

KINEMATIC FACTORS AND VOLLEYBALL SPIKE JUMP PERFORMANCE OF STATE AND NATIONAL LEVELS MALE VOLLEYBALL PLAYERS

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ABSTRACT

The study purpose was to compare two different functional classes of volleyball players on the selected kinematical variables of spike jump performance. A total of eighteen (8 national and 10 state level) male volleyball players were selected as the subjects for this study. For obtaining 2-D kinematical data each subject was asked to perform volleyball spike jump. There was a setter who set the ball for spiker to spike. Each spiker spike for three times and their spike jump performance was recorded in a high speed Canon Legria HF S10 camcorder. The camcorder was placed on a tripod at the height of 1.5 meters on the sagittal plane; the focus of the camcorder was perpendicular to the side-line at a distance of 13 meters away from the point of jump. The movement of the spiker was recorded until the peak of the spike jump from the onset of the movement. Acquired 2-D data were analyzed with the help of Silicon Coach Pro7 motion analysis software. The jump height (JH), range of motion (RoM), angular velocity (AV), hyperextension joint angle at shoulder joint (HJASJ), and duration of arm swing (DAS) were taken as the kinematic variables for this study. The t test was used to statistically analyze the data. Results of study indicated that there was a significant difference in the variable of JH, RoM and DAS between national and state level male volleyball players, whereas insignificant difference observed in the variable of AV and HJASJ in their volleyball spike jump performance. For optimum spike jump performance the jump height is one of the important factor. Arm swing duration was a prominent factor of spike jump performance as when this increases the jump height is also increases and vice-versa. Maximization of the speed of the arm swing improves spike jump performance. Though increase in shoulder hyperextension joint angle doesn't have any role in the spike jump performance.

Keywords: Volleyball, arm swing, spike jump, spiker, national, state.

INTRODUCTION

Volleyball is one of the highest participation sports in the world. The most appealing asp-

ects of this sport are that it can be played indoors and outdoors, by young and old, by males and

females. The main reasons for the popularity of volleyball may be that the sport requires a less amount of equipment and anyone can participate throughout their lives at a variety of skill levels.

The game's popularity makes it more challenging and tough at all level of participation. Service, receiving, passing, setting, blocking and spiking are the basic skills of volleyball game. Spiking is used as an attacking skill in volleyball. Spiking is the most complex skill in volleyball game. The height and velocity are major factors influencing the performance of spiking (Hussain, Mohammad & Khan, 2011). According to Hsieh and Heise (2008) a successful volleyball spike jump consists of several different factors and a balanced combination of these variables; arm swing was recognized as one of these variables. Since spiking is an attacking skill and it's become an integral and important part of volleyball game. To enjoy best results of spiking a good amount of jump is required. The spike jump performance depends on various kinematical factors (Tillman, Haas, Brunt & Bennett, 2004). In the past different bio-

mechanical parameters of volleyball spike jump performance were analyzed by the researchers (Coleman, Benham & Northcott, 1993; Coutts, 1982; Li-Fang & Gin-Chang, 2008; Tilp, Wagner & Muller, 2008). Most of the studies showed that arm swing has a significant influence on jump height (Wagner, Tilp, Duvillard & Mueller, 2009; Baudin, 1980; Moore, Weiss, Schilling, Fry & Li, 2007). These studies indicated that arm swing increases the angular velocity which resultant in good amount of jump height (Bénédicte, [Jean-Louis](#), [Guido](#), Jean-Michel & Marc, 2005; Kensaku, Shintaro, Satoshi, Satoshi & Satoshi, 1999; Roemer, Kuhlmann & Milani, 2008). Additionally, Hsieh and Heise (2006) [15] found that arm swing was one of the most important factors which contributed to volleyball spike jump height. Although these studies examined the effect of arm swing on jump height, few of them have examined the performance of the arm swing in different skill level players (Marquez, Masumura, Ae, Endo & Yasuda, 2007; Marquez, Masumura & Ae, 2005; Ridgway & Hamilton, 1991). The lack of study of about this skill at

different level demands for bio-mechanical research in this connection. Thus, this study was structured with a purpose to examine the arm swing which influences the volleyball spike jump performance, on selected kinematic factors at national and state level male volleyball players.

METHODS AND MATERIALS

Subjects

Eight national and ten state level a total of eighteen male volleyball players were tested in this study. To maintain the homogeneity of the subjects only right handed players were selected. The age, height, body weight and training age of selected subjects is presented in the following table 1.

Table-1
Descriptive statistics of national and state level volleyball players

	National Volleyball Players		State Volleyball Players	
	Mean	SD	Mean	SD
Age	24.88 years	± 1.89	18.2 years	± 1.55
Weight	62.63 Kg	± 4.80	55.3 Kg	± 5.60
Height	177 cm	± 4.14	166.5 cm	± 3.10
Training Age	6.88 years	± 1.36	2.35 years	± 0.67

Tools and Equipments

The experimental tools and equipments used in this investigation were as camcorder with tripod (Canon Legria HF S10), measuring tap, weighing machine, body markers, motion analysis software (Silicon Coach Pro7) and volleyball.

Procedure

Prior to actual data collection field setting was done. A camcorder which is operated at shutter speed of 1/2000, with a frame rate of 60 frames/second was fixed on a tripod, the height of the camcorder from the ground was 1.5 meters. It was paced at a distance of exactly 13 meters from the subjects; the focus of the camcorder was perpendicular to the subjects right lateral aspects i.e. perpendicular to the side-line of the court (Figure 1). A well trained setter among them was asked to volunteer in the study and set the ball for the study's subjects.

To obtaining 2-D kinematical data each subject was asked to spike the volleyball. When they spike their spike jump performance was recorded in a high speed Canon Legria HF S10

camcorder. 2-D data was recorded from the onset of movement until the peak of the spike jump. Acquired 2-D data were analyzed with the help of Silicon Coach Pro7 motion analysis software. The variable for the study were taken as the jump height (JH), range of motion (RoM), angular velocity (AV), hyperextension joint angle at shoulder joint (HJASJ), and duration of arm swing (DAS). The duration of arm swing was the time when maximum hyperextension of shoulder joint has occurred prior to the feet impact [3].

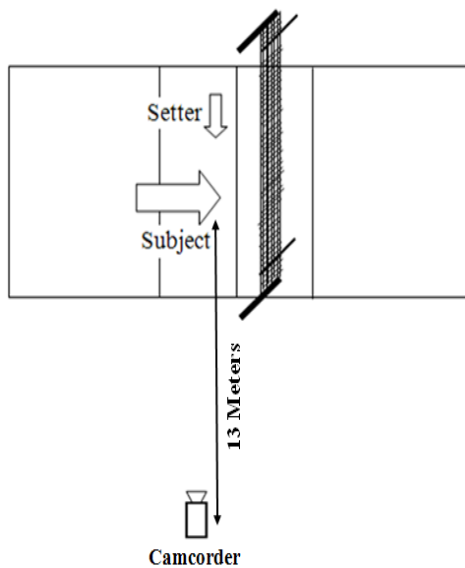


Figure-1
Experimental setup showing of subject, setter and camcorder position

Statistical Analysis

One tailed t test was used to analyze the data and the level of significance was set at 0.05.

RESULTS

The results of this investigation are presented in the preceding tables.

Table-2
Mean difference (MD) and calculated t of kinematical variables of arm swing performance between national and state level male volleyball players

Variables	National Players		State Players		MD	Cal t
	Mean	SD	Mean	SD		
JH	0.71 m	± 0.13 m	0.47 m	± 0.06 cm	0.24 m	2.61*
RoM	236.25°	± 21.97°	161.33°	± 25.20°	74.92°	3.10*
AV	458.38°	± 53.45°	359.60°	± 78.83°	98.78°	0.004
HJASJ	103.00°	± 23.92°	71.10°	± 19.37°	31.90°	0.003
DAS	0.31 sec	± 0.05 sec	0.21 sec	± 0.04 sec	0.10 sec	9.50*

*Significant at 0.05 level of significance with 16 df t = 1.75

From the above cited table 2 it is evident that the mean values of national and state level male volleyball players in their JH was 0.71 m and 0.47 m, respectively with a mean difference (MD) of

0.24 m; RoM was 236.25° and 161.33°, respectively with a MD of 74.92°; AV was 458.38° and 359.60°, respectively with a MD of 98.78°; HJASJ was 103.00° and 71.10°, respectively with a MD of 31.90°; DAS was 0.31 sec and 0.21 sec, respectively with a MD of 0.10 sec.

Comparing the mean differences of the selected variables of arm swing viz. jump height (JH), range of motion (RoM), angular velocity (AV), hyperextension joint angle at shoulder joint (HJASJ) and duration of arm swing (DAS), between national and state level male volleyball players revealed that, there was significance difference observed between national and state level male volleyball players in the variable of JH, RoM and DAS as the calculated t value concerning these variable of arm swing was found more than tabulated t value (1.75) at 0.05 level of confidence with 16 degree of freedom which shows significance differences between both experimental groups, whereas insignificant difference observed in the variables of AV and HJASJ as calculated t value was found less than tabulated t value.

DISCUSSION

The results of the study verifies that the jump height which is a influential variable of spike jump performance was much higher in the national level volleyball players in comparison with state level volleyball players, the reason might be the arm swing which is much requisite to enhance the jump height was reported higher in the national level volleyball players which automatically increase the range of motion as well as angular velocity. One of the main reasons for a significant difference between national and state level volleyball players in their arm swing performance is the higher hyperextension of joint angle at shoulder joint which resulted increase of duration of arm swing as when the duration of arm swing increase is provide higher range of motion as well as angular velocity which increase the spike jump performance. When angular velocity and hyperextension joint angle at shoulder joint are taken into account it was observed that there was an insignificant difference observed between national and state level players. That is due to the reason that these two factors of

volleyball spike jump performance does not play a significant role in spike jump performance. The findings of the study are in the line of Hsieh and Heise (2006) who investigated the arm swing of volleyball spike jump performance between advanced and recreational female players and found advanced players performed significantly higher than recreational players. Marquez, Masumura and Ae (2005) biomechanically analyzed the spike motion of average, top and lower skill level groups of male volleyball players and reported in their findings that top skill level players exhibited better spike motion in comparison with other two skill level groups players. Ridgway and Hamilton (1991) in their study examined the spiking technique of elite and intercollegiate male volleyball players and found that spiking technique of elite volleyball players were far better than intercollegiate volleyball players.

CONCLUSIONS

On the basis of the results obtained from the present empirical investigation the following conclusion can be drawn:

- For optimum spike jump performance the jump height is one of the important factors as national level players have greater jump height that improve their spike performance.
- Though angular velocity is one of the main kinematic factors in the determination of spike jump performance but in this study it was not evidenced as there was an insignificant difference observed between both study groups.
- The duration of arm swing was a prominent factor of spike jump performance as when duration of arm swing increases the jump height is also increased.
- Maximization of the speed of the arm swing would improve spike jump performance.
- Increase in shoulder hyper-extension joint angle does not play any significant role in the spike jump performance.

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REFERENCES

- Baudin, J. P. (1980). A biomechanical analysis of the volleyball spike jump. Master of Science Degree Thesis, Faculty of Graduate Studies and Research, The University of Alberta.
- Bénédicte, F., Jean-Louis, C., Guido, C., Jean-Michel, C. and Marc, C. (2005). Factors correlated with volleyball spike velocity. *Am J Sports Med*, 33, (10), 1513-1519.
- Coleman, S., Benham, A. and Northcott, S. (1993). A three-dimensional cinematographic analysis of the volleyball spike. *J Sports Sci*, 11, 259-302.
- Coutts, K. D. (1982). Kinematic differences of two volleyball jumping technique. *Med Sci Sports Exe*, 14 (1), 57-59.
- Hsieh, C. and Heise, G. D. (2008). Arm swing of volleyball spike jump performance between advanced and recreational female players. Proceeding of Fourth North American Congress on Biomechanics, University of Michigan, Ann Arbor, Michigan, USA, (August 5-9), pp.306-307.
- Hsieh, C. and Heise, G. D. (2006). Important kinematic factors for male volleyball players in the performance of a spike jump. Proceeding of 30th American Society of Biomechanics Conference, Virginia Tech, Blacksburg, VA, (Sep. 6-9), 76-77.
- Hussain, I., Mohammad, A. and Khan, A. (2011). A relationship between anthropometric and kinematic variables of spike jump of inter-collegiate level male volleyball players. *Int J Per Ana in Sports*, 11 (3), 583-588.
- Kensaku, M., Shintaro, T., Satoshi, M., Satoshi, H. and Satoshi, T. (1999). Motion analysis in volleyball spike. Proceedings of Annual Meeting of Japanese Society for Orthopaedic Bio-mechanics, 20, 377-380.
- Li-Fang, L. and Gin-Chang, L. (2008). The application of range of motion (ROM) and coordination on volleyball spike. In: Know Y.-H., Shim J., Shim J. K., Shin I.-S. (Eds.), Proceedings of 26th International Symposium on Biomechanics in Sports, Seoul- Korea, (July 14-18), 16-51.
- Marquez, W. Q., Masumura, M. and Ae, M. (2005). A Bio-mechanical analysis of spike motion for different skill levels of male volleyball players. In: Davis B., van de Boget T. (Eds.), Proceedings of the 20th Congress of the International Society of Biomechanics and the 29th Annual Meeting of the American Society for Biomechanics, Cleveland Ohio, (July 31 to August 5), 518.
- Marquez, W. Q., Masumura, M., Ae, M., Endo, T. and Yasuda, M. (2007). Biomechanical analysis of the spike motion for world class male volleyball players. In: Menzel H. J., Chagas M. H. (Eds), Biomechanics

- in Sports XXV, Proceedings of the XXV International Symposium on Biomechanics in Sports, Ouro Preto, Brazil. (August 23-27), 328.
- Moore, C. A., Weiss, L. W., Schilling, B., Fry, A. C. and Li, Y. (2007). Acute effects of augmented eccentric loading on jump squat performance. *J Str Con Res*, 21 (2), 372-377.
- Ridgway, M. E. and Hamilton, N. (1991). Spiking technique of elite and intercollegiate male volleyball players. In: Tant C. L., Patterson P. E., York S. L. (Eds.), *Biomechanics in Sports IX*, Iowa State University, Ames, IA, 35-38.
- Roemer, K., Kuhlmann, C. and Milani, T. L. (2008). Investigation of shoulder kinematics in volleyball spikes. In: Kwon Y.-H., Shim J., Shim J. K., Shin I. S. (Eds.), *Biomechanics in Sports XXVI, Proceedings of XXVI International Conference on Biomechanics in Sports*, Seoul, Korea (July 14-18), 506-509.
- Tillman, M. D., Haas, C. J., Brunt, D. and Bennett, G. R. (2004). Jumping and landing techniques in elite women's volleyball. *J Sports Sci Med*, 3 (1), 30-36.
- Tilp, M., Wagner, H. and Muller, E. (2008). Differences in 3D kinematics between volleyball and beach volleyball spike movements. *Sports Bio*, 7 (3), 386-397.
- Wagner, H., Tilp, M. and Duvillard, S. P. (2009). Mueller E., Kinematic analysis of volleyball spike jump. *Int J Sports Med*, 30 (10), 760-765.