KINEMATICS ANALYSIS ON THE CHINESE ELITE ATHLETES TAN SIXIN'S BALANCE BEAM MOVEMENT OF CHANGE LEG RING LEAP

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The purpose of this study was to obtain a series of kinematics parameters of Tan Sixin's change leg ring leap with the help of software and to make kinematics analysis, in order to reveal the kinematic rules and technical characteristics of the change leg ring leap movement, thus providing theoretical basis and reference for athletes to consummate technique and coaches to guide training.

KEY WORDS: jump, different stage, action, body position.

INTRODUCTION: As one of the three most difficult jump, level E in the balance beam, change leg ring leap is of highly important research value, while currently in China, footwork movement researches are rarely involved with most scholars concentrated their explorations on mounting, somersault and dismounting. Therefore, study on change leg ring leap movement is of great theoretical and practical significance and can reveal the kinematic rules and technical characteristics of the change leg ring leap movement by studying this footwork by Chinese elite athlete Tan Sixin(hereafter referred to as "Tan"), the balance beam champion of the national games in 2013, thus providing theoretical basis and reference for athletes to consummate technique and coaches to guide training. Kinematic analysis was made to obtain a series of kinematics parameters of this technical action, so that we can evaluate the action from the view of mechanics and give suggest.

METHODS:

1 Three-dimensional video analysis:

The 2013 National Games employed two made-in-Japan JVC9800 cameras (shooting frequency:50fpS) to shoot synchronous on the entire movement of Tan. Then the exertion videos was analyzed by the 3D Signal TEC V3.2HDC software, frame by frame. Japanese Hideki Matsui(16 links, 21 joints parameter) was chosen as the mannequin. For the study need, the analysis added two points (midpoints of the ends on the upper surface of the balance beam). Parameters(including joint angles of different links, etc.) was gotten via available original data processed smoothly by low-pass digital filtering method, with cutting frequency up to 8Hz.

2 Stage analysis method:

According to its characteristics, change leg ring leap can be divided into three stages: 1. approach stage (her left foot pedal off the balance beam for the first time to her left foot pedal off the balance beam the second time); 2. change leg and ring stage. This stage can be divided into the follows: (1) change leg phase(her left foot pedal off the balance beam the second time to completing the exchange of leg); (2) splits and ring phase(completing the

exchange of leg to completing the ring); 3. buffer stage (completing the ring to her body center of gravity reach the lowest height).

RESULTS: Parameters acquired by 3D Signal TEC:

Moment	Height of C.G. (m)	Hip angle (°)	Knee angle (°)	Shoulder angle (°)	Barycentric velocity (m/s)
		left right	left right	left right	Vx Vz
Last step of approach	0.79	150.7 156.6	145.3 138.2	-	2.64 -0.50
left foot pedal off	1.05	163.5 110.4	176.6 178.3	101.6 100.4	0.88 2.18
Change leg	1.21	-	-	-	1.25 1.20
Highest C.G.	1.24	-	170.3 126.1	-	0.80 0.04
Ring moment	-	-	175.6 157.8	-	-
Buffer start	0.75	140.5 137.8	132.7 128.3	-	-1.67 1.20
Lowest C.G,	0.66	112.0 124.7	103.6 115.0	-	-0.06 0.27

DISCUSSION:

1 Approach stage

Approach is an essential part in order to better complete the jumping motion, which can help obtain horizontal speed and create conditions for take-off and get vertical speed. Tan took the method of two-step run-up to complete the approach action, making the total displacement of 2.74 m on the X-axis direction in 0.74 s. At the end of the approach, Tan's center horizontal speed was of 2.82m / s. Compared with other Chinese elite athletes, Tan finished well on the increase the horizontal velocity in the approach stage.

At the last step of approach, while landing to the beam, the height of Tan's body center of gravity is 0.79 m, and the left and right hip angle were of 150.7 ° and 156.6 °. At this time, Tan's in a great extent of hip flexion and upper body bending, but the body center of gravity was still high.

From landing to kicking and to the end of approach, Tan used 0.19s, and her left hip angle increased 12.8 ° from 150.7 ° to 163.5 °, while right hip angle reduced 46.2 ° from 156.6 ° to 110.4 °, left / right knee angles increased 31.3 ° / 11.1 ° respectively from 145.3 ° / 138.2 ° to 176.6 ° / 149.3 °. All these parameters showed that Tan was making her upper body upward , kicking her left leg and swinging her right leg actively, in order to obtain a higher body center of gravity height for the initial jump and prepare to jump higher. At this phase, Tan completed the action in a short time, her left hip angle increased considerably large, at the same time, her right hip angle decreased rate was also great, which meant Tan moved fast with large amplitude at this phase, thus prepared very well for the following jump. By observing the game video, Tan also actively kicked her left leg and swung her right leg while her upper limb wad also positive swinging with the whole body sharply. In this phase of landing to the end of approach, Tan's height of the body center of gravity increased 0.26 m, which showed that her good coordination of the whole body also helped her to get up more upward speed. In addition, Tan's horizontal velocity decreased

1.76 m/s from 2.64 m/s to 0.88 m/s while her landing, what changed a lot. The vertical velocity of Vz = 2.18 m/s at the moment when her foot pedal off the balance beam showed that her horizontal velocity was changed into vertical velocity, thus help her to get a higher lift height and provide enough space for her to change leg and make the ring. On the other hand, in this phase, Tan' change of speed was very big, which was bound to sacrifice the fluency of the action. The takeoff angle of 86.7 ° can facilitated Tan to get higher lift height. However, for the whole movement, the essence of change leg ring leap operation was not simply to get the height, but also to ensure that there was a forward movement trend to achieve the purpose of buffer smoothly and make sure the continuity of the whole movement.

2 Change leg and ring stage

The international Gymnastics Federation required change leg ring leap in "women's gymnastics scoring rules (movement list of balance beam)" : upper back arch and head release with foot to head height; 180°split of leg; front leg at horizontal position.

According to the research, Tan completed the ring action not at the time when her body center of gravity reached the highest point, but after 0.08 s of it, which showed that the change leg ring leap was very complex and the technical action, ring, carried out after the change leg and splits movements in the air. For better study of change leg ring leap techniques, this paper divided this whole stage into two phase: change leg phase and the splits and ring phase.

To complete the change leg phase, Tan used 0.10 s, with her body center of gravity height of 1.21m, horizontal velocity of 1.25 m/s and vertical velocity of 1.20 m/s by the moment the end of change leg. At this time, her body center of gravity was low and her vertical velocity was also not fast, which could not help provide bigger space for her to complete following actions, while her horizontal velocity was also not fast, which can make her have enough time to do following movements. Tan's legs' Angle was of 67.5 ° at the beginning of change leg and of 17.5 ° after her completion of the change leg moment, changed 83.8 °.Tan's right leg swung in the progress of change leg, while the swing range was not big enough, which was one of the reasons caused the vertical velocity of 1.20 m/s and her low body center of gravity height.

At the moment when the body center of gravity reached the highest point, Tan splits with body center of gravity height was of 1.24 m, increased 0.23 m after her pedal off, legs angle of 150.6 °, not of 180 °, with the vertical velocity of 0.08m / s. The horizontal direction movement trend was not obvious, and the whole action stretched smoothly. The torso angle of 12.9 ° showed that Tan had a tendency to straighten her back.

Right after the splits, Tan made the ring, with angle between her left leg and the balance beam of 2.7 °, with her action standard beyond the requirement of in a horizontal position. Tan's legs Angle was of 186.6 °, more than requirement of 180 °. At the moment the ring completed, Tan's torso Angle was 19.4 °, and angle of head and torso was 92.4 °, suggesting that Tan bend her body back to form a relatively round ring. The height difference between Tan's head and her right foot was of 0.02 m, with her toe slightly higher than the head. Distance in horizontal direction between Tan's head and her right foot was of 0.21 m, thus showing that Tan's ring position was very good.

3 Buffer stage

In buffer stage, athletes are required to let lower limbs landing to the beam actively, to make the knee joint bend, to tighten lumbar muscle, to keep the upper body upright, and adjust the whole body to keep a steadily landing.

In buffer stage, Tan's body center of gravity height fell from 0.75 m to 0.66 m in 0.11 s.Tanused both feet landing method, with the left foot in front, and her both feet almost touch the support surface at the same time. The landing angle of 88.7 ° ensured the landing center of gravity within the support surface on one hand, and also ensured that the body was not easy to move forward and backward. Her feet immediately buffer after the fast landing. Her left and right hip angle decreased respectively from 134 ° and 142 °when the start of buffer to 92 ° and 100 °when the body weight decreased to the lowest point, while the left and right knee angle reduced from 157 ° and 155 ° to 115 ° and 116 °. This buffering action is necessary, which can reduce force of her body gravity on the balance beam, but also can reduce the vertical velocity of the body center of gravity and the horizontal velocity of moving forward.

In the whole process, the outreached arms played a balancing role in keeping the body's center of gravity steady in order to successfully complete the change leg ring leap action.

CONCLUSION: Tan kept a relatively high speed while run-up and with bad coordination, thus in this stage athletes should make harmony and continuity. Change leg, splits and ring action should be fully stretched, and at the end of change leg, kicking was very important to get vertical velocity and height. While landing, speed can be high or low, but must be steady.

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