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Does Practicing Tai Chi Chuan Make a Difference for Postural Balance in the Elderly? A Pilot Study

Hat das Praktizieren von Tai Chi Chuan einen Einfluss auf die posturale Balance bei Senioren? Eine Teststudie

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Summary

- **Balance** plays an important role in the daily lives of elderly people to prevent them from falls and injuries. A suitable exercise to improve balance is Tai Chi Chuan. The purpose of this study was to analyze balance control in Tai Chi Chuan practitioners and compare it with non-practising active elderly people.
- **Ten Tai Chi Chuan practitioners,** mean age 70.1±4, (5 women and 5 men) were willing to participate in this study. Twelve elderly with a mean age of 71.9±5 years, served as the control group. An oscillating suspended platform (Posturomed) was used to measure the horizontal movements in two orthogonal directions using a small ultrasonic marker (Microswing). The measured displacements in the two directions, anterior-posterior (AP) and medio-lateral (ML), were used to establish a balance index. The total sway line g can be divided into the x- and y-component (ML and AP sway). Four different stances were analyzed to evaluate balance ability: shoulder-wide stance with eyes open and closed, legs together, semitandem and tandem stance.
- **An independent t-test** was used to compare the groups. The Tai Chi Chuan group showed a significantly (p=0.04) better balance control in the ML direction in the shoulder-wide stance with eyes closed than the control group.
- **In summary,** practicing Tai Chi Chuan may have a positive influence on balance control when vision is obstructed and balance has to rely on the vestibular system.

KEY WORDS:
Postural Sway, Proprioception, Aging, Exercise

Zusammenfassung

- **Balance** spielt eine wichtige Rolle im Leben älterer Menschen, um sie von Stürzen und daraus resultierenden Verletzungen zu bewahren. Eine geeignete Sportart, um das Balancevermögen zu verbessern ist Tai Chi Chuan. Das Ziel dieser Studie war es, das Balancevermögen von Tai Chi Chuan-Praktizierenden mit dem von aktiven gleichaltrigen nicht Tai Chi Chuan-Praktizierenden zu vergleichen.
- **Zehn Probanden,** deren Durchschnittsalter 70,1±4 betrug, (5 Frauen und 5 Männer) waren bereit, an dieser Studie teilzunehmen. 12 Probanden mit einem Durchschnittsalter von 71,9±5 Jahren dienten als Kontrollgruppe. Das Posturomed, eine schwingende Plattform wurde verwendet, um die horizontalen Bewegungen in zwei orthogonalen Richtungen mit einem kleinen Ultraschallmarker (Microswing) zu messen. Die gemessenen Verschiebungen in den zwei Richtungen, anterior-posterior (AP) und mediolateral (ML), wurden verwendet, um einen Bilanzindex zu ermitteln. Die Gesamtschwankungslinie g kann in die x- und y-Komponenten (ML- und AP-Ausgleichsschwingung) unterteilt werden. Zur Bewertung des Gleichgewichtsvermögen wurden vier verschiedene Positionen analysiert: schulterbreiter Stand mit offenen und geschlossenen Augen, Füße zusammen, Füße schulterbreit versetzt und Füße hintereinander.
- **Ein unabhängiger T-Test** wurde zum Vergleich der beiden Gruppen (Tai Chi und Kontrolle) verwendet. Die Tai Chi Chuan-Gruppe zeigte ein deutlich besseres Balancevermögen in der schulterbreiten Position in ML Richtung mit geschlossenen Augen (p=0.04).
- **In unserer Teststudie** schien die Tai Chi Chuan-Gruppe ein besseres Gleichgewichtsvermögen zu haben, wenn das visuelle System ausgeschaltet war und die Teilnehmer sich nur auf das vestibuläre System verlassen konnten.

SCHLÜSSELWÖRTER:
Gleichgewicht, Propriozeption, Altern, Kampfkunst

Introduction

Nowadays with a growing older population sport scientists are interested in researching the effect of exercise on older people. Especially when looking at the fall statistics and caused injuries through fragility it is of great importance to analyze to what extend sport can prevent injuries and falls in the elder. Balance plays an important role in the prevention of falls. Three sensory (somato-sensory, visual, vestibular) organs are involved in postural control. The information from the sensory systems is important to maintain balance. The somato-sensory organs embrace the mechanoreceptor, which are located in the joints, capsules, muscles, tendons, ligaments and skin (1, 20). They respond to mechanical pressure or distortion. Proprioceptors are receptors that provide information from mechanical forces within the ›

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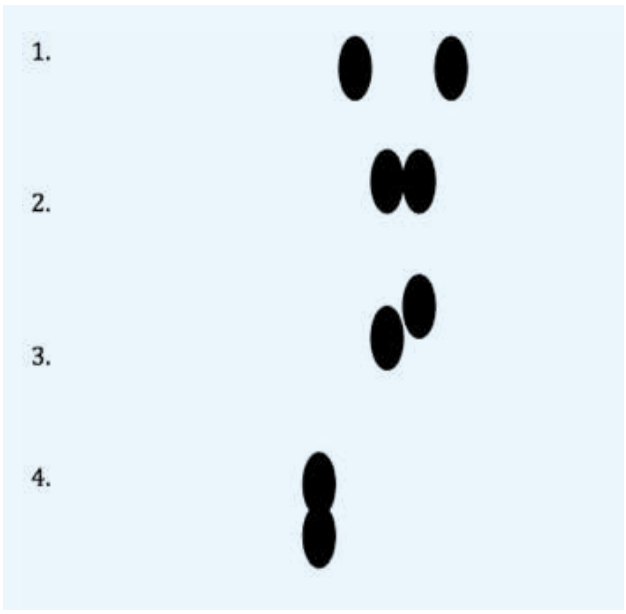

Figure 1

Four different stances used in this research 1.=shoulder-wide, 2.=leg-together, 3=semi-tandem and 4=tandem stance

musculoskeletal system. They signal to the nervous system the position of the limbs and the direction and speed of its movement (17). The information of these receptors is important to maintain balance and to regain it quickly when challenged. Postural balance then depends on the right sensory feedback, the right interpretation in the brain and the correct efferent answer as well as the speed of the nervous system. The proprioceptive ability has been found to diminish with age (10) and causing an increase in falls in elderly (16). Therefore, sensory-motor training seems to be an important tool for enhancing postural balance in elders.

Many studies have researched balance control and exercise in older people. In an intervention study, Rehfeld et al. (19) compared the effects of a 90 minutes dance class and a 90 minutes traditional fitness program including endurance, strength and flexibility training on balance and hippocampal volume. The hippocampal volume increased in both groups. But only the dancer showed a significant increase in the composite score of their balance test, the Sensory Organization Test. In their dance program they learned many different dances. Dancing is a coordinative challenging exercise and includes memorizing different movements and sequences. Similar to dancing, Tai Chi Chuan (TCC) is also a coordinative challenging exercise where participants need to remember many different movement patterns and put them together. TCC was originally developed as a martial arts form. In Asia it has been used for centuries as an exercise for health. Its slow and thoughtful movements made it especially attractive to elderly people. Basically TCC consists of several individual movements, which are combined together in a smooth and continuous way, so that one movement smoothly leads to the next. The harmony between body and mind is achieved by breathing and concentration. Especially the constant weight shifting from one leg to the other challenges balance and TCC therefore seems to be a good exercise to enhance balance. Several researches have been done to study its effects on balance (9, 11, 5, 13, 18). Tsang and Hui-Chan, for example, suggested that a four weeks intensive TCC training is sufficient to improve balance on a level similar to experienced TCC practitioners (23). In another study balance control in elder TCC practitioners who trained in average over 13,2 years was examined. Both their left and right leg standing ability with closed eyes were better than those in the sedentary control group ($p<0.05$) (6). In another study balance, and in particular the mechanisms of controlling the stepping strategies of the swing leg were more efficient in TCC practitioners than in the control group (5). However, TCC practitioners compared to people with a similar activity level did not differ in balance abilities when looking at quiet-stance data (18).

Most of these data except for the last one used sedentary people as control group. In comparison to sedentary people TCC practitioners are better considering many physical fitness parameter (8). However, when compared with community-dwelling people who are not sedentary but without any special kind of sport activity in their daily life, the positive effect of TCC itself on balance might be questionable and needs therefore to be further investigated. Although intervention studies are more likely to show some kind of adjustment, TCC is coordinative challenging and requires good memory and therefore needs time to be acquired. It seems that for example a 12-week TCC practice is not enough to enhance balance (21). Therefore we choose to compare TCC practitioners who were already practicing TCC for at least 1 year with non-practitioners. Although there have been several studies which found an improvement in balance parameter when practicing TCC, we wanted to analyze whether TCC influences only the stances that we find in TCC, like the empty stance, or the bow stance or other stances not found in TCC as well. The purpose of this pilot study was to see if postural balance in TCC practitioners is better in comparison to community-dwelling elderly people who were not practicing any specific kind of sport in different stances.

Method

Participants

As Jimenez et al (7) pointed out, the years of practicing TCC seems to be important to improve balance, therefore, TCC practitioners had to have at least 1 year of TCC experience to participate in the study. Ten subjects (5 females and 5 males) were recruited from two outdoor practicing Yang style TCC clubs in Taichung. They had an average of 2±1.1 years of TCC experience. They were 65 years and older and agreed to participate in this study. Their mean age was 70.1±4 years. A health questionnaire revealed no severe sensory motor problems or health problems. In average subjects trained 11.2 hours of TCC per week. Twelve elderly community-dwelling people (6 male and 6 female), mean age of 71.9±5 years served as control group. They did not practice any specific kind of sport but were working, gardening, volunteering or taking care of their grandchildren. The questionnaire did not reveal any sever sensor motor problem for the control group either.

Measures

The Posturomed is a sensorimotor prevention, therapy, and diagnosis device designed by Haider in Germany (10). It is an oscillating suspended platform, which measures the horizontal movements in two orthogonal directions using a non-contact measurement system. The platform is 60cm x 60cm big and 12 kg heavy. The platform is stabilized with cable ropes at each corner, which make the platform swing 5 cm above the ground. The cable ropes have a plastic coating in order to damp the platform movements. The sway properties can be regulated on three levels due to a special platform suspension in which four, six or eight cable ropes are activated. Because of this construction,

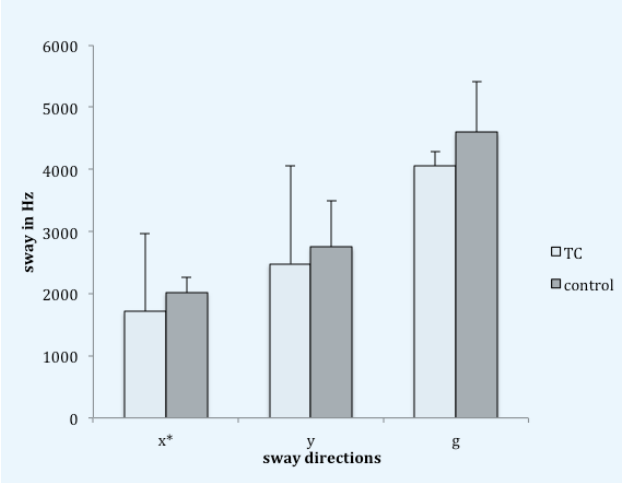

Figure 2

Comparing TCC and control group's x, y and g sway-line in shoulder-wide-stance with eyes closed, x* significant with p=0.04.

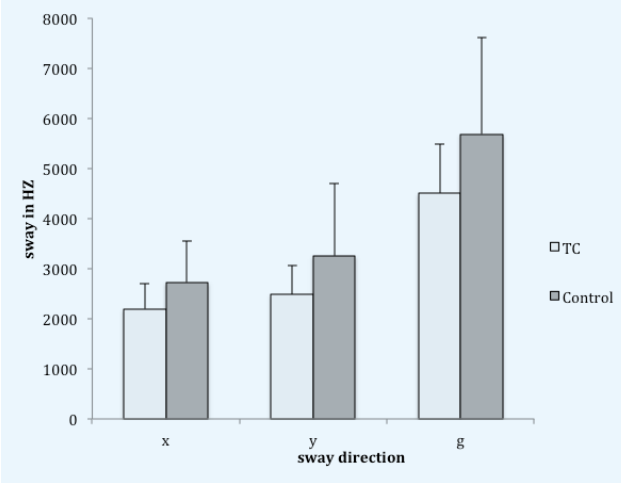

Figure 3

Comparing TCC and control group's x, y and g sway-line in leg-together-stance.

the surface of the platform will move if the center of gravity moves. The dampening of the oscillating elements then helps to stabilize the surface again. A small ultrasonic marker (Microswing) was attached under the platform to measure the acceleration force on the horizontal plane (the medio-lateral (ML) and anterio-posterio (AP) sway). The data was then digitalized by an analog digital converter and processed by the Microswing measurement software. In this study the ML and AP sway with a 250Hz time resolution were recorded. The measured displacements – the length of the movement path from a virtual point of the plate - in the two directions ML (x) and AP (y) were used to establish a balance index in millimeters (mm). The distance between the x- and y-values (g) was calculated by using the Theorem of Pythagoras. So the balance index displays the distance from one point to the next (250 points per second). The longer the distance the more the subjects move in order to maintain balance.

Procedure

Based on Gardner's research on balance in the elderly, we used the same stances to evaluate balance: legs put together (l-t), semi-tandem (s-t) and tandem stance (t) (4). We replaced the one-leg stance by a shoulder wide stance with eyes open (s-w-eo) in order to avoid injuries because the one leg stance is very challenging when performed on an oscillating platform. The shoulder wide stance with closed eyes (s-w-ec) was included in our research to rule out the influence of the visual system (Figure 1).

Participants positioned themselves on the unmoving platform. After they positioned themselves in the right position (see above), the test was started and the platform was set free. Each involuntary movement of the participants resulted in swinging motions of the platform. Each position was measured over 20 seconds according to the Posturomed guidelines.

Data Analysis

SPSS 17.0 was used to run a paired t-test in order to compare the TCC group with the non Tai Chi participants.

Results

The average values of the five stances for the directions x, y and g were calculated. A paired t-test was used to compare the two groups (TC and control). No significant differences were found in the shoulder-wide stance when eyes were open and the semi-tandem stance. However, the ML sway (x- value) in the shoulder-wide stance with closed eyes was significantly (p=0.04) better in the TCC group (Figure 2).

There was a tendency for better balance in the leg-together-stance AP direction in the TCC group, but it missed significance level with p=0.07 (Figure 3). In the semitandem stance and the tandem stance no significant difference was observed between TCC practitioners and control group.

Discussion

The benefits of TCC have been discussed in several studies before. Many studies used an intervention design to evaluate the effect of TCC on balance. In these studies the effects cannot be denied. However, most of these studies compared TCC groups with a sedentary control group (4). Likewise any kind of activity might improve elder's balance compared to an older sedentary control group. Few studies have been done to compare TCC with other activities or sports popular in the elder. One of these studies compared TCC practitioners with active elders and found that the elder TCC practitioners swayed significantly less than the active control group in more difficult conditions (e.g. disruption by conflicting visual input or tilting of the supporting surface) and not in the more simple conditions of static balance (28). In this study they used the SMART Balance Master to evaluate balance. They also did static balance tests with closed eyes but did not find any differences between the TCC group and the control group. However, when participants somatosensory system was challenged by tilting the platform and the eyes were covered the TCC practitioners showed a significantly better performance than the non-practitioners. Here they concluded that TCC practitioners have better balance control in more challenging positions. In our study TCC practitioners showed better balance ability with a stance that was very familiar to them but was more challenging since vision was obstructed.

A controlled clinical trial examined visually impaired older adults and the effect of a 16-week TCC program on their balance control in comparison to a control group (3). In this study the TCC practitioners improved their knee proprioception and balance control significantly. ›

In contrast another study analyzed balance control under different sensory conditions and found out that TCC practitioners showed better balance control when the conditions demanded an increased reliance on the visual and vestibular system (24). In a study by the same study group, where elderly TCC practitioners were compared to elderly golfers, the results showed that both golfers as well as TCC practitioners had a well-developed sense of knee joint proprioception (25). It seems that if proprioception is well developed by practicing TCC or golf, balance can be maintained even if the visual system is cut off.

In all of these studies TCC practitioners showed better balance control when balance relied on the vestibular system. This is supported by another study where they used vestibular stimulation and compared long-term TCC practitioners with older control subjects (26). It showed that the TCC practitioners swayed less in the AP direction than the control group after vestibular stimulation. Our pilot study supports the previous research in so far that TCC practitioner's balance performance was better than the control group when the reliance on the vestibular system increased and the visual system was left out. Looking at TCC movements, we would have expected an improvement in the AP direction as well, since the weight shifting takes place from the heels of the foot towards the toes, so to say in an AP direction. It might be the small sample size why there was no significant difference in our study. Another point might be that the position of moving forward is never in a shoulder wide parallel position. During weight shifting, the back foot points in a 45 angle while the front foot points to the front. The weight is shifted from the back leg to the front leg into a so-called bow stance with a weight distribution of (70/30) towards the front leg.

In contrast to the other studies, our study showed a significant better outcome in the ML direction. The TCC practitioners showed better balance control in a shoulder wide stance with eyes closed in ML direction. This position is well practiced in TCC, though with open eyes. This stance is the basic stance where all movements align from and is thoroughly practiced so that the somatosensory system should be well developed. It is also a very specific situation. It seems that TCC practitioners, maybe through improved proprioception as suggested by studies mentioned above (3, 25), and a more sensitive vestibular system, have better balance control with eyes closed. We only included one stance with closed eyes. It would be interesting to know if this also applies to the other stances with closed eyes, which are not practiced in TCC like the legs together, semi tandem or the tandem stance.

In another study the same study group found out that TCC practitioners only showed significantly better performance when under challenging conditions (22). They used a limit of stability (LOS) for this evaluation. Although our pilot study did not include a limit of stability (LOS) test to evaluate balance control, the semi-tandem and tandem stance are challenging position because they are hardly found in daily life activities as well as in any TCC form. So it has to be defined what challenging conditions are. The LOS measures the subjects' ability to shift their weight in different direction. TCC also requires shifting of body weight, and is therefore practiced in any TCC form. It seems that TCC practitioner's balance abilities are better, especially in conditions that are practiced in TCC like weight shifting and proprioception in specific areas of the body (e.g. hip, knee or ankle) but what about other stances? In the semi tandem or tandem stance TCC practitioners did not show a better balance control. Since this was a pilot study, the sample size is too small to come to any conclusions but in the future we would like to investigate whether TCC practitioners generally cope better with challenging situations where the visual system is disabled even when standing in uncommon stances.

Furthermore, TCC seems to influence brain structure and cognitive fitness (2, 12, 27). Therefore, it might be that improvements on a higher cognitive level might also influence balance. Pons van Dijk et al, for example, found out that Taekwondo could enhance motor orientation ability (15). It might be useful to include other measurements of the brain or different cognitive function tests associated with balance and see if there is a connection.

Limitations

There are several limitations to this study. First of all the definition of what sedentary means has to be defined clearly, although there does not seem to be a standard definition for it, it needs to be defined within the sample group. Secondly, the activity levels of the groups need to be measured either in minutes or better in METs. Thirdly, the sample size needs to be bigger.

Conflict of Interest
The authors have no conflict of interest.

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