

## STUDIES ON THE KINEMATICS OF CHINESE ELITE MAN HAMMER ATHLETE THROWING TECHNOLOGY

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The purpose of this study is to provide the theoretical basis for the teaching and training of the hammer throwing and improve Chinese man hammer to reach world-class as soon as possible. This paper made a 3D camera resolution on the top three men's hammer throwers in 2012 China Long Throw Open (Shizhu Wang, kun Guo and xiao Feng). With the comparative analysis on the related kinematic parameters of the world elite men's hammer throwers, it presents the main problems and gaps in China men's hammer throwers motion technology.

**KEY WORDS:** elite male, hammer, throwing techniques, kinematics.

**INTRODUCTION:** Hammer throw is an old event but the only throw race project to use both hands in athletics. As for its short history of in China, it is urgent to improve the technique of Chinese men's hammer throwers because of their unsatisfactory performances in international competitions.

This paper makes researches on the shooting and analyzing throw technique movies from several Chinese elite men's hammer throwers (Shizhu Wang, kun Guo and xiao Feng), and makes quantitative analysis on some major technology aspects during the throwing process including the pre-swing phase, the rotating stage and final exertion phase, so as to look for reasonable factors and internal relations for improving achievements. Compared to some technical indicators between Chinese and foreign elite men's hammer throwers, this paper identifies the shortcomings and gaps in Chinese athletes throw, and it is positive and important to improve the technical level of China's hammer throw.

**METHODS:** This research mainly uses three dimensional camera analytic methods, (The research object shown in Table 1), and the whole process of the competition was recorded by two GC-PX10 video cameras (JVC, Japan) at 50 Hz from different angles (the included angle of the principal optic axes of two cameras was about 120 °), Video analysis by the 3-DSignalTec video analytical software, by image analysis, rotation and finally explosion which are analyzed, and choose Japanese Matsui's human body model (16 links, 21 articulation point), the original data was smoothed by low-pass filter with a cutoff frequency of 6 Hz, and the relevant kinematic indicators for analysis.

**Table 1**  
**Basic Research of Objects**

Athlete	Age (years)	Height (cm)	Weight (kg)	Sports level	Result (m)
Shizhu Wang	23	185	90	Master	69.17
Kun Guo	19	189	115	Master	63.97
Xiao Feng	23	189	124	Master	63.93
Litvin Ivanov	—	180	98	Internationa l master	85.14
Sedych	—	184	100	The world record	86.74

**RESULTS:** Pre-swing is the preparation phase into the rotation stage. From Table 2, the pre-swing time of the four athletes are different from one another, but compared to the

pre-swing time of the outstanding foreign athletes Sedych 1.06s, the pre-swing time of the four athletes respectively are 2.07s, 2.21s, and 2.54s. It seems to the pre-swing time which are too long, which lead to the pre-swing speed too slow, and it will speed up in a hurry in the first, second, third and the fourth lap to hammer accelerate significantly increase the burden of the rotation process.

**Table 2**  
**Pre-swing Time in the Pre-swing Phase (s)**

Athlete	Shizhu Wang	Kun Guo	Xiao Feng	Sedych
Result (m)	69.17	63.97	63.93	86.74
Time(s)	2.07	2.21	2.54	1.06

Compared to foreign countries, Chinese athletes has a long way to go in velocity increment on pre-swing stage, on which stage it is bigger than on others. For example, the best of Shizhu Wang (14.92 m / s) is far behind the world record of Sedych (17.6m / s).

The rotation total time of the three is longer. The four-circle rotation time of Shizhu Wang is gradually reduced in an obvious way, which means that he has strong acceleration capability in a rotating, while the situation of the other two athletes is not so optimistic, even with a negative increment.

Shizhu Wang's single, double support d / s ratio is 1:0.89, Kun Guo's single, double support d / s ratio is 1:0.89, Xiao Feng's single, double support d / s ratio is 1:1.46. Through the analysis of the characteristics of the time above, we find that in addition to Xiao Feng without taking into account the total rotation time, there is a large gap between the single, double support d / s ratio of the other two athletes and the theoretical 1:1. Through the single, double support d / s ratio of each lap, only Xiao Feng's single, double support d / s ratio in the three athletes is greater than 1 in the total rotation of four laps.

From Table 3, The hammer average velocity increment of the three athletes is only 1.41 m / s in the fourth lap. Compared with the previous two laps significantly decrease, and with the augment in the number of our athletes rotations in rotating stage, the ability to accelerate are more and more weak, which greatly limits the speed of the final shot.

**Table 3**  
**Hammer Velocity Increment in the Rotating Stage(m/s)**

Athlete	Result (m)	T1	T2	T3	T4
Shizhu Wang	69.17	-1.94	2.76	2.40	1.93
Kun Guo	63.97	1.35	2.33	2.06	1.05
Xiao Feng	63.93	0.92	2.16	2.12	1.24

The average left knee angle change from a single support beginning to ending of three athletes is 29.67 °, with a 13.13 ° difference to 42.80 ° of Litvin Ivanov, and that value in every lap is about 10 ° smaller than Litvin Ivanov. The body weight descend range of our athletes decreased to a lesser extent, in order to resist the powerful centrifugal force of the hammer throw run, the prevalence of different degrees of compensatory upper body backwards and narrowing chest to pull the ball in single, double support phase action.

The bevel angle change of China athletes is smaller than that of Litvin Ivanov 's, which is respectively 4.40°, 3.50°, 6.10°.

The final explosion of stage time of the three athletes are longer than that of Sedych (0.27s), which is respectively 0.32 s, 0.34 s and 0.34s.

The final shot speed of our athletes is slower than that of foreign famous athlete Sedych (30.7 m /s), with Shizhu Wang of 23.77 m /s, kun Guo of 20.84 m /s , xiao Feng of 20.74 m /s and a biggest difference of 9.96 m /s.

**DISCUSSION:** On the transverse, the pre-swing time of each is too long, compared to that of the outstanding foreign athletes Sedych (1.06s), which leads to a low pre-swing speed and creates a significant burden on rotation process, and there are still gaps on the hammer velocity increment during the pre-swing stage between the three and the world elite athletes.

Compared with the world's elite athletes, the three hammer throwers still have the following disadvantages in the rotation stage: the rotation total time is too long; the single and double support time is unreasonable distributed---the relatively long single support time and the short hammer speed-growth time is not conducive to speed up the rotation; the capability of sustained acceleration is weak; the falling range of the center of gravity is not enough, and there are compensatory actions to varying degree of upper body backwards and narrowing chest to pull the ball on single and double support phase; the bevel angle variation amplitude is inadequate, leading to a backward trunk or the clamping arms, narrowing chest and bending elbow, which is not conducive to keep balance and to link up and complete the subsequent technical movement.

The hammer throw running time of the three Chinese athletes on the final explosion phase, which is relatively long, should be shortened, especially the time from the lowest point to the shot moment. In terms of the hammer speed, the three time phase velocity of final exertion phase shows a growing trend, and the velocity increases significantly, but there is a great gap in the final shot speed between Chinese athletes and foreign elite athletes.

**CONCLUSION:**The time and hammer velocity increment in the pre-swing stage are much larger than the dates of outstanding foreign athletes,the rotation total time is much longer, and the single to double supporting time is distributed unreasonable, what's more, the change between the left knee joint and bevel angle is too small,longer hammer throw running time and the shot speed is less than the outstanding foreign athletes, which are all the reasons for the performance of Chinese athletes. The hammer throw running time with a longer and the final shot speedless on the final exertion phase than the outstanding foreign athletes, the reasons is to affect the performance of Chinese athletes. In training, emphasize the extended double support time, reduce the loss of hammer speed in the single support phase, emphasize acceleration force emphasis on rotation in double support phase, and at the same time strengthen the rotation speed of the rhythm to avoid as the number of turns increase in rotational speed is not incremented. Increase the speed and force of the knee rotation and kicking, maintain more smoothly center of gravity,do better the accelerated rotation, and increase the speed increment of hammer throw at final exertion phase while reducing movement time.

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