Dumlupınar Üniversitesi Fen Bilimleri Enstitüsü Dergisi
Sayı: 8 Temmuz 2005

EVALUATION OF TAI CHI CHUAN (TCC) TRAINING EFFECTS ON MUSCULOSKELTAL SYSTEM IN HEALTHY YOUNG SUBJECTS

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Abstract

Tai Chi Chuan (TCC) can be defined as a series of graceful movements that are made for a spiritual, mental and physical health. The purpose of our study was to evaluate the effects of 37 TCC movements as exercise training on balance, kinesthetic sense and flexibility in sedentary university students. 23 students as TCC group aged 20 ± 2.76 (16 female, 9 male), and 14 students as a control group aged 20.02 ± 3.07 (9 female, 5 male) were participated in and practiced 8 weeks (3 days a week) TCC exercise program. Each session consisted of 20 minutes of warm-up (3-min. breathing controlled walk, calistening and stretching exercises) 24 minutes of practiced 37 postures Yang style TCC program (originally 108 postures) and 10 minutes cool-down exercises. Static and dynamic balance, sit and reach test, flexibility tests and kinesthetic sense were evaluated before and after TCC training. Static balance with eyes closed, dynamic balance with eyes open, flexibility (hyperextension and sit and reach tests) and in kinesthetic sense were improved with statistical significance after TCC training ($p<0.05$). 8 weeks TCC training has improved the balance, flexibility and kinesthetic sense in sedentary young subjects as in elderly. TCC is a low-technology exercise and can be easily implemented in different communities. TCC has potential benefits in health promotion, and is appropriate for implementation in community.

1. INTRODUCTION

Shadow boxing (Tai Chi Chuan (TCC)) is a traditional Chinese martial art. It consists of many fundamental postures having graceful movements. During the performance of TCC, deep breathing and mental concentration are required to achieve harmony between body and mind [1,2]. Proponents claim TCC is suitable for older persons and for patients with chronic diseases. Several cross-sectional studies have also suggested that TCC training might be beneficial to health [3,4]. However, the effect of TCC training on the maintenance of balance, kinesthetic sense and flexibility in healthy sedentary young subject are unknown. The purpose of this study is to demonstrate the effect of eight weeks 37 TCC movement as exercise training on balance, kinesthetic sense and flexibility in sedentary healthy university students.

Key Words: Tai Chi Chuan (TCC), unipedal balance test, flexibility, kinesthetic sense.

Subjects and Study Design: Study subject were recruited from a Dumlupinar University health institution of higher education physical therapy and rehabilitation students. All subjects lived in the community and led a normally active lifestyle. All subjects had not engaged in any exercises training program. Subjects who had a history of significant cardiovascular, pulmonary, metabolic, and musculoskeletal diseases were excluded. Examinations, including static and dynamic balance when the eyes are open and closed, dominant, nondominant, sit and reach test, flexibility tests and kinesthetic sense were evaluated. All measures were evaluated before and after TCC training. 60 subjects were randomly divided in to TCC group (n: 30) and Control group (n:30). Two subjects because of aorta stenosis and chronic bronchitis, and four subjects did not continue regularly in TCC group and sixteen subject because of starting new basketball and football exercise program (8 subject) and did not come to for assessment (8 subject) were excluded in Control group. 24 subjects in TCC group and 14 subjects in Control group were completed the study. The TCC group including 9 male and 16 female subjects were practiced eight weeks (3 days a week) Yang stile 37 postures TCC (Originally 108 postures). The control group including 5 male and 9 female with age and body size matched to the TCC group. In duration of eight weeks TCC control group continue daily living activities and did not allow starting any exercises activity.

Balance Tests (One Leg Standing Test): One leg standing tests were measured on dominant and non-dominant leg in three position; eyes open (60 sec), eyes closed (30 sec) and eyes open with head rotation (30 sec)] with arms held comfortably at the side. Subjects were tested on level tile flooring with athletic-type rubber-soled shoes. Subjects were allowed one practice trial for each of the balance tests. In standing on one leg test, stable platform for static balance and trampoline for dynamic balance were used. The position of the non-weight bearing leg was chosen by subject. Test was accepted failure when the stance foot shifted in any way or the nonstance foot touched the ground. Each subject performed three trials and the best result of the three trials recorded [5-10].

Flexibility Tests: Trunk flexion, hyperextension, lateral flexion (by using tape line) and 30 cm (12 inches) sit and reach box tests were using for assessment flexibility. The sit and reach test is the most common of all the flexibility tests [11,12,13]. It measures the flexibility of the lower back and hamstrings. The objective is to assess the flexibility of the lower back and posterior thigh. The student should be able to reach a specified distance while sitting at a sit-and-reach box.

Kinesthetic Sense: For assessment of kinesthetic sense (static joint position sensation) was measured by goniometry. Subjects were lie supine, shoulder positioned 90^0 abduction and elbow 90^0 flexion. In this position tester were performed passively 30^0, 45^0 and 60^0 shoulder internal rotation first with eyes open, then students were repeated same rotations actively with eyes closed. Each test was performed three times and minimal results were recorded [14,15].

Tai Chi Chuan Training: Each training session included 20 minutes of warm up (including stretching exercise, gentle calisthenics, 3 minutes walking), 24 minutes of

TCC practicing, and 10 minutes of cool down. Each set of TCC included 37 postures (originally 108 postures): some popular TCC postures have been published in English [12]. During the performance of TCC, they were led by a Tai Chi master and imitated the motions and postures with the same speed [9-16]. This study was approved by the local Human Research Committee of the Dokuz Eylül University Hospital. The procedures were fully explained to all students, and informed consents were obtained.

Statistical Analysis: SPSS Windows 9.0 statistical program was used for all statistical analyses. Results were presented as mean ± SD. To determine the effect of TCC training, within-group differences were analyzed by using the paired t tests. Statistical evaluation of the data was performed with unpaired t test for comparison between two groups, (control subjects versus TCC group). Findings with an error probability value of less than 0.05 were considered as statistically significant.

3. RESULTS

The baseline physical characteristics of the subjects are shown in Table 1. There is no difference in age, weight, height, sex and their habits between the TCC and control group.

Table 1. Baseline Data of the Subjects*

Group	TCC (n: 23)	Control (n: 14)
Physiological variables		
Age (yr)	20.5 ± 2.8	20.0 ± 3.1
Body Height (cm)	167.7 ± 9.0	163.1 ± 10.9
Body Weight (kg)	56.7 ± 10.8	59.4 ± 11.0
Sex n. (F / M)	16 / 7	9 / 5
Dominant side (R / L)	22 / 1	14 / 0
VAS	2.1 ± 2.5	1.7 ± 2.4
Exercises habit n. (%)	8 (35)	3 (21)
Musculoskeletal pain n. (%)	10 (43)	5 (36)
Smoking habit n. (%)	7 (30)	6 (43)

TCC: Tai Chi Chuan, VAS: (Visual Analog Scale), n: number, * P>0.05, data are listed as mean ± SD

Balance Test Results: No statistical differences were found between groups before TCC training ($p>0.05$). In static test only on dominant leg with eyes open ($p<0.05$) and dynamic test results on both legs were statistically increase in TCC group after TCC training ($p<0.01$). When comparing groups after TCC training static and dynamic balance were observed higher in both legs in TCC group than control ($p<0.05$) (Table 2).

Flexibility Test Results: Before TCC training body hyperextension was found higher in TCC group ($p<0.05$). All flexibility tests of the subjects were increased after training in TCC group ($p<0.01$). Sit and reach and body hyperextension tests were found higher in TCC group than control after training ($p<0.05$, $p<0.001$) (Table. 3).

Table 2. One leg standing test results before and after Tai Chi Chuan training

Group	TCC (N:23)		Control (N:14)		P[a]
Static Test	**Baseline[b]**	**Follow-up**	**Baseline[b]**	**Follow-up**	
Dominant leg (sec)					
EO	58.9 ± 5.2	59.1 ± 0.4	57.3 ± 8.8	54.6 ± 13.6	NS
EC	23.8 ± 8.2	26.3 ± 7.0*	19.6 ± 9.1	19.4 ± 9.9	<.05
With head rotation EO	27.0 ± 13.2	27.6 ± 12.2	18.6 ± 8.8	17.0 ± 9.9	<.05
Non-dominant leg (sec)					
EO	58.1 ± 5.9	59.3 ± 2.3	57.4 ± 6.8	54.0 ± 12.9	NS
EC	24.9 ± 8.5	26.3 ± 5.3	20.1 ± 10.4	19.2 ± 9.2	<.05
With head rotation EO	25.8 ± 13.3	28.4 ± 9.4	17.4 ± 8.0	16.4 ± 7.7	<.01
Dynamic Test					
Dominant leg (sec)					
EO	48.7 ± 17.9	56.9 ± 8.0**	45.7 ± 17.6	49.5±15.2	<.001
EC	9.6 ± 8.6	12.7 ± 9.2**	7.4 ± 8.2	10.0 ± 8.3*	NS
With head rotation EO	10.4 ± 9.2	15.4 ± 10.5**	8.1 ± 4.1	9.5 ± 5.0	NS

Non-dominant leg (sec)					
EO	42.5 ± 20.1	53.6 ± 11.9**	33.0 ± 22.3	30.1±20.9	<.001
EC	6.6 ± 6.6	10.6 ± 8.0**	4.8 ± 1.8	5.6 ± 2.6	NS
With head rotation EO	12.4 ± 11.6	16.7 ± 10.9**	8.0 ± 4.7	8.7 ± 4.6	<.05

TCC: Tai Chi Chuan, EO: Eyes open, EC: Eyes closed, NS: Non-significant, [a] To compare the group differences between the TCC and the control group. [b]No statistical differences in two groups in baseline values.* P<.05, **P<.01, within-group differences from baseline to follow-up. Data are listed as mean ± SD.

Kinesthetic Sense Test Results: Before TCC training in shoulder 30^0 was found lower kinesthetic sense in TCC group ($p<0.05$), but after training, kinesthetic sense in all degrees were increased with statistical significance ($p<0.05$, $p<0.01$). No statistical significance were observed after TCC training in comparing groups ($p>0.05$) (Table 4).

Table 3. Flexibility test results before and after Tai Chi Chuan training

Group	TCC (N:23)		Control (N:14)		P [a]
Flexibility Test	**Baseline**	**Follow-up**	**Baseline**	**Follow-up**	
Body movements (cm)					
Left rotation	22.7 ± 5.9	25.1 ± 6.1*	25.9 ± 7.1	24.7±7.0	NS
Right rotation	22.8 ± 4.7	25.2 ± 4.7*	26.2 ± 8.0	25.1±7.8	NS
Sit and reach	16.6 ± 8.2	19.9 ± 6.3*	13.9 ± 9.0	12.4±8.7	<.05
Hyperextension	27.7 ± 10.4[b]	30.8 ± 8.6*	21.0±6.1[b]	20.4±6.6	<.001
Left lateral flexion	21.6 ± 4.4	23.0 ± 4.3*	21.1 ± 4.6	22.0 ± 4.8	NS
Right lateral flexion	20.8 ± 4.6	22.1 ± 4.6*	19.5 ± 5.0	20.5 ± 5.3	NS

TCC: Tai Chi Chuan, EO: Eyes open, EC: Eyes closed, NS: Non-significant, [a] To compare the group differences between the TCC and the control group. [b]Found statistical significance in two groups in baseline values. *P<.01, within-group differences from baseline to follow-up. Data are listed as mean ± SD.

Table 4. Kinesthetic feel results before and after Tai Chi Chuan training

Group	TCC (N: 23)		Control (N:14)	P[a]
Shoulder Degrees	Baseline	Follow-up	Baseline	Follow-up
30^0	3.8 ± 2.2[b]	2.9 ± 2.0**	2.2 ± 1.3[b]	2.5± 1.2 NS
45^0	3.1 ± 2.0	2.7 ± 1.7*	2.3 ± 2.5	2.5± 2.0 NS
60^0	3.0 ± 1.7	2.5 ± 1.6*	2.6 ± 2.3	3.1± 1.8 NS

TCC: Tai Chi Chuan, EO: Eyes open, EC: Eyes closed, NS: Non-significant, [a] To compare tl group differences between the TCC and the control group. [b]Found statistical significance in two groups in baseline values. *P<.05, **P<.001, within-group differences from baseline to follow-up. Data are listed as mean ± SD.

4. DISCUSSION

TCC is a Chinese traditional exercise and is unique for slowly graceful movement. From the standard-point of exercise prescription, TCC practice has been used for centuries as an exercise for health in a wide age range, particularly in elderly. It is an exercise with low impact and low velocity, and the orthopedic complication is minimal. In addition, TCC can be practiced any time and any place because it needs neither wide space nor any equipment. In addition, it has an interest for many people because it's from is fully variety. However, same TCC programs for sedentary young healthy subjects have not been established, and their exercise result remains controversial. Tsai et al [17] reported that Tai Chi exercise training in young healthy subjects could decrease blood pressure and results in favorable lipid profile changes and improve subject's anxiety status. Therefore, Tai Chi could be used as an alternative modality in treating patients with mild hypertension, with a promising economic effect.

The training effect of an exercise program depends on its exercise mode, intensity, frequency and duration. However, the training characteristics in TCC studies are quite variable, and hence the results are difficult to compare. In future research, a standardized training program should be utilized according to the principles of exercise prescription. Novice practitioners usually need 2 to 3 months to learn a complete set of TCC movements if they practice it everyday. During the familiarization phase, the exercise intensity and amount of training are inconsistent. Therefore, 6 months of training may be a minimum to evaluate the training effect of TCC. In addition, suitable exercise duration for a TCC program is 40 to 60 minutes including warm-up and cool down. If a program only utilities several TCC postures instead of a complete set of TCC movements, "tai chi –like exercises" or "tai chi movements" are better descriptions for training mode [5].

In novice young practitioners are difficult to make physiological changes. In this study 3 days 8 weeks TCC exercises training program was found effective on

balance and flexibility like older subjects. Originally TCC is included 108 postures but in novice practitioners difficult to teach all of them. Therefore, we were practiced 37 postures as an exercise in our subject.

During the performance of TCC, bodyweight shifting, body rotation, and single-leg standing in different postures are repeatedly practiced. Delicate joint control with muscle coordination is important to maintain balance during motions. Therefore, TCC practitioners display better balance function than nonpractitioners [5]. In studies using simple balance tests (such as time duration in single-leg standing with eyes open or closed) older TCC practitioners showed better postural control than sedentary individuals [6,7,8]. In studies using computerized balance systems, TCC practitioners showed no differences in simple conditions (such as postural sway when standing with eyes open or closed) compared with a control group [9,10]. However, in more complex conditions, the TCC group demonstrated better results in eyes closed with sway surface, sway vision with sway surface, and forward-backward body-weight shifting test [9].

TCC also improves balance function in novice practitioners. In the FICSIT study in Connecticut, US [18] a TCC program could preserve the balance gains achieved after a 3-month balance training course, and showed a trend towards further improvement in balance. In FICSIT study in Atlanta, US 15 weeks of TCC training increased the sway in stance and decreased the fear of falling [19].

In our study after TCC training only dominant leg with eyes open in static tests and all tests on both legs in dynamic tests were increases in TCC group. Most of the both groups subjects were completed the static balance tests with successful. When comparing groups after TCC training on both legs eyes closed and with head rotation eyes open in static test, and on both legs eyes open and nondominant leg with head rotation were found higher in TCC group than control. TCC is performed in a semi-squat posture at a slow speed. During the performance, various degrees of concentric and eccentric contraction are demanded of the lower extremities. The slow motion and low posture place a greater muscular demand on knee extensors; however, excessive stress to joints may be prevented because most motions of TCC are performed in closed kinematic chain. Therefore TCC training improved stability with improvement in integration of sensorimotor function within the nervous system.

Graceful and slow thoracic rotations are increased in flexibility [11,12,13]. In addition warm up and cool down stretching exercises were effected like TCC exercise. Randomized elected subjects of TCC group were made better hyperextension. After TCC training all body movements were increased in TCC group. Before training were not found any flexibility and range of motion limitations in both groups because of the young healthy subjects. However, after training TCC groups sit and reach test was found higher scores than control. TCC movements can be used for increasing flexibility in young subjects as elderly.

Kinesthetic feel is a proprioception sense and important for balance and body movements. TCC practitioners need to perform spiral movements of the upper extremities with delicate control. Jacobsen et. al. [20] reported that a 12 – week TCC program could increase participant's shoulder kinesthetic sense at 60^0. In addition, an 8-week TCC program also significantly reduced movement force variability in manual aiming tasks, which implies that TCC improves arm movement control and might be beneficial for daily activities [21].

Pincivero et al (in knee joint) [14] as in the present study for assessment of kinesthetic sense were used electrogonimetery. Before TCC training in shoulder 30^0 was found lower kinesthetic sense in TCC group than control but after TCC training kinesthetic sense in all degrees were increased. No change was observed between groups after TCC training. This test can be better used in lower extremities. TC movement is apply pressure to joint especially lower extremities. Therefore, TCC training may increase in neuromuscular sense in the joints and improve in balance.

In Conclusion: 8 weeks TCC training has improved the balance, flexibility and kinesthetic sense in sedentary young subjects as in elderly. Traditional exercise studies focus on laboratory training requiring expensive equipment. Although a high-technology program is effective in short-term training, practicing it in everyday life is difficult. TCC is a low-technology exercise and can be easily implemented in different communities. TCC has potential benefits in health promotion, and is appropriate for implementation in community.

5. ACKNOWLEDGMENT

The authors wish to thanks to the Class III students of Dumlupinar University Physical Therapy and Rehabilitation of 2001 - 2002.

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TAI CHI CHUAN (TCC) EĞİTİMİNİN SAĞLIKLI GENÇ BİREYLERDE MUSCULOSKELTAL SİSTEM ÜZERİNE ETKİLERİNİN DEĞERLENDİRİLMESİ

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ÖZET

T'ai Chi Ch'uan'i (TCC) bir ruh, zihin ve beden sağlığı için yapılan bir takım uyumlu hareketler olarak tanımlayabiliriz. Çalışmamıza TCC eğitiminin üniversite öğrencilerindeki muskuloskletal etkilerinin değerlendirilmesi amacıyla Kütahya Dumlupınar Üniversitesi Sağlık Yüksekokulu Fizik Tedavi ve Rehabilitasyon Bölümünde okuyan yaş ortalaması 20.54 ± 2.76, 23 öğrenci TCC gurubu (16 kız, 9 erkek) ve yaş ortalaması 20.02 ± 3.07 14 öğrenci Kontrol gurubu (9 kız, 5 erkek) olarak 37 öğrenci dahil edilmiştir. TCC gurubuna 8 hafta boyunca haftada 3 olmak üzere 20 dk ısınma (3 dk solunum kontrollü yürüyüş, germe ve kalistenik egzersizler), 24 dakika 37 adet Yang stili TCC hareketleri ve 10 dk soğuma programı yaptırılmıştır. Değerlendirme parametreleri olarak statik ve dinamik denge testleri, Quadriceps ve hamstring kaslarının kas kuvveti, gövde esneklik ve sit and reach testleri, omuzun 30, 45 ve 60 derecelerdeki rotasyonları kullanılarak kinestetik duyu, değerlendirilmiştir. TCC eğitimi sonrasında gözler kapalı pozisyonda statik denge, gözler açık dinamik denge, gövde esnekliklerinden hiperekstansiyon ve sit and reach testlerinde kontrol gurubuna göre istatistiksel olarak anlamlı gelişme sağlanırken; TCC gurubunu ek olarak kendi içinde değerlendirilmesinde eğitim sonrasında dominant ve nondominant quadriceps ve hamstring kas kuvvetinde istatistiksel olarak anlamlı artma saptanmıştır ($p<0.05$). 8 Haftalık TCC eğitimi denge, esneklik ve alt ekstremite kuvvetini literatürle uyumlu olarak artırırken, kardiyopulmoner fonksiyonlarda gelişme sağlanmamıştır. TCC eğitiminin sağlıklı bireylerde güvenli ve etkili olduğu, klinik şartlarda kullanılabileceği belirlenmiştir.

Anahtar Kelimeler: Tai Chi Chuan, egzersiz, muskuloskletal, denge, fleksibilite.

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