exercise,⁸¹ and self-management programs⁸² aim to improve pain, function, and psychological well-being. As discussed previously, Tai Chi is an aerobic exercise that provides muscle strengthening and improves balance and coordination. All these attributes are thought to be able to contribute to pain relief in arthritis.⁸³ In addition, Tai Chi improves psychological well-being and enhances body-mind control, which encourages better coping strategies and minimizes fear avoidance.⁸³ It might therefore be helpful in the management of osteoarthritis.

Review of Evidence

Five RCTs^{84–88} (Table 3) and 3 systematic reviews^{89–91} published to date examine the effects of Tai Chi on patients with osteoarthritis. Although 11 RCTs had been included in those systematic reviews, 6 of them were excluded for discussion because of various reasons (Table 4).^{92–98} Because it is impossible to blind the Tai Chi intervention, the maximum Jadad score is 3 (Table 3). To minimize the bias, the outcomes in 3 studies were assessed by investigators blind to the groups assigned (Table 3). All RCTs demonstrated an improvement in physical functioning and/or health status. Three trials included only patients with osteoarthritis of knee, and all showed a reduction in pain.

In summary, there is strong evidence to suggest that Tai Chi is beneficial for pain relief, physical function, and psychological well-being among patients with osteoarthritis of the knee (level Ib, recommendation A).⁹ Evidence of analgesic benefit in patients with osteoarthritis in other joints is not convincing.

Fibromyalgia

Background

Fibromyalgia (FM) is characterized by the presence of widespread pain for more than 3 months.⁹⁹ The new diagnostic

TABLE 3. Published RCTs for Tai Chi Intervention in Osteoarthritis

First Author/ Year	OA Regions; Total No. of Patients Randomized/ Analyzed	Jadad Score/ AC/Blind Assessor	Tai Chi Intervention	Control	Pain Outcome at 12th Week	Other Outcome at 12th Week	Remarks
Hartman/ 2000	Multiple; 35/33	3/-/-	Yang; 2/wk; 12 wk	Routine care and usual physical activity	NS—ASE	↑Arthritis self-efficacy ↑Satisfaction general health (AIMS) ↓Tension (AIMS)	Baseline ↑Arthritis pain in TC group
Song/2003	Knee; 72/43	3/+/-	Sun; 3/wk.; 12 wk	Routine treatment	↓ Pain-K-WOMAC	↓Stiffness, ↑physical functioning K-WOMAC ↑Balance	
Brismee/ 2007	Knee; 41/39	3/-/+	Yang; 3/wk for 6 wk; home Tai Chi 6 wk	Attention control program*	↓Overall and maximum pain—VAS	↑Overall and physical function in WOMAC	
Fransen†/ 2007	Hip/knee; 97/97‡	3/+/+	Sun; 2/wk; 12 wk	Wait list	NS—WOMAC	↑Physical function in WOMAC; better timed stair climb	3 groups in comparison with hydrotherapy
Wang/2009	Knee; 40/40‡	3/+/+	Yang; 2/wk; 12 wk	Attention control program*	↓Pain—WOMAC	↑Physical function in WOMAC, patient, and physician global VAS; ↑balance, SF-36 PCS; ↓ CES-D	

* Attention control program: referred to lectures in health topics in Brismee's study and to wellness education and stretching exercise in Wang's study.

† In Fransen's study, the third group—hydrotherapy group—was not included.

‡ Intent-to-treat statistical analysis.

AC indicates allocation concealment; AIMS, Arthritis Impact Measure scales; ASE, arthritis self-efficacy, questions are scored on a Likert scale from 0 to 100, with higher scores representing greater self-efficacy; CES-D, scores on the Center for Epidemiologic Studies – Depression index ranging from 0 to 60, with higher scores indicating more dysphoria; K-WOMAC, WOMAC in Korean; NS, no significant difference; PCS, Physical Component Summary of SF-36; SF-36, Medical Outcomes Study 36-Item Short-Form Health Survey is a self-administered, 36-item questionnaire that assesses the concepts of physical functioning, role limitations due to physical problems, social function, bodily pain, general mental health, role limitations due to emotional problems, vitality, and general health perceptions (scores range from 0 to 100, with higher scores indicating better health status); Universities Osteoarthritis Index, scores are standardized to a 0 to 100 range, with higher scores indicating greater pain or physical disability; VAS, visual analog scale; WOMAC, Western Ontario and McMaster.

criteria discarded the use of tender points but added a symptom severity scale.¹⁰⁰ A recent work showed that patients with FM have a diminished efficacy of descending pain inhibitory mechanisms or the diffuse noxious inhibitory control.^{101,102} Diffuse noxious inhibitory control modulates nociceptive signals through opioid receptors, or nonopioid receptors, such as noradrenergic or serotonergic pathways.⁵² Treatment philosophy includes pharmacotherapy to inhibit pronociceptive input and augment modulatory signaling, such as antidepressants and gabapentinoids; psychotherapy; aerobic exercise to help restore physical function and improve self-efficacy; and other modalities to manage comorbidities, such as sleep disturbance.¹⁰³ Of those treatment modalities, aerobic exercise and multicomponent therapy stand out in effectiveness for improving fatigue, mood, and physical fitness.^{104,105} Pharmacologic therapies currently available for the treatment of FM are associated with limitations, including small effect size and tolerance

issues.^{83,106–108} A combination of pharmacological and non-pharmacological therapies is appropriate.

Tai Chi offers an appealing treatment modality with its 3 components addressing the multifaceted problems of FM: an exercise component for physical function, mind-body interaction to address the deficit in diffuse noxious inhibitory control, and a meditation/breathing component for psychological well-being. In addition, there is evidence to suggest the enhancement of sleep with Tai Chi.^{83,109}

Review of Evidence

Two preliminary studies, 1 pilot nonrandomized study and 1 case series, suggested the beneficial effects of Tai Chi in patients with FM.^{110,111} Recently, Wang et al¹¹² conducted a single-blind, RCT evaluating the effect of a 12-week training program of classic Yang-style Tai Chi on patients with FM

TABLE 4. Reasons for Exclusion of Studies for Tai Chi Intervention in Osteoarthritis

First Author/Year	Listed in Review Article	Reason for Exclusion	Remarks
Alder/2000, 2007 ⁹³	Lee, ⁸⁹ Hall, ⁹⁰ Escalante ⁹¹	Published in abstract in 2000 and PhD dissertation 2007	No formal publication find in index article other than these abstract and dissertation
Song/2007	Hall, ⁹⁰ Escalante ⁹¹	Data duplicated from Song et al (2003)	
An/2008	Escalante ⁹¹	Baduanjin is not Tai Chi	21 patients in total completed the trial
Lee/2008	Escalante ⁹¹	Nonrandomized study	Many methodology issues
Lee/2009	Escalante ⁹¹	“Tai Chi Qigong” as the intervention	Control group of 15 patients
Ni/2010	Escalante ⁹¹	Withdrawn from journal because of suspected fabrication	

compared with a control group undergoing wellness education and stretching (Table 5). There were significant improvements at the end of 12-week training in the Tai Chi group, according to the Fibromyalgia Impact Questionnaire score, physical and mental component scores from the 36-Item Short-Form Health Survey, patient's and physician's global assessment scores, a 6-minute walk test, Pittsburgh Sleep Quality Index, and Center for Epidemiologic Studies – Depression index (CES-D), and Chronic Pain Self-efficacy Scale. All improvements (except for the 6-minute walk test and Chronic Pain Self-efficacy Scale)

remained significant at reassessment 12 weeks after the training. Of note, the effect sizes found in this study were much larger than those from Food and Drug Administration–approved pharmacotherapy, including antidepressants, gabapentinoids, and milnacipran.^{106–108}

In summary, there is only 1 RCT available. On the basis of this high-quality trial with narrow confidence intervals and high adherence, evidence suggests that Tai Chi is beneficial for pain relief, physical function, and psychological well-being in patients with FM (level Ib, recommendation A).⁹

TABLE 5. Published RCTs on Other Pain Conditions

Pain Condition: No. Patients Randomized/ Analyzed	First Author/ Year	Jadad Score/ Allocation*/ Blind Assessor	Tai Chi Intervention		Pain Outcome†	Other Outcome at 12th Week	Remarks
			Control				
Rheumatoid arthritis: 20/20	Wang/ 2005	2/–/+	Yang; 2/wk; 12 wk	Wellness education and stretching exercise	VAS, HAQ-NS	↑Mood (CES-D), ↑vitality (SF-36); ↓disability (HAQ)	
Rheumatoid arthritis: 42/31	Lee/ 2005	2/–/–	Sun; 1/wk; 6 wk	Usual activity	VAS-NS	↑Mood (Profile of Mood State)	
Tension-type headache: 47/30	Abbott/ 2007	2/–/–	Yang; 2/wk; 15 wk	Wait list	↓HIT-6	↑SF-36—MCS	
Fibromyalgia: 66/66‡	Wang/ 2010	3/+/+	Yang; 2/wk; 12 wk	Wellness education and stretching exercise	↓FIQ	↑Sleep (PSQI), SF-36 (MCS, PCS), Global assessment by patient and physician; mood (CES-D) CPSS	All improvement maintained at 24 wk except CPSS
Low back pain: 160/160‡	Hall/ 2011	3/+/–	Sun; 2/wk for 8 wk, 1/wk for 2 wk	Wait list	↓Pain bothersome ↓Pain MRS	↓PDI, RMDQ, QBPDS, PSFS	

*Allocation concealment.

†In certain pain conditions, the principal outcome measurement is not by the pain intensity but a well-validated composite score such as FIQ in fibromyalgia and HIT-6 in tension-type headache.

‡The study was analyzed based on the intent-to-treat analysis.

CES-D indicates the Center for Epidemiology Studies – Depression index; CPSS, Chronic Pain Self-efficacy Scale; FIQ, Fibromyalgia Impact Questionnaire; HAQ, Health Assessment Questionnaire and includes pain in the past week (15-cm VAS that is scored 0-3); MCS, Mental Component Summary of SF-36; NS, no significant difference; PCS, Physical Component Summary of SF-36; PDI, Pain Disability Index; PSFS, Patient-Specific Functional Scale; PSQI, Pittsburgh Sleep Quality Index; QBPDS, Quebec Back Pain Disability Scale; RMDQ, Roland-Morris Disability Questionnaire; SF-36, Medical Outcomes Study 36-Item Short-Form Health Survey; VAS, visual analog scale.

Chronic Low Back Pain

Background

Among all musculoskeletal disorders, chronic low back pain is the most prevalent and costly.^{2,3,113} In the United States, the prevalence rate for chronic low back pain during a 12-month period and a lifetime prevalence rate are 19% and 29.5%, respectively.¹¹⁴ Although a number of nonpharmacologic treatments are available for managing chronic low back pain, most of them show little or no effects.¹¹⁵ Among the effective interventions, exercise therapy shows small to moderate effects on pain and functional outcome improvement.^{115,116} There are many different philosophies and approaches for exercise therapy, but the components most predictive of good outcomes are supervision, strengthening, and stretching.¹¹⁷

Tai Chi is 1 of the top 3 CAM modalities with perceived benefits chosen by patients with chronic low back pain.¹¹⁸ Because it is an exercise involving gentle, flowing circular movement, constant weight shifting, meditation, breathing, and various techniques to train mind-body control under supervised training, Tai Chi exercise can potentially be beneficial to patients with chronic low back pain.

Review of Evidence

Despite the high prevalence of low back pain and perceived benefits among back pain patients using CAM, there is only 1 trial on this subject (Table 5).¹¹⁹ This is a good-quality RCT with large sample size (160 patients). The intervention was 10 weeks of Sun-style Tai Chi training, with wait list as control. Tai Chi reduced the bothersomeness of back symptoms and pain intensity by 1.7 points and 1.3 points, respectively, on a 0 to 10 scale. There was also improvement in almost all other measures of health-related quality of life, mood, and cognitions: Roland-Morris Disability Questionnaire, Pain Disability Index, Quebec Back Pain, and Patient-Specific Functional Scale. The follow-up rate was greater than 90% for all outcomes. These treatment effects were considered worthwhile by both the researchers and participants.

In summary, only 1 RCT is available. On the basis of this high-quality trial with narrow confidence intervals and high adherence, there is evidence to suggest that Tai Chi is beneficial for pain relief and disability associated with chronic low back pain (level Ib, recommendation A).⁹

Rheumatoid Arthritis

Background

Rheumatoid arthritis (RA) is a systemic, inflammatory, and autoimmune disorder that can lead to joint destruction and systemic complications.¹²⁰ The course of RA is often progressive and results in pain, joint damage, fatigue and disability.¹²¹ In addition, associated comorbid conditions can play a pivotal role in the outcomes. Cardiovascular complications are the leading contributor to mortality¹²² and osteoporosis resulting in bone fractures represents a major source of morbidity in RA patients.¹²³ Thus, the major goals of treatment are to relieve pain, reduce inflammation, slow down or stop joint damage, prevent disability, prevent and manage the comorbidity, and preserve or improve the person's sense of well-being and ability to function.^{83,120,124}

Current treatment medications are limited in their efficacy and adverse effects are always a concern.¹²⁵ Exercise programs are reported to improve physical functioning in patients with RA by maintaining muscle strength, preserving joint mobility, and maintaining flexibility, balance, endurance, and aerobic capaci-

ty.¹²⁶ Tai Chi exercise may be beneficial to patients with RA because of its effects on muscle strength, stress reduction, and cardiovascular and bone health, as well as improved health-related quality of life.⁸³

Review of Evidence

The evidence to support the role of Tai Chi in patients with RA is unclear. Two systematic reviews have been published. One is a Cochrane review that includes 4 trials (2 RCTs and 2 controlled clinical trials [CCTs]).¹²⁴ The review suggested that Tai Chi does not exacerbate symptoms of RA and has some benefits on range of motion. However, this review included 2 studies of mixed intervention groups (not Tai Chi alone), and the remaining 2 trials were basically on a similar group of patients published in the same article by the same investigators.¹²⁷ Furthermore, the latter one was not a randomized trial. Thus, this review should be considered with caution.

Another systematic review published later addressed these concerns and included more studies.¹²⁸ Two RCTs and 3 non-randomized CCTs met all inclusion criteria. The included RCTs were of low quality and small sample size (Table 5).^{129,130} Neither demonstrated effectiveness on pain reduction compared with control. They reported some positive findings for Tai Chi on disability index, quality of life, depression, and mood for RA patients.

In summary, the evidence to support the use of Tai Chi in RA is lacking. Further high-quality RCTs are required to support the role of Tai Chi in patients with RA.

Headache

Background

Tension-type headache (TTH) is very common, with a lifetime prevalence of 69% in men and 88% in women.¹³¹ It can occur either in single episodes or chronically and is often the result of temporary stress, anxiety, fatigue, or anger. Standard care for TTH includes relaxation routines, massage, biofeedback, pharmacological interventions, and stress reduction.^{131,132} Tai Chi may have a therapeutic value in the treatment of TTH because of the mind-body interaction and relaxation effects.

Review of Evidence

There is 1 RCT published that concerns patients with TTH (Table 5).¹³³ Patients were randomized to receive 15 weeks of Tai Chi or to remain on the waiting list as the control group. Although 47 patients were randomized, 5 did not participate in the study and 12 patients dropped out and were lost to follow-up. With approximately one-third loss of patients after randomization, the investigators analyzed the results without an intention-to-treat imputation method. They found statistically significant improvements in favor of intervention for the Headache Impact Test 6 (HIT 6) score and the pain, energy/fatigue, social functioning, emotional well-being, and mental health summary scores in the 36-Item Short-Form Health Survey.

In summary, in view of the methodological limitations, more high-quality research is required in this area before a definitive recommendation can be made.

LIMITATIONS OF STUDIES ON TAI CHI

In contrast to the studies on pharmacological agents, there are a number of intrinsic limitations in designing studies to evaluate mind-body therapies like Tai Chi. The challenges and difficulties in designing studies for Tai Chi were well summarized in 2 reviews.^{57,134} First, in designing studies on mind-body interaction, it is basically impractical to use a double-blinded

design because the patients will be aware whether they are performing Tai Chi or not. Second, many components of Tai Chi may contribute to the therapeutic effects.⁵⁷ It is a major challenge to design a sham mind-body intervention when one attempts to separate the various mind and body components. Third, there are different families or styles of Tai Chi that bear different philosophies and training. This can contribute to the heterogeneity of the treatment effects. Instructors or masters of different experience can affect the size of the therapeutic effect. Finally, different studies may choose different intensities of training, such as 1 h/wk for 6 weeks versus 3 h/wk for 3 months. This is similar to the dosing of drugs, and this can contribute to different effect size and difficulty in comparing the results between studies.

DIRECTION FOR FUTURE RESEARCH

In the last 10 years, there has been a growing body of research aimed at investigating the health benefits of Tai Chi for various chronic health conditions, especially chronic pain. More than half of those published randomized trials were on musculoskeletal health, and they showed that individuals with musculoskeletal conditions were more likely to practice Tai Chi.¹³⁵ Most of the early published trials, unfortunately, are of low quality.^{35,70,71} High-quality trials with increased scientific rigor are needed. The spectrum of the trials should be extended to other common chronic pain conditions, such as various models of neuropathic pain, low back, and neck pain.

A double-blind design is important to avoid bias. However, this is impossible to achieve in studies on Tai Chi, and some investigators even consider it undesirable because they believe that some of the therapeutic effects require patients to believe in and anticipate benefits from Tai Chi.⁵⁷ However, that belief can lead to expectation and a subsequent increase in placebo effects,⁵¹ and can therefore make the interpretation of a controlled trial challenging. Deemphasizing is a technique that can minimize the influence of preexisting beliefs and expectations with respect to Tai Chi and thus minimize its possible placebo effect. This technique was adopted in 1 recent trial in FM in which patients were informed that the study was designed to test the effects of 2 different types of exercise training programs, 1 of which was combined with education.¹¹² The baseline outcome expectations of benefit from an exercise intervention were similar in both study groups (Tai Chi and control groups: 3.7 ± 0.8 and 3.9 ± 0.7 , respectively), supporting the successful use of this neutral presentation of the interventions.

Devising a sham control for Tai Chi is a challenge. This also applies to other mind-body therapies and acupuncture.^{136,137} Nevertheless, the development of some form of sham intervention for use in future studies of Tai Chi is a desirable goal. Unlike other drug trials, there is no dose response study to determine the optimal dose. However, 2 high-quality RCTs adopted the training with two 60-minute Tai Chi sessions weekly for 12 weeks, and they achieved very impressive effect sizes in different outcome measures.^{88,112} More intense treatment is unlikely to achieve further benefits and may affect adherence to the Tai Chi practice. Because there are multiple components of Tai Chi that may contribute to health benefits, outcome measures should cover a wide range of assessment, including pain, function, self-efficacy, and psychological well-being.¹³⁸

CONCLUSIONS

Tai Chi, an ancient martial and health art that was developed a few hundred years ago, involves gentle flowing circular movement of the upper limbs, constant weight shifting of lower limbs, meditation, breathing, moving of qi (the internal energy in

Chinese belief), and various techniques to train mind-body control. It is a mild-to-moderate aerobic exercise. Because the movements are slow and gentle, an individual with chronic illness and pain can pace according to their physical fitness. The constant shifting of body weight helps to improve the balance, minimize the risk of falling, and maintain BMD in postmenopausal women. Tai Chi helps individuals to focus and improve their body-mind control. The role of higher centers in pain modulation is well supported by an abundance of literature. The traditional belief of Tai Chi—"the mind moves the qi and the qi move the body"—helps individuals optimize their coping mechanisms. Meditation, breathing and visual imagery are essential components of Tai Chi and help the individual to control his or her mood. Tai Chi is associated with improvements in psychological well-being, including reduced stress, anxiety, depression and mood disturbance, and increased self-esteem.

The scientific literature examining the role of Tai Chi in various chronic pain conditions is limited in its study design. High-quality research supports the beneficial role of Tai Chi in osteoarthritis, low back pain, and FM. More high-quality research is required in the future.

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