

## KINEMATICAL ANALYSIS OF DISMOUNT OF STRAIGHT BACK SOMERSAULT WITH A TURN OF 90° : A CASE STUDY

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The techniques of dismount of straight back somersault with a turn of 90° performed by Tan Sixin (winner of all-round of China's gymnastics championships in 2011) and Jiang Yuyuan (winner of champion of the balance beam of World University Games in 2009) was filmed using 3-D camera method. The kinematics data were collected and analyzed by motion performance analysis system. The conclusions came out that overall execution of Tan Sixin was good, while the action of Jiang Yuyuan needed to be improved. The results of the analysis will provide a theoretical basis of balance beam training for athletics and trainer.

**KEYWORDS:** balance beam, dismount of straight back somersault with a turn of 90° , kinematic

**INTRODUCION:** Balance beam is an powerful sports event in China. This study selected two top level balance beam players, Tan Sixin, the winner of individual all-around Gymnastics Championship in 2009, and Jiang Yuyuan , the winner of balance beam in National Gymnastics Championship in 2010 as samples. Based on the comparative analysis of related kinematic parameters of dismount of straight back somersault with a turn of 90° done by Tan and Jiang, this paper revealed the kinematic characteristics and technical key of this techniques, and provided some meaningful suggestions for coaches and athletes.

**METHODS:** 3-D camera analytical method. In 2011 National Gymnastics Championships, balance beam final of the whole process, used two JVC cameras (50 frame/s) from different angle (two main beam axis camera angle was 90 °) to shoot the entire final process of balance beam. With 3-D SignalTec analytic system, obtained comparative kinematics parameters by analyzing the dismount techniques and adopting low-pass digital filter method to smooth the original statistics with cut frequency at 8Hz.

**RESULTS:** At the leaving moment, the vertical heights of the body center of gravity (CG) of Tan and Jiang were 1.023m , and 0.993m respectively, the vertical velocities of center of gravity were 2.54m/s and 2.35m/s respectively, resultant velocities were 3.04m/s and 2.91m/s. Other data were listed as follows: left shoulder angles were 89.7° and 76.4°; right shoulder angles were 131.7° and 132.9°; left hip angles , 143.1° and 152.4°; right hip angles , 134.0° and 153.3°; left knee angles: 169.6° and 161.6°; right knee angles: 174.0° and 156.9°. There was no difference between joint angles of these two gymnasts. (shown in figure 1)

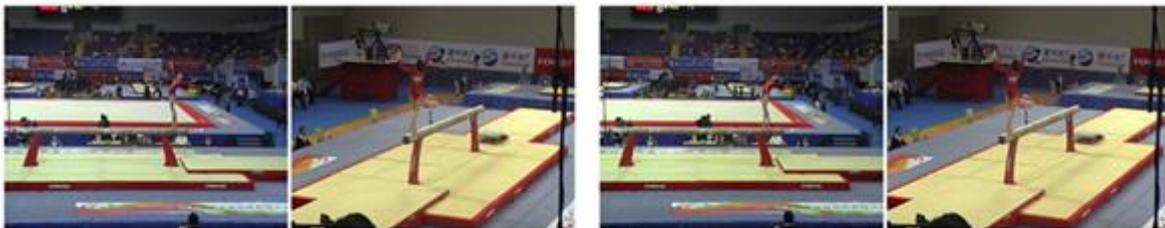


Figure 1: Pictures of leave the balance beam moment, Tan Sixin left, Jiang Yuyuan right

At the moment of the peak point of CG, the vertical heights of CG of Tan Sixin and Jiang Yuyuan were 1.364m and 1.310m respectively. The horizontal velocities of CG : 1.13m/s and 1.54m/s respectively, and resultant velocities of CG : 4.93 m/s and 4.55 m/s respectively. Jiang Yuyuan's horizontal velocity of CG was relatively faster, while the resultant velocity was

slower, which caused the lower vertical height of CG. Left shoulder angles of Tan and Jiang were  $34.1^\circ$  and  $42.4^\circ$ ; right shoulder angle:  $43.1^\circ$  and  $49.4^\circ$ . Left hip angle:  $155.7^\circ$  and  $151.8^\circ$ ; right hip angle are  $168.5^\circ$  and  $167.0^\circ$ . According to the law of moment of momentum, shortening the radius of the vertical axis can accelerate the body speed of turning. The shoulder angle of Tan was smaller than that of Jiang's, which indicated that Tan's arm holds tighter. (shown in figure 2)



**Figure 2: Pictures of peak point of CG ,Tan Sixin left, Jiang Yuyuan right**

From leaving moment to the touchdown moment, Tan and Jiang took 0.82s and 0.78s respectively. At the touchdown moment, the vertical height of CG of Tan and Jiang were  $-0.164\text{m}$  and  $-0.199\text{m}$  respectively, the resultant velocity:  $0.27\text{m/s}$  and  $1.31\text{m/s}$ . Left shoulder angle of Tan and Jiang :  $127.7^\circ$  and  $66.6^\circ$ , right shoulder angle are  $162.7^\circ$  and  $46.5^\circ$ . Left hip angle:  $160.0^\circ$  and  $173.2^\circ$ , right hip angle:  $168.4^\circ$  and  $173.2^\circ$ . Left knee angle:  $148.0^\circ$  and  $151.9^\circ$ ; right knee angle:  $152.5^\circ$  and  $153.8^\circ$ . At this time, there is a significant difference between Tan and Jiang. The resultant velocity of gravity of Jiang was faster. (shown in figure 3)



**Figure 3: Pictures of touchdown moment, Tan Sixin left, Jiang Yuyuan right**

From the touchdown moment to the moment of the lowest point of CG, Tan used 0.10s time to buffer with stable landing. At the moment of the lowest point of CG, the vertical height of CG of Tan is  $1.364\text{m}$ , and the resultant velocity was  $0.27\text{m/s}$ . Left and right shoulder angle were  $38.6^\circ$  and  $119.3^\circ$ , at the same time, left and right hip angle are  $104.2^\circ$  and  $96.2^\circ$ , and left and right knee angle :  $108.2^\circ$  and  $93.8^\circ$ . Her body was buffered well by the flexion of hip and knee. The height of Jiang decreased  $0.24\text{m}$  after the touchdown, while the resultant velocity was  $1.31\text{m/s}$ , Left and right shoulder angle were  $50.9^\circ$  and  $66.1^\circ$ , while left and right hip angle :  $154.6^\circ$  and  $128.1^\circ$ . Jiang landed a litter unstable, because it had no enough time to buffer by bending the hip, so made her right foot a step forward. (shown in figure 4)



**Figure 4: Pictures of lowest point of CG, Tan Sixin left, Jiang Yuyuan right**

**CONCLUSION:** As above-mentioned discussion, the findings came out as follows: At the leaving moment, the shoulder joint angles of Tan Sixin and Jiang Yuyuan were relatively larger, through which the effects of both arms have been exerted maximally. Meanwhile it was helpful to increase the speed and the height of flight. The height of center of gravity, the horizontal velocity and vertical velocity of center of gravity, the resultant velocity of Tan Sixin were larger than those of Jiang Yuyuan. At the take-off stage, the flight height was obviously higher than that of Jiang Yuyuan, provided advantages for completion of following action. At the whole salto stage, the salto height and time of Tan Sixin were better than that of Jiang Yuyuan, and posture was kept in good shape. The salto height of Jiang Yuyuan was not high enough, neither tight twisted arms, to affect twist velocity. The landing of Tan Sixin was very firm based on active bending knees and hips, stretching arms to maintain balance. However Jiang Yuyuan has not stretched arms in time to buffer when touching the floor. Therefore her body was still in stretched position without bending knees and hips. This was because the height was not sufficient. Generally speaking, techniques of Tan Sixin were better, while the action of Jiang Yuyuan needed to be improved.

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