JOINTS ACTIVITY AND ITS ROLE IN THE UPPER EXTREMITY IN BADMINTON STROKES: A BIOMECHANICAL PERSPECTIVE OF SPORTS EDUCATION

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Abstracts

Purpose of the Study: This study aims to describe the muscle activity and its role in the upper extremity in Badminton Strokes and also investigates the Kinematics differences of Badminton forehand overhead shot, i.e., precise, smash and drop in wrist joint, elbow joint, and shoulder Joint from a biomechanics perspective.

Methodology: Total [n=10] numbers of male badminton players were randomly selected from the badminton match practice group of L.N.I.P.E. Gwalior, Madhya Pradesh, India. The match practice group consisted of (n=78) players who at least participated in Inter-University badminton competition, and their age ranges from 17-25 years of old. Go Pro HERO 7, 2D camera was used. A video camera was mounted on a tripod at a height of 1.05 meters from the ground. 2D data of wrist joint, elbow joint, and shoulder joint were put in Kinovea 0.8.27 software. One way ANOVA was used.

Principal Findings: The results of the finding demonstrate that Brain vibrations, paradoxically, are critical to the stability of movement and high performance. There are significant muscle activity and kinematics differences among forehand clear, forehand smash and forehand drop-in shoulder joint angle, elbow joint angle, and wrist joint angle.

Applications of this Study: The Study may use by the badminton Players as well as coaches for the successful execution of badminton Skill. This study will provide the mechanical area of movement of badminton Players. The same kind of study may use in other games.

Novelty/Originality of this Study: The Study explores the mechanical advantages of badminton forehand overhead Skill. It will give the reader new ideas to think of a similar kind of study in different games.

Keywords: Kinematics, Badminton, Forehand Clear, Drop, Smash, Biomechanical Perspective, Sports Psychology.

INTRODUCTION

A Comprehensive Analysis of multiple biological signals, while the body is in motion, will undoubtedly provide critical insights into the psychological determinants of athletic performance. Early specialization is characterized by participation in intense specialized training for one sport. (Beker et.al 2009) It is believed that Badminton is a racquet game played over a net with the shuttle. The Smash of a Chinese player was measured more than 206 miles per hour which is faster than a Golf ball (Brahm, 2010). Smashing performance is a key factor in winning points during the badminton game and commonly used from different positions and places on the court. Often, smash stroke is the execution that determines the advantage of one player over another during the game and probably is the most overused stroke among the younger players, with the efficiency of a stroke that primarily influenced by two tasks: smashing velocity and accuracy (Grice, 2008; Brahms, 2014). Badminton players need to conduct various movement patterns during the game including specialized twists, jumps, footwork, and swings to strike the shuttlecock and keep it moving back and forth on the court. Thus, the game is characterized by a changing temporal structure with actions of a short period and high or medium intensity coupled with a short resting time (Phomsoupha and Laffaye, 2015).

Badminton requires specific physical conditioning in terms of motor and action controls; coordinative variables such as reaction time, foot stepping, and static or dynamic balances, which are essential motor demands in this sport (Phomsoupha and Laffaye, 2015; Laffaye et al., 2015). Therefore, badminton players need enough strength and a high level of dynamic balance during the rapid postural movements around the court. Frohlich et al., (2014) Suggested that player who performs overhead smash stroke must go through various movement and direction patterns to reach in the optimum hitting point with the stretched entire body, which means that upper body and smashing arm will be in the optimum coordinated stretching position. Moreover, the core musculature acts as a connecting bridge between upper and lower extremities limb in overhead athletic endeavors such as smashing in Badminton or throwing in handball sport and plays an important role with regard to transferring energy from the proximal to the distal body segments (Hirashima et al., 2002; Saeterbakken et al., 2011).

Forehand overhead smash is a technical method executes by a Badminton player which requires more power and energy to produce high shuttle velocity (Bo, 2011). Badminton forehand clear shot is a stroke in Badminton where the opponent intendant to move to backcourt so that the player gets enough time to be in attacking position (Wang, 2017). Badminton forehand shot is the basic skill where the player tosses the shuttle to opponent court and shuttle landed downward near the net and compelled the opponent to come forward and become passive in Games (Liao, Pan, & Tsai, 2014). Previous studies mentioned about different forehand overhead shot in Badminton. The previous study was conducted by

researchers in Badminton. Such as A Cinematographic analysis of upper extremity in badminton Strokes (Poole, 1970). The 2D model was used to describe the Smash (Waddel & Gowitzke, 2000). Also, previous studies focused on the description of forehand strokes of Badminton players, such as Poole, 1970; Adrian & Enberg (1971); and Gowitzke & Waddell, 1979, they used 2D model to describe the smash strokes.

A Study did in Analysis of Badminton Smash with the mobile device based on Accelerometer (Jaitner & Garwin, 2007) Research conducted on "Kinematical analysis of forehand and Backhand Smash in Badminton" (Hussain & Bari, 2011). The research examined on Smash Motion Analysis for Badminton from Image (Magiko et al., 2012). Kinematics does not concern with the Forces, which may be External and Internal because of the motion (Winter, 2009).

The objective of the Study

The present study aims to find out the angular kinematic differences among Badminton forehand smash, clear, and drop.

Research Questions

1. Are there any differences in wrist joints among clear, smash, and drop?

2. Are there any differences in the elbow joint among clear, smash, and drop?

3. Are there any differences in the shoulder joint among clear, smash, and drop?

LITERATURE REVIEW

Tsai, L. T., Shu, H, K., & Chang, S, S. (2005) Conducted a study on "Biomechanical analysis of EMG activity between badminton smash and drop shots" (Tsai, Shu, & Chang, 2005). They took four elite badminton players of Taiwan who were of 21 years of old Height was 175 cm, and weight was 68 kg. To capture the motion they used Redlake 1000 High-Speed digital cameras and motion were captured at the point of contact. They employed a paired t-test for the study at the significant level of 0.05. Researchers found a significant difference during a time of contact (sec). Shuttle Velocity (m/s), Elbow Angle (Deg), and Wrist Angle velocity (Deg/s). Rajpoot, Y. S., Ghai, G, D., & Bagchi A. (2012) did their Study on Biomechanical Analysis of selected Holding positions on Parallel Bar in Gymnastic where their positions were L-Hold, Straddle L-Hold and Handstand. They selected total [N=6] numbers of Gymnast selected for the study. The variables they choose were Hip Joint, BMI, Weight, Stature and they used Drat fish software to analyses the data. An overall score of each holding position was divided into five faces position of head and seat, the position of legs, duration of hold, the position of the arm, initial swing to handstand. They concluded that in the angle of straddle L-hold and L-hold are negatively skewed.

In the case of correlation, they found none of the biomechanical and anthropometrical variables possess a significant difference. Jaitner, N. & Garwin, W. (2007) did their research on Analysis of badminton smash with mobile measure devices based on Accelerometry. To collect data total of 7 numbers of subjects were selected where one was international elite player others participated up to the national level. Series of five smashed was given to the subject perform. Kinematic data were taken by using two high-speed cameras (Redlake) at 250 Hz. They concluded that 80% velocity of the shuttle is explained by the acceleration of racket velocities. Hussain, I. & Bari, M, A. (2011) did their Research on "Kinematical analysis of forehand and Backhand Smash in Badminton". The duration time of point of contact during forehand Smash was (0.004 Sec) which was greater than the Backhand Smash. Researchers got the significant result in the velocity of the shuttle, Height of contact, angle of racket, wrist angle, and angular velocity of elbow joint where the Researcher's failed to get the significant difference in flight angle, shoulder angle, elbow angle, the angular velocity of the wrist joint (Hussain & Bari, 2011). Researchers found that there was a Positive correlation between the velocity of shuttle and wrist angular velocity.

Tsai, C, L., Yang, C, C., Lin, M, S., & Huang K, S. (2008) did research on the topic "The surface EMG activity analysis between Badminton Smash and Jump Smash" (Tsai et al., 2008). They found the result that the jump smash exerted higher EMG activity than the standing smash before the point of contact phase. Li, S., Zhang, Z., Wan, B., & Wilde, B. (2016) conducted a study on "The relevance body positioning and its training effect on Badminton smash" (Li et al., 2016). They got the result that body positioning has a direct relationship with angle of clearance, Height of clearance, and shuttlecock release. Ibrahim, R., Faber, G, S., Kingma, I., & Dieen, J, V. (2016) conducted a study on "Kinematic analysis of the drag flick in field Hockey". The study was conducted on ten [N=10] elite hockey players. The US. Angular velocity of shoulder, elbow, and wrist was calculated by the digital segment than used the equation of Berme and Capozzo. Okubu, H. & Hubbard, M. (2015) investigated "Kinematics of arm joint motions in Basketball Shooting". They found the result that elbow and wrist joint mostly produced vertical component of release velocity whereas shoulder angle produced vertical component of release velocity (Hiroki Okubu & Mont Hubbard, 2015). Amar, A., Chtourou, H., Abdel. O., & Parish, A. (2015) conducted a study on "Free throw shot in Basketball: Kinematic analysis of scored and missed shots during the learning process", a total of ten numbers of male college students were selected for their study.

Researchers found a significant difference only in the Knee Joint (Ammar et al., 2015). Ahsan, M. (2018) did research on "An angular kinematical analysis of soccer instep and inside kick at impact phase of university soccer players", he

selected 20 male footballers 11from Fiji National University. He found that the angle of the hip Joint showed a significant difference between Instep and Inside Kick (Ahsan, 2018). Ibrahim, R., Kingma, I., Boode, A. V., Faber, S. G., & Dieen, V. (2018) investigated on "Kinematic and kinetic analysis of the goalkeeper's diving save in football" they concluded that goalkeeper dive by pushing off their collateral leg (Ibrahim et al., 2018). Bingul, M. B., Aydin, M., Bulgan, C., Gelen, E., Ozbek, A. (2016) conducted a Study on "Upper Extremity Kinematics of Flat Serve in Tennis" 15 Elite national Turkish tennis players were selected. Employed Spearman Correlation technique was used. They found that there is a relationship between angular velocity and elbow angular velocity and wrist angular velocity was found (Bingul et al., 2016). Wagner, H., Tilp, M., Duvilard, V., & Mueller, E. (2009) examined on "Kinematic analysis of volleyball spike Jump." The 3-D study was measured in 16 elite volleyball players through VICON capture motions. Researchers found there was a significant correlation between Jump Height and Spike Jump (Wagner et al., 2009).

Srrein, B., Oijen, J., Goossens, M., & Baeyens, P. J. (2016) conducted a study on "A motion analysis in the volleyball Spike – Part 1:three-dimensional kinematics and performance" They conducted an experiment on both male and female junior volleyball players. They got an interaction effect between the level of expertise and Gender from the shoulder and elbow Joint. Lockie, G, R., Callaghan, J, S., & Jeffries, D, M. (2014) experiment on cricket game there topic was "Acceleration kinematics in Cricketers: Implications for performance in the field" eighteen male cricketers were selected for the study. They did not get any difference in sprint time. They got a significance relation of Knee flexion with both step length. Beach, J, A., Ferdinands, R, E., & Sinclair, J. P. (2014) did experiment on" Three dimensional linear and angular kinematics of a spinning cricket ball, sports technology", thirty-four district level were selected for the study. They found that spin bowler uses a combination of spin velocity vectors and spin rate to turn and swerve off the pitch. Struzik, A., Konieczny, G., Stawarz, M., Grzesik, K., & Winiarski, S. (2016) did their experiment in "Relationship between lower limb angular kinematic variables and the effectiveness of the sprinting during the acceleration phase "their aim of the study was to find out if there is any relationship between 10M and 30M sprint. They recorded kinetic data and they concluded that during acceleration phase hip Joint might have unfavourable effect on running time.

HYPOTHESIS DEVELOPMENT

H₁: There are differences in Wrist Joint among Forehand Smash Clear and Drop.

H₂: There are differences in Elbow Joint among Forehand Smash Clear and Drop.

H₃: There are differences in Elbow Joint among Forehand Smash Clear and Drop.

METHODOLOGY

Ten right-handed elite male badminton players who are studying in who at least participated in state-level or university level were randomly selected for the study. We were interested in Analysis during the point of contact. Go Pro Hero 7, 2D camera whose frequency was 129 f/sec was used to capture the video. A video camera was mounted on a tripod at a height of 1.05 meters from the ground.
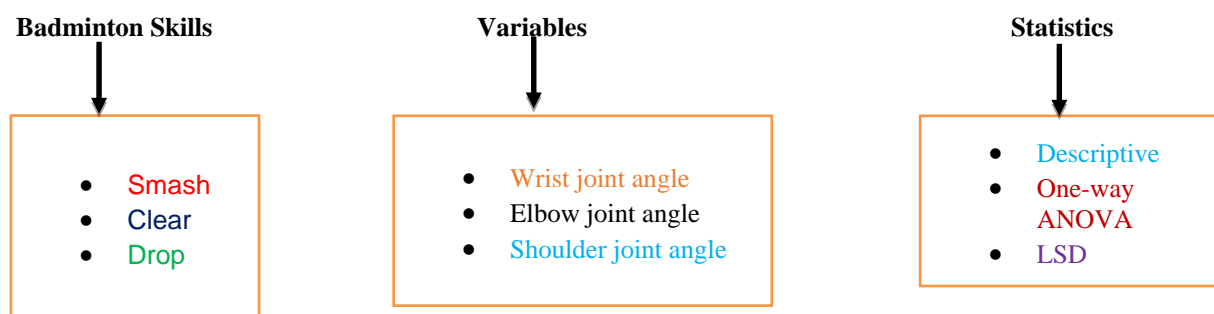
Badminton Skills	**Variables**	**Statistics**
• Smash • Clear • Drop	• Wrist joint angle • Elbow joint angle • Shoulder joint angle	• Descriptive • One-way ANOVA • LSD

Figure 1: Structure of the Study

The subjects were instructed to take a stance position in the centre of the court to prepare to hit the shuttle. The subjects got enough time to warm-up. 2D data including wrist joint angle, elbow joint Angle, shoulder joint Angle were extracted by using Kinovea 0.8.27 software. For the Analysis of the data SPSS 20 software was used. One-way ANOVA was used to see mean differences among forehand overhead smash, forehand overhead clear, forehand overhead drop. The subjects possessed a minimum deviation in Physical characteristics (Age, height, weight, and fat percentage to measures the physiological demography Stadiomerter, Grip strength dynamometer, Skinfold calliper were used.

Table 1: Physical Profile of Selected Subjects of the Study

	N	**Mean**	**Std. Deviation**
Height	10	168.80	3.93
Weight	10	62.50	4.92
Grip Strength	10	44.01	6.20

Abdominal	10	13.60	1.71
Iliac Crest	10	7.90	2.60
Triceps	10	7.90	2.76
Thigh	10	13.60	2.06

In the table 1 showed that mean Height was 168.80 and the standard deviation was 3.93, mean weight was 62.50 and the standard deviation was 4.92, mean Grip strength was 44.01 and the standard deviation was 6.20, mean of abdominal was 13.60 and the standard deviation was 1.71, mean of Iliac Crest was 7.90 and the standard deviation was 2.60, mean of triceps was 7.90 and standard deviation 2.76, mean of the thigh was 13.60 and standard deviation 2.06 (Verma, 2011).

RESULTS AND DISCUSSION

Table 2: Descriptive Study of the shoulder joint, elbow joint, and wrist joint

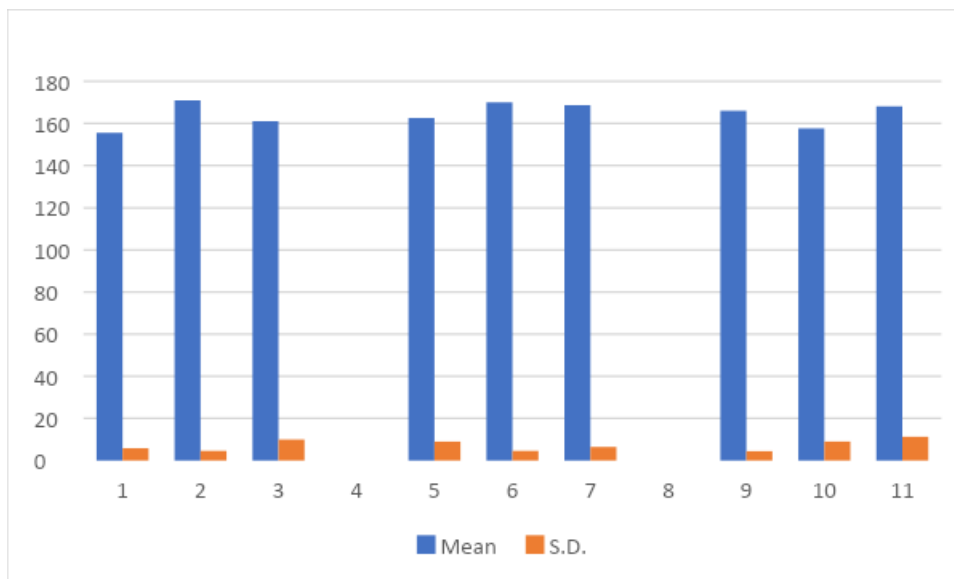| N		Mean	Std. Deviation	Std. Error	N
Shoulder joint	Smash	10	155.50	5.83	1.84
	Clear	10	171.00	4.59	1.45
	Drop	10	161.00	9.97	3.15
Elbow Joint	Smash	10	162.60	8.98	2.84
	Clear	10	171.00	4.59	1.45
	Drop	10	168.70	6.44	2.03
Wrist joint	Smash	10	166.00	4.44	1.40
	Clear	10	157.70	9.01	2.85
	Drop	10	168.20	11.27	3.56

Figure 2: Graphical representation of variables

In Table 2 mean smash of the shoulder joint was 155.50 degree whereas the standard deviation was 5.83 degrees, standard error 1.84. The mean of clear was 171.00 degree whereas Standard deviation was 4.59 degree and standard error was 1.45. The mean value of drop was 161.00 degree Standard deviation was 9.97 degree and standard error was 3.15. In the elbow joint Mean of Smash was 162.60 degree whereas the standard deviation was 8.98 degree, the standard error was 2.84. In case of clear, the mean was 171.00 degree whereas the standard deviation was 4.59 degree and standard error was 1.45. In the skill drop, the mean value was 168.70 degree standard deviation was 6.44 degree and standard error was 2.03. In the wrist, the joint mean smash was 166.00 degree whereas the standard deviation was 4.44 degrees, standard Error 1.40. In case of clear mean was 157.70 degree whereas the standard deviation was 9.01 degree and standard error was 2.85. In the skill drop, the mean value was 168.20 degree standard deviation was 11.27 degree and standard error was 3.56 (Verma, 2011).

Table 3: ANOVA table of the shoulder joint, elbow joint, and wrist joint

		Sum of Square	df	Mean Square	F	Sig.
Shoulder joint	Between Groups	1235.00	2	617.50	11.97	**.000**
	Within Groups	1392.50	27	51.57		
Elbow joint	Between Groups	376.86	2	188.43	3.94	**.031**
	Within Groups	1290.50	27	47.79		
Wrist joint	Between Groups	613.26	2	306.63	4.03	**.029**
	Within Groups	2053.70	27	76.06		

In shoulder Joint, the p-value was 0.00 which was less than 0.05 hence researcher can reveal that there was a significant difference. In Elbow joint the p-value was found to be 0.031 which was less than 0.05 hence null hypotheses was rejected. In the case of wrist joint p-value was found 0.029 which was less than 0.05 hence the null hypothesis was rejected (Verma & Salam, 2019).

Table 4: Post hoc test table of the Shoulder joint, elbow joint, and wrist joint

Dependent Variable	(I)Forehand Overhead Shot	(J)Forehand Overhead Shot	Mean Difference (I-J)	Std. Error	Sig.
Shoulder joint	Smash	Clear	-15.50*	3.21	.000
		Drop	-5.50	3.21	.098
	Clear	Smash	15.50*	3.21	.000
		Drop	10.00*	3.21	.004
	Drop	Smash	5.50	3.21	.098
		Clear	-10.00*	3.21	.004
Elbow Joint	Smash	Clear	-8.40*	3.09	0.01
		Drop	-6.10	3.09	0.06
	Clear	Smash	8.40*	3.09	0.01
		Drop	2.30	3.09	0.46
	Drop	Smash	6.10	3.09	0.06
		Clear	-2.30	3.09	0.46
Wrist joint	Smash	Clear	8.30*	3.90	.043
		Drop	-2.20	3.90	0.57
	Clear	Smash	-8.30*	3.90	.043
		Drop	-10.50*	3.90	.012
	Drop	Smash	2.20	3.90	.577
		Clear	10.50*	3.90	.012

As the F-value is a significance post hoc test required to be done. In comparison, it can be seen that in the case of the shoulder joint when smash compared with clear it was found to be significant as the p-value for the mean difference was 0.00 which was less than 0.05.in the same way when smash was compared with drop it was found to be insignificant as the p-value was 0.09 which was more than 0.05. when clear was compared with drop the p-value was found to be significant as the value was 0.04 which was less than 0.05 (Verma & Salam, 2019). In elbow joint when smash compared with clear p-value was 0.01 which was significant in nature as the value was less than 0.05, in the same way

when the smash compared with drop shot p-value was found to be 0.06 which was more than 0.05 which was insignificant in nature, when clear compared with drop the p-value was 0.46 which was more than 0.05 (Verma & Salam, 2019). In the variable wrist joint when smash was compared with clear the p-value was found to be significant as the value was 0.043 which was less than 0.05.in the same way when Smash was compared with a drop shot the result was found to be insignificant as the p-value was 0.57 which more than 0.05 when clear was compared with Drop the p-value was found to be significant as the value was 0.12 which was more than 0.05 (Verma & Salam, 2019).

The result of kinematical Analysis has shown at the wrist joint angle, at elbow joint angle and shoulder joint angle exhibited significant difference amongst the badminton clear Shot, smash and drop shot. The study agreed with the previous study which was done by Singh, H., Singh, D. (2017).& "Biomechanical analysis of spiking in volleyball" (Singh & Singh, 2017) they took ten Inter-university players and got a significance relationship at the variables Wrist joint, elbow Joint, and Shoulder Joint. The study is also agreed with the previous study with the title on "Kinematical analysis of forehand and backhand smash in badminton" (Hussain & Bari, 2011). They got a significant result in shuttle velocity, contact height, racket angle, wrist angle, the angular velocity of shoulder velocity, and angular Velocity of elbow Joint. The previous result established criteria of different variation of seoi nage technique in Judo to find out the contributing motor fitness factor biomechanical anthropometric flexibility (Sao, 1992) He found the result that some of the variables showed that there is a significant difference those are right shoulder joint angle, right wrist joint angle right knee joint angle, right ankle joint (Sao 1992). It is not possible to get an error-free solution by using a 2D camera to get better results one may go through 3D motion analysis.

CONCLUSION

It was found that there is a significant difference among Badminton Forehand Clear, Smash and Drop shot in Wrist Joint, Elbow Joint, and Shoulder Joint. To execute different Forehand overhead skill player should take a different angle to get more advantages which may lead to winning the game. The research may assist players, coaches, and researchers in performance analysis in Badminton. The study will provide a mechanical area of movement of a pattern of Badminton Players.

LIMITATION AND STUDY FORWARD

Researchers used only two-dimensional Analysis it is not possible to get all the perfect video through the two-dimensional camera so researchers recommend that for further Study one can use three-dimensional Analysis. One can Increase the variables. Similar kinds of research may carry out in other games and sports too. Further researchers can add electromyography to know about the activation of muscles from different angles.

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AUTHORS CONTRIBUTION

First Author had written Introduction, collected the data, and analysed the result. The second author helped in searching Review related literature, Taught to handle the Kinovea Software, Helped in data collection and methodology, and Suggested for the Topic.

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