

# PREDICTION OF PERFORMANCE IN VOLLEYBALL FOREARM CONTACT: AT HIGH INCOMING BALL VELOCITIES

Wayne Marryatt

Laurence E. Holt  
Dalhousie University  
Halifax, N.S.  
B3H 3J5

The forearm contact while returning service, has received considerable attention in literature pertaining to volleyball techniques. However, universal agreement on the proper method of performing the technique has not been attained. The published resources available to the volleyball coach are replete with the subjective and sometimes conflicting reports of the various authors, eg. Keller, (1968); Scates, (1972); Bratton, (1968); Kich, (1979); Tenant, (1978).

All authors identify preparatory positions and movements sequences which they claim are important parameters of the successful execution of the initial phase of service return using the forearm contact. The validity of these contentions is difficult to ascertain because a measurable criterion of successful performance has not previously been established.

The purpose of this study was to determine if the body movements and postures which occur in executing the forearm contact, in response to a ball approaching at or near service velocities will account for performance differences.

## METHODS

### Selection of Subjects

Subjects (S's) were delimited to twenty-three male persons above sixteen years of age, residing in Nova Scotia. They were chosen based on their skill and experience in volleyball in order that all levels of ability to perform the forearm contact would be represented.

### Data Collection

Data collection was conducted on a regulation size volleyball court with the net set up at the men's height of 2.43 meters. A specially designed mechanical device (Fig. 1) projected the ball over the net toward the S's from behind the end line. The velocity of the ball as it approached the S was consistently between 12-13 meters/second.

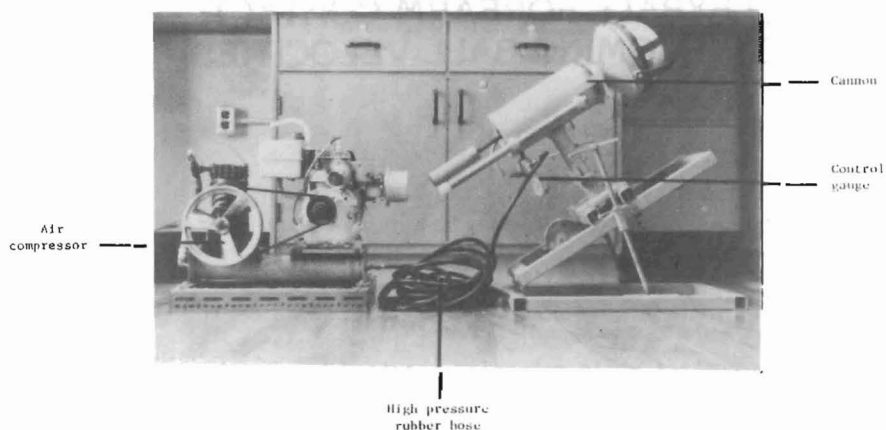


Fig. 1  
Projecting Cannon

The area within which the ball was to be played was marked on the floor with masking tape. S's stood within this area and attempted to direct the ball to the setter. The S, setter and projecting cannon were all arranged in a straight line down the center of the court. The arrangement is diagrammed in Figure 2.

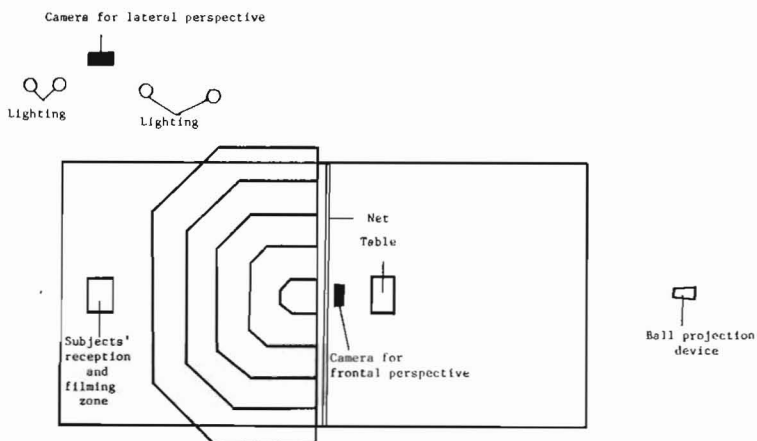


Fig. 2  
Set-up for Data Collection

The success of each performance was evaluated in the following manner. S's were instructed to pass the ball to a setter standing in the usual setter's position by the net (area 10 in Figure 3).

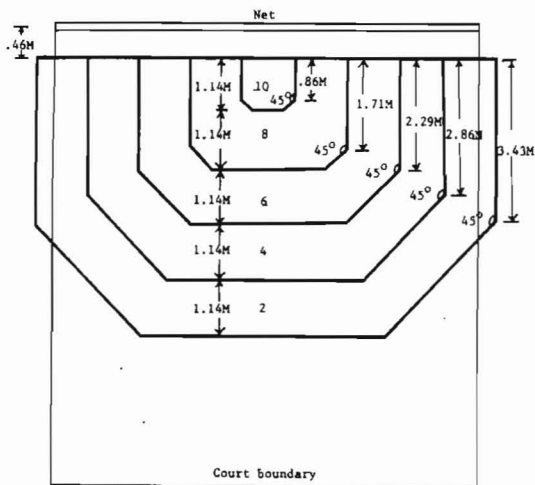


Fig. 3  
Target Zone

The setter attempted to play each pass using the overhead contact. A score was assigned based on the position of the setter's feet (at contact), within a target zone which was marked off on the court with masking tape. This zone is diagrammed with dimensions and score values indicated in Figure 3. The following items were also considered in scoring each performance:

1) If the setter's feet straddled one of the lines between two scoring areas, the S would receive a score midway between the scores assigned to those areas. (i.e. one foot in the area scored eight and one in the area scored six would result in a score of seven).

2) If the setter's feet straddled the line nearest the net, one point was subtracted from the score assigned to the area in which the foot furthest from the net was situated.

3) If the setter touched the net in playing the ball, the resulting score would be zero.

4) If the setter scrambled after a ball and managed to hit it back into the court, the score would be a one.

5) One point was subtracted for balls which the setter had to play with a forearm contact.

6) Any ball which went out of the target area received a zero. The setter was allowed frequent rest periods between S's.

S's were given a verbal ready signal just before the ball was projected. Each S completed a total of ten trials.

The average values and standard deviations of each S's scores were computed and the S's were ranked from lowest to highest based on their average scores.

The rankings were divided into three groups representing (approximately) the top, middle and bottom S's. The top and middle groups contained eight members each with the bottom group had seven members. The four S's from each group selected for cinema-computer analysis and the multiple linear regression (MLR) analyses were those whose scores exhibited the smallest standard deviations in their group.

For filming, the S's were required to perform exactly the same task as in the previous session and were permitted to warm up until they felt ready to proceed with the filming. Following the warmup each trial was evaluated in the same manner as in the previous session. Each trial was filmed until the S achieved a score similar to the average of his previous scores. The number of filmed trials of each S varied from one to five.

Filming was conducted from two perspectives. The lateral perspective was filmed at 125 frames per second and the frontal perspective was filmed at 64 frames per second.

### Data Analysis

Cinema-computer analysis and forward stepwise MLR analysis were used to analyze the data. MLR builds an equation which will predict a dependent variable from a combination of independent variables.

Two performance variables were recorded in the study. The first consisted of the average of a S's ten scores during the first data collection session, and was a good indicator of his general ability to perform the skill. The second was the actual score attained on the trial being filmed and later analyzed via the cinema-computer process, and was important because it was a direct result of the movements and positions of the body which were being measured. A review of the literature revealed a large number of body movements and positions which the various authors claimed were related to successful performance of the forearm contact. Forty-eight of these body movements and positions were measured and analyzed in this study including displacement and velocities of the upper and lower limbs and the body's C.G. For the purpose of MLR analysis, selected movements and positions of the body were submitted as independent variables and the two performance variables were submitted as dependent variables.

Since the maximum number of variables which the program will admit to the equation is the number of subjects minus one ( $n-1$ ), it was decided that only the most important  $n-1$  of the 48 variables should be submitted to each analysis. The selection of the most important variables was accomplished by the first submitting all of the variables to the program. Part of the printed output of the program is a correlation matrix in which all the intercorrelations among the variables are listed. This matrix was used to identify the  $n-1$  variables which were most closely correlated with each of the dependent variables. Any intercorrelations of .7 or above among these variables were examined and variables which were highly related were noted.

Table 1 shows that these variables form a significant regression equation which can account for 82.33% of the variance of the average scores from the first session.

TABLE 1  
Final Analyses of the Data with Common Predictors from  
the Preliminary Analyses

Average Scores from Session One as Dependent Variable							
Variable Number	Significance	Multiple R	R Square X 100%	R Square Change x 100%	Simple R	Overall F	Significance
45	.001	.835	69.78	69.78	-.835	23.10	.001
31	.132	.877	76.85	7.06	.654	14.94	.001
16	.154	.907	82.33	5.49	-.467	12.43	.002

Regression Equation constructed with the common predictors (Significance = .002)

Estimated Score =  $-.079$  (Var. 45) +  $.164$  (Var. 31) -  $.073$  (Var. 16) - 19.66

Table 2 shows that the same three variables form a significant regression equation which can account for 80.13% of the variance of the scores of the analyzed trials.

TABLE 2  
Final Analyses of the Data with Common Predictors from  
the Preliminary Analyses

Scores of the the Analyzed Trial as Dependent Variable							
Variable Number	Significance	Multiple R	R Square X 100%	R Square Change x 100%	Simple R	Overall F	Significance
31	.004	.764	58.37	58.37	.764	14.02	.004
16	.018	.886	78.46	20.09	-.422	16.39	.001
45	.435	.895	80.13	1.68	-.674	10.75	.004

Regression Equation constructed with the common predictors (Significance = .004)

Estimated Score =  $.307$  (Var. 31) -  $.110$  (Var. 16) -  $.28$  (Var. 45) - 44.22

The members of each set of highly related variables were then ranked according to their correlations with the dependent variables from highest to lowest. Each of these variables was also scrutinized for the ease with which it could be measured. From each group of highly related variables only one was submitted to the regression analysis. The variable chosen from each group was either the one which was most easily measured or, if all were equally easy to measure, the one which was most highly correlated with the dependent variable. The variables which were thus eliminated were replaced by the variable next most highly correlated with the dependent variable provided it was not highly related to a variable already included.

This procedure was repeated in preparing for each of the preliminary regression analysis. These preliminary analyses were used to identify the variables which significantly predicted each performance score.

The variables which formed significant regression equations in the preliminary analyses were examined so that common predictors of both the scores of the filmed trials and the average scores from the first session were identified. These common predictors were resubmitted to the analysis to determine the amount of variance of each performance score for which they could account.

## RESULTS

This analysis resulted in the identification of three variables which were common predictors of the two performance scores. These three variables were:

1. The angle of the left elbow at contact (Var. 31, lateral perspective).
2. The angle formed by the left elbow, mid grip and right elbow at contact (Var. 16, frontal perspective).
3. The difference (in degrees) between the path of the left elbow through contact and the path of the rebound ball (Var. 45, lateral perspective).

## DISCUSSION

The two final regression analyses reveal that three variables can account for approximately 80% of the variance in the performances of the forearm contact at service velocity.

These analyses discovered that the greater the angle of the left elbow at contact, (it is assumed that the right elbow is in a similar position) the more successful the contact would be. This finding was the same as that observed in another study analyzing the forearm contact with the ball approaching at lower velocities, and the suggested reason for its importance is the same. Full extension of the elbows at contact helps to prepare the largest, flattest and most stable surface possible with which to contact the ball.

The angle formed by the left elbow, mid grip and right elbow is a characteristic of the contact surface which was included for study to determine if it had any influence on performance. The analyses revealed that it did have an important influence in that the smaller it was, the more

successful was the resulting performance. As this angle becomes smaller, the contacting surface formed by the forearms becomes more and more a single large surface and less and less two separate smaller ones. Minimization of this angle and maximization of elbow extension together provide the optimum surface with which to contact the ball.

The difference (in degrees) between the path of the elbow through contact and the path of the rebounded ball was included for study to ascertain whether the ball could be accelerated along the desired path by moving the forearms along that path during contact. This study provided support for this idea in finding that the smaller the difference between the two paths the more successful the contact. In the better performances, the low coefficient of restitution resulting from the collision of the ball with the forearms may allow the two surfaces to remain in contact for a sufficient length of time during which the forearms are able to redirect the motion of the ball along the desired path.

## CONCLUSIONS

The following factors were found to be associated with the successful performance of the forearm contact while initiating the return of service simulated in this study:

1. The greater the angle of the left elbow at contact with the ball, the more successful the contact.
2. The smaller the angle formed by the left elbow, mid grip and right elbow, the more successful the contact.
3. The smaller the difference (in degrees) between the path of the elbow through contact and the path of the rebounded ball, the more successful the contact.

## REFERENCES

- Bratton, R.D. Power Volleyball for Player, Teacher, and Coach, Scarborough, Canadian Volleyball Association, 1968.
- Keller, V. Point, Game and Match, Hollywood, Cal., Creative Sports Books, 1968.
- Kich, L. Volleyball Coaches Manual II, Ottawa, Canadian Volleyball Association, 1979.
- Nie, N.H. Statistical Package for the Social Sciences, Toronto, McGraw-Hill Inc., 1975, Revised, 1979.
- Scates, A.E. Winning Volleyball: Fundamentals, Tactics and Strategy, Boston, Allyn and Bacon, 1972.
- Shondell, D.S. and J.L. McNamara, Volleyball, Englewood Cliffs, N.J.: Prentice-Hall, 1971.
- Tenant, M. Volleyball Coaches Manual I, Ottawa, Canadian Volleyball Association, 1978.