International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2013): 6.14 | Impact Factor (2013): 4.438

Kinematic Comparison of Different Approach Runs used in Spike and Jump Serve

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Abstract: ***The purpose of this study was to compare between the approach run of spike and jump serve used in volleyball. Five All India Inter University volleyball players were selected as the subjects for the study. The mean age of the subjects were 20years (±3 years). All subjects were right-handed volleyball players. The players were allowed to have warm-up and trials. Each subject was asked to do the spike and jump serve. Five spikes and five services were recorded from one side of the body with a high speed camcorder (Canon 70D EOS) operating with a frame rate of 30 frames per second. Data were collected from the sagittal plane for first, second and third step of approach run until take-off. The camcorder was mounted on a tripod at a height of 1.45 m from the ground for spike and jump serve, and was placed perpendicular to the sagittal plane and parallel to the horizontal plane at a distance of 12.21 m for spike and 6.65 m for jump serve from the midpoint of the initial line. Recorded data were digitized with the help of Silicon Coach Pro-7 motion analysis software. The selected biomechanical variables were: the height of the centre of gravity (of each step in centimetres), stride length (length of the steps in centimetres) ankle joint angle, knee joint angle and hip joint angle. The t test was used for statistical analysis of the data by using SPSS-18 version software. The results revealed significant differences between the angle of right ankle at first step and third step, angle of left ankle at third step, angle of left hip at first step and angle of right knee at first step of spike and jump serve.***

Keywords: Biomechanics, Kinematic, Approach run, Stride length, Height of centre of gravity.

1.Introduction

Biomechanics is most helpful in improving the performance in sports or activities where technique is the dominant factor rather than physical structure or physiological capacity. Since biomechanics is essentially the science of movement technique. Biomechanics research and sports techniques sometimes tend to lack behind the changes that are naturally occurring in sports. Athletes and coaches experiment with new techniques all the times. Students of biomechanics may be surprised to find that there are often limited biomechanical studies on many techniques in many popular sports. The vast number of techniques, their variation and their high rates of changes and innovation tends to out distance biomechanics research resources. All movement of material bodies both of men and animal are subjected, without exception, to the laws of mechanics as every movement involve mechanical movement and the locomotion of part of mass in space and time. It is the only first test of science to recognize this it is necessary to make this qualification, because movement is not only locomotion, but is also a change in quality in field above the purely mechanical. The concept of optimum skill development is broad and has implication for everyone who deals with movement i.e. the parents, the teacher, the coaches, physical educators, and research in this field.

2.Methodology

2.1 Protocol

Five male All India Inter-University participants in volleyball of 18 to 25 years of age, who had participated for Lakshmibai National Institute of Physical Education, Gwalior, were selected as subjects for this study. Since the subjects had been undergoing training for considerable period, therefore it was considered that they posses good level of technique and experience. The purpose of the study was explained to all the subjects and urged to put their best during each trial and had participated willingly.

2.2 Selection of variables

The independent variables were selected for the purpose of this study, such as Ankle joint, Knee joint, Hip joint, Height of centre of gravity at the time of first, second and third step of approach run and the distance between first second and third step.

2.3 Experimental Set-up and Procedures

Photograph-I

The digital cinematography was used as a technique for comparing the different approach runs used in the skill of spike and jump serve with the selected kinematic variables. A standard motor driven camera with a speed of 30 frames per second i.e., Canon - 70 D EOS was used to obtain photo sequences of selected movements during the spike and jump serve, such as first, second and third step(i.e. moment take-off) in sagittal plane by a professional photographer. The

camera was mounted on a tripod at a height of 1.45 m from the ground for spike and jump serve. The camera was placed perpendicular to the sagittal plane and parallel to the horizontal plane at a distance of 12.21 m for spike and 6.65 m for jump serve from the midpoint of the initial line. The skill of spike and jump serve of different subjects was filmed at Lakshmibai National Institute of Physical Education, Gwalior. The digital cinematography was taken under controlled conditions. The subjects performed the skill five times each. The best of the five trials of each subject was taken into account. The photographs obtained by the use of digital cinematography were analyzed by standard analysis method. Selected variables were as under. The scholar developed stick figure on the photographs from which the selected angular & linear biomechanical variables were calculated using joint point method. The center of gravity at each step of approach run, the stride length and the vital joint angles of all the five subjects was measured by using segmentation method, and Kinovea software respectively.

2.4 Statistical Analysis

To make the comparison between the selected biomechanical variables of spike and the selected biomechanical variables of jump serve Independent t-test was implemented. All the Data were analyzed by Statistical Package for Social Science (SPSS) version 20. For testing the level of significance was set at p> 0.05.

3.Result

Table 1: Descriptive statistics of the different groups

Spike Jump serve					
Name of the variables N Mean Std. Deviation Mean Std. Deviation					
Height of Centre of gravity first step	5	93.57	7.168	92.22	6.911
Height of Centre of gravity second step	5	90.08	7.666	89.35	7.884
Height of Centre of gravity third step	5	94.44	10.063	94.85	3.474
Stride length in first step	5	67.32	21.995	51.55	21.145
Stride length in second step	5	84.15	20.558	91.07	17.583
Stride length in third step	5	53.61	26.025	56.13	26.758
Angle of left ankle in first step	5	89.80	3.114	104.00	14.577
Angle of left ankle in second step	5	91.20	12.637	85.20	6.140
Angle of left ankle in third step	5	94.60	6.804	117.80	12.518
Angle of right ankle in first step	5	115.80	15.189	89.40	19.982
Angle of right ankle in second step	5	106.20	21.707	122.80	10.281
Angle of right ankle in third step	5	86.80	5.630	109.60	12.012
Angle of left knee in first step	5	135.20	3.962	124.20	19.032
Angle of left knee in second step	5	126.60	13.278	123.40	10.691
Angle of left knee in third step	5	146.80	20.030	139.80	13.180
Angle of right knee in first step	5	164.60	8.019	143.20	16.529
Angle of right knee in second step	5	138.60	16.380	132.40	8.325
Angle of right knee in third step	5	137.20	19.267	124.60	15.469
Angle of left hip in first step	5	170.20	12.911	153.60	9.607
Angle of left hip in second step	5	109.80	11.032	119.60	7.232
Angle of left hip in third step	5	126.00	16.310	131.80	11.389
Angle of right hip in first step	5	130.40	8.204	127.60	4.506
Angle of right hip in second step	5	160.80	11.777	164.40	16.682
Angle of right hip in third step	5	142.20	16.694	155.40	22.37

Table 2: t-table for mean difference and t-test

t-test for Equality of Means			
Variables	Mean difference	df	t-test
Height of Centre of gravity first step	1.354	8	.304
Height of Centre of gravity second step	.722	8	.147
Height of Centre of gravity third step	-.414	8	-.087
Stride length in first step	15.772	8	1.156
Stride length in second step	-6.918	8	-.572
Stride length in third step	-2.522	8	-.151
Angle of left ankle in first step	-14.200	8	-2.130
Angle of left ankle in second step	6.00	8	.955
Angle of left ankle in third step	-23.200	8	-3.641
Angle of right ankle in first step	26.400	8	2.352
Angle of right ankle in second step	-16.600	8	-1.545
Angle of right ankle in third step	-22.800	8	-3.843
Angle of left knee in first step	11.000	8	1.265
Angle of left knee in second step	3.200	8	.420
Angle of left knee in third step	7.000	8	.653
Angle of right knee in first step	21.400	8	2.605
Angle of right knee in second step	6.200	8	.755
Angle of right knee in third step	12.600	8	1.140
Angle of left hip in first step	16.600	8	2.306
Angle of left hip in second step	-9.800	8	-1.661
Angle of left hip in third step	-5.800	8	-.652
Angle of right hip in first step	2.800	8	.669
Angle of right hip in second step	-3.600	8	-.394
Angle of right hip in third step	-13.200	8	1.057

As shown in Table-2 the angle of right ankle at first step (2.352) and third step (-3.843), angle of left ankle at third step (-3.641), angle of left hip at first step (2.306) and angle of right knee at first step (2.605) are found to be significant as they have greater value of calculated t then tabulated t (2.306) at 0.05 level of significance.

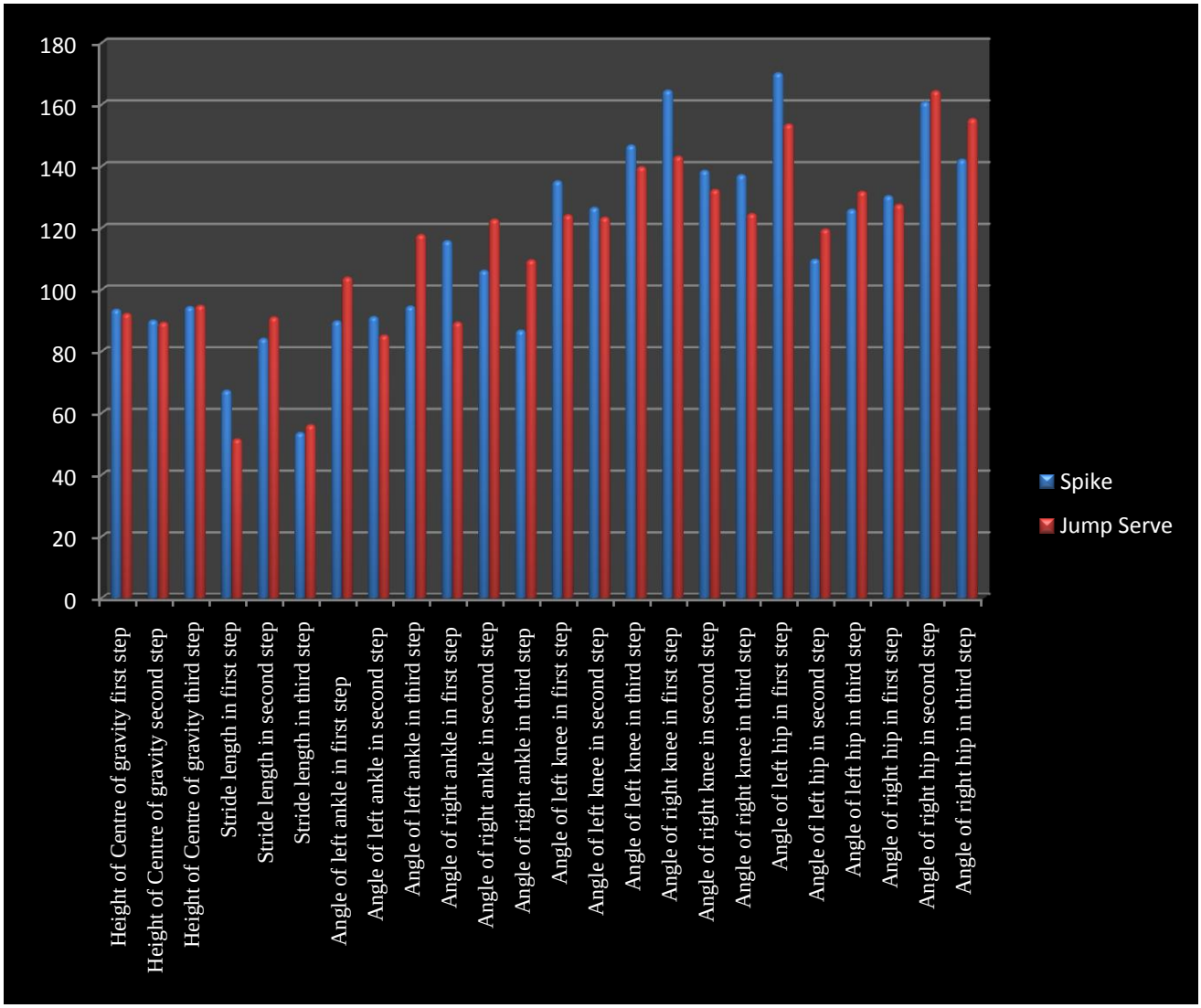

Figure 1: Means of the different variables

The graph above, shows the differences between the means of the selected variables of Spike and Jump Serve

4.Discussion

As shown in the Table 3 and 4 the variables that were found to be significant at 0.05 level are the angle of right ankle at first step (2.352), angle of right ankle at third step (-3.843), angle of left ankle at third step (-3.641), angle of left hip at first step (2.306) and angle of right knee at first step (2.605). This means during approach run of spike and jump serve there is no significant difference found except in those of the angle of right ankle at first step, angle of right ankle at third step, angle of left ankle at third step, angle of left hip at first step and angle of right knee at first step. However, linear kinematic variables i.e., height of c.g. at first, second and third step of spike and height of c.g. at first, second and third step of jump serve and stride length at first, second and third step of spike and stride length at first, second and third step of jump serve did not showed significant difference. The findings of the study have shown that only in case of angle of right ankle at first step, angle of right ankle at third step, angle of left ankle at third step, angle of left hip at first step and angle of right knee at first step, at the time of approach run of spike have shown significant difference to that of the same variables of the approach run of jump serve. There are significant differences between the angle of left ankle in third step of spike (94.60˚) and the angle of left ankle in third step of jump serve (117.80˚) and in between the angle of right ankle in third step of spike (86.80˚) and the angle of right ankle in third step of jump serve (109.60˚).

This is probably because in spike a lower stance is attained in third step than jump serve in order to lower down the body for more eccentric contraction and also to thrust the body downward to gain more amount of ground reaction force which helps the players to jump higher. As in jump service player also requires great amount of vertical jump same as spike but in jump serve players also have to cover horizontal distance along with the vertical distance so that they are able to contact the ball more closer to the net which gives less time to react opponent receiver's.

Hence more amount of planter flexion is seen during the moment take off of jump service than spike. A lower stance by the spiker may help to maintain dynamic balance. By keeping the body lower helps him resist the forward momentum and so does the horizontal displacement after

take-off. As, it is needed for the spiker to hit the ball at the maximum height, which is only possible, when the horizontal displacement is compromised to the vertical displacement.

But in jump serve the server needs to cover a greater horizontal distance so that the distance covered by the ball will be less and its velocity will be more. And in order to do so, the server attains a higher third step before take-off. Higher the C.G. of the body, greater will be the moment of inertia in the forward direction. Hence, the body will have greater forward momentum and greater horizontal displacement.

A significant difference is seen between the angle of right ankle in first step of spike (115.80˚) and the angle of right ankle in first step of jump serve (89.40˚). Also there is significant difference between the angle of right knee in first step of spike (164.60˚) and the angle of right knee in first step of jump serve (143.20˚).

This is because, during jump serve the ball is self tossed and in order to toss the ball to an optimum height a remarkable amount of force is required. So, to generate the force the lead leg is more flexed from the ankle and knee. As the force is exerted to toss the ball some amount of force is to be applied on the ground with the extension of the ankle and knee joint. The law of 'transfer of force from part to whole', provide evidence that to toss the ball higher the force is applied via the ankle, knee, hip and shoulder joints simultaneously.

Whereas, in the first step of spike the spiker accelerates in a forward direction as he initiate the approach run. The spiker attains a upright position or less forward inclined position because there is no need of force to be applied vertically. A significant difference is found between the angle of left hip in first step of spike (170.20) and the angle of left hip in first step of jump serve (153.60).

This is probably because in jump serve the server in order to toss the ball high enough lowers the torso from hip joints at the initial stance (first step), whereas, in spike downward inclination of the torso is not needed in the first step as the body takes the approach run.

5.Conclusion

The following angular kinematic variables showed significant difference between the steps of approach run in spike and jump serve in volleyball:

The angle of right ankle at first step (2.352), angle of right ankle at third step (-3.843), angle of left ankle at third step (-3.641), angle of left hip at first step (2.306) and angle of right knee at first step (2.605).

Finally, we must close the gap between practitioners and biomechanists. It will be important to standardize terminology and to agree on reporting conventions, once new biomechanical knowledge is gained, it is the responsibility of the research community to present it to athletes in an understandable manner. On the whole, the significance shown by the variables clearly mean that these variables are contributing to the skill of spike and jump serve differently. More research should be carried out in relation to biomechanical analysis of different skills in volleyball and with more subjects.

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