A CINEMA/VIDEO ANALYSIS OF SETTING IN VOLLEYBALL

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In the game of volleyball, a setter directs the offense much like a Quarterback on a football team. The skill most used by setters to position the ball for attackers is the overhead pass. A beginning setter, as well as all players on a team, should become consistent at executing accurate high front passes.

The technique of the high overhead pass is described in books of basic volleyball skills by Bratton and Lefroy (1980), Keller (1970), Scates (1976) and others. Actual cinematographic analysis of this technique has been conducted by Adebayo (1976), Prsala (1974 and 1982), Ryan (1979) and Wehrman (1977).

However, the job of a setter does not stop with the mastering of the high front pass. A setter must be able to execute passes of varying heights, distances and directions; frequently, under less than ideal conditions.

Many setters develop their skill through trial and error, or through information passed on by "word of mouth". When learning to run a fast offense, a setter is often expected to make short sets and direct them accurately towards a hitter with limited feedback about technique. Coaches are unable to provide this feedback because the information on the techniques of setting a quick attack is either scarce or obscure. As well, research describing the anatomical and mechanical analysis of the contact phase of the overhead pass is inadequate.

STATEMENT OF THE PROBLEM

The purpose of this study was to conduct a thorough analysis of front setting techniques and to determine kinematic differences among the high front, medium front and "A" front sets. Based on the available literature, it was hypothesized that the following kinematic characteristics would be directly proportional to the length of the set.

1. Linear displacement and average velocity of joint centers.
2. Contact time.
3. Contact distance.
4. Average velocity of the outgoing ball.

METHODS

Selection of Subject

This study was delimited to one female subject. The criteria for selection were:

1. The subject must have played as a starting setter on a University Varsity Team for three years or more; the University league being the highest calibre of play in this area.

2. The subject must be able to successfully and consistently execute the necessary sets.

The subject in this study had the following qualifications:

1. Five years as a starting setter on a University Varsity Team; national champions 1982.

2. Starting setter on the Canadian National Team.

Sets for Analysis

Three types of sets were selected for analysis: 1. high front, 2. medium front and 3. "A" front (figure 1). Ten successful trials of each set were analyzed.

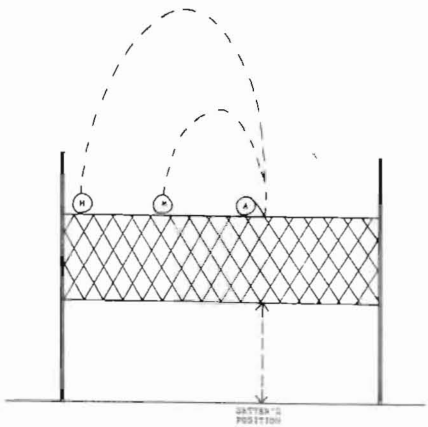

Figure 1. Sets for analysis; high, medium and "A" front.

Officials

Three volleyball officials were selected to evaluate each trial, which included the performance of subject and assistants.

A successful trial consisted of the following:

1. Contact within prescribed film zone.
2. Clean contact.
3. Appropriate ball trajectory.
4. Proper distance from the net.
5. Successful spike.

Data Collection

The collection of data was conducted on a regulation size volleyball court, with the net set at women's height of 2.24m. The subject was positioned in the setting area next to the net. One assistant, positioned in a regular left back service reception area, used an overhead pass to project the ball to the subject. A second assistant, the hitter, spiked each ball as it was set (figure 2).

Key

1 = posterior camera

2 = lateral camera

3 = video

S = subject

H = hitter

P = passer

◁ = lights

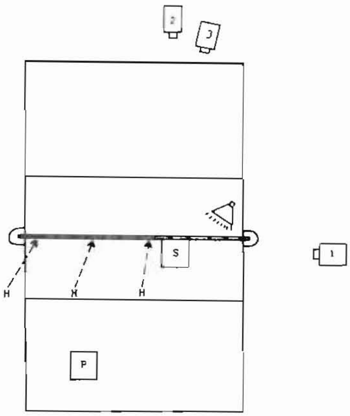

Figure 2. Court set-up.

The subject was filmed from two perspectives. The lateral perspective was filmed at 100 frames per second and the posterior perspective was filmed at 200 frames per second. A JVC video camera was also used to record the whole sequence of events, from passer to subject to hitter.

Data Analysis

Each trial from the lateral perspective was digitized by hand. It was determined that the precontact phase started 15 frames before contact. The contact phase included the absorption and projection of the ball, and the follow-through lasted seven frames after release. Linear displacements and average velocities were calculated for each phase.

Contact time was calculated from the posterior perspective film. Tracings of each trial were made from the films, and measurements were calculated. Significance at the .05 level was determined by using an Analysis of Variance, and when differences were found a Tukey Test was used to determine where differences occurred.

RESULTS

Table 1 reveals the average contact time for the three sets. It was found that the "A" set was significantly longest and the high set was significantly shortest.

TABLE 1
CONTACT TIME, (SEC).

	Mean	SD
"A"	.074*	.00550
Medium	.054*	.00369

An * indicates significance at the .05 level in all tables.

Table 2 gives the average displacement of the ball during the contact phase. They were: 1. vertical absorption, 2. vertical projection and 3. horizontal displacement. Figure 3 displays displacement of the ball for each type of set. The middle circle for each example represents the position of the ball at contact. The lowest circle is the ball after absorption and the highest circle represents the position of the ball at release. The "A", medium and high sets differed significantly from one another.

TABLE 2
AVERAGE DISPLACEMENT OF THE BALL, (CM).

	Absorption		Projection		Horizontal	
	Mean	SD	Mean	SD	Mean	SD
"A"	7.0*	1.01	12.1*	1.4	7.6*	1.7
Medium	4.5*	1.20	16.6*	1.5	2.7*	1.3
High	2.8*	1.03	20.3*	2.7	.3*	1.2

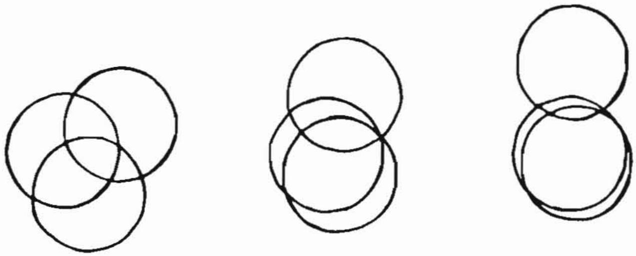

Figure 3. Displacement of the ball during contact.

Table 3 shows that the average linear velocities of the outgoing ball for the "A", medium and high sets were 2.88, 5.28 and 7.40 m/sec, respectively.

TABLE 3
AVERAGE LINEAR VELOCITY OF THE OUTGOING BALL, (M/SEC).

	Mean	SD
"A"	2.88*	.16
Medium	5.28*	.21
High	7.40*	.31

Figures 4, 5 and 6 show the linear displacement of joint centers during precontact, contact and follow-through. Table 4 includes the average linear velocities of joint centers for all three sets.

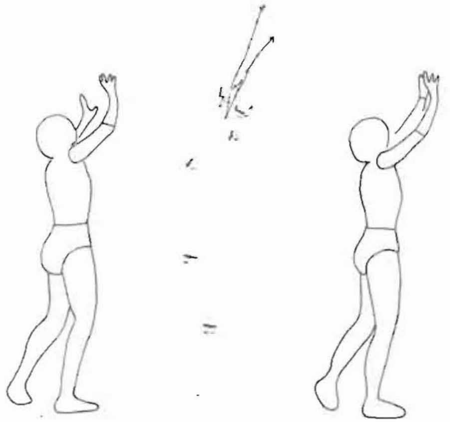

Figure 4. Linear displacement of joint centers, "A" set.

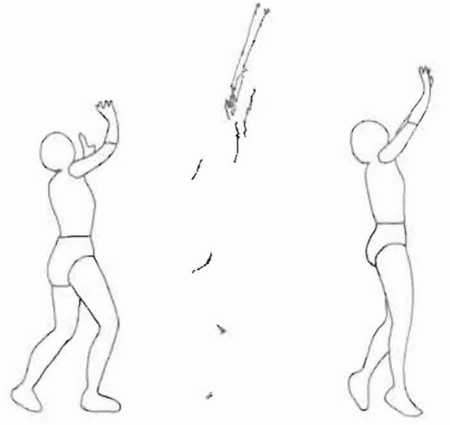

Figure 5. Linear displacement of joint centers, medium set.

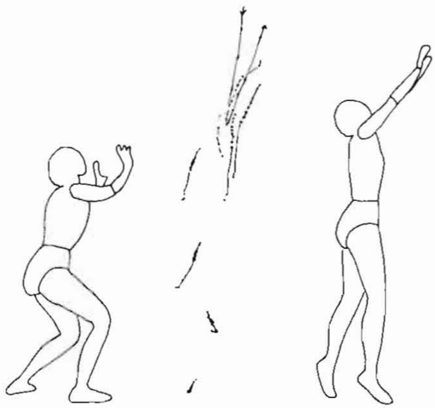

Figure 6. Linear displacement of joint centers, high set.

TABLE 4
AVERAGE LINEAR VELOCITY OF JOINT CENTERS DURING PRECONTACT (PRE) AND CONTACT (CON), (CM/SEC).

		"A"		Medium		High	
		Mean	SD	Mean	SD	Mean	SD
Pre	Hip	13*	10.7	59*	17.6	121*	12.5
Con		6*	10.1	60*	15.6	124*	12.9
Pre	Elbow	17*	6.4	70*	16.5	200*	14.9
Con		19*	12.9	96*	23.8	228*	10.4
Pre	Wrist	25*	16.1	76*	22.0	206*	11.8
Con		66*	17.6	150*	17.1	286*	18.3
Pre	Index	18*	16.0	65*	15.6	170*	30.7
Pro	Finger	278*	14.8	395*	32.9	502*	50.8

Note: only the projection phase of the index finger was calculated.

DISCUSSION

In readiness to contact the ball, it was observed that the fingers at the metacarpophalangeal joint (MP joint) were in an extended position and the wrists were slightly hyperextended. The thumbs were between an abducted and extended position. The thumb, however, was obscured by the ball during the contact phase.

Upon contact, the momentum of the ball forced the wrists and index fingers at the MP joint into further hyperextension. The yielding of these joints to the ball is the absorption phase. Because of this absorption of the ball's momentum, there was no visible ball compression.

It was observed that of the MP joints, only those of the index fingers actually participated in the absorption and projection of the ball. The thumbs and middle fingers seemed to form a pocket to keep the ball in place over the index fingers.

The action of the index fingers during absorption caused the other fingers to perform in opposition, that is to move towards the thumb. The position of the ball, however, prevents total opposition from actually occurring, and the fingers rest momentarily on the ball. The reverse action occurred during projection.

The extensible and elastic properties of a muscle (and tendon) enable it to be stretched like an elastic band. When the stretching force is discontinued, the muscle will return to its normal resting length (Wells and Luttgens, 1976).

It was therefore assumed that the impact of the ball caused the flexor muscles and tendons of the index fingers to be stretched. As the ball came to a stop, thereby removing the downward force, the muscles and tendons of the index fingers recoiled. This recoil action aids in the projection of the ball.

It was also observed that, although flexion of the wrist occurred during projection, the wrist joint did not flex past the anatomical position of extension. At the end of the follow-through for the "A" and medium sets, the wrist joints were actually in a slightly hyperextended position.

From the posterior view it was observed that at contact, the midpoint of the ball was always to the left of the subject's center point. As well, the right hand usually contacted the ball slightly before the left hand during the "A" and medium sets.

Since the incoming ball was not passed from a position directly in front of the subject but from an approximate angle of 55 degrees, it may have been advantageous to contact the ball off center. This would allow the subject to counteract the influence of the ball's momentum towards the net and enhance ball control. Under these circumstances, it may be difficult for the setter to achieve perfect alignment under the ball.

The upper body movement of the medium and high sets was nearly symmetrical (figures 8 and 9). The action of the "A" set, however, was asymmetrical, (figure 7). The left hand during the execution of the "A" set was always slow getting into position to receive the ball. At contact the left wrist was lower than the right wrist but at release the left wrist was even with or higher than the right wrist. The latter was caused by greater elevation of the left shoulder girdle and abduction of the shoulder joint during the contact phase. Rotation of the trunk towards the net was also observed during the execution of the "A" set.

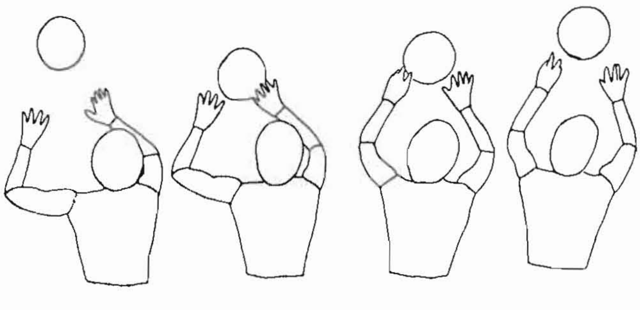

Figure 7. Upper body, posterior view, "A" set.

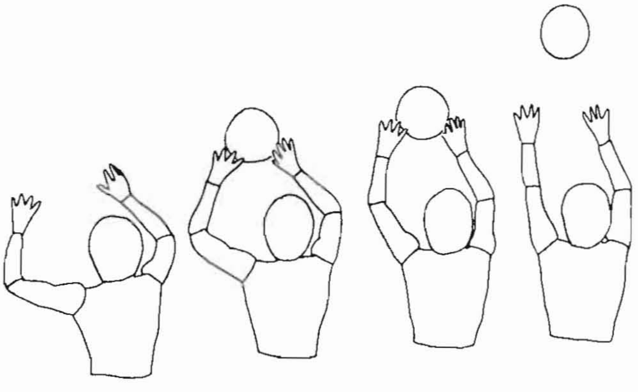

Figure 8. Upper body, posterior view, medium set.

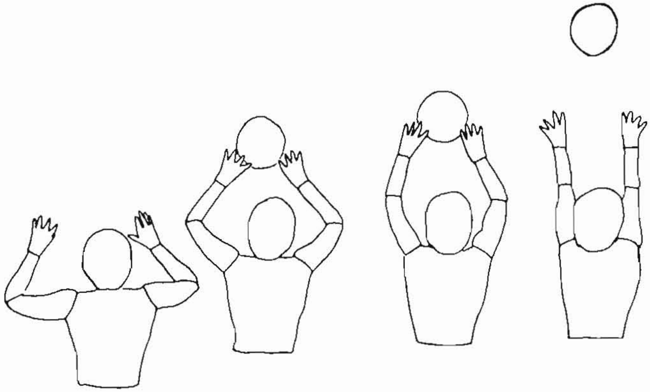

Figure 9. Upper body, posterior view, high set.

These actions probably account for the significant amount of horizontal displacement of the ball during contact and produced the appropriate trajectory of the ball. It must be noted that the "A" set, especially when the subject is in a position away from the net, must be projected towards the net and hitter. This will result in a lower outgoing angle for the "A" set than the other two sets.

It was found that the contact time of each set differed significantly from one another; however, the results did not correspond with the hypothesis. The reverse actually occurred, where the longest set, the high set, had the shortest contact time and the shortest set, the "A" set, had the longest contact time.

Results of the vertical displacement of the ball during the projection phase as well as the average velocity of the outgoing ball concurred with the hypotheses. It can be concluded that the velocity of the outgoing ball was a result of contact time coupled with vertical displacement of the ball during the projection phase.

Figures 4 and 5 revealed that most of the linear displacement of joint centers for the medium and high sets was directed vertically and occurred in an overlapping type of sequence. In contrast, the linear displacement of joint centers for the "A" set (figure 3) was usually horizontal, except at the wrist and index fingers. The backward horizontal movement of the joint centers indicates that trunk rotation occurred during the execution of the "A""set.

Northrip et al (1974) stated that the final motion of a sport instrument is the result of the summation of several relative velocities. The findings of this study show that the average linear velocity of joint centers for each type of set differed significantly. Therefore, it was deduced that the height and length of a set was directly dependent on the summation of velocities at these joint centers.

CONCLUSION AND RECOMMENDATIONS

The anatomical analysis of this study led to the following conclusions:

1. of the fingers and thumb, only the index fingers took part in absorption and projection of the ball.
2. the wrist joint did not go past the anatomical position of extension during the execution of a set.

The kinematic analysis of this study led to the following conclusions:

1. contact time was reversely proportional to the length of the set.
2. The following characteristics were directly proportional to the length of the set:
   a. Linear displacement and average velocity of joint centers.
   b. Contact distance.
   c. Average linear velocity of the outgoing ball.

The following topics are recommended for future study:

1. Research similar to this study, using more subjects.
2. Analysis of quick sets with varying incoming passes.
3. Analysis of jump settng.

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