A BIOMECHANICAL ANALYSIS OF SPIKE MOTION FOR DIFFERENT SKILL LEVELS OF MALE VOLLEYBALL PLAYERS

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PURPOSE

The purpose of this study was to three-dimensionally analyze the spike motion for world elite and Japanese university volleyball players, and identify differences in swing motion to obtain information for coaching spike techniques.

METHODS

Eighteen male volleyball players (1.94±0.07 m, 85.7±8.67 kg) participated in this study as subjects. Nine were national players from Canada, Serbia Montenegro, and Japan, and seven university players of Japan. Spike motions of Serbia Montenegro and Japanese players were recorded during two official games of the World League (2002, Osaka) with two high-speed VTR cameras (250 Hz, 1/1000 sec). Canadian players and Japanese university players' spike motions were captured with Vicon Motion System 612 (eight cameras, 120 Hz) using 39 reflexive markers. 3D data from VTR were reconstructed using a DLT method. Data smoothing was done with a Butterworth digital filter and the Wells and Winter method at optimum cutoff frequency of 5~12Hz. The trial in which the fastest right hand velocity at impact was obtained for each subject was used for further analysis. The subjects were grouped by the right hand velocity as a criterion. The five fastest and the five slowest players were referred to as the top and lower groups, respectively. Upper arm joint angle and joint angular velocity were primary variables for comparison of spike motions. Right hand height and velocity at the impact, trunk kinematics and relative velocity between segment end points were also computed. The data were normalized from the toe-off to the impact as 100% and averaged every 1%. Right hand velocity at the impact was related to the other variables by Pearson's correlation coefficient with $P<0.05$. Differences between the two groups were tested with t-test at $p<0.05$.

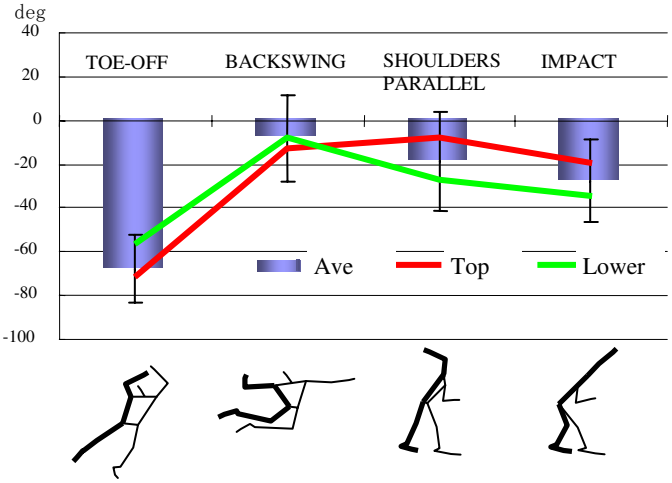

Figure 1: Right shoulder horizontal adduction/abduction angle.

RESULTS AND DISCUSSION

Right hand velocity at the impact was significantly related to the shoulder abduction and horizontal adduction angles at the toe-off.

Figure 1 shows the right shoulder horizontal add/abd angle at the events of spike motion for the average, top and lower groups. During the backswing phase following toe-off, the top group elevated the upper arm. However, the lower group abducted the right shoulder considerably smaller than the top group. Figure 1 indicated that the lower group started the horizontal abduction earlier and greater than the top group. Moreover, the horizontal adduction at the impact was greater in the lower group than that of the top group. The right shoulder was accelerated through the forward rotation of the trunk, and then, the upper arm horizontal adduction was retarded in the top group in the forward swing, whereas the lower group precociously adducted the shoulder mentioned above.

Figure 2 shows the change in angular velocity of the right elbow joint after the toe-off. Although there was no difference in the pattern of the elbow angular velocity before the start of rapid shoulder abduction (indicated by a vertical dotted line in figure 2), after the start, the elbow angular velocity for the top group became negative, and then increased rapidly toward the impact. This indicated that the lower group continued extending the elbow after the start of shoulder abduction while the top group could use stretch-shortening cycle to increase the elbow extension velocity.

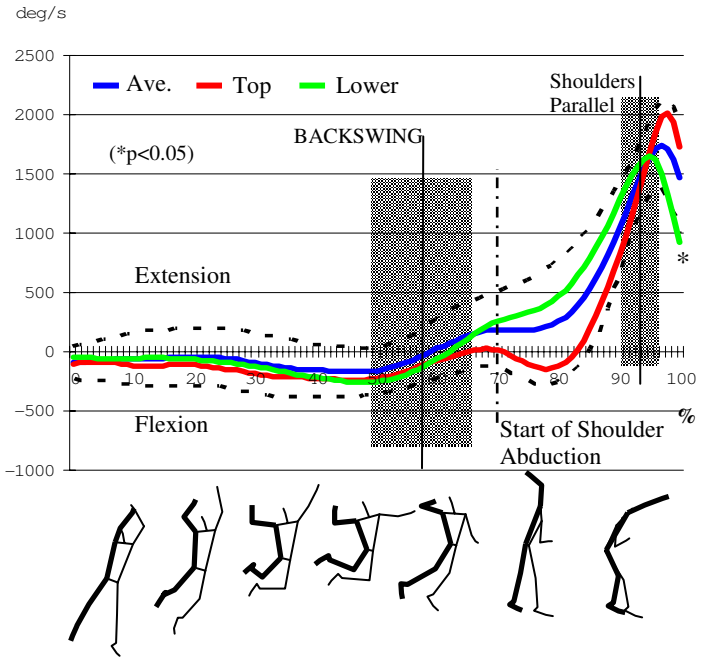

Figure 2: Right elbow angular velocity from toe-off to impact moment. Ave=average