# THE GROUND REACTION FORCE AND ELECTROMYOGRAPHIC PATTERNS OF TAI CHI GAIT

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## INTRODUCTION

In the past few years, Tai Chi has become more and more popular in the west. Until now, there are more than one hundred articles about Tai Chi in the MEDLINE database. According to these studies, Tai Chi is beneficial to cardiorespiratory function, balance, postural control, strength, flexibility, and psychological profile [1]. However, most studies focused on Tai Chi training performances, the mechanisms of Tai Chi are still unclear [2,3]. In addition, the subjects in these studies were the beginner (who practiced Tai Chi for only 1 year or less) or amateur. They could not perform the typical characteristics of Tai Chi. In order to understand the mechanisms of Tai Chi, the foundation have to be identified. There are many movements in Tai Chi, like classical Yang style 108 forms, simplified style 24 forms etc. In these different forms, Tai Chi gait is the fundamental movement of Tai Chi. Therefore, the purposes of this study were to understand the ground reaction force and electromyographic patterns in Tai Chi master.

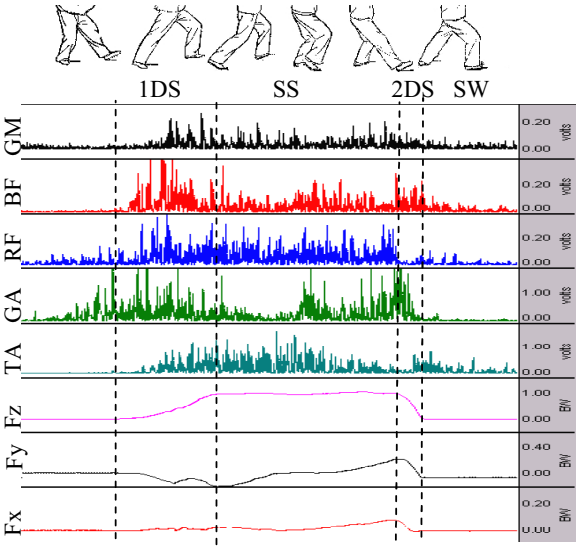
## METHODS

A Tai Chi master was selected to be subject in this study (38 years, 166 cm height, 77 kg weight). He has been practicing Tai Chi for at least 2 hours every day for 15 years. The subject was asked to do the Tai Chi gait at a self-determined speed for five trials in the experiment. The gait cycle was determined by the video from digital camera, and divided into four phases: first double support phase (1DS), single limb stance phase (SS), second double support phase (2DS), and swing phase (SW). One digital camera (JVC, 60 Hz) positioned laterally 4m from the subject to check the subject movement, such as foot contact and toe-off. The 3D ground reaction force pattern was collected by a force plate (AMTI, 1000 Hz). The electromyography (EMG) pattern was measured by surface electrodes (Biovision, 1000 Hz) on each of following four muscles of the left leg: gluteus maximus (GM), rectus femoris (RF), biceps femoris (BF), tibialis anterior (TA), and gastrocnemius (GA) to record the muscle activities. The EMG data were processed by full-wave rectification (band-pass filtered at 10-500 Hz). All data was synchronized and calculated by SIMI motion system (SIMI Reality Motion Systems GmbH, Germany).

## RESULTS AND DISCUSSION

Tai Chi gait is a slow movement which requires the lower limbs to move with joints in flexion position. The typical GRF and EMG patterns for the Tai Chi master are displayed in Figure 1. The average duration of Tai Chi gait cycle was 3.07± 0.38 second. The percentages of the four phases were: 21% (1DS), 35% (SS), 9% (2DS), and 35% (SW).

By comparing the Tai Chi gait with normal gait [4], the results show that not only the gait cycle duration, but also the




percentage of SS phase of Tai Chi gait was longer than normal gait. According to the GRF, the master demonstrated good control of GRF during the gait. He maintained low level body position while traveling slowly and steadily from one leg to another. A stable GRF was followed during body weight shifting, while the balance of the whole body was maintained. In addition, from EMG patterns, compared to normal gait, the BF and RF muscles had longer proportion of co-contraction. That may also help to maintain the weight shifting during 1DS to SS phase.

Based on these findings, it is not difficult to infer that the improvement of muscle strength after long term Tai Chi training. Therefore, it had also explained some of the effect of Tai Chi training in previous studies.

## CONCLUSIONS

Different muscular control strategies involved in Tai Chi gait was determined in this study. The long duration of muscle co-contraction during Tai Chi gait should be one of the important factors of Tai Chi movements. The findings could provide the information for future investigations or Tai Chi training intervention.

## REFERENCES

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