

# Kinematic Factors of Off-Speed and Power Spike Techniques in Volleyball

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## Abstract

The aim of this study was to compare the selected kinematics factors of power and off speed spikes of junior elite volleyball players of India and obtain insights into the techniques for off speed spike motion. The subjects selected for this study were twelve male junior national volleyball players of Uttar Pradesh state team. The purposive sampling technique was used. All subjects had been participating in 39th Junior National volleyball Championship for boys and girls held at Shari Dungargarh, Bikaner, Rajasthan (India) from 22-12-2012 to 28-12-2012. All of them had practiced volleyball regularly for the last three years and participated in Sub-Junior National Championships. They were considered skilled and their technique was treated as stabilized. The mean age, height and body weight of intervarsity players were 16 years ( $\pm 2.28$  years), 177.77 cm ( $\pm 5.43$  cm) and 64.67 kg ( $\pm 5.95$  kg). All subjects in this study were right-handed volleyball players. The performance of spike was recorded by the score in the spike which was obtained by using three point scales by the three judges. The video camera (Casio Exilim EX-F1) was used for filming. The subjects were made to take three trials only. The 300 frames per second as obtained by the use of high speed videography. The selected moments were analyzed (the best trial) by Silicon coach Pro-7 software. Only best spike frame was recorded and developed into the stick figures from which various kinematic variables were obtained.

The results revealed that there is no significant difference between off speed spike and power spike technique in relation to all angular kinematic factors i.e. shoulder angle, elbow angle, wrist angle and body inclination. This study also showed that the kinematic variables of pre-impact arm swing speed and post-impact ball speed were not significantly varied in both techniques. The result has showed that the calculated 't' values of all the selected variables were less than tabulated 't' value at 0.05 level of significance with 10 degree of freedom. These results lead to the assumption that the technique of spike jumps seems to be highly individual in top level junior volleyball players.

**Keywords:** Kinematic, Off-speed spike, Power spike,

## 1. Introduction

In Biomechanical term, Volleyball is a sport of constant motion. The nature of this game is rebound, reversed roles of offence and defense. Volleyball is well known team sport with a physical barrier preventing most direct one-to-one physical contact. There are two unique zones of play. Most of the sports is played in the mid-zone which is the area between the top of the head and the knee mid-zone – the low-zone and the high-zone. The low-zone is between the knees and the floor. Players are trained to be comfortable on the floor using such skills as diving, rolling and flying recovery techniques which are standard in Volleyball. The high zone is the topmost reach of the players. Much of Volleyball is played in the high-zone, therefore Volleyball players are trained to jump more than athletes of any other sports.

The rivalry in modern volleyball games focuses on the dominance over the net, and the best way to win this dominance is to recruit athletes who are taller with greater jumping ability. Previous investigations indicated that elite volleyball players demonstrated advantageous physique characteristics. The major characteristics of volleyball players include high stature and standing reach height, long arm span, long Achilles' tendon and long lower-limb and calf. (Ling, 2007), (Huang, 1992).

In every sport, there is some aspect that has the spectator leaping from their seats, volleyball too has its golden moment, when player jump high in the air hit the set ball into opponent court called Attack. The powerful attack increased the chances of scoring in both side-out and transition.

In the game of volleyball, the spike is one of the most difficult and demanding techniques to master. The athlete is expected to jump and hit a ball with maximum force and accuracy at the approximate peak of the jump. Each

spike technique has its own unique pattern of movements. Techniques directly concerned to mechanical factors and system of operation which follow definite laws scientific knowledge has revolutionized the standard of performance in sports discipline.

The powerful spike is the most frequently used technique to obtain a point and important offensive tool which dominates the result of a competition. The power spike skill has lost much of its effectiveness after gaining all round physical performance because of the emergence of double and triples blocking. However, off speed spike may be very effective in this situation. The spike motion consists four phases in the analysis of the spike: the approach, preparation, hitting, and landing (Prsala,1982). The attack hit involves maximum jump height with approach. Jump height of the hit provides the advantage of attack angle and time in the air (Abendroth-Smith &Kras, 1999).In hitting phase body angles in space, center of gravity of an athlete in specific positions, velocity of the released object, angle of release, height of release etc. plays an important role in the spiking performance. (Coleman,1997).Numerous studies have shown that arm swing has a significant influence on jump height (Lees et. al.,2004). Arm swing raised the COM height at takeoff by 2-3% when compared to no arm swing ((Feltner,et.al.,1999).The backswing style generally produces the greater velocity and more acute angle of ball trajectory (Maxwell 1982).These studies indicated that an arm swing increases the angular velocity and torque at lower extremity joints, COM height, and velocity at take-off for a countermovement jump. The range of motion of the hitting hand to be relative to the power of the spike. The suitable timing and coordination of body segments during volleyball spike, also influence to the midair spike of the volleyball. The duration of the spiking motion is 0.6 to 0.8 seconds, and can be divided into the following phases: back-swing, turn-swing, and forward swing. Elite level spikers hit the ball half way into the jump at 0.3 to 0.4 seconds. This makes the spiking technique one the most complicated skills in sports (Li-Fang, 2008).

The off speed spike has been recently incorporated in offensive combinations increasing the complexity of volleyball tactics and making games more sophisticated. Such combinations are now seen in as a strategy of feinting to overcome the double and triples block more effectively. Although some investigations analyzed power spike techniques, no study has been done on the off speed spike motion for junior players in official games. Therefore, the aim of this study was to compare the selected kinematics factors of power and off speed spikes of junior elite volleyball players, and obtain insights into the techniques for off speed spike motion.

## 2. Objective of the Study

The aim of this study was to compare the selected kinematic factors of power and off speed spikes of junior elite volleyball players.

## 3. Method of Study

In this this section, sources of data, selection of subjects, sampling method, criterion measure, filming protocol, analysis of film, selection of variables, description of test, have been described.

### 3.1 Source of Data:

The sample consisted of twelve male national volleyball junior players aged ranged 16 years ( $\pm 2.28$  years). All subjects had participated in 39<sup>th</sup> Junior National Championship for boys and girls held at Shari Dungargarh, Bikaner, Rajasthan (India) from 22-12-2012 to 28-12-2012. All of them had practiced volleyball regularly for the last three years and participated in Sub-Junior National Championships. They were considered skilled and their technique was treated as stabilized. The players were informed about the essence of the studies planned, and they as well as their coaches consented to voluntary testing. Participants were provided with information at their level of comprehension about the purpose, methods, demands, risks, inconveniences, discomforts, and possible outcomes of this research. The researcher has obtained approval by the Organizing Committee of Competition and Volleyball Federation of India.

#### 3.1.1 Selection of Subject

The subject selected for this study was twelve male national junior volleyball players of Uttar Pradesh state team. The purposive sampling technique was used for selection of subject. The mean age, height and body weight of national junior volleyball players were 16 years ( $\pm 2.28$  years), 177.77 cm ( $\pm 5.43$  cm) and 64.67 kg ( $\pm 5.95$  kg). All subjects in this study were right-handed volleyball players

#### 3.1.2 Criterion Measure

In this study the spiking performance of the subject recorded by subjective judgment criterion measures. The performance of spike was recorded by the score in the spike which obtained by using three point scales by the three judges. Three spikes were recorded for each volleyball player in both techniques and the recorded mean of the scores for trial was performance of spiker as there is no established standard test to test the spike.

#### 3.1.3 Selection of Variable

Based on literary evidence, correspondence with the expert and scholar's own understanding and keeping the

feasibility criterion in mind, the research scholar selected the following kinematic variables for the study.

- Shoulder Joint (Hitting arm)
- Elbow Joint (Hitting arm)
- Angle of Wrist joint(Hitting arm)
- Body inclination
- Pre Impact Arm swing Speed
- Post-Impact Ball Velocity

(Figure 1, 2 and 3)

#### 3.1.4 Procedures of Video graphic Technique

The Videography was done during 2:30 pm to 6:00 pm on day of competition. After obtaining informed consent, each athlete's spiking mechanics were evaluated on an outdoor volleyball court. A standard volleyball net was arranged in the court at regulation height 2.43 meter. An experienced volleyball setter set the ball for each trial. Subjects started from a self-selected position about 4-5 m from the net, and approached the marked line 1.50m from the net line. Subjects each took several warm-up trials to become acclimated to the environment and to become familiar with the timing and height of the set. For the recorded trials, the participants were instructed to spike the ball with full effort. Each subject had about three minutes rest among three trials in rotations.

Three national coaches as judge, who well acquainted with the spike in volleyball, were requested to judge the best spike on three point scale of both techniques.

#### 3.1.5 Filming Protocol & Analysis of Film

The video camera (Casio Exilim EX-F1) was adjusted on a tripod at a height of 1.57 meter from the ground; it was placed perpendicular to the execution line and parallel to horizontal plane at a Displacement of 5.80 meter from the midpoint of the execution line. The subjects were made to take three trials only.

The 300 frames per second as obtained by the use of high speed videography. The frame was analyzed (the best trail) by Siliconcoach Pro-7 software. Only best spike frame was obtained and developed the stick figures from which various kinematic variables were obtained.

## 4. Results

Descriptive statistics was used to compare the selected kinematic factors of power and off speed spikes of junior elite volleyball players. The “t” test was used to carry out the kinematical comparison on the performance in both techniques. In order to test the hypothesis the level of significance was set at 0.05. The researcher reached at the results of this empirical investigation which is presented by the respective tables: 1. The result presented in the table 1, revealed that there is no significant difference between off speed spike and power spike technique in all angular kinematic factors shoulder angle, elbow angle, wrist angle and body inclination. This study also showed that the kinematic variables of pre impact arm swing speed and post impact ball speed were not significantly greater in both techniques. The result has showed that the calculated t values of all the selected variables were less than tabulated ‘t’ value at 0.05 level of significance with 10 degree of freedom.

### 4.1 Discussion

The aim of the study was to compare biomechanical factors of power spike and off speed spike techniques of wrist, elbow, and shoulder and body inclination angles in hitting phase. The result showed insignificant differences among kinematic factors of power spike and off speed spike techniques in relation with wrist, elbow, shoulder and body inclination angles in hitting phase. Coleman (1997) found that hand post-impact velocity was significantly correlated with ball velocity but insignificant with the COM horizontal velocity, therefore minimum angle in wrist may not generate ball speed. He also reported significantly correlated among pre-impact maximum elbow angular velocity, humerus angular velocity with ball velocity. Earlier peak pelvic angular velocity and maximum shoulder external rotation are associated with higher ball speed.

## 5. Practical Implication:

Pedagogically, instructors, coaches, and trainers may focus on the coordination of arm swing during the performance of a volleyball spike technique. Arm swing forward should have begun before the feet planted at the last step. Further study is suggested in comparing the two styles of hitting larger and more equally distributed sample between styles of hitting might further help clarify significant differences between the styles. Coaches must emphasis on enhancement of range of motion in wrist joint for off speed spike. The study provides useful information for coaches training of power spike and off speed spike techniques.

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Figure 1. Body inclination during Hitting Phase of Spike





Figure 2. Angle of Joints during Hitting Phase of Spike



Figure. 2 Post- Impact Ball Velocity in Hitting Phase of Spike

Table 1. Comparison Kinematics Factors of Power Spike and Off Speed Spike Techniques

S.No.	Variables	Power spike		Off speed Spike		Calculated 't'
		Mean	Standard Deviation	Mean	Standard Deviation	
1.	Angle of Shoulder joint(Degree)	157.33	11.29	158.17	4.75	0.87
2.	Angle of Elbow joint(Degree)	152.50	8.04	155.17	6.68	0.55
3.	Angle of Wrist joint (Degree)	167.33	8.69	150.50	5.05	0.002
4.	Body Inclination(Degree)	13.09	0.46	11.08	0.34	0.001
5.	Post-Impact Ball Speed (m/s)	22.82 m/s	1.12	20.02	1.72	0.001
6.	Pre-Impact Arm Swing Speed(m/s)	13.63	0.43	12.73	0.28	0.002

\*Significant at 0.05 level with 10 degree of freedom

tab.t=2.23

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