TAI CHI IMPACTS ON NEUROMUSCULAR FUNCTIONS IN THE LOWER LIMBS OF THE ELDERLY

EFEITO DO TAI CHI SOBRE AS FUNÇÕES NEUROMUSCULARES NOS MEMBROS INFERIORES DOS IDOSOS

EFECTO DEL TAI CHI EN LAS FUNCIONES NEUROMUSCULARES DE LOS MIEMBROS INFERIORES DE LOS ANCIANOS

Original Article
Artigo Original
Artículo Original

Zhen Zhang[1]
(Physical Education Professional)

1. Zhengzhou Technical College, Department of Mechanical Engineering, Zhengzhou, Henan, China.

Correspondence:
Zhen Zhang
Zhengzhou, Henan, China, 450100.
serrt009009@163.com

ABSTRACT

Introduction: Exercise can retard the effects of aging and improve the physical function of the elderly. Tai Chi is a widespread exercise practice among the elderly in China. Although studies show the positive effects of Tai Chi practice, there is no consensus about compared studies. Objective: Evaluate the impact of regular Tai Chi exercise on neuromuscular stability in the lower limbs of elderly people, comparing the results of practitioners between sedentary and walking elderly groups. Methods: Twenty-two Tai Chi practitioners were selected, with a mean age of 59.3±3.5 years and a mean practice time of 18.4±13.2 years. This experiment mainly tests the balance ability compared to individuals practicing walking and other sedentary individuals. Results: The muscle strength of the knee flexors and extensors in the Tai Chi group was significantly greater than in the sedentary group (p=0.001 to 0.00160°/sec; P=0.002 to 60°/sec extensors; p=0.002 to 120°/sec; 120°/sec flexors, p=0.003). Similarly, there was a significant difference in muscle strength between the Tai Chi group and the walking group (the P values of the flexors and extensors at both speeds were less than 0.001). Conclusion: Tai Chi, as a regular exercise, can increase muscle strength of the general knee flexors and extensors and improve the neuromuscular stability of lower limbs in the elderly. ***Evidence Level II; Therapeutic Studies - Investigating the result.***

Keywords: Elderly; Lower Limbs; Tai Ji.

RESUMO

Introdução: Exercícios podem retardar os efeitos do envelhecimento e melhorar a função física dos idosos. O Tai Chi é uma prática popular de exercício entre os idosos na China. Embora haja estudos que evidenciem os efeitos positivos da prática de Tai Chi, ainda não há um consenso sobre os estudos comparados. Objetivo: Avaliar o efeito do exercício regular de Tai Chi sobre a estabilidade neuromuscular nos membros inferiores em idosos, comparando os resultados dos praticantes entre grupos idosos de sedentários e praticantes de caminhada. Métodos: Foram selecionados vinte e dois praticantes de Tai Chi, com idade média de 59,3±3,5 anos com tempo médio de prática de 18,4±13,2 anos. Este experimento testa principalmente a capacidade de equilíbrio comparando aos indivíduos que praticam caminhada e outros sedentários. Resultados: A força muscular dos flexores e extensores do joelho no grupo Tai Chi foi significativamente maior do que no grupo sedentário (p=0,001 a 0,00160°/s; P=0,002 a extensores de 60°/s; p=0,002 a 120°/s; flexores de 120°/seg, p=0,003). Similarmente, houve uma diferença significativa na força muscular entre o grupo Tai Chi e o grupo de caminhada (os valores P dos flexores e extensores em ambas as velocidades foram inferiores a 0,001). Conclusão: Exercícios regulares, como o Tai Chi, podem alterar a força muscular dos flexores e extensores gerais do joelho, e melhorar a estabilidade neuromuscular dos idosos nos membros inferiores. ***Nível de evidência II; Estudos Terapêuticos - Investigação de Resultados.***

Descritores: *Idosos; Membros Inferiores; Tai Chi.*

RESUMEN

Introducción: Los ejercicios pueden retrasar los efectos del envejecimiento y mejorar la función física de las personas mayores. El Tai Chi es una práctica de ejercicio muy popular entre las personas mayores de China. Aunque hay estudios que demuestran los efectos positivos de la práctica del Tai Chi, todavía no hay consenso sobre los estudios comparativos. Objetivo: Evaluar el efecto del ejercicio regular de Tai Chi en la estabilidad neuromuscular de las extremidades inferiores en ancianos, comparando los resultados de los practicantes entre grupos de ancianos sedentarios y caminantes. Métodos: Se seleccionaron 22 practicantes de Tai Chi, con una edad media de 59,3±3,5 años y un tiempo medio de práctica de 18,4±13,2 años. Este experimento pone a prueba principalmente la capacidad de equilibrio en comparación con los individuos que practican caminata y otros sedentarios. Resultados: La fuerza muscular de los flexores y extensores de la rodilla en el grupo de Tai Chi fue significativamente mayor que en el grupo sedentario (p=0,001 a 0,00160°/seg; p=0,002 a 60°/seg extensores; p=0,002 a 120°/seg; 120°/seg flexores, p=0,003). Del mismo modo, hubo una diferencia significativa en la fuerza muscular entre el grupo de Tai Chi y el grupo de caminantes (los valores P de los flexores y extensores a ambas velocidades fueron inferiores a 0,001). Conclusión: Los ejercicios regulares, como el Tai Chi, pueden modificar la fuerza muscular de los flexores y extensores generales de la rodilla y mejorar la estabilidad neuromuscular de los ancianos en las extremidades inferiores. ***Nivel de evidencia II; Estudios terapéuticos - Investigación de resultados.***

Descriptores: *Ancianos; Miembros Inferiores; Tai Chi.*

DOI: http://dx.doi.org/10.1590/1517-8692202228052022_0015 Article received on 01/28/2022 accepted on 02/11/2022

INTRODUCTION

After long-term research, people basically affirm that environmental hygiene, mental state, living habits, diet, drugs, and exercise are closely related to human aging.[1] Good environmental hygiene, mental condition, living habits and diet, can not make the human body's functional activity level be improved. Exercise is different, it can not only increase the joy of life and invigorate the spirit, and it can also enable the functional activities of many tissues of the human body, from the low level at rest, to reach or exceed the highest level of activity. Therefore, the functional level of the human body can be maintained and improved. Exercise can delay aging, and for the elderly, as the adaptability of middle-aged and elderly people is significantly reduced, once they bear an excessive load, it is more likely to cause a decline in the function of the heart than young people, the excessive amount of exercise will also lead to an increase in sports injuries. Therefore, the elderly can only engage in reasonable sports, in order to achieve the purpose of improving body function and delaying aging. Therefore, Tai Chi is not only a physical exercise, at the same time, consciousness effectively controls physical activity to achieve exercise effect, through Tai Chi exercise, people can improve breathing control during physical exercise, the coordination of hands and eyes, the coordination of body and consciousness, these promote the improvement of balance ability from all aspects.[2]

METHOD

Select 22 Tai Chi practitioners (12 males and 10 females), with an average age of 59.3+3.5 years old, the period of practicing Taijiquan is 18.4+13.2 years, this experiment mainly tests the balance ability of subjects. The experiment started at 9:00 am, and the subjects were required to maintain a good and comfortable physical condition. Before the experiment, all subjects received intensive guidance on the experiment, understand the purpose and requirements of the experiment.[3] Before the experiment, all subjects measured their weight and height. The test subject stands on the three-dimensional force plate with legs apart, the distance between your feet should be shoulder-width apart, and your hands should hang down on your side, with both eyes looking forward, the subject stood still and motioned to the researcher, the force plate starts data collection, the data collection time is 30 seconds, and a total of 3 tests are performed, between every two, take a five-minute rest. Test 2 requires the same experiment as Experiment I, the subject is tested on the three-dimensional force plate in case B, it can collect the position of the center of gravity and pressure at every moment, the collection time is 30 seconds, and a total of 800 points are collected, computer's three--dimensional force measurement system software, automatically draw a trajectory diagram of the movement of the center of gravity projection point, at the same time, the text data of the position of the projection point in the X and Y coordinate directions of the force plate is given.

The camera is placed at a distance of 8 meters from the plane of motion perpendicular to the sagittal plane, the shooting range is 2 meters, and the scale is placed on the side of the force plate, in the same sagittal plane as the motion path. Two 1000-watt tungsten lamps are used for lighting. Use the Aijie video analysis system to analyze the video of the subject, the subject uses the location on the left heel as the starting point, analyze a single-step process, some subjects were tested for left and right symmetry, and the result was that, during normal walking, the movement of the left and right lower limbs is basically symmetrical.[4] The internal angles of the hips, knees, and ankles are defined as the joint angles. Through video analysis, the maximum joint angle of the subject's hip, knee, and ankle joints when walking is obtained, the subjects' step length, pace, and the proportion of single and double support time in the walking cycle.

RESULTS

Force plate balance experiment

The balanced experiment results can been shown as Table 1, Table 2, Figure 1 and Figure 2. The experimental results show that: In the A experiment, the experimental group is in the seven indicators of Mx, Dx, Dy, Lng, LngX, LngY, AREA, there is a significant difference from the control group. And in experiment A, the eight indicators selected in the experiment, the experimental group and the control group have only one indicator of Dy, which is significantly different from the control group. MAXY represents the maximum displacement of the subject's center of gravity in the Y direction, explain the greatest deviation of the subject's center of gravity, from the experimental results, in the experiment, the maximum deviation of the experimental group was 196.3+11.22mm, while that of the control group was 235.5+20.68mm, there is a significant difference between the two, explain the maximum deviation of Tai Chi practitioners, in the Y direction, it is significantly smaller than those who have not practiced. The meanings of Dx and Dy reflect the range of movement of the center of gravity in the X and Y axis directions.[5]

Table 1. Balance test results A.

	Mx* (mm)	My* (mm)	Dx* (mm)	Dy** (mm)	LNG* (mm)	LNGx* (mm)	LNGy* (mm)	AREA** (mm)2
Test group	115.8+ 20. 2	196.3+ 1l.3	23.4+ 7.9	15.3+ 3.6	2590.4+ 512	1085.2+ 211.87	2157.8+ 444.6	286.19+ 139.8
Control group	286.19+ 139.9	235.5+ 20.7	31.3+ 72.43	23.7+ 13.6	3194.2+ 1096	1406.8+ 569.61	2619.5+ 849.5	596.9+ 384.3

Table 2. Balance test results B.

	Mx (mm)	My (mm)	Dx (mm)	Dy** (mm)	LNG (mm)	LNGx (mm)	LNGy (mm)	AREA (mm)2
Test group	117.8+ 25.5	202.3+ 18.8	30.9+ 10.3	17.4+ 4.19	3014.9+ 747.7	1319.6+ 326.8	2474.7+ 631.3	447.9+ 236.8
Control group	126.7+ 20.8	235.7+ 18.8	33.6+ 13.7	21.5+ 6.57	3007.7+ 716.8	1319.5+ 317.8	2468.4+ 597.5	594.8+ 368.4

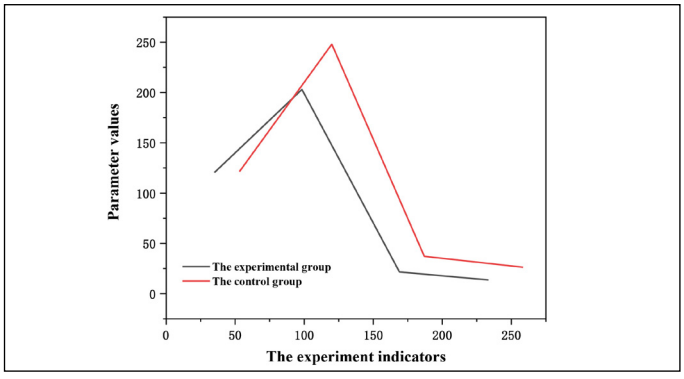

Figure 1. Balanced experiment results Figure A.

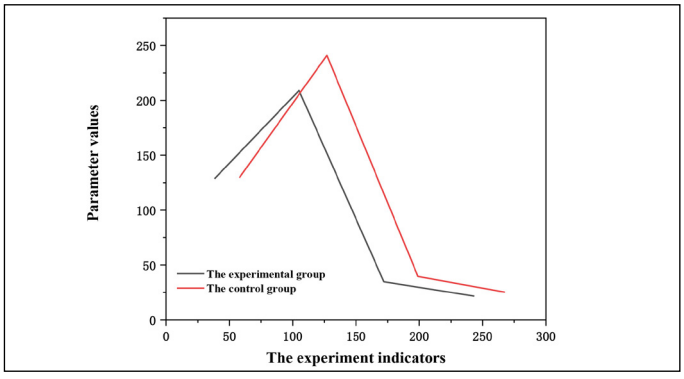

Figure 2. Balanced experiment result B.

From the experimental results, in the A test, Tai Chi practitioners on the X and Y axes are significantly smaller than those who have not practiced, explain that the practice of Taijiquan, when practitioner A stands still, the center of gravity control on the frontal axis and sagittal axis has an effect. In experiment B, in the sagittal axis, there are significant differences between Tai Chi practitioners and non-practitioners. Three indicators, Lng, LngX, and LngY, are commonly used and more effective indicators to reflect the body's static balance ability. Because of these three indicators, it reflects a continuous balance effect of the human body under static standing. Among them, Lng reflects the whole test process, the movement distance of the body's center of gravity, it also has the meaning of average speed, so it can reflect the static standing, the body's ability to control the center of gravity.[6]

DISCUSSION

In this experiment, it was found that, in Experiment A, Tai Chi practitioners throughout the test, the total displacement of the entire center of gravity, significantly smaller than those who have not practiced, and on the X axis and Y axis, the total length of the trajectory of the center of gravity of the Tai Chi practitioners appears, less than the phenomenon of non-practitioners.7 Explain Tai Chi practice, it has a significant impact on improving the ability to control the stability of the body's center of gravity. Reason analysis: When people stand still, the angle of the legs is small, the balance angle between the frontal plane and the sagittal plane axis is small, when practicing Tai Chi, one of the most basic movements is standing stance, when the practitioner is standing, with legs open, the center of gravity drops, both the frontal axis and the sagittal axis of the balance angle increase, the movements of Tai Chi are basically done with knees bent, this posture is very good for improving the ability of the practitioner to control the two axis directions of the body, therefore, after long-term practice of Taijiquan, the practitioner's ability to control the center of gravity has been significantly improved.[8] AREA is an expected indicator made by researchers for the trajectory of the center of gravity, because from the experimental results, the trajectory diagram of the center of gravity movement, it is mostly an ellipse-like shape. Researchers based on the similar shapes of a large number of trajectory graphs, select Dx and Dy as the long and short axis, calculate the area of an ellipse. Trying to use this indicator as an effective indicator of balance ability, because the collected center of gravity coordinates are mostly concentrated in this area, the results of the experiment found that, the ellipse area of the experimental group and the control group is significantly different.[9-10]

CONCLUSION

It was found in the static standing A experiment that, Taijiquan practitioners have a number of indicators, significantly different from the control group, explain that in the static standing experiment A, Tai Chi practitioners have stronger ability to control the center of gravity in the neuromuscular response of the lower limbs, long time Tai Chi practice, should improve the exerciser's static A standing lower limb balance ability. In the static standing B experiment, Tai Chi practitioners are only in the Y-axis direction, among the indicators of maximum distance, it was found to be significantly different from the control group, the experimental results are consistent with previous literature reports, explain Tai Chi practice, the improvement in balance control ability of lower limbs in static standing B is not obvious. Tai Chi practitioners have a wide range of hip joints, which shows that Tai Chi exercises enable practitioners to fully extend their hips, the leg lift is large, and the muscles around the hip joint have better stretch and elasticity. One-way analysis of variance shows that, at 60°/sec and 120*/sec two speeds, the relative peak torques of the knee flexors and extensors in the Tai Chi group, both are greater than the relative peak torque of the other two groups. Further analysis can conclude, the muscle strength of the flexors and extensors of the knee joint in the Tai Chi group, significant buckwheat is larger than the sedentary group (p=0.001 at 60°/sec flexor; p=0.002 at 60°/sec extensor; 120*/sec flexor, p=0.002; 120*/sec flexor, p=0.003), in the same way, the muscle strength of the Tai Chi group was compared with that of the walking group, there are also significant differences (the p-values of the flexors and extensors at the two speeds are both smaller than 0.001). Long-term Tai Chi practice and walking, can change the muscle strength of the general knee joint flexors and extensors, among them, Tai Chi exercise has a better effect on muscle strength than walking.

The author declare no potential conflict of interest related to this article

AUTHORS' CONTRIBUTIONS: The author made significant contributions to this manuscript. ZZ: writing, data analysis and article review.

REFERENCES

1. Wang S, Su L, Li J, Xu D. Effects of Long-Term Tai Chi and Jogging on Neuromuscular Latency and Time to Peak of EMG in Older Males during Lateral Sudden Perturbation. Yiyong Shengwu Lixue/Journal of Medical Biomechanics. 2018;33(2):163-7.
2. Baptista LC, Dias G, Souza NR, Veríssimo MT, Martins RA. Effects of long-term multicomponent exercise on health-related quality of life in older adults with type 2 diabetes: evidence from a cohort study. Quality of life research: An international journal of quality of life aspects of treatment, care and rehabilitation. 2017;26(8):2117-27.
3. Owosho AA, Brady P, Wolden SL, Wexler LH, Antonescu CR, Huryn JM et al. Long-term Effect of Chemo-Intensity-Modulated Radiation Therapy (chemo-IMRT) on Dentofacial Development in Head and Neck Rhabdomyosarcoma Patients. European Paediatric Haematology & Oncology. 2016;33(6):383-92.
4. Arai T, Mangyo R. Long-term Effects on Physical Fitness of an Exercise Program for Community-dwelling Elderly. Rigakuryoho Kagaku. 2017;32(6):845-9.
5. Fukusaki C, Leetawesup K, Kato N, Kadokura Y, Nakazawa K, Yano H et al. Effects of Defensive Style Nordic Walking Intervention in Patients with Lumbar and Lower-Limb Osteoarthritis. Journal of Novel Physiotherapies. 2018;8(2):1-7.
6. Chang S, Zhou J, Hong Y, Sun W, Cong Y, Qin M et al. Effects of 24-week Tai Chi exercise on the knee and ankle proprioception of older women. Research in Sports Medicine. 2016;24(1):84-93.
7. Hermassi S, Chelly M, Fieseler G, Bartels T, Schulze S, Delank KS et al. Short-Term Effects of Combined High-Intensity Strength and Sprint Interval Training on Anthropometric Characteristics and Physical Performance of Elite Team Handball Players. Sportverletz Sportschaden. 2017;31(04):231-9.
8. Devanathan D, Madhavan S. Effects of anodal tDCS of the lower limb M1 on ankle reaction time in young adults. Experimental Brain Research. 2016;234(2):377-385.
9. Ehlers DK, Banducci SE, Daugherty AM, Fanning J, Awick EA, Porter GC et al. Effects of Gait Self-Efficacy and Lower-Extremity Physical Function on Dual-Task Performance in Older Adults. BioMed Research International. 2017;2017(4): 8570960.
10. Razzaghi S, Khodaverdiloo H, Dashtaki SG. Effects of long-term wastewater irrigation on soil physical properties and performance of selected infiltration models in a semi-arid region. Hydrological sciences journal. 2016;61(10):1778-90.