BIOMECHANICAL ANALYSIS ON SOME MARTIAL ART ASPECTS OF TAI CHI CHUAN

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INTRODUCTION

There is currently a lack of biomechanical studies on Tai Chi Chuan with the aim of improving the effectiveness of its movements in a martial arts context. The objective of this study is therefore to analyze the kinematics and kinetics of the fundamental defensive and attacking movements of Tai Chi Chuan by using modern motion analysis techniques.

Power absorption in neutralizing an attack and power generation in making the counterattack are the two main topics in this study. These are also the two main elements in the two-man push-hand exercise of Tai Chi Chuan. The results gathered from this investigation will help provide scientifically based guidelines on the correct execution of Tai Chi movements, thereby increasing their effectiveness from a martial art's point of view.

METHODS

A male subject was recruited for this experimental study. Reflective body markers were placed on all his important joints, as well as the weight and punch bag used in the tests. Movements of these objects were recorded using a video camera and the images were then transferred to a computer for processing using the motion analysis software Peak Motus 8.3 [1].

The first series of tests focused on the defensive or power absorption capability of the subject in annihilating a simulated attack by performing the Tai Chi 'sitting-back' movement. The subject was asked to receive with both hands an incoming swinging weight released from a distance and bring it to a stop with the 'sitting-back' technique. The test was repeated by using stances with different longitudinal and lateral distances between the feet, including a standard stance recommended by a certain school of Tai Chi Chuan. In analyzing the movements, the subject was modeled as a simple damper system which provided a resisting force to the swinging weight. The time-dependent resisting force was calculated using the equivalent damping coefficient of the subject, also time-dependent, derived from the motion analysis. The stance which produced the lowest resisting force throughout the whole 'sitting-back' movement was considered to be the most effective. This is because, according to Newton's 3rd Law, the force acting on the subject would also be the lowest.

The second series of tests focused on the attacking aspect of Tai Chi Chuan by investigating the force generated from the forward push movement. The subject was asked to start from the 'sitting-back' position, then quickly move forward and push the punch bag with both hands. This was again repeated by changing the longitudinal and lateral distances between the feet. The effectiveness of each stance was assessed by considering the peak acceleration of the punch bag, from which the force exerted by the subject could be calculated.

RESULTS AND DISCUSSION

Fig. 1 presents the resisting force versus displacement curves for one of the stances used. They show that the resisting force provided by the subject to the swinging weight built up rapidly and then fell off just as rapidly as the weight was being brought to a halt. The maximum resisting force had a value of approximately 50N, with a corresponding damping coefficient of about 30 N/m/s. Some curves have a rather flat profile in the middle together with a lower maximum resisting force value.

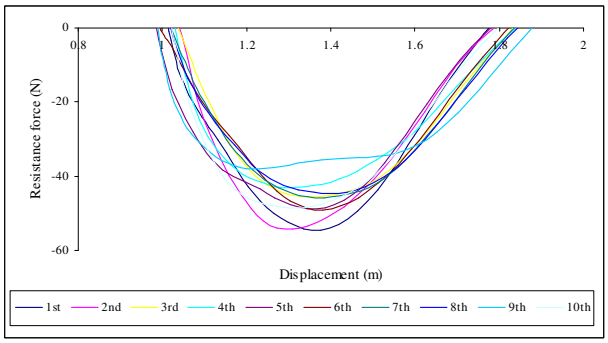

Figure 1: Resisting force versus displacement curves

By plotting the maximum resisting force against the total distance covered by the subject for all attempts, a trend of decreasing maximum resisting force with increasing total distance was revealed.

In the power generation experiments, forces of around 400N were reported. Increasing the length of the stance increased the force generated. This is perhaps not surprising given that, with a longer stance, the subject was able to extend his build-up of power over a longer period, thus generating more power at the end. Changing the width of the stance had a negligible effect on the results.

CONCLUSIONS

The basic power absorption and power generation movements of Tai Chi Chuan have been examined using motion analysis techniques together with a simple mass-damper model. This study has shown that the standard stance recommended by a certain school of Tai Chi Chuan may not be optimum in terms of minimizing the resisting force in defense and maximizing the force generated in a counterattack.

REFERENCES

1. www.peakperform.com