

A Biomechanical Study on the Takeoff Motion of the Japanese Junior Long Jumpers

-Comparison with the Standard Motion and Motion Variability of the World Class Jumpers-

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INTRODUCTION

When we coach an athlete for motions in the various sport activities such as the long jump, it is basically important to observe the performance and motions of the athlete. And then, we refer to the motion of elite athletes as models in order to improve and optimize the technique of the athlete we coach. However, these models possessed by many of the coaches seem subjective and diversity, and not to be standardized yet. Ae(2007) tried to solve these problems from view point of the standard motion obtained by averaging the motion of the several elite athletes in the high jump and sprint. He mentioned that the standard motion obtained from elite athletes is useful to extract the primary body segments, and to clarify the technical faults of the athlete. Since these concept proposed by Ae(2007) is novel, there are no reports examining the various sport activities or comparing the various level of the athletes.

The purpose of this study was to clarify the Japanese junior long jumper's (J-jumper) features and improvements of the motion during the takeoff based on the World's class jumpers (W-jumper) kinematics data, the standard motion and the motion variability.

METHODS

Seven men's W-jumpers, with personal best record ranging from 8.20m to 8.62m, were filmed at the final of the 11th IAAF World championships in athletics held in Osaka, Japan (2007). A high speed video camera was placed in the stadium so that it might be perpendicular to the take off board, and filmed the jumpers during the takeoff(250f/s). Sixteen boy's J-jumpers, with personal best record ranging from 7.17m to 7.87m, were filmed at the final of 2003 and 2004 Japan High School Track & Field Championships by the Biomechanical Project team of the Japan Amateur Athletic Federation. Digital video camera was placed at perpendicular to the takeoff board, and filmed the jumpers during the takeoff (60f/s). Best trials of the W-jumpers and J-jumpers were analyzed using FRAME DIAS system (DKH Co., Japan). Base on the digitized coordinate data, we obtained the normalized coordinate data relative to the jumper's anthropometric variables (i.e. body height) and take-off time, first. And then, several joint angles, segment angles, standard motion, the average standard motions, coefficients of variation(CV) and the average coefficients variation were calculated (Ae, 2007). The t-test was used in the statistical comparison with some variables between the W-jumpers and J-jumpers. The statistical significant level was less than 5%.

RESULTS AND DISCUSSION

The average athletic record of the W-jumper and the J-jumper was 8.28 and 7.35, respectively, and there were statistically significance ($p<0.001$). The horizontal velocity at the touchdown and at the release of the takeoff foot in the W-jumper was greater than those of J-jumper ($p<0.001-0.05$). However, the loss of the horizontal velocity during the takeoff

of the W-jumper was greater than those of the J-jumper ($p<0.01$), the vertical velocity of the release of the takeoff foot and the takeoff angle of the W-jumper were larger than those of the J-jumper. These results might be suggested that the use of the body segments during the takeoff in the W-jumper and the J-jumper were different.

Both the W-jumpers and the J-jumpers showed small value of the average CVs of the trunk segment angle, joint and segment angles of the takeoff leg (thigh, knee and the shank) and the thigh segment angle of the free leg. If the variability of the motion among the athletes is small, CV of the joint angle and segment angle becomes small (Ae, 2007). Therefore, trunk and takeoff leg during the takeoff of the long jump might be important role, regardless of athletic level.

The average CVs of the trunk segment angle and the thigh segment angle of the takeoff and the free leg for the W-jumpers were smaller than those of the J-jumpers, especially at the trunk segment angle showed significantly small value ($p<0.01$). There is interesting difference of the standard motion of the trunk segment angle during the second half of the takeoff phase between the W-jumpers and the J-jumper. The W-jumper's trunk segment angles showed large positive value during the second half of the takeoff phase, indicating the trunk leans forward. On the other hand, the J-jumpers showed negative value of the trunk segment angle during the second half of the takeoff phase, indicating the trunk leans backward. The trunk segment angle of the W-jumpers reached zero value at 40% of the normalized time for takeoff phase, and also the CV curved line of the trunk segment angle for W-jumpers during the takeoff phase showed the lowest value at the 40% of the normalized time. These results indicated that inclining the trunk from backward to forward during the first half of the takeoff phase might be one of very important motion for long jump. Meanwhile, the trunk segment angle of the J-jumpers reached zero value at 60% of the normalized time for takeoff phase, and they tended to lean the trunk backward during the second half of the takeoff phase as mentioned above. Therefore, the J-jumpers might be asked to improve the motion and timing for the inclination of the trunk during the takeoff phase.

In this study, we could clarify that the trunk and the takeoff leg played important role during the takeoff phase for both the J-jumpers and the W-jumpers. However, the trunk motion of the J-jumpers during the takeoff phase was fairly different from those of the W-jumpers. Further studies including the examination of other body angle and segment angle are needed to clarify the suitable takeoff motion for the J-jumpers.

REFERENCES

1. Michiyoshi Ae, et al. A Biomechanical Method to Establish a Standard Motion and Identify Critical Motion by Motion Variability: With Examples of High Jump and Sprint Running. Bull. Inst. Health & Sport Science, Univ. of Tsukuba, 30, 5-12, 2007.