Speeding up Skills for Improving Japan's Elite Female Cross-country Skiers' Double Poling Skills to an Internationally Competitive Level

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1 OBJECTIVES

As a strategy to improve the double-poling skills of female cross-country skiers and enable them to become internationally competitive level, we have identified the importance of rapid elbow joint extension during the poling phase and hip joint extension during the gliding phase, as well as overcoming the trade-off between cycle length and cycle rate. To keep up with the faster speeds seen in competition in recent years, it will be necessary to improve the timing skills entailed in coordinating the movements of the main parts of the body involved in the gliding movement. It is believed that this will contribute in overcoming the trade-off (Yoshimoto and Suzuki, 2013).

The female athletes who participated in this study include some who have won a prize in international competitions. The short cut to raising their level to the point at which they can consistently be in contention for medals is the presentation of a motion model that allows them to acquire the main timing skills involved in the gliding movement, which have enabled elite male skiers to increase their speed. In this study, we have attempted to create a motion model regarding the timing skills that female skiers need to acquire, based on image analysis data of double poling movements by elite Japanese male and female skiers.

2 METHODS

2.1 Experimental Participants

One elite female Japanese skier and fourteen elite male Japanese skiers participated in this experiment. They were classified into a high-rank group of six skiers whose gliding speed in a set measurement zone was faster than the mean of all of the skiers. Male B with the fastest gliding speed was extracted, and the male athletes, female A, male B were compared with each other.

2.2 Experimental Task

The task was a maximum effort double-poling on a straight, 8-m ascending (5% incline) course. Two high-speed cameras (300 f/s) were set up in front of and beside the subjects, and recorded their double poling gliding motions.

2.3 Measurement Items

Motion analysis software (Frame-DIAS IV, made by DKH) was used to find three-dimensional coordinate values of different parts of the body by direct linear transformation (DLT) from the resulting video. Part of one cycle of their gliding motion, from the ground contact of the poles to take-off from the ground, was understood to be the poling phase (Phase P), and the part from take-off from the ground to the next ground contact was understood to be the gliding phase (Phase G). (See fig. 1 for measurement items and definitions of angles)

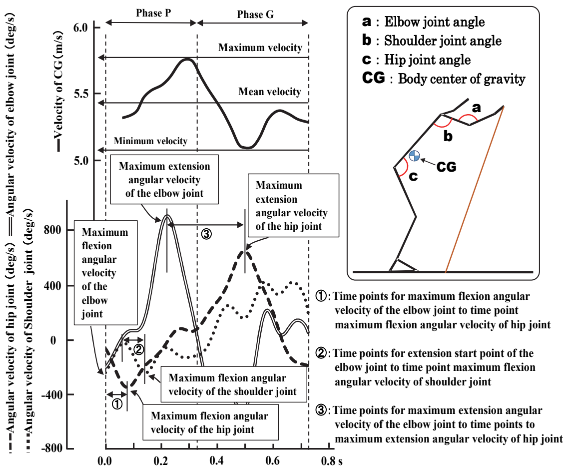

Figure 1: Measurement items and definitions of angles.

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3 RESULTS

3.1 Gliding Velocity, and Minimum Velocity Relative to the Maximum Velocity to the Slowdown Late

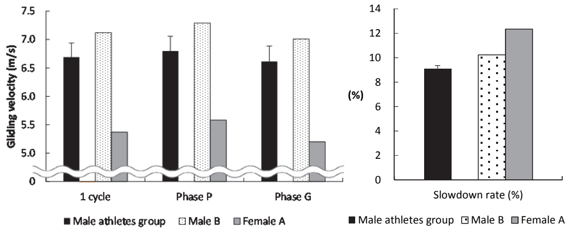

Figure 2: Gliding velocity of each phase, and the deceleration rate of the minimum velocity to the maximum velocity.

Female athlete A, mean velocity of each phase islower than male athletes. The deceleration rate of the minimum velocity to the maximum velocity was equal to or less than 10% in male athlete group and male athlete B, but it was about 12% in female athlete A.

3.2 Angular Velocity Changes of the Upper Limb Joints, and the Time Relationship between Elbow Joint Extension and Shoulder Joint Flexion

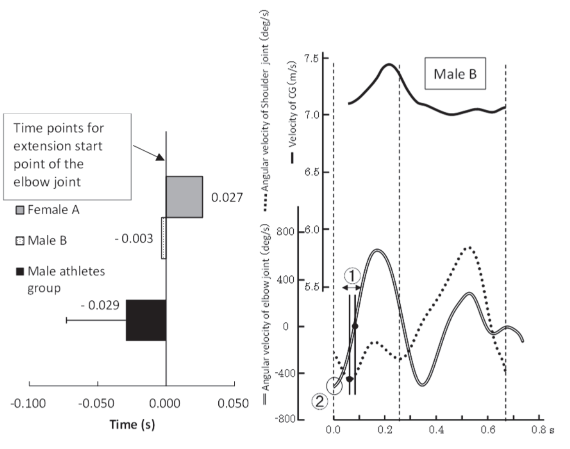

Figure 3: In phase P, Time relationship between elbow and shoulder joint motions, male B's angular velocity changes.

Maximum flexion angular velocity of the shoulder joint relative to the elbow joint extension start point was high in the male athletes group, and low in the female athlete A. But both time points coincided formale B (fig. 3 ①).

In the time from the Nagano Olympics (1998) to the Turin Olympics (2006), skiers at an internationally competitive level have had coinciding time points for maximum flexion angular velocity of the shoulder joint and elbow joint (Suzuki et al, 2002). However, currently the time point for the maximum flexion angular velocity of the elbow joint has, appearing at about the same time as ground contact of the poles, as is the case with male athletes group and male B (fig. 3 ②).

3.3 Each Joint Flexion Angular Velocity，and Time Relationship between Elbow Joint Flexion and Hip Joint Flexion

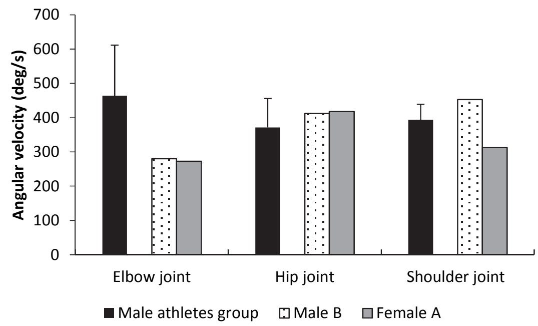

Figure 4: In phase P, Maximum flexion angular velocity of the elbow joint, hip joint, shoulder joint.

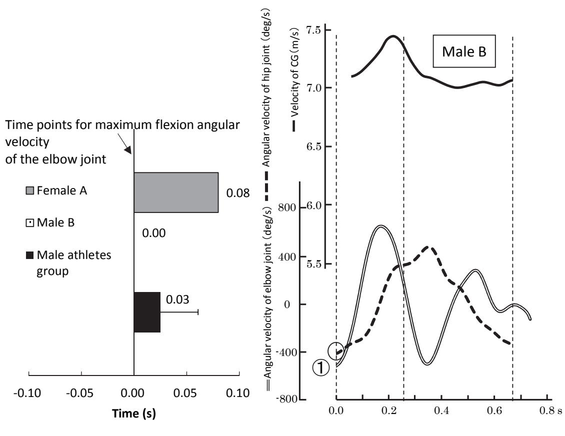

Figure 5: Time relationship between elbow and hip motions, male B's angular velocity changes.

In phase P, Female A's maximum flexion angular velocity of the elbow joint and hip joint was substantially the same as the male B, and Compared with male athletes group, lower elbow joint, but higher in the hip joint.

Female A's maximum flexion angular velocity of the shoulder joint, relative to male B and male athletes group, was the lowest.

The time point of maximum flexion angular velocity of the hip joint, relative to the time point of maximum flexion angular velocity of the elbow joint, female A is the largest, then was a male athletes group. Both time points coincided for male B (fig. 5 ①).

3.4 Each Joint Extension Angular Velocity and Time Relationship between Elbow Joint Extension and Hip Joint Extension

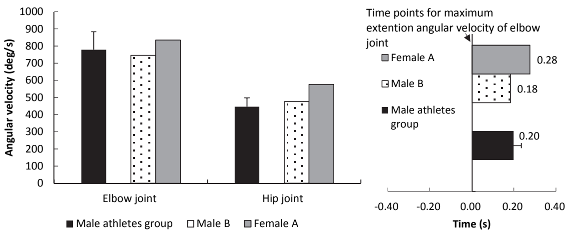

Figure 6: In phase G, elbow and hip Joint extension angular velocity, and time relationship between elbow and hip joints motions.

The maximum extension angular velocity of the elbow joint and shoulder joint in phase G, female A was the highest. The time point of maximum extension angular velocity of the elbow joint, relative to the time point of maximum flexion angular velocity of the hip joint, male athletes group and male B was within 0.2s, then female A was slower about 0.28s.

4 DISCUSSION

Compared to male athletes, female A has a lower gliding velocity and a higher slowdown rate of phase G. However, the angular velocity of flexion and extension of the main joint is not low, and the muscle power exerted by each movement seems to be sufficient. In contrast, flexion of the elbow joint and hip joint in phase P, and the gap in the timing between shoulder joint flexion and elbow joint extension is different from that of male athletes. For example, the timing of the flexural movement of the elbow joint and hip joint of male B, it is considered that support to the skill corresponding to the recent velocity of gliding up. Suggests that female A different from it timing to not mastered of the velocity of gliding up. Flexion of shoulder joint is final situation of the kinetic chain that each body sites part to pushing the pole behind.

Female A has high angular velocity of flexion and extension of the elbow joint and hip joint, but power generated by these movements is not effective. One of the causes is timing skills. Therefore, not only increasing the muscle power to pushing the pole behind, if power generate the timing skills, such as to exert a male B, increases angular velocity of flexion of shoulder joint is final situation of the kinetic chain, it is expected to increase in the gliding velocity.

Although the angular velocity of extension of the elbow joint and hip joint is high in female A in phase G, the timing of hip joint extension is delayed. Correction of this timing skill, is supposed to contribute to controlling the slowdown rate of phase G.

From the above, the features of the motion model which could make female athlete A acquire the main skills of the gliding motion of a male athlete.

(1) Because the muscle power exerted by flexion and extension of the elbow joint and hip joint is efficient, the present joint angular velocity is maintained.
(2) The timing is synchronized to let the elbow joint extend in phase P with the time point for maximum angular velocity of flexion of the shoulder joint.
(3) The timing is synchronized to allow bending of the elbow joint and hip joint in phase P. In other words, flexion timing is hastened so that maximum angular velocity of hip joint flexion appears with pole grounding approximately at the same time.
(4) The timing is hastened to let the hip joint extend in phase G. About after 0.2s at the approximately the time point for maximum angular velocity of elbow joint extension.

REFERENCES

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