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Kinematic Analysis Forearm Passing in Volleyball at Different Distances

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Abstract
The main goal of this study is to determine which of the applied kinematic parameters best predictor of accuracy in passing forearm. At the same time we want to establish the differences in the variables applied during the execution of the lower forearm pass to smaller and further away . The sample for this study is a 31 years old student of II study and cycle studies at the Faculty of Physical and sport of the University. All subjects were male average age of 21.66 ± 1.58 , average body height 180.37 ± 9.00 and an average weight of 76.43 ± 14.25. The video camera Casio Exilim EX-F1 was used for filming. The subjects were five times performed the technique on a smaller and five times farther away. To calibrate the space was used for calibration frame 1m x 1m x 2m. The camera was working at a frequency of 300 Hz resolution 720 x 576. The data was processed using a Kinovea software. On the basis of applied statistical analysis we can say that on the basis of certain kinematic parameters can make the prediction results in criteri variables in both groups. Also, it was found that there were statistically significant differences in the observed kinematic parameters between groups "Closer" and the group "Farther", and these differences are significance at the level .01 and .05. Consequently , our study is focused in order to obtain relevatinih information that will contribute to the understanding of the mechanical characteristics of the movement which ultimately contributes to more efficient training process . The results of our study indicate differences in kinemtičkim parameters when performing techniques of the lower forearm pass but in relation to the different position of the target. For faster and more efficient process of training the lower forearm passing volleyball, very important is the optimization of the angles of individual body segments as well as the defining characteristic of a breach during the execution of technical elements. This study allows us to obtain information that is relevant to the faster and more successful training techniques lower forearm passing.
Key words: Kinematic, forearm pass, degree, distances

1. Introduction

Application of kinematic measurement system for the purpose of conducting biomechanical analysis of sport movement structures today becomes part of programming and control of the training process . Kinematic analysis of sports movements allow precise registration of the size and parameters of movement of athletes when performing any sports techniques (Singh and Tripathi , 2012) . To improve the technical performance it is necessary to implement and biomechanical analysis of movement in accordance with the order to develop new and more effective techniques of movement (Bergun et al . , 2009) . Results obtained on the basis of kinematic measurement system can help us in improving the process of training of technical elements in volleyball . A review of research to notice that most of them dealt with the biomechanical analysis of those technical elements related to achievement points in the volleyball game (Tiwari 2012 ; Bergun et al . , 2009 ; Lidor et al . , 2007 ; Sing and Rathore , 2013) . From the aspect of the game in the volleyball reception service is very important and of great lower forearm rejection depends on whether the number of possible variations in the attack be higher or lower (Jankovic and Marelic 1995) . The accuracy of the lower forearm near the pass correctness technical performance can be affected by parameters that are related to the collision of elastic bodies , and it is known that the direction and speed of the ball determines the effect of internal pressure (Opavská , 2000) . In this regard, some research states that the peak rejection (passing overhead) is far more accurate than the lower forearm rejection , because the contact fingers while depreciation reduces the compression phase (Okauchi et al . , 2000) . The importance of the lower forearm rejection reflected in the application of the technical elements of the game because he is just one of the technical elements that distinguishes winners from losers team (Marelic et al . , 2004 ; Tilp and Koch , 2009) . The latent space , defines two types of precision : precision protruding missile and precision guided missile (Jankovic , 1988) . Volleyball is particularly important precision peak and forearm rejection (Bosnar and Schneider 1983 ; Horga et al . , 1983) Given the complexity of the technical elements and its importance in the complex flow of one volleyball game , very important that the technical performance of this elemnt at a high level . Accordingly, the information obtained in this study may contribute to the completion of the kinematic gauge when the lower forearm forcible entry which would ultimately contribute to faster and more efficient training process of this technique . The research revealed that the applied kinematic parameters contributes most to the accuracy of the lower forearm passing. At the same time we want to establish the differences in the variables applied during the execution of the lower forearm pass to smaller and further away . It should be noted that when training any technical element alone is not enough practical demonstration , but we have to use the key information that should be aimed at key stages of certain techniques (Mansur et al . , 2009) . Through literature can be clearly seen that the movements in the lower forearm rejection at a greater distance analog movements pass to shorter distances (Jankovic and Marelic 1995) . However , it should be emphasized that the evident differences in PARTICULAR stages of movement with respect to the strength of ball . Each technique differs in part in accordance with the needs of mechanical and physical requirements , when an athlete has to adapt to the movements of the body in a split second (Scates abd Linn , 2003 , Hussain et al . , 2013 , Moore et al . , 2013 ; Tilp et al . , 2008) . It must be emphasized that at the lower forearm pass itself changes positions of the hands can lead to a variety of ball trajectories . Consequently the difference between the lower forearm pass to smaller and larger distances may be reflected in some other factors such as range of motion, force impulse, etc. Within our study, we will present the model values for tracked kinematic variables. Optimization of the angle between the individual segments of the body when performing lower forearm rejection, will ultimately contribute to the technique of this element to be effective. Winning the information we can use so we can clearly identify and define the characteristics of movement while bouncing the ball on a smaller and more distance.

2. Methods

2.1 The Subjects

The sample for this study is a 31 years old student of II study and cycle studies at the Faculty of Physical and sport of the University. One of the criteria for participation in the study was that the students wanted to participate voluntarily in the study . Another criterion for entry into the sample of respondents was that they were students who passed the exam in the subject Volleyball I. The structure of the course is designed so attendance (theoretical and practical) and the assessment exam relating to volleyball technique . All subjects were male average age of 21.66 ± 1.58 , average body height 180.37 ± 9.00 and an average weight of 76.43 ± 14.25 . It should be emphasized that each of the thirty-one subjects first performed the technique of the lower forearm pass to shorter distances and at five attempts . Kinematic parameters that are monitored in these 155 performance techniques are classified in the group of entities "Closer ." Also, each of respondent had five performance techniques lower forearm pass to greater distance and kinematic parameters that are monitored in these 155 performance techniques are classified in the group of entities "Farther " .

2.2 Selection of variable

For the purposes of this research, a collection of seventeen (17) variables for estimating kinematic parameters : HCGP - height center of gravity of the body in the preparatory phase (cm) , HCGF - height center of gravity of the body in the final stage (cm) , HCGD - height differences center of gravity of the body between the preliminary and final phase - derived variable (cm) , SAP – shoulder angle in the preparatory phase (degree) , SAF - shoulder angle in the final stage (degree) , SDPF - angle difference in the preliminary and final phase in shoulder angle - derived variable (degree) , HAP – hip angle in the preparatory phase (degree) , HAF - – hip angle in the final stage (degree) HDPF - angle difference in the preliminary and final phase in hip angle (degree) , KAP – knee angle in the preparatory phase (degree) , KAF – knee angle in the final stage (degree) , KDPF - angle difference in the preparatory and final phase in knee angle (degree) , AAP – ankle angle in the preparatory phase (degree) , AAF - ankle angle in the final stage (degree) , ADPF - angle difference in the preparatory and final phase ankle angle (degree) , SCORE1 - number of points scored in each of the attempts at a short distance SCORE2 - number of points scored in each of the attempts at a greater distance .

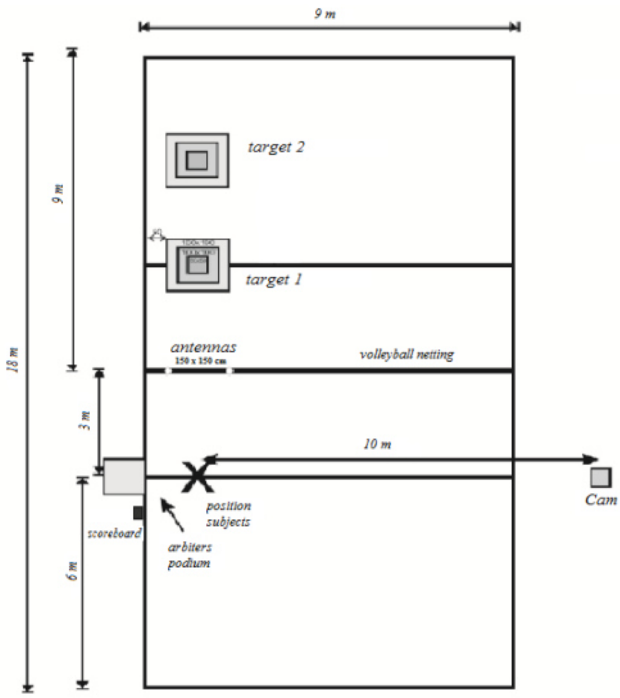
2.3 Testing protocol

Testing was conducted at the University sports hall in Tuzla , which is equipped with machines and props that are necessary for this research . Respondents to the test came in the weight class of 15 students . Before the start of the test subjects are the theoretical and practical presentation of familiar tasks and testing protocol . After theoretical and practical presentation of the respondents have access protocol warming that have passed all the subjects in order to have the same treatment prior to testing . Protocol warm (warm-up procedures) lasted 15 munita and consisted of two parts . The first part is related to warming through natural forms of movement and consisted of the following exercises : jogging circulation to one or the other hand , running with both hands circling , circling with running forearms , walking in a crouch , Jumps with both feet , Jumps from one to another leg . The second part is related to a specific warm-up and consisted of the following exercises : bump , so that the subject receives the ball and then adds his teammate , bump into the air and then turn 180 degrees and forearm pass over his head , lower bump , alternately add the distance of 3 meters , bump alternately pass at a distance of 6 feet , bump alternately pass at a distance of 9 meters , a player smash ball and the other he returns again to spike forearm . After participants completed the protocol warming passed to the procedure of collecting video.

2.4 The procedure of collecting video

Respondent during performance techniques lower forearm pass stood at a distance of 3 m from the network and 1 m from the left side of the line of beach volleyball court (Figure 1). The ball was spat with judge ' stand that was located on the left side line distance of 1 m from the position of the respondents . At the podium is Standing assistant holding the ball with both hands at shoulder height , which is after the beep emitted by the respondent . The camera is located on the right side in terms of the position of the respondents , at a distance of 10 m The camera (Casio Ex - F1) is placed in parallel with the position of the respondents and the camera is mounted on a tripod height of 100 cm . To calibrate the space was used for calibration frame 1m x 1m x 2m. The camera was working at a frequency of 300 Hz resolution 720 x 576 The data was processed using a Kinovea software. Above the network and against the position of the respondents is limited space measuring 150 x 150 cm through which the respondent had probaciti ball when hitting off the smaller and greater distance . Space is limited by means of specially designed antenna for the purposes of this study . Antennas are placed so that the antenna that is closer to the left side line distance of 25 cm and 175 cm distant from the left side of the line . Accordingly, the respondent during the execution of the techniques contained exactly in the middle of the limited space . For the purposes of this study were defined two targets . One target was located at a distance 6 ma other at a distance of 9 m from the position of the respondents (the center of the target - position of the respondents) . Dimensions of both targets are 150 x 150 cm mounted flush to the respondent but otherwise volleyball field . The left edge of the target away from the left side of the line of 25 cm , and the right edge of the target distance is 175 cm from the same . Within the dimension of the target is defined as three squares one inside the other . Each square carries a certain defined number of points . If during the execution of techniques ball hits the small rectangle measuring 50 x 50 cm counts with three points , the middle square 100 x 100 cm with two counts a large rectangle measuring 150 x 150 cm scored 1 point . If the ball falls outside the target is scored with 0 points . For each subject were made by 10 video clips of which 5 video performance techniques on a smaller distance and 5 at higher distance . For poterebe this study were used balls brand " MIKASA " . Used 5 new balls to order the respondents would not have too much pause between repetitions . In order to efficiently analyze the video used is specially made semaphore that was placed on the ground next to the judge ' stand. Scoreboard had a cardboard stand and it was located five sheets of A3 paper with printed numbers 1-5 over cjelog list . Scoreboard is used to help in analyzing the collected video knew the ordinal number of performance techniques for each participant . In this way we have a more efficient analysis as well as minimizing errors that could possibly could occur . The protocol of collecting video participated one timekeeper and five assistants . Timekeeper was the operator of the camera . One server is performing tasks that are related to the traffic lights , one was on the judicial podium and threw the ball to respondents , one pass the ball to the judicial assistant to the podium, he collected one goal and one after five repetition is called out subjects that approaches the performance of the techniques and inscribed generated code points to test precision after each repetition .

Figure 1 : Testing protocol



The values of individual kinematic parameters were monitored in the initial and final stages of design techniques lower forearm rejection. Therefore, we will define the characteristics of both phases. Data were collected at the time of the lowest positions the center of gravity of the body and this moment was defined as the initial stage performance techniques. Data were also collected at the moment of contact with the ball and the momentum was defined as the final stage performance techniques.

2.5 Statistical analysis

For the purposes of this study we used the t-test to determine differences in variables in which the data were obtained with proportionate scale measurements. T - test was administered to three variables that encouraged the proportionate scale measurements. This is one of the most frequently used statistical procedures, which actually represents the ratio between the difference of means and standard errors of their differences and shows how many times the difference between the arithmetic mean is greater than its faults. Calculation of T-test was performed by the following formula (Figure 2)

Figure 2 :

$$t = \frac{\bar{x}_1 - \bar{x}_2}{S_{\bar{x}_1 - \bar{x}_2}}$$

Median test are applied to determine the variables in which the data obtained from the interval scales of measurement . Median test consists in finding a common median for the combination of the two samples to be compared. It should be emphasized that the median one that furnished the data series is divided into two equal work. Subsequent counting of the cases above and below the median value of each sample , as a contingency table . Data observations are not connected or are correlated , and the number of respondents within two sample may be different.

Regression analysis was applied to determine the significance and size of the impact of the predictor variables on the criterion of the system . The goal of multiple regression analysis is explaining or predicting criteria using the system of predictor variables . In the analysis of applied calculate certain parameters and the most important are : mulriple correlation coefficient (R) , coefficient of determination (R Square) , the significance of multiple correlation coefficient (F), the product moment correlation coefficient between each manifest and criterion variables (Zero - oreder) partial correlation (partial) , partial regression coefficients of each predictor variables (Beta) , the contribution of each predictor variables that the variance of the criterion that can be evaluated on the basis cjelog system variables (t) , the probability that a critical ratio appeared if the standard value of the regression coefficient 0 (sig.) . Prior to the processing of data at the level of multivariate data that were obtained in the testing procedure were subjected to Bloom this procedure to data from intervane scale switch to a higher level , ie in proportional scale , to regression analysis could be applied .

All of applied analysis were calculated by mathematical formulas and linear equations in matrix algebra given in the literature (Mejovšek , 2003 ; Malacko and Popovic , 2001 ; Petz , 1997)

3. Results

T-test are applied in order to observe the kinematic parameters which observed a statistically significant difference between the lower forearm rejection (forearm passing) in small and large distances. Based on the results obtained in Table 1, we can see that the statistically significant difference between the lower forearm pass to smaller and more distance is present in two variables: HCGF - height center of gravity of the body in the final stage (cm) , HCGD - height differences Center center of gravity of the body between the preliminary and final phase - derived variable. Also, based on the value of the arithmetic mean (Table 1 - Mean) we can see that no statistically significant differences in favor of the group "Farther".

Tabela 1. T – test

		Group Statistics				Independent Samples Test		
Varijable	GROUP	N	Mean	Std. Deviation	Std. Error Mean		t	Sig. (2-tailed)
HCGP	Close	*152*	*84.3766*	*5.49480*	*.44569*	Equal variances assumed	*.029*	*.977*
	Farther	*149*	*84.3591*	*5.15858*	*.42261*	Equal variances not assumed	*.029*	*.977*
HCGF	Close	*152*	*96.1454*	*5.72444*	*.46431*	Equal variances assumed	*-1.931*	*.050*
	Farther	*149*	*97.4284*	*5.80020*	*.47517*	Equal variances not assumed	*-1.931*	*.050*
HCGD	Close	*152*	*11.7907*	*4.09887*	*.33246*	Equal variances assumed	*-2.889*	*.004*
	Farther	*149*	*13.0731*	*3.58067*	*.29334*	Equal variances not assumed	*-2.892*	*.004*

To determine the difference in the observed kinematic parameters between the lower forearm pass to smaller and further away, but for those variables which do not originate from a proportional scale of measurement, applied the Median test. Based on the results in Table 2 we can see that the statistically significant difference was found in the variables that estimate the shoulder angle in the preparatory phase (degree) (SAP), the shoulder angle in the final stage (degree) (SAF), angle difference in the preliminary and final phase in hip angle (degree) (HDPF), angle difference in the preparatory and final phase in knee angle (degree) (KDPF) angle difference in the preparatory and final phase ankle angle (degree) (ADPF). The variables SAP and SAF was no statistically significant difference in favor of the group "Closer", while the remaining three variables showed a statistically significant difference in favor of the group "Farther".

Table 3 shows the results of applied regression analysis . The predictor set of variables in both regression analysis represent the variables for estimating kinematic parameters . Two criterion variables representing the precision of the test , ie number of points that has been made during the execution of the techniques of the lower forearm pass to smaller and further away . In the first regression analysis shows that the connection of the whole system of predictor variables with the criterion (bump on a smaller distance) is statistically significant at the .05 level . Multiple correlation coefficient R is .41 , and the predictor variables of the system is explained (R Square) 17 % common variance . The analysis of individual influence can be seen that only one variable (HAP) has a statistically significant impact on the criterion where the beta coefficient amount to - .801 and what is the significance level of .05 (sig.) . The ratio of original and partial correlation is declining (Correlations) which tells us that the projection of these variables on the criterion largely dependent and the other predictor variables .

In the second regression analysis shows that the connection of the whole system of predictor variables with the criterion (bump at a greater distance) is statistically significant at the .05 level . Multiple correlation coefficient R is .41 , and the predictor system explained (R Square) 17 % common variance . The analysis of individual influence can be seen that the three applied predictor variables have a statistically significant impact on the individual prediction results in criteri variables . Achieve better results in the criterion variables that contribute to estimate the hip angle in the preparatory phase (degree) (HAP) where the beta coefficient is -1200 , the angle difference in the preliminary and final phase in hip angle (degree) (HDPF) where the beta coefficient is - .549 and the ankle angle in the final stage (degree) (AAF) where the beta coefficient is -1139 . The ratio of original and partial correlation is increasing (Correlations) which tells us that the projections of these variables on the criterion is largely independent of the other predictor variables within the system . Consequently , we can say that the prediction results in criteri variables largely dependent of the three predictor variables .

Table 2. Median test

Frequencies				Test Statistics			
		GROUP		Median	Chi-Square	df	Asymp. Sig.
		Close	Farther				
SAP	> Median	93	53	48.00	19.763	1	.000
	<= Median	59	96				
SAF	> Median	89	59	70.00	10.817	1	.001
	<= Median	63	90				
SDPF	> Median	70	77	22.00	.953	1	.329
	<= Median	82	72				
HAP	> Median	81	64	129.00	3.220	1	.073
	<= Median	71	85				
HAF	> Median	67	81	149.00	3.184	1	.074
	<= Median	85	68				
HDPF	> Median	58	83	19.00	9.304	1	.002
	<= Median	94	66				
KAP	> Median	76	68	126.00	.574	1	.449
	<= Median	76	81				
KAF	> Median	70	77	153.00	.953	1	.329
	<= Median	82	72				
KDPF	> Median	62	85	26.00	7.959	1	.005
	<= Median	90	64				
AAP	> Median	73	67	61.00	.283	1	.595
	<= Median	79	82				
AAF	> Median	79	70	71.00	.751	1	.386
	<= Median	73	79				
ADPF	> Median	63	79	10.00	4.044	1	.044
	<= Median	89	70				

Table 3. Regression analysis of the lower forearm pass to smaller and longer away

Regresion analysis of kinematic parameters on the accuracy of lower forearm passing to smaller distance												
Coefficients												
	Unstandardized Coefficients		**Standardized Coefficients**			**Correlations**			Model Summary		ANOVA	
	B	**Std. Error**	**Beta**	**t**	**Sig.**	**Zero-order**	**Partial**	**Part**	**R**	**R Square**	**F**	**Sig.**
(Constant)	.638	.529		1.204	.231							
HAP using Blom's Formula	-.727	.359	-.801	-2.022	.045	-.230	-.171	-.158	.408	.166	1.808	.039
Regression analysis of kinematic parameters on accuracy of the lower forearm passing on the longer distance												
(Constant)	1.113	.468		2.378	.019				.414	.172	1.983	.024
HAP using Blom's Formula	-.900	.233	-1.200	-3.871	.000	-.139	-.317	-.304				
HDPF using Blom's Formula	-.412	.170	-.549	-2.418	.017	.053	-.204	-.190				
AAF using Blom's Formula	-.855	.406	-1.139	-2.103	.037	-.083	-.179	-.165				

In Table 4 are given the model values of the observed kinematic variables when performing techniques of the lower forearm pass to lesser and greater distance . For an analysis of the minimum and maximum values for all observed variables were taken into account only those respondents who when performing techniques (bump on the lower and longer distance) hit the target. Also , for each variable is presented and the mean (median / mean) . Mean values and the minimum and maximum result in execution techniques lower forearm pass to shorter distances are: HCGP - 85.04 (mean) , from 70.06 to 95.21 (min - max) , HCGF - 95.28 (mean) 81.44 to 107.20 (min - max) , HCGD - 10.91 (mean) , 3.00 to 20.76 (min - max) , SAP - 54 ° (median) , 26 ° -98 ° (min - max) , SAF - 75 ° (median) , 45 ° -111 ° (min - max) , SDPF - 21 ° (median) , 0 ° -40 ° (min - max) , HAP - 125 ° (median) , 105 ° -152 ° (min - max) , HAF - 144 ° (median) , 121 ° -182 ° (min - max) , HDPF - 19 ° (median) , 2 ° -36 ° (min - max) , KAP - 126 ° (median) , 97 ° -161 ° (min - max) , KAF - 153 ° (median) , 123 ° -176 ° (min - max) , KDPF - 24 ° (median) , 8 ° -44 ° (min - max) , AAP - 64 ° (median) , 33 ° -93 ° (min - max) , AAF - 74 ° (median) , 44 ° -93 ° (min - max) , ADPF - 9 ° (median) , 0 ° -23 ° (min - max) . Mean values and the minimum and maximum result of either technique when performing lower forearm rejection at a greater distance are: HCGP - 84.44 (mean) , from 74.28 to 94.61 (min - max) , HCGF - 96.22 (mean) , 87.44 to 106.02 (min - max) , HCGD - 13.17 (mean) , 5.41 to 20.36 (min - max) , SAP - 44 ° (median) , 20 ° -78 ° (min - max) , SAF - 67 ° (mean) , 46 ° -90 ° (min - max) , SDPF - 23 ° (median) , 10 ° -48 ° (min - max) , HAP - 123 ° , 98 ° -161 ° (min - max) , HAF - 151 ° (median) , 113 ° -171 ° (min - max) , HDPF - 21 ° (median) , 1 ° -44 ° (min . - max) , KAP - 124 ° (median) , 109 ° -161 ° (min - max) , KAF - 151 ° (median) , 124 ° -172 ° (min - max) , KDPF - 29 ° (median) , 5 ° -46 ° (min - max) , AAP - 59 ° (median) , 33 ° -79 ° (min - max) , AAF - 67 ° (median) , 51 ° -88 ° (min . - max) , ADPF - 11 ° (median) , 0 ° -18 ° (min - max) .

Table 4. Model values

Forearm passing on smaller distence				Forearm passing on longer distance		
Varijabla	Median /Mean	Min	Max	Median /Mean	Min	Max
HCGP	85,04	70,06	95,21	84,44	74,28	94,61
HCGF	95,28	81,44	107,20	96.22	87.44	106.02
HCGD	10,91	3,00	20,76	13.17	5.41	20.36
SAP	54°	26°	98°	44°	20°	78°
SAF	75°	45°	111°	67°	46°	90°
SDPF	21°	0°	40°	23°	10°	48°
HAP	125°	105°	152°	123°	98°	161°
HAF	144°	121°	182°	151°	113°	171°
HDPF	19°	2°	36°	21°	1°	44°
KAP	126°	97°	161°	124°	109°	161°
KAF	153°	123°	176°	151°	124°	172°
KDPF	24°	8°	44°	29°	5°	46°
AAP	64°	33°	93°	59°	33°	79°
AAF	74°	44°	93°	67°	51°	88°
ADPF	9°	0°	23°	11°	0°	18°

3.1 Discussion

Based on the results of this study (Table 1) , we can see that between the lower forearm pass to smaller and larger distance statistically significant difference was present in the variables that estimated the amount of the center of gravity of the body in the final stage as well as variables that estimates the difference in height of the center of gravity body between the initial and final phases. Significant differences were observed statistical going to use internet group "Farther" . From Table 1 we can see that the average height of the center of gravity of the body in the final stage in the group "Closer " is 96.14 inches, and in the group "Farther" 97.42 cm . This tells us that the respondents during the execution of the lower forearm rejection at a greater distance had on average a greater height the center of gravity of the body in the final phase of construction techniques. Also , we can see that the difference in height of the center of gravity of the body between the preliminary and final phase in the group "Closer " is 11.79 cm and in the group "Farther" 13.07 cm . To see the amount of the center of gravity of the body in the initial stage there were no statistically significant differences between groups where the average values for both groups almost identical . Consequently , we can say that the subjects of the group "Farther" when performing techniques contact with the ball exercised in higher point of difference from the group of respondents "Closer". According to the protocol of the test , we can say that one of the factors that contributes to a greater range missile is ejected right height ejections . Thus, for example, found that the greater the range of the ejected hammer (hammer throw) is an important high ejection angle (39.68 °) and high altitude ejections (1.78 m) (Antateleković , 2008) . In support of this talk and discussion of research in which a statistically significant correlation (R 2 = 0.50) between the longitudinal measures dimenzionanosti (Xiphoidal height , Suprasternal height) and ball reception efficiency (Stamm , 2004) . Also , in some studies it was found that the longitudinal dimension of the skeleton significant and positive predictor of situational performance in all age categories

(Grgantov et al., 2007) . However, the Median test results (Table 2) show that the significant differences in the angular values of the shoulder angle in the preliminary and final stages. This tells us that the subjects of the group "Closer" when performing techniques exercised greater angular values shoulder angle in relation to the treatment group "Farther". Given the above, we can see that the respondents, while the lower forearm rejection at a greater distance, along highlands positions the center of gravity of the body, a technique performed with the arms (upper arm - forearm) closer to the body. The results of our study clearly indicate that the shift in targets at a greater distance and changing the mechanical characteristics of the entire body , which is consistent with some previous research (Tseng and Scholz , 2005). Confirmation of this discussion provideresults in Table 4 , where it can be seen that the subjects of the group "Farther" exercised less angular values in relation to the group "Closer ." Accordingly, the position of the center of gravity of the body and angular values shoulder angle, we can say that the ball bearing in mind the protocol test, had less parabolic tarjektoriju at the lower forearm rejection at a greater distance. We must also emphasize that through some previous studies found that subjects with higher specific motor knowledge exercised lower trajectory ball compared to those with poorer specific motor knowledge (Ridgway and Hamilton 1987; Thissen - Milder and Mayhew, 1991; Gabbett and Georgieff, 2006) . From Table 2 it can be clearly seen that the respondents in the lower forearm rejection had higher average value of the differences in the angles of variables HDPF , KDPF and ADPF . When we look at the median (Table 4) we can see that the respondents group "Closer " exercised an average of 7 degree angle inferiority hip angle in the final stages of movement . In the initial phase, the average value of the angles is far less distinguished . This tells us that the subjects of the group "Closer" during the performance techniques have greater fluctuations hull in terms of tilting back and forth. So Ridgway and Wilkerson (1986) in their study found a different position in the hull of ball handling techniques and different variations at different distances (front set = 101 , 86 ° , set back = 96.45) . The authors found changes in the position of the trunk (trunk positioned) at the moment of contact with the ball in relation to the initial position (front set = 90.60 ° , set back = 74.77) . In our study, the subjects of the group "Farther" realized something inferiority angles (knee angle) in the initial phase of the movement, compared to the group of "Closer ." Since the same subjects performed the technique on a smaller and farther away it tells us that the respondents in performance art movement started with a slightly lower position and ended up in something higher position. The reason for this can achieve a greater impulse of force, which would be logical, given that the test is performed under the same conditions and the target was shifted to 9m distance of respondents (Opavský , 2000). Also one of the reasons may be ii lower level of technical preparedness of players. Studies that have dealt with this issue indicate that players with poorer knowledge of specific motor had more bent redeemed by players with better knowledge of specific motor (Ridgway and Hamilton 1987) . When we compare the value of our respondents with respondents in the above study (Low Skilled 125.61 ° , High Skilled 134.82) we can see that the values of angles in our patients almost identical but with respondents who have poor knowledge of specific motor .

When we look at the results of the regression analysis (Table 3) we can see that only one variable has a statistically significant impact on individual criteria (HAP) . To see the value of the beta coefficient is a negative sign . On this basis, we can say that the smaller the angle (hip angle) in the preparatory stage performance techniques resulting in less antagonistic angle. According to the protocol of the test applied, less antagonistic angle ultimately contributes to a lower trajectory ball as in our case contributes to greater precision in performance techniques (Opavský, 2000; Thissen - Milder and Mayhew, 1991; Gabbett and Georgieff, 2006) .

The regression analysis of kinematic parameters on the accuracy of the lower forearm rejection at a greater distance we can see that three variables (HAP, HDPF, AAF) had a statistically significant impact on individual criteria. The ratio of original and partial correlation is increasing, which indicates that the prediction results in criteri variables largely dependent on these variables. The sign of the beta coefficient is negative, so we can say that respondents with lower values of angles in these variables achieve a better result in the criteria. We can say that the technical quality isipitanici when performance techniques have smaller tilt forward fuselage and in the initial stage of implementation techniques. Also, we can say that they are technically better players better adjusting the position of the body in accordance with spatial relationships (respondent-target), about which information is obtained primarily by visual means (Williams, 2002; Ward et al., 2002; Vickers, 1996; Dicks et al. , 2009). Posture before bouncing the ball directly restricts the height of the ball trajectory which eventually affects the precision of hitting a target. You can see that the smaller the difference between the angle of the upper leg and trunk between the initial and final phases (hip angle) respondents achieved better results in the criterion. Consequently, we can assume that for better technical performance, ie greater precision, subjects while performing techniques should not have large variations in terms of troops back and forth. The results clearly indicate that all respondents who had an inferiority corners of the lower leg and the ground (ankle angle) achieved better results in the criterion. This tells us that respondents are less precise less estimated time of contact with the ball (Vickers, 1996; Williams, 2002). Based on this, we can assume that the earlier move toward the incoming ball is bouncing at the moment of maximal or near maximal leg extensions. By refusing ball at this point is largely lost previously achieved speed and power that is achieved leg movement.

4. Conclusion

To make the process of training the lower forearm rejection (forearm pass) was as effective , is extremely important to know the importance of the application of certain technical elements within the game . Also very important is the knowledge of structural analysis of an element which also contributes to the knowledge of the kinematic profile of technical elements. Consequently , our study is focused in order to obtain relevatinih information that will contribute to the understanding of the mechanical characteristics of the movement which ultimately contributes to more efficient training process . The results of our study indicate differences in kinemtičkim parameters when performing techniques of the lower forearm pass but in relation to the different position of the target. Summarizing the results we obtained that the subjects of the group "Farther" have an average position the center of gravity of the body in the final phase of construction techniques as well as higher realized average amplitude of motion of the leg. Also clearly evident that these subjects during performance techniques besides highlands positions the center of gravity of the body and having a hand position slightly closer to the trunk. In relation to the input angle of the ball , such a position contributes less repulsive hand corner of the goal . Patients in group " Farther" when the performance of the techniques had more upright position hull unlike the group "Closer " it is evident where the larger tilting forward fuselage. It is evident that the subjects of the group "Farther" in the initial phase of the movement had somewhat lower average values of angles knee, which indicates the commission of movement with a slightly lower position .

Summing up the results of multiple regression analysis, we can see that the respondents group "Closer " were more accurate if you are the triangles (hip angle) in the initial phase of the movement were smaller.

Patients in group "Farther" were accurate for targets when they realized inferiority angles (hip angle) in the initial phase of the movement. This tells us that in both groups of patients the optimum tilt forward fuselage important to achieve greater precision . It must be emphasized that according to the distance of the target tilt troops must not lead to a distortion of the equilibrium position. Also , the accuracy of guessing targets at a greater distance , it is important that participants do not have large fluctuations in terms of troops leaning forward - backward . The results clearly indicate that the subjects of the group "Farther" were more accurate when they realized agri values angle between the tibia and the soil in the final stages of movement. This indicates that the respondents passing precise ball slightly lower point in the Dons on less precise subjects who passing the ball at the moment of maximum or near maximum extension .

In addition to the obvious facts that indicate the results of this study we can say that the space-time relations are important for better accuracy . Spatial according to the distance of the target , and the time in terms of more accurate estimates of time of contact with the ball during the performance techniques . We believe that knowledge of the information provided by this study the training process can be far more effective . Future research , of a similar type , should be directed in order to determine the differences in kinematic parameters between the different ranks volleyball competitions . Within the research should include dynamometric measures, especially of the lower extremities on dynamometric platform, as well as measure the speed of individual body segments and angular acceleration. To get poptpunije information about this technical element, these parameters should be measured in different conditions in terms of the different incoming ball speed.

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