DOES TAI CHI AFFECT POSTURAL SWAY & MUSCLE ACTIVITY IN OLDER ADULTS?

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INTRODUCTION

Tai Chi has been promoted to older adults as an intervention to improve physical and mental fitness (Kutner et al., 1997) and prevent falls (Wolf et al., 1996). Practitioners of Tai Chi (TC) report that their balance improves as a consequence of TC. Previous studies, however, have found mixed results as to whether elderly practitioners of TC demonstrate better standing balance as compared to non-practitioners (Hong et al., 2000; Tse & Bailey, 1992; Wu, 2002). Tai Chi also emphasizes complete relaxation, and has been called meditation in motion. This relaxed state may possibly reduce muscle activity.

Our study examined whether various center-of-pressure (COP) and muscle activity measures were capable of detecting differences between Tai Chi practitioners and non-practitioners during tests of quiet and mildly-perturbed stance. The purpose of this study was to better characterize the effects of TC experience on static (quiet-stance) and dynamic (perturbed-stance) postural control and lower limb muscle activity in elderly adults.

METHODS

A cross-sectional study was conducted with fifteen elderly TC practitioners (9 females; mean age 69 ± 4 yrs) and thirteen elderly controls matched by age, gender, and activity level (8 females; mean age 69 ± 2 yrs). Two TC practitioners (one male and one female) had 33 years of experience. The remaining practitioners averaged 3.2 ± 1.6 years of experience (range of 1.5 to 7 years). All subjects were community-dwelling, had no neurological, gait, or postural disorders. Informed consent was given by all subjects.

Twenty randomized trials were conducted: 10 quiet-standing trials and 10 perturbed trials, all 30 s in duration. To generate a weak impulse perturbation (a backward tug), the subject was tethered to a suspended 2.3 kg weight that was released after a delay of 10-20 s (Figure 1). The tug necessitated only a postural sway response. After the weight fell, the tether slackened and allowed the subject to readjust to an upright posture. The subject stood with both feet on a force plate, arms crossed at the chest, and eyes open.

COP data were determined from force plate recordings, which were originally sampled at 1500 Hz and then resampled to 100 Hz. Quiet-stance COP data were analyzed using techniques from both stabilogram-diffusion analysis (SDA) (Collins & De Luca, 1993) and more commonly-reported or traditional sway analysis procedures, e.g., maximum COP displacement, sway speed, and swept area. For the perturbed-stance trials, the maximum posterior COP displacement immediately after the tug was determined.

Surface electromyography (EMG) bilaterally monitored four lower extremity muscles: tibialis anterior, soleus, vastus lateralis, and biceps femoris. EMG data were collected at

1500 Hz. Raw EMG signals were bandpass-filtered (20-450 Hz, inverse Chebyshev), processed with a 40 ms moving RMS window to obtain a linear envelope, adjusted to mean baseline offsets from relaxed seated data, and finally normalized to maximum voluntary isometric contraction measurements. In addition, the percentages of muscle activation time and antagonist muscle pair co-activation times were also computed. For the quiet-stance data, the muscle activity parameters were first bilaterally averaged to determine mean values over each 30s trial and then averaged over all ten trials for each subject.

RESULTS AND DISCUSSION

For the quiet-stance data, no significant differences were found between TC practitioners and controls in any EMG or COP analysis parameters, except for a decrease in the SDA term for critical time interval in the radial direction for the Tai Chi group ($p = 0.03$). The critical time interval approximates the transition from open-loop to closed-loop postural control. Non-statistically significant trends in the data ($p > 0.05$) were, however, noted. SDA short-term diffusion coefficients tended to be larger for controls. Larger coefficients imply greater instability. Controls also tended to have their muscles active during more of the trial period than TC practitioners. Additionally, they had greater muscle activity and more co-activation in the thigh muscles and less activity in the shank muscles.

For the perturbed-stance data, an unexpected trend was found in the maximum amplitude of backward sway immediately after the tug. TC practitioners had significantly greater posterior sway than controls (32 ± 8 mm and 25 ± 6 mm, respectively; $p = 0.01$). These results may suggest that Tai Chi practitioners may be more willing to allow larger excursions within their base of support after a perturbation than their untrained counterparts. Older adults have been noted to have smaller backward excursions compared to young adults during a similar protocol (unpublished data) and voluntary sway (Blaszczyk, 1994).

SUMMARY

These results suggest that practicing Tai Chi may not necessarily reduce quiet-standing postural sway, but may influence static postural control mechanisms more subtly. The greater benefit of Tai Chi training may be that it influences how individuals respond to external disturbances to balance. Our future work will examine whether TC practitioners adopt different postural strategies and how these may influence postural control and stability. These studies may help to explain why Tai Chi appears be an effective intervention for preventing falls in older adults.

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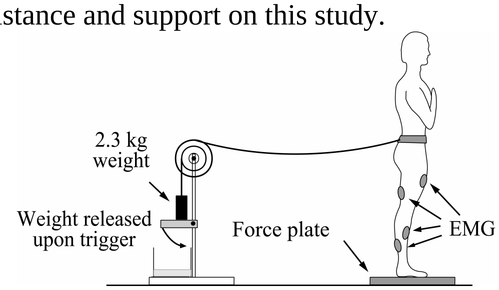

Figure 1. Experimental set-up.