

Kinematics Analysis on the Cross Step Skills of Chinese Female Javelin Thrower Lv Huihui

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Abstract—The paper use the documents the mathematical statistics and the three-dimension picture analysis on the cross step skill of Lv Huihui, the champion of China Long Open in 2013 and get the kinematics parameters and summarize her skill features . The results show that Lv made a proper leaning back during the cross step stage. Her elbow angle is 146.4° , while the angle of world outstanding female javelin athletes is 160.2° , it has a big gap of 13.8° . In the horizontal velocity during the cross step, Lv Huihui lags behind world outstanding female athletes. The conclusion shows that Lv did not fully extend her elbow joint in the cross step stage, the elbow stress is not enough, throwing arm shoulder too loose; the speed of Lv need to be improved. Because the step size is too long, will effect postpone time of the force, thus affect the coherence of action, reduce the running speed and force effect, ultimately affect the performance in the competition; the long cross step time is the main reason for the loss of horizontal speed.

Keywords- biomechanics; the three-dimension picture analysis; javelin thrower; the cross step skills

I. INTRODUCTION

The paper aims to use the three-dimension picture analysis on the cross step skill of Lv Huihui in China Long Throw Open in 2013 and get the kinematics parameters and summarize her skill features. Additionally, the paper also makes a comparison of her related kinematics parameters and other elite javelin throwers to find her advantages and drawbacks. All these results provide coaches and athletes the kinematics quantitative indicators in order to improve Lv Huihui' skills and enrich javelin technological theories.

II. METHODS

The main method is three-dimension picture analysis. We used two JVC9800 Synchronized cameras at the right side and back side at the game site. machine height is 1.2m. The main optical axis camera into 90 Angle (As shown in Figure 1) .The shooting frequency is 50 frames per second. The record analysis used 3-DSignalTec system and series analysis. The anthropometric dummy is Japanese Song jing xiu zhi phantom(21 articulation points, 16 segments and additional 2 testing points and 1 segment, i.e. Javelin's two endpoints and javelin link). It pass the original data filter and the cutoff frequency is 8Hz.

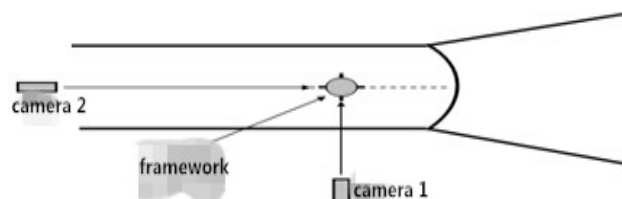


FIGURE I. THE MAIN OPTICAL AXIS OF CAMERA.

III. RESULTS

Throwing steps phase is usually set foot on his left foot marker 2 step right leg began to finally force left foot landing, a total of four steps. (As shown in Figure 2) .The third throwing step is cross step that start from the left foot landing and the right foot actively swing ,and go to the right foot landing. When the left foot landing it should actively swing , thigh leg drive positive and powerful forward swing out, ,make the lower limbs forward acceleration to surmount apparatus to be a good post .when the right foot landing , the left leg should in the in the front of the right leg to speed up the landing time . This is a critical step to connection the run-up and the last exertion.

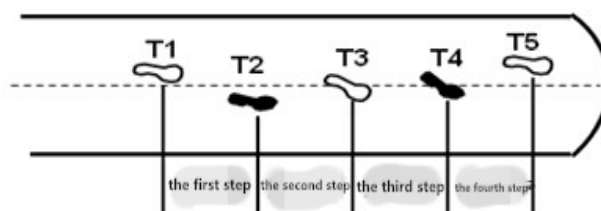


FIGURE II. THE THROWING STEPS PHASE

A. The Analysis Of The After Trunk Angle Of Lv During The Cross Step

Angle of trunk leaning back is the angle between the axis of javelin throwers' trunk and the vertical plane in the process of throwing. It reflects the degree of trunk leaning back. Proper leaning back can not only maintain the horizontal velocity of throwers' center of gravity, but also increase the effective distance working with javelin. Therefore, it is one of the most important elements that will increase the throwing speed. The main function of the cross step is to keep throwers' balance between velocity and the posture which form forces as a whole, therefore, the proper trunk leaning back, no doubt, makes the basis for increasing distance for the last strength. This moment, the average angle of trunk leaning back of world outstanding

female javelin athletes is 23.3° , while Lv 23.6° . It can be known from the data that there is a little gap between their angle, which means that Lv made a proper leaning back during the cross step stage.

B. *The Analysis Of Shoulder Angle And Elbow Angle Of Lv During The Cross Step*

Proper angle of right shoulder of a thrower during the cross step is the most important indication to judge his quality of directing the javelin, and an important hallmark to tell if a javelin athlete's throwing arm makes full use of arm length to increase kinetic energy produced by whiplash in the process of throwing heavily as well. Besides, proper angle of right shoulder can keep a thrower's body in moderately tense readiness, which further rushes muscles to fully prepare for whiplash.

This moment, her shoulder angle is 92.5° , compared with the world's outstanding female javelin athletes' 95.4° , it has little gap, her elbow angle is 146.4° , while the angle of world outstanding female javelin athletes is 160.2° , it has a big gap of 13.8° . According to above data, Lv shoulder and arm's muscle is loose and muscle tensivity should be strengthened.

C. *Analysis Of Horizontal Velocity Of Lv Huihui In Cross Step*

The performance is in positive correlation with the horizontal velocity of body center of gravity after the cross step, that is the speed after the cross step is more important than the speed before the cross step; the horizontal velocity after the cross step reflects horizontal momentum before the final force. Therefore, the bigger the horizontal velocity, the larger the chance for athletes to get good performance; at the same time, the difference of horizontal velocity between before the cross step and after shows the amount of lost speed, which indirectly shows the effect of the cross step. Therefore, a bad cross step will affect the effect of the final force. So, the less loss of the horizontal velocity before and after the cross step, the better the performance. The horizontal velocity of Lv Huihui before the cross step is 6.6m/s , and after the cross step, the horizontal velocity is 5.79m/s . The difference is 0.81m/s . This shows that in the horizontal velocity during the cross step, Lv Huihui lags behind world outstanding female javelin athletes.

D. *Analysis Of Step Size And Time Of Lv Huihui During The Cross Step*

Run-up gives athletes and instrument system a certain horizontal velocity and makes preparation for withdraw javelin [6] iversity, 2012,14 (1).

and the final force. The rhythm of throwing steps is very important to successfully complete a series of actions from withdraw javelin to throwing in a run-up with higher speed. The rhythm of throwing steps is a guarantee for right throwing steps. Only with appropriate rhythm can throwing steps be successfully completed. According to the study of Peter Cheyne, the size and time of throwing steps affect the coordinated cooperation between the trunk and the action of upper limb. They are the conditions affecting the throwing of javelin. In theory, the average size of throwing steps of Lv Huihui should be $1.46\text{m}-1.63\text{m}$, while the actual average size is 1.68m . In theory, the size of cross step is $1.61\text{m}-1.87\text{m}$, while the actual average size is 2.19m . Too long size of steps postpones the moment of the final force, which affects the coherence of the whole skilled movement, reduces the speed of run-up and the effect of force. Therefore, the throwing performance is affected. The time of cross step of Lv Huihui and the world's outstanding athletes is 0.44s and 0.36s respectively. Longer time of the cross step reduce more of the horizontal velocity.

IV. CONCLUSIONS

The after trunk angle of Lv in the cross step stage is suitable; while the elbow joint angle has a big gap with world excellent athletes. This shows that Lv did not fully extend her elbow joint in the cross step stage, the elbow stress is not enough, throwing arm shoulder too loose; the speed of Lv need to be improved. Because the step size is too long, will effect postpone time of the force, thus affect the coherence of action, reduce the running speed and force effect, ultimately affect the performance in the competition; the long cross step time is the main reason for the loss of horizontal speed.

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