



Research Article

ISSN : 0975-7384
CODEN(USA) : JCPRC5

Analysis on Tai Chi center of gravity tracks and thoracic vertebra curvature change based on biomechanical

Heng Li

Sports Department, Nanjing University of Aeronautics and Astronautics, Nanjing, China

ABSTRACT

Perennial practicing Tai Chi helps physical and psychological health. In order to promote the sport more scientific, this paper collected movement data using infrared long-range program for ten 24-style Tai Chi coach. Use EXCEL to plot the data picture to get the kinetic parameters variation rule of Tai Chi. Then analyze the characteristic of the figure and data using biomechanical principles. At last, it obtained 24-style Tai Chi movement science improvement suggestions. Research by the proposed method and analyzed results, this paper not only provided a more scientific and technical guidance for the 24-style Tai Chi exercise, but also provided a theoretical basis for the study of Tai Chi.

Key words: Biomechanics, Infrared Long-range Test System, EXCEL, Data Processing

INTRODUCTION

Tai Chi originated in ancient times, it had earlier called "long fist", "cotton fist", "13 potential", "soft hands". To the qing dynasty emperor Qianlong years officially changed its name to Tai Chi. The traditional Tai Chi has many sects, which is mostly technical action boxer who summed up their own experience of combining heritage from the body through proprioception. Until 1956, the state sports commission (now) of the state sport general administration organized compiling 24-style Tai Chi. The 24-style Tai Chi is a sport way, which is easy to learn, fitness obvious and favored by many fitness enthusiasts. In the city streets, squares and gardens in the morning, you can see much tai chi fitness.

With the improvement of people's living standards, many people choose 24-style Tai Chi as a fitness way. So there are a lot of skilled movements of Tai Chi scholars, who have made various studies and guidance aimed at mining and fitness effects of Tai Chi to improve the regulation of its skilled movement. Liu Chong(2010) through the center of gravity envelope area, postural sway track length, the center of gravity trajectory MSE, the energy loss of the four factors of the human body as a judge of the standard static balance. He combined with statistical data, and presented that Tai Chi can improve the static balance of the elderly [1]. Xi Yongping(2011) through exercise biomechanics analysis showed piles of Tai Chi round: In 24-style Tai Chi skilled movement exercises, people must focus on the idea of relaxation, guided by conscious breathing, thereby regulating the action in order to achieve a natural harmony rounded state[2]. Peng Ying(2012) by Wu style Tai Chi lunge action sports biomechanics research indicates that the lunge movement should pay attention to the back foot off the ground, rear heel, when the center of gravity forward motion technology essentials. The torso bent forward when you lunge movement within a range of 0 to 10 degrees of volatility and other technical essentials [3].

This paper combined with previous research findings and biomechanical principles of Tai Chi. The skilled movement of 24-type Tai Chi can be divided into two categories in accordance with the set movement, the moving movement. This paper researches both types of skilled movement, which is inherit its advantages and improve its shortcomings. In order to make 24-style Tai Chi skilled movement more standardized, make scientific technical

guidance for Tai Chi exercisers.

BIOMECHANICAL ELEMENTS ANALYSIS OF THE 24-STYLE TAI CHI

The skilled movement can be divided into two categories: 1. The set movement. 2. The moving movement. This paper will research these two kinds of skilled movement group.

The Kinematics Data Statistics of Tai Chi Set Movement

First, the 24-style Tai Chi classification by step type is shown in Table 1.

Table 1- Main step type classification

Step Type	Movement Categories	Number	Movement Name
Open step	Legs open	2	Start form, Cross hands
Lunge	Left Lunge	11	Parting the wild horse's mane, Brush knee and twist step, Embrace bird tail, Single whip, Lady shuttle, Flash the arm, Moving bar hammer
	Right Lunge	9	Parting the wild horse's mane, Brush knee and twist step, Embrace bird tail, Bimodal ears, Lady shuttle
Empty stance	Alice legs left empty stance	1	Hand strum the lute
	Left empty stance	3	High pat on horse, White stork stretching wings, needle at the bottom of the sea
Crouch step	Left crouch step	1	The single whip type
	Right crouch step	1	Under the single whip type
Foot stand	Left independent	1	Left foot stand
	Right independent	1	Right foot stand
Kick	Kick with left heel	1	Kick with left heel
	Kick with right heel	1	Kick with right heel

Select ten height form similar Tai Chi coaches, and use infrared distance measurement system to make the detection of the kinematic data statistics, and then get the Table 2.

Table 2- Ten coaches set movement data statistics

Number	Movement Categories	Left Knee Angle		Right Knee Angle		Left Elbow Angle		Right Elbow Angle	
		Average	Standard deviation	Average	Standard deviation	Average	Standard deviation	Average	Standard deviation
110	Left Lunge	98.35	9.93	160.42	7.33	135.15	21.87	140.88	23.13
90	Right Lunge	160.65	7.66	97.56	8.03	139.12	27.01	139.08	22.23
30	Left empty stance	145.63	15.11	105.14	12.31	134.33	32.68	134.12	33.07
10	Left independent	54.77	24.92	151.24	10.71	132.63	14.51	150.07	17.37
10	Right independent	159.1	3.92	73.3	4.95	147.74	14.29	135.58	15.26
20	Crouch step	171.5	2.05	39.5	1.26	126.9	1.95	149.66	11.24

BIOMECHANICAL ELEMENTS ANALYSIS OF THE 24-STYLE TAI CHI

Biomechanical Analysis of the Set Movement

According to the biology principles, the set movement can be divided into two categories : 1.the lunge, empty stance, crouch step. 2. Independent step.

By data in Table 2 may know that in the skilled movement of 24-style Tai Chi, two side lunges' weight-bearing leg knee angle value is around 98°, non-weight-bearing leg knee angle value is around 160°, and the elbow angle is about 137°. The empty stance's weight-bearing leg knee angle value is around 105°, non-weight-bearing leg knee angle value is around 145°, and the elbow angle is about 134°. The crouch step's weight-bearing leg knee angle value is around 39°, non-weight-bearing leg knee angle value is around 171°. For non-weight-bearing legs, the lunge, empty stance, crouch step's knee angle values are about 160°, it indicates that the non-weight-bearing legs are not straight. This shows the traditional Tai Chi's characteristic of "Bend more storage". As for weight-bearing legs, the knee angles are not in conformity with the biomechanics of harmonious and unified technical requirements. According to the main movement of 24-style Tai Chi biomechanical characteristics analysis can know, the traditional Tai Chi lunges steps empty stance, crouch step's movement angle of the characteristic value is decided by its aggressive. However, today Tai Chi as a way of fitness does not need its aggressive, while it needs to improve these angles, increase its scientific nature, and achieve physical fitness purposes. The weight-bearing legs' knee angle value is more little, the greater the bearing force of thigh muscles. So it can reduce weight-bearing legs' knee angle value, in order to improve the fitness person of quadriceps muscles and tendons and membrane biceps exercise the leg muscles, such as strengthen the strength of lower limbs.

In traditional Tai Chi independent step movement, non-weight-bearing legs angle value is around 60°. This illustrates the supporting leg in knee without tightening, and it reflects the characteristic of easy to attack in

traditional Tai Chi. Modern Tai Chi does not need to attack, so increasing the intensity of knee can improve this problem. Elbow remain at around 145° reflected that the traditional Tai Chi has the characteristic of everywhere arc, belt strength. However, modern Tai Chi does not need these characteristics, so it can make reasonable improvement combined with biomechanical principles, to make the body more upright flatter stretch, and make your muscles more sufficient exercise.

From the above you can know 24-style Tai Chi “Bend more storage” pay more attention to the attack, all the movement range is small. It is helpful for the force and transform moves, but for fitness enthusiasts. But for the fitness enthusiasts does not require it’s aggressive, so in daily fitness workout, you can reasonably increase the range of motion, so that the muscles get a fuller workout.

Biomechanical Analysis of the Moving Movement

Tai Chi for 24-style skilled movement in the action by marching gait classification obtained in Table 3.

Table 3- The main footwork classification

Footwork	Movement
Forward step	Parting the wild horse's mane, Brush knee and twist step, Lady shuttle
Back step	Step back and whirl arms
Side step	Cloud hands

The moving movement main has three key points:1.Center of gravity change trend. 2.knee joint angle. 3.the change trend of thoracic vertebra curvature. The following this three points are respectively analyzed.

(1) The center of gravity requirement of 24-style Tai Chi is "stable center of gravity", and the specific movement of gravity requirements are: "The body center of gravity should be not smooth undulating, evenly movement", which is centuries boxer who summed up the experience with practice talk. However, maintain stable center of gravity is not the issue, if the blind pursuit of stable center of gravity, would cause other drawbacks such as in coordination. This paper based on the analysis of the center of gravity changes hopes to improve and perfect the technical requirements of the center of gravity.

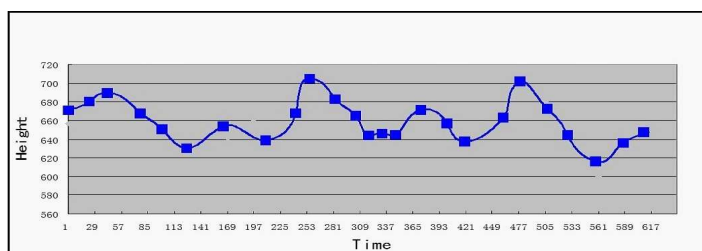


Figure 1: Center of gravity variation general trajectory of parting the wild horse's mane

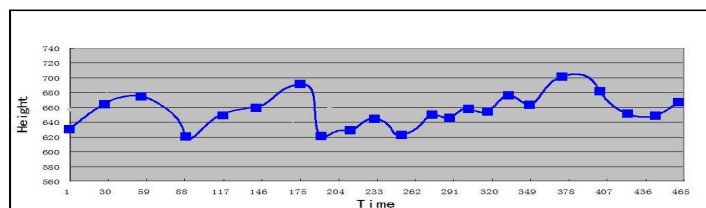


Figure 2: Center of gravity variation general trajectory of step back and whirl arms

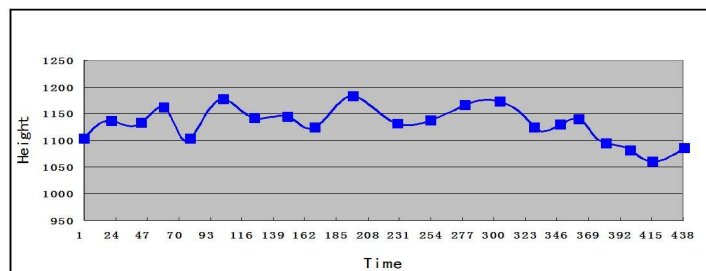


Figure 3: Center of gravity variation general trajectory of cloud hands

Ten coaches of the three moves: parting the wild horse's mane, step back and whirl arms, cloud hands use infrared long-range test, the resulting ten sets of data were averaged and plotted with EXCEL available. Then we can get the 24-style center of gravity variation general trajectory rule shown in the Figure 1, Figure 2 and Figure 3.

From Figure 1, Figure 2 and Figure 3 show that the center of gravity is not as smooth as we thought and feeling, but with changes in the movement ups and downs. From biomechanical analysis, when the squat body, the center of gravity naturally decreases, whereas when the body is raised, the center of gravity naturally rises. Therefore, the skilled movement in 24-style Tai Chi, you want to keep the body stable center of gravity is impossible. Only can keep relatively stable within a certain range, for example: the cloud hands a foot movement, if the blind pursuit stable center of gravity, it may lead to physical incoordination and cause joint tension. So that the whole stiff and even fall injuries. Therefore in the process of cloud hands a foot movement, the focus must allow small amplitude fluctuation. Before the feet, loose waist mention hips, pubes, and then the feet. So, in daily fitness does not need to ensure the center of gravity in the same horizontal plane. Allow proper center of gravity ups and downs, consistent with the principles of biomechanical limb coordination, so as to enable the body to get a better workout.

(2) In almost all of the movements in the 24-style Tai Chi are inseparable from the movement of the knee. Knee angle value is an important indicator of 24-style "sit knees legs" boxing theory. "Sit knees legs" is one of the most important boxing theory in Tai Chi skilled movement. Its main role is to sink the gas, so that the muscles get bigger across the knee stretch on exercise. There is a very significant health effects, and this posture allows alternating legs, mutual break his legs while avoiding the disadvantages of force fatigue. Therefore, the analysis of changes in the value of the knee angle is very important. For 10 coaches parting the wild horse's mane after the average value of the sum take images shown in Figure 4.

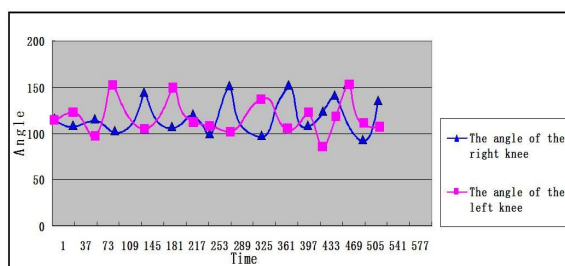


Figure 4: Parting the wild horse's maneknee angle change

We can see from Figure 4 that, left and right leg knee angle alternating high and low values. That is one leg stretch a leg contraction. The left and right leg knee angle from 70 °to 170°.The second peak is less 15 °than the first peak. We can know that 24-style Tai Chi bent leg sit magnitude is larger, but it did not completely focus after shift. According to biomechanical principles of coordination and stability may know, the focus should shift back in order to keep the body stable. Therefore the movement of this technology can make reasonable adjustments to shift the center of gravity to enhance scientific and rational after 24-style Tai Chi.

(3)"Chest pull back" is the most important requirements of traditional figure in Tai Chi. According to biological principles, chest requires neither concave chest, not stand out that chest become backbone pull long pillar. Chest is good for the muscles of the gut wall. Chest can make internal diaphragmatic diastolic down; form a deep breath, diaphragmatic shrink. At the same time it can make the abdomen pressure movement, to promote the liver function and blood have good physiological function. According to ergonomic principles, the role of pulling back shoulder and back muscles stretch to get more active, help "force sent by the ridge."

Former boxer who just came by their own practice and proprioception experience chest movement, the chest pull back with the influence of the human body is not very clear.

Here on the 10 testers parting the wild horse's mane hold the ball out of the thoracic curvature data changes were made and averaged in Figure 5.

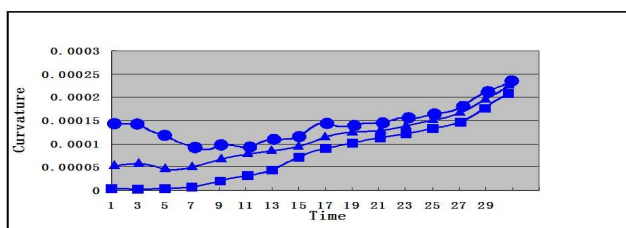


Figure 5: Parting the wild horse's mane holding out feet stages thoracic vertebra curvature variation

From the Figure 5, we can see that:

1. This phase of curvature is gradually increased, it means the curvature of the thoracic vertebrae described also increased.
2. Three curves from top to bottom in turn means the thoracic curvature of the twelfth thoracic, the third thoracic vertebra and the ninth thoracic. This shows that the more close to the waist and neck the greater bent thoracic curvature. It conforms to the natural physiological regulation
3. The ninth thoracic curvature is bigger than the third, the twelfth thoracic. This is in conformity with the Tai Chi chest theory.

By combining the above three points and biomechanical principles need to know in 24-style "chest pull back" this important scientific stature asked to make improvements, namely: in the exercise of Tai Chi, the time moves forward, so chest has a lesser extent. After shift, so the chest extent is larger. In the action-set time, so the chest amplitude reaches a maximum.

CONCLUSION

As for the skilled movement of the lunge, empty stance, crouch step in 24-style Tai Chi, they can moderately reduce the weight-bearing leg knee Angle value to improve the exercises of quadriceps, semitendinosus, semimembranosus and biceps femoris muscles, so that can strong the limbs strength. Combine biomechanical principles can know that Tai Chi manager "smooth center of gravity" needs to have a correct understanding and application. Stable center of gravity is a relative term, in the transformation moves the center of gravity inevitable ups and downs. If one blind pursuits of stable, not only from the effect of physical fitness may even be injured because of uncoordinated limb movement. As for the theory of "sitting knees legs", the extent of sitting knees legs is bigger, but its center of gravity is not completely shift. It caused the center of gravity is not stable. Therefore, this can make reasonable adjustments to the skilled movement, shifting the center of gravity in order to enhance the stability of the coordination body. By the change in thoracic curvature known for technical essentials 24-style Tai Chi following improvements should be made. When the body forward, should make chest a lesser extent, after shift, so the larger the magnitude chest. In the action-set time, so the chest amplitude reaches a maximum. 24-style Tai Chi has been improved than the traditional style, but it still retains a lot of aggressive movements. With modern Tai Chi physical sexual request has the certain conflict, so in the later moves to improve, should try to reduce their aggressive and increase their physical nature.

REFERENCES

- [1] Liu Chong. *Hubei Sports Science*. 2010. (7).
- [2] Tong Jixi. *Beijing Physical Education*, 2008,9 (3) :14-15.
- [3] Wu Chengliang, et al. *China Sport Science and Technology*. 2011.47(6):25-29.