

Tai Chi as a Potential Intervention for Symptoms of Mild Traumatic Brain Injury in Veterans



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Submission: December 16, 2017; **Published:** April 16, 2018

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Abstract

Many Veterans of the conflicts in Afghanistan/Iraq who experienced repeated concussions due to blast exposure, also referred to as mild traumatic brain injury (mTBI), have persistent post-concussive symptoms (PCS). Additionally, these Veterans often have comorbid, overlapping posttraumatic stress disorder (PTSD) symptoms that further impact recovery. PCS include sleep disturbance, headaches, musculoskeletal pain, anxiety, dizziness/balance problems, fatigue, insomnia, impaired concentration and attention, memory problems, and increased irritability. Veterans with mTBI and PCS tend to have higher rates of unemployment and disability, report a decline in self-rated health and often suffer from anxiety and depressed mood. Multi-modal treatment options remain very limited. Emerging evidence supports the effectiveness of Tai Chi in improving physical and mental well-being, including many common PCS. Adverse events reported in Tai Chi studies tend to be on par with other exercise interventions. Despite this, potential health and physiological benefits of Tai Chi practice in Veterans with mTBI have not been investigated. Physiologically, TBI is associated with chronic autonomic dysregulation along with elevated levels pro-inflammatory cytokines causing neuroinflammation. Numerous studies have demonstrated decreases in pro-inflammatory immune markers following Tai Chi practice. In addition, Tai Chi studies of physiologic measures of noradrenergic function demonstrate short-term decreases in sympathetic tone, and overall greater parasympathetic outflow in Tai Chi practitioners. Given the vast potential for Tai Chi as a treatment modality for mTBI and associated comorbidities, controlled trials, especially in Veterans, are sorely needed.

Keywords: Mild traumatic brain injury; Tai chi; Post-concussive symptoms; Veterans; Blast-related

Abbreviations: mTBI: Mild Traumatic Brain Injury; PCS: Post-Concussive Symptoms; PTSD: Posttraumatic Stress Disorder; SM: Service Members; VA: Veterans Affairs

Background

Chronic complex symptoms in combat-related mTBI

Many Veterans who experienced repeated blast mild traumatic brain injury (mTBI) have persistent post-concussive symptoms (PCS), often with comorbid, overlapping PTSD symptoms that further impact recovery [1,2]. PCS include sleep disturbance, headaches, musculoskeletal pain, anxiety, dizziness/balance problems, fatigue, insomnia, impaired concentration and attention, memory problems, and increased irritability [1]. Veterans with mTBI and resultant persistent PCS tend to have higher rates of unemployment and disability [3] and report a decline in self-rated health [4,5]. Deployment-acquired mTBI is often comorbid with PTSD, and a recent study demonstrated that mTBI increases the likelihood of subsequent anxiety and depressed mood [6]. Current treatments are typically fragmented among multiple providers and benefit is

often marginal. The efficacy of Tai Chi in individual cognitive and behavioral interventions for PCS and mTBI in civilians has been explored [7], but few therapies have been studied in Veterans. Most relevant studies tend to suffer from methodological issues and do not adequately address all symptom domains - a multidisciplinary treatment plan appears necessary but has not been standardized or adequately studied. Multi-modal and safe treatment approaches are sorely needed.

Tai Chi: a mind-body intervention

Tai Chi is a centuries-old martial art that originated in China and has become increasingly popular as a movement meditation in the West over the past 30 years. Multiple styles exist, but all share slow intentional movements coordinated with breathing and imagery. Tai Chi has been increasingly studied - a recent Veterans Affairs (VA) -driven meta-analysis identified 107

distinct reviews of studies of Tai Chi as a clinical intervention [8]. Studies support the effectiveness of Tai Chi in improving physical and mental well-being in both healthy subjects [9,10] and in subjects with medical morbidities. For example, a trial (N=88) comparing participants who engaged in a Tai Chi intervention to sedentary controls, found significant improvement in blood pressure readings as well decreases in both state and trait anxiety [11].

Multiple studies have demonstrated the efficacy of Tai Chi in improving individual PCS, as summarized in Table 1. Those studies include a trial of the effect of Tai Chi on headache severity, which showed improvement in patients randomized to a 15 week Tai Chi intervention vs waitlist control (N=30) [12]. Several studies have shown improvements in anxiety after Tai Chi training compared to a variety of control conditions, including treatment as usual

(N=139, 2/3 female participants), martial arts training (N=68, mostly over age 60), and medication management (N=80, mean age 65, and N=90, young healthy participants) [13]. Insomnia has been examined in multiple studies, with beneficial results in healthy older adults over 60 (N=112) [14], and Tai Chi was found to be as effective as empirically validated cognitive behavioral therapy for insomnia in 123 older adults [15]. Studies of changes in cognitive functioning have mostly been done in older adults, but demonstrate improvements in attention and executive functioning [16]. Tai Chi has been efficacious in treating complex multi-domain symptoms, which was recently demonstrated in clinical trials of Tai Chi in fibromyalgia patients, who showed improved functioning and improvements in sleep quality, pain, mood and quality of life. Clinical efficacy was demonstrated in anxiety treatment in a 5-week Tai Chi trial, indicating that even short trials of Tai Chi practice can have measurable effects [17].

Table 1: Randomized controlled trials of Tai Chi's effect on PCS and quality of life.

PCS	Participants	Duration, Frequency	Outcome
Headache [12]	N=13, both sexes	15wks, 2x/wk	↓ headache impact on Headache Impact Test-6
Anxiety [13,17]	N=359, patients with morbidities	5-24wks, 2-4x/wk	↓ anxiety across morbidities
Insomnia [14,40,41]	N=408; mostly elderly patients	12-24wks, 1-5x/wk	↑sleep on Pittsburgh Sleep Quality Index
Concentration/ Attention deficits [16]	N=125; elderly patients	24wks-3 years, 3x/wk	↑ attention focus time, ↓ attention dispersal
Memory impairment [16]	N=213; elderly patients	24-40wks, 3-7x/wk	↑ memory measures
Irritability/ Anger [20]	N=9, mixed TBI, civilians	6 wks, 2x/wk	↓ anger on Visual Analog Mood Scale
Dizziness [38]	N=20, elderly men	18wks, 2x/wk	Improves dynamic balance
Fatigue [39]	N=42, women with breast cancer	14wks, 1x/wk	↓ fatigue on Fatigue Symptom Inventory
Health-related quality of life [42]	N=989; multiple morbidities	4-24wks	Improvement in overall HRQOL

PCS: Post-Concussive Symptoms; PSQI: Pittsburgh Sleep Quality Index; HRQOL: Health-Related Quality of Life; wk/wks: Week/Weeks

Safety of Tai Chi

Adverse Events (AEs) reported in Tai Chi studies tend to be on par with other exercise interventions and not as prevalent as in combat-oriented martial arts [18]. However, a review of randomized controlled trials (RCTs) of Tai Chi found that only a small fraction of published trials included AE reports at all, and those reports were frequently incomplete [18]. Most common AE reported were minor musculoskeletal aches and pains, particularly lower extremity pain, along with reports of back pain [18]. No serious AE have been reported in the literature [18].

Mind-body interventions in veterans with mTBI

Potential health benefits of Tai Chi practice specifically in Veterans with mTBI have not been investigated. Two small civilian studies of Tai Chi, for varying levels of TBI, yielded improvements in measures of mood and relaxation but did not assess PCS directly [19,20]. Two feasibility studies of Qigong

practice, a mind-body intervention similar to Tai Chi, reported in 6 [21] and 16 [22] military Service Members (SM) with mTBI, found improved mood and sleep, and decreased stress, anxiety, and pain. They also demonstrated the feasibility of a mind-body intervention in SM, including minimal adverse effects and the suitability of such interventions in mTBI patients.

Potential mechanisms of Tai Chi's effect on PCS

TBI is associated with chronic autonomic dysregulation along with elevated levels of central and peripheral pro-inflammatory cytokines causing neuroinflammation [23-25]. Numerous studies have demonstrated a decrease in cytokines and pro-inflammatory immune markers [15,26,27] and increased cell-mediated immune response [28-30] following Tai Chi practice, but this has not been studied in mTBI or PTSD groups. In addition, multiple studies have demonstrated a decrease in inflammatory gene transcription after Tai Chi interventions [15,27]. Tai Chi studies of physiologic measures of noradrenergic function demonstrate short-term decreases in sympathetic tone via

mechanisms which include vagal modulation [10,31,32], though it remains unclear how long new practitioners must engage in Tai Chi to have lasting noradrenergic modulation. Increased heart rate variability and overall greater parasympathetic outflow were demonstrated in long term Tai Chi practitioners compared to sedentary matched controls [33].

Future Research Directions

The evidence base for Tai Chi as an intervention for a variety of medical and psychiatric complaints is increasing exponentially, and has shown efficacy in reducing individual PCS. Recent feasibility studies in Veterans show that Tai Chi is a positively regarded intervention both in residential and outpatient settings [34-36]. Despite these encouraging results, many knowledge gaps persist. Tai Chi is an art which constantly evolves, and teaching methods can vary widely [37]. There is no standardized frequency of Tai Chi practice established in previously published Tai Chi studies, few long-term prospective studies exist, and sample sizes are often small. Generalizability is further limited in relevant studies due to a lack of an appropriate active control group, variable session durations ranging from 20 minutes to 2 hours, or an exclusive focus on elderly participants. Symptom improvement could largely be driven by placebo effects of the group experience; in addition, trials differ vastly in length, and it is not evident that longer treatment courses, i.e., 12 weeks, yield results superior to shorter trials of Tai Chi. While the increased availability of Tai Chi in medical centers such as the VA is a positive development, the lack of high quality placebo controlled trials and the uncertainty about needed treatment length leave clinicians without guidance regarding to whom and when to recommend Tai Chi. Future studies need larger numbers of participants and active control groups (such as a walking intervention), and would ideally compare outcomes of different treatment durations. More variety is needed in the populations studied, as healthy controls and younger patients are often excluded. Despite these ongoing challenges, Tai Chi remains a promising potential treatment option for Veterans with mTBI [38-42].

Conclusion

There is clear evidence that Tai Chi practice could improve multiple PCS, such as headache, dizziness, poor concentration, along with PTSD, anxiety and depression that are commonly seen in the Veterans with mTBI. However, there exists very limited data on whether Tai Chi is effective for treatment of PCS in mTBI and few existing Tai Chi studies have been conducted with Veterans. Given the symptom and physiological benefits, and demonstrated relative safety of Tai Chi, controlled trials in Veterans with mTBI are sorely needed.

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DOI: [10.19080/JYP.2018.04.555645](https://doi.org/10.19080/JYP.2018.04.555645)

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