A COMPARISON OF THE VOLLEYBALL JUMP SERVE AND THE VOLLEYBALL SPIKE

C. L. Tant, B. Greene, M. Bernhardt

Iowa State University
Ames, Iowa, USA

INTRODUCTION

The jump serve (JS) and spike (SP) require a performer to move through a wide range of kinematic parameters which introduces unfamiliar timing and sequencing problems. Both skills are identified as overarm striking patterns requiring the performer to apply a force, sequentially, from jumping with the legs, to the trunk and upper body armswing. The preparatory armswing used on the approach and during ball contact has been considered identical for both skills (Strohmeyer, 1991). Therefore, the purpose of this study was to investigate the differences and similarities in the three-dimensional kinematics and temporal structures of the JS and SP.

METHODOLOGY

Five male (age 20.6 ± 0.55 yrs; height 182.0 ± 5.7 cm; mass 88.4 ± 4.4 kg) and five female (age 20.6 ± .56; height 177.2 ± 5.9 cm; mass 78.0 ± 7.1 kg) intercollegiate volleyball players served as subjects. Two trials of each skill for each performer were videotaped with two Panasonic AG-450 camcorders positioned at a 80° convergence angle to the endline for the JS and net for the SP. The high speed shutters were set at 1/1000 s and nominal frame rates of 30 Hz.

After filming the subjects, the Ariel Performance Analysis System, AST 386 computer, and Panasonic 7300 VCR set at 60 Hz were used in digitizing 17 data points. The views were captured, digitized, synchronized, and transformed. The Direct Linear Transformation (DLT) algorithm was used for conversion to three-dimensional data. The data were smoothed with a digital filter set at 10 Hz.

ANOVA with repeated measures was utilized to examine differences in the kinematic variables and temporal structures of both the JS and SP. The Scheffe post hoc procedure was performed if differences were found between conditions.

Identified as discrete skills, the JS and SP were divided into 3 phases for analysis purposes. The preparatory phase began as the performer started the approach and was completed when the arms became parallel to the floor. The force phase began at this point, the takeoff, and finished at ball contact and the follow-through phase followed ball contact to the landing.

RESULTS AND DISCUSSION

The covention for the angles of the arm are illustrated in Figure 1. During the spiking and jump serve motion the performer attempts to develop maximum velocities with an accuracy component. A significant difference ($p<0.05$) was found between the female spike (FSP) and jump serve (FJS) variables of resultant linear ball velocity (LBV) and resultant linear hand velocity (LHV), but no differences were found between the male spike (MSP) and male jump serve (MJS) of these two variables. However, a significant difference was found between the males and females of each skill (Table 1). The males generated greater resultant hand and ball velocities and seemed to maintain

the same amount of effort regardless of skill. No significant differences were found between the relative joint angles at contact of the shoulder (RAS), elbow (RAE), and wrist (RAW) for the females between the skills. A significant difference was found between the RAW for the men, but not at the RAS and RAE. Significant differences were noted between the sexes at the RAW and RAE (Table 1). The results indicate that at the point of contact, the armswing seems to be identical between the skills within each sex, however differences were noted between the sexes. This difference may be attributed to the greater vertical displacement of the males above the net, permitting the males to further extend at the elbow and flex greater at the wrist.

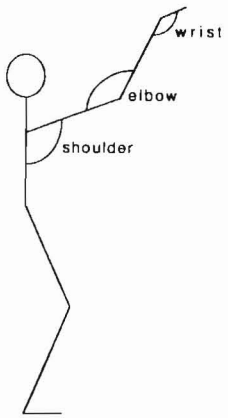

Figure 1. Angle convention.

Table 1. Resultant velocities and relative joint angles.

Skill	LBV (m/s)	LHV (m/s)	RAS (°)	RAE (°)	RAW (°)
MSP	22.4	15.4	141.1	174.7	104.9
MJS	19.7	13.6	145.9	173.8	157.3
FSP	17.8 *	13.8 *	147.0	148.1 *	135.6 *
FJS	13.2 *	10.6 *	141.1	146.3 *	141.5 *

(* $p<0.05$ between male and female subjects)

Significant differences were found between skills and sexes for center of gravity (CG) displacements and velocities. Both males and females exhibited greater horizontal displacements (CGX) and less vertical displacements (CGY) for the JS. This would be expected as the intent of the JS is to move horizontally forward onto the court, whereas the horizontal displacement of the SP is restricted because of the net. Vertical velocities (CGVY) were greater than horizontal velocities (CGXV) at takeoff for the SP. The performer is transferring the horizontal velocity obtained during the approach to maximize the takeoff in the vertical direction (Table 2). Significant differences between the sexes occurred within each variable, except CGX. Displacement in the horizontal direction may be similar because of the court and net restrictions for the spike.

The temporal structure between the skills was less variable for the males than the females. Significant differences were found between total movement time (TMT), contact time (CT), the percentage of time spent in the preparatory phase (RTP), and

the relative time in the force phase (RTF) between sexes (Table 3). The females demonstrated significant differences in both the RTP and relative time in the force phase (RTF). No significant differences were noted for either group on the relative time of the follow-through (RTFT). This invariant temporal structure and relative angles suggests that the SP and JS have some very similar characteristics. Significant differences were found between the TMT and CT of each skill. Greater total time was observed with the JS as the performer is able to start further back off the court and has no net restriction.

Table 2. Center of gravity displacements and velocities.

Skill	CGX (cm)	CGY (cm)	CGZ (cm)	CGXV (m/s)	CGYV (m/s)	CGZV (m/s)
MSP	226.6	92.9	77.8	3.63	3.93	0.13
MJS	401.3	89.3	58.1	2.85	3.26	0.60
FSP	212.6	71.3 *	58.1 *	2.13 *	2.82 *	1.12 *
FJS	326.2 *	70.3 *	22.6 *	1.84 *	2.73 *	0.99 *

(* $p<0.05$ between male and female subjects)

Table 3. Temporal characteristics.

Subj.	TMT (s)	CT (s)	RTP (%)	RTF (%)	RTFT (%)
MSP	1.78	1.22	33.5	38.6	27.8
MJS	2.97	2.13	35.3	33.9	30.8
FSP	2.18 *	1.73 *	41.7 *	37.8	20.7 *
FJS	2.94	2.82	52.0 *	25.2 *	22.8 *

(* $p<0.05$ between male and female subjects)

CONCLUSIONS

The JS appears to replicate the SP in many angular and temporal parameters. Tant and Witte (1991) found that the hand from which the ball is tossed favors the hitting arm of the performer. The toss of the JS introduces a timing mechanism which parallels the timing of the set with the SP. For the coach/teacher the mechanics of both skills are very similar and could be introduced together. Because of the complexity of both the JS and SP these two skills are very difficult to instruct to the beginner. The performer should be aware that additional velocity of the armswing is not needed with the JS as the performer is using greater horizontal distance and velocity of the entire body moving forward onto the court. The transition from horizontal to vertical displacement of the body during the SP must be made within the constraints of the court and net.

REFERENCES

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