EFFECTS OF EXERCISE ON ANKLE PROPRIOCEPTION DURING SIXTEEN WEEKS OF TRAINING AND EIGHT WEEKS OF DETRAINING IN OLDER ADULTS

Zhang Cui[1], Sun Wei[2], Mao Dewei[3], Song Qipeng[4]

Shandong Sports Science Center, Jinan, China

This study evaluates the ankle proprioception in older adults. Sixty women (age 62.1±4.3yr) were randomly assigned to three groups to undergo a 16-week training (one group practice Tai Chi, one group practice brisk walking and one group reading) and 8-week detraining program. Proprioception of ankle plantarflexion (PF), dorsiflexion (DF) were measured, better proprioception is defined as being able to detect a smaller degree in joint angle. The results showed that degree PF and DF changes earlier and were smaller in TG than in BG in training; degree of PF and DF declined in all groups during the detraining, but TG exhibited a significant difference with pre-training data. So Tai Chi can more effectively improve and maintain ankle proprioception as well as prevent fall in old age. However, the extent of benefit depends on the regularity of training in older adults.

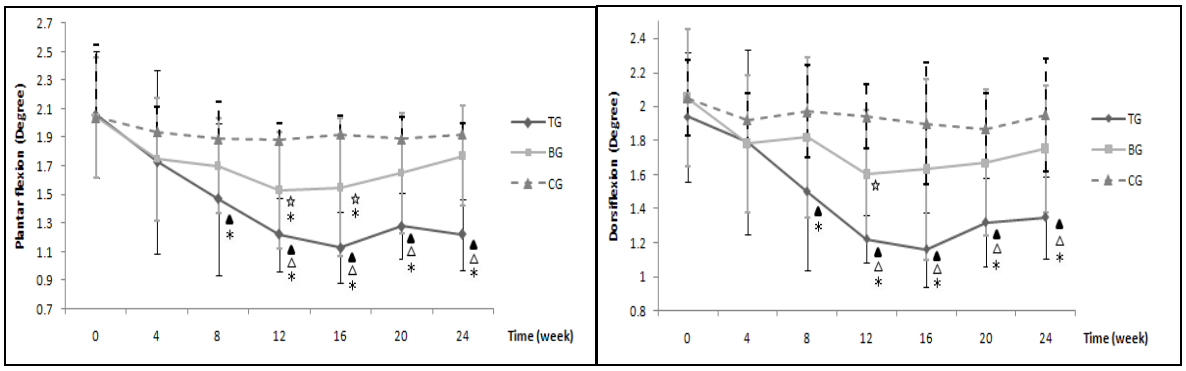
KEY WORDS: ankle proprioception; detraining; Tai Chi; brisk walking; older adults

INTRODUCTION: Proprioceptors contribute afferent information on body position and balance (Jacobson, Chen, Cashel, & Guerrero, 1997). Elderly groups depend more heavily on proprioception than vision for maintenance of balance (Colledge et al., 1994). Ankle proprioception (AP) is important for maintaining proper postural control in adults (Okada, Hirakawa, Takada, & Kinoshita, 2001). As a traditional Chinese exercise, Tai Chi (TC) has demonstrated its beneficial effects on the balance control in older adults (Zhang, Mao, Riskowski, & Song, 2011), muscle strength (Hong, L, & Robinson, 2000), and proprioception (Xu, Hong, Li, & Chan, 2004; Li, Xu, & Hoshizaki, 2009). The detraining effect is as important as the training effect. Older adults commonly suffer from different situations which may be compelling them to abandon exercise programs. In summary, the importance of AP in postural stability and movement control of older adults makes it beneficial to understand the proprioception changes induced by detraining, which remains unreported.

METHODS: Sixty community-dwelling older women (age: 62.1±4.3yr, body weight: 65.1±10.0kg) were recruited and randomly assigned to three different groups with 20 participants each: the Tai Chi group (TG), the brisk walking group (BG), and the control group (CG). Participants with regular training experience, cardiovascular disease, diabetic or orthopedic disorders were excluded from the study. Each participant provided an informed consent prior to tests. The training–detraining program continued for 24 weeks. The training program was conducted during the first 16 weeks for at least five 60-minute sessions per week. The TG participants were taught the 24-form TC during the first three weeks. The BG participants were organized to perform walking (heart rate 55% to 65% MHR) which is similar to TC (Li, Hong, & Chan, 2001). The CG participants were organized to read newspaper in entire 24 weeks. The TG and BG participants joined the CG in the last 8 weeks. An ankle

proprioception test was performed every four weeks which using the instrumentation described by Lentell et al. (Lentell et al., 1995). The instrumentation has already used in previous study with some minor modifications (Xu et al., 2004; Li et al., 2009). The device is a box with a movable platform that rotates on two axes: frontal and sagittal planes. The platform is moved by two electric motors at a rotational velocity of 0.2°/s, and the ICC was 0.85. The subjects were instructed to put foot on the movable platform, concentrate on their foot and to press the hand switch when they could sense motion and identify the direction of the movement.

All data are presented as means and standard deviations. Two-way ANOVA with mixed design was performed to determine the effects of group (TG, BG, and CG) and time (0, 4th, 8th, 12th, 16th, 20th, and 24th week) on AP. In case of a significant interaction effect of group and time, one-way ANOVA with repeated measure were performed to determine the effect of time on AP in each group. Post hoc paired t-tests were performed to locate time differences if a significant main effect of time was detected. Post hoc independent t-tests were performed to locate group differences if a significant main effect of group was detected. $P < 0.05$ was considered statistically significant.



a b

Figure 1: Angle of ankle plantarflexion(a) and dorsiflexion(b). Significance level is set at p < .05. ∗ : the value indicates a significant difference with the pre-training data in the group; ▲: between TG and CG at one time; △: between TG and BG at one time; ☆: between BG and CG at one time.

RESULTS: No statistical differences in basic information were indicated among the groups. Fifty-two completed the 24-week test (86%). Group did not seem to significantly affect the groups on any of the outcomes at the baseline data. As Figure 1a shows, the degree of PF became smaller from 8th week in TG ($P < 0.05$), while from 12th week in BG ($P < 0.05$) relative to the pre-training data, and it was smaller than that in BG ($P < 0.05$) from 12th week. The degree of PF in TG was increasing in detraining period, bigger than that in predetraining but not obvious ($P > 0.05$) and smaller than that in pretraining ($P < 0.05$). Compared with BG and CG, TG showed a larger increase in speed and amplitude in training period and better maintains. As Figure 1b shows, the degree of DF in TG became smaller from 12th week ($P < 0.01$) relative to the pre-training data. The degree of DF in TG was increasing in detraining period, to a greater extent than that in predetraining but not obvious ($P > 0.05$) and smaller than that in pretraining ($P < 0.05$). Compared with BG and CG, TG showed a larger increase in training period and better maintenance.

DISCUSSION: The current study found the TG showed more rapid and larger improvements in proprioception at the ankle joint during the training period and better maintenance during detraining in both PF and DF. This is contrary to previous findings. Li et al. (2008) found the training effect of TC on AP was not evident in 16 weeks training. This result could be attributed to the different training protocol: two more training time per week was incorporated, teaching time was shortened, and training time was increased in the present study.

We considered that TC involves six step directions: forward, backward, up-and-down, sideways, turning, and fixing (Mao, Hong, Li, 2006), and has been recognized as an effective exercise for older adult (Li et al., 2008; Zhang, Mao, Riskowski, & Song, 2011), the practitioner learns to maintain balance and stability in various postural positions (Hong et al., 2000). So the AP will improve after certain intensity and training time, and the results confirm the point of view. Walking, is a cyclic exercise with PF, DF, IV and EV, which has demonstrated positive effects on postural stability (Melzer, Benjuya, & Kaplanski, 2003) in older adults. Will the AP improve after training? The results show us positive answer. People walk everyday, the body has already adapted that station, as the results of CG shows. However, the changed intensity and time brought new stimulus to the ankle, therefore, the PF and DF of BG improved. Although the PF and DF were improved in both CG and BG, there is a little difference. The promotion of TG in PF and DF are four weeks earlier and greater than BG in training period, which was attributed to the characteristics of exercise movements. The awareness of joint position and movement always is emphasized during TC training. Compared with TC, BW involves repetitive foot PF and DF actions did not aware joint position and angle. Additionally, most exercisers do not pay much attention to the techniques involved in the BW. Except for the movement studies, researchers on electromyographic found more: Hong et al. found TC movements increase the intensity of antero-posterior direction electromyographic activity compared with normal walking (Hong, Li, Robinson, 2000). This may explain why PF and DF of TG improved faster and better in this study.

All results decreased but not obviously during detraining, which means the gains were maintained, which is similar to former study who found maximal voluntary contraction of the plantar flexor and electromyographic activity exhibited no change between pre-detraining and a 5-weeks detraining (Gondin, Duclay, &Martin. 2006). However, only TG maintained a significant difference with the pre-training data, we considered the greater improvement of PF and DF in TG induces to longer retain.

Research has shown that postural control stability is significantly affected by the decline in proprioception in the lower limb (Lord, Clark, & Webster, 1991). Clinical research has demonstrated that individuals with proprioception reaction deficits are less capable of maintaining postural stability (Pintsaar, Brynhildsen, & Tropp, 1996). Thus, TC training may effectively help older adults preventing forward and backward falls, future studies are needed to confirm this results.

CONCLUSION: Compared with brisk walking, TC can more effectively improve and maintain ankle proprioception and these enhancements of proprioception have implications for the prevention of falls in the elderly. However, the benefit of the effect depends on the regularity of training in older adults.

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