

## KINEMATIC ANALYSIS OF BASKET WITH 5/4 TURN TO HANDSTAND OF SHIXIONG ZHOU ON PARALLEL BARS

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The basket with 5/4 turn to handstand on parallel bars is a representative movement of E group; in 1896 it is listed as the Olympic Games project. The parallel bars have been one of the Chinese men's gymnastics advantage projects since 1980s. From 1980 to 2011, China's elite athletes Li Yuejiu, Lou Yun, Li Jing, Huang Liping, Zhang Jingjin, Li Xiaopeng and Yang Wei won more than a dozen times world champion on the parallel bars in the world gymnastics competitions. China's athletes can keep long-term advantage of this project status and competitive strength, in addition to keep pace with the times innovation of difficult moves, there is another important reason is to continuously improve the leading trend of action quality.

**KEY WORDS:** Kinematic analysis, Shixiong Zhou, parallel bars.

**INTRODUCTION:** At present, only Chinese gymnast ShiXiong Zhou can complete this action in the world, in the final of the 2012 national gymnastics championships in the parallel bars, ShiXiong Zhou failed to complete the action very well. Therefore, in order to improve the quality of this action, it's necessary to analyze the action from both qualitative and quantitative aspects. We made a 3D camera resolution on ShiXiong Zhou at the game site, with the three-dimensional analysis we gained the kinematic parameters. Thus to analyze the reasons of errors, which provides theoretical and technical basis for the development and improvement of Chinese athletes.

**METHODS:** 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 60 °). After the match, we put three-dimensional scale with 24 control points in filming area. We used 3-D Signal TEC V1.0C software, and built the coordinate system. In order to meet the research needs, we added the parallel bars as the 22 test points in Songjing Model (16 links, 21 joints). The original data was smoothed by low-pass filter with a cut off frequency of 6 Hz.

**RESULTS AND DISCUSSIONS:** In order to facilitate analysis the technical movement, this action can be divided into three stages by four events as follows (see figure 1).

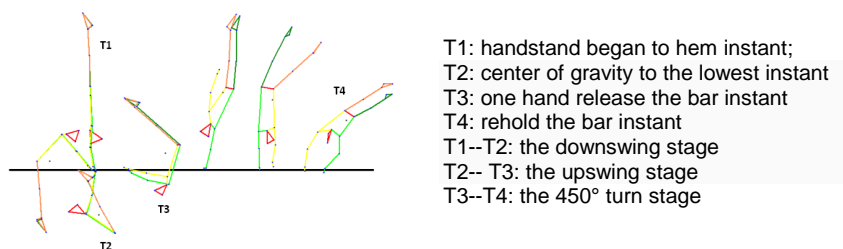


Figure 1: Schematic diagram of the stage division

**The downswing stage:** In the process of downswing, the shoulder angle first decreases, the minimum values of shoulder angle are 74.6 ° and 76.7 °, the hip angle and knee angle keep extension. Left hip angle is 174.5 ° and right hip angle is 173.7 °, left and right knee angle is 172.8 ° and 176.4 ° respectively. When the body center of gravity down to the horizontal plane, the horizontal distance from the body center of gravity to the bar is 0.57m. When the center of gravity down to the lowest position, the vertical distance from the body center of gravity and the holding point is 0.63 m, left and right shoulder angle are increased to 107.6 ° and 106.6 °, left

and right hip angle decreased to 26.8 ° and 31.1 °, knee angle decreases slightly, left and right knee angle are 170.6 ° and 171.2 °

To sink the shoulder Angle in order to increase the thick stick down force, its purpose is making thick stick down deformation, when the body upward movement can be done using the elastic potential energy of thick stick better behind the action. Due to the effect of gravity when the body to a vertical plane under bars, the speed center of gravity to the maximum 3.97 m/s. Handstand from the poles to the vertical plane under bars, run about 1.44 s, center of gravity hold rotate 180 °, the rotating angular velocity of 2.18 rad/s.

**The upswing stage:** When the body center of gravity close to the level before the bar surface, the shoulder angle are reduced to 92.1 ° and 93.8 °, left and right hip angle are increased to 85.9 ° and 87.2 °. The hip angle is too big, which shows the athlete hip extension too early, the range is too big, thus will affect the later twist action. The horizontal distance of the body center of gravity and the holding point is reduced to 0.47 m, 0.09m shorter than the bar after the horizontal surface of the body center of gravity and the holding point distance 0.56m. Body weight speed ratio under bars vertical surface velocity is up to 4.07m/s, which the vertical velocity to play the main role. When the body center of gravity around to the bar above the water level of about 23.1 ° and 0.21m from the bar, the right hand released, left and right shoulder angle increased to 94.3 ° and 96.8 °, left and right hip angle increased to 116.1 ° and 117 °, left and right knee angle are 177.8 ° and 179.3°

**The 450° turn stage:** The body already has a 180° turn when the body center of gravity to the highest point, the left shoulder angle is 169.4 °, left and right hip angle are 168.1 ° and 164.3 °, left and right knee angle are 168.9 ° and 170.2 °, the height of center of gravity up to 0.979 m, the center of gravity speed is decreased to 0.71 m/ s, in the process of continue to complete the rest of 270 ° rotation, the body center of gravity does not fall on the supporting shaft, thus affected the handstand action. The left and right shoulder angle are 113.3 ° and 134.1 °, left and right hip angle are 163.1 ° and 174.2 °, left and right knee angle are 172.4 ° and 176.1 ° and the speed of body gravity is 2.01 m/ s.

**CONCLUSION:** According to the kinematics parameters from the three-dimension picture analysis, the athlete (Zhou) had completed the basket with 5/4 turn to handstand in the competition but the quality of the action needed to be improved. At the upswing stage, hip extension of the athlete is too early and exceeded, which makes a larger horizontal distance from the center of gravity to the supporting point when supporting by one arm, and this is the reason why the body has a lateral tilt.

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