

Angular Kinematical Analysis of Left Knee Angle in Different Phases of Take-off in Fosbury-Flop Technique in High Jump

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ABSTRACT

Background: The purpose of the study was to assess and compare angular kinematical analysis of Left Knee Angle in different phases of take-off in fosbury - flop technique in high jump.

Methods: Eight male (national / inter university level) high jumpers of Sub Centre Sports Authority of India, Lucknow and Guru Gobind Singh Sports College, Lucknow (who had been participating regularly and who have attained the performance level of 01.95 meters) were selected and their age ranging between 16 to 28 year. The purpose of the study was explained to the subjects and requested to Fosbury-flop technique in high jump in their best effort during each attempt. The data was analyzed by applying Descriptive Statistics (Mean, Standard Deviation) and Analysis of Variance (ANOVA) technique to assess and Compare angular kinematical analysis of Left Knee Angle in different phases of take-off in fosbury - flop technique in high jump. The level of significance was set at 00.05.

Results: There was insignificant difference between initial Take-off and during Take-off of male high jumpers in fosbury flop technique in relation to Left Knee Angle, as mean difference was (7.63), which was lower than the critical difference value of (8.71) Further, significant difference was found between initial Take-off and final Take-off; during Take-off and final Take-off of male high jumpers in Fosbury-flop technique in relation to Left Knee Angle, as mean differences were (15.00) and (22.63) respectively which were higher than the critical difference value of (8.71).

Conclusion: The Left Knee Angle of final Take-off was found greater than during Take-off as well as initial Take-off in Fosbury-flop technique.

Key words: Angular, Kinematical, Fosbury-flop technique, Left Knee joint, Left Knee Angle and High jump.

Objectives of the Study

1. To assess angular kinematical analysis of left knee angle in different phases of take-off in fosbury -flop technique in high jump.
2. To compare angular kinematical analysis of Left Knee Angle in different phases of take-off in fosbury - flop technique in high jump.

PROCEDURE AND METHODOLOGY

Selection of Subjects

For the purpose of the study, Eight male (national / inter university level) high jumpers of Sub Centre Sports Authority of India, Lucknow and Guru Gobind Singh Sports College, Lucknow (who had been participating regularly and who have attained the performance level of 01.95 meters) were selected and their age ranging between 16 to 28 year. The purpose of the

study was explained to the subjects and requested to Fosbury-flop technique in high jump in their best effort during each attempt.

Selection of Variables

Keeping the feasibility criterion in mind, the Angle of Left knee joint variables of different phases of take-off skill in Fosbury-flop technique in high jump was selected for the present study.

1. Angle of Left Knee joint Variables at initial Take-off (touching the ground by Take-off foot) in Fosbury-flop technique in high jump.
2. Angle of Left Knee joint Variables at during Take-off (total body weight on the Take-off foot) in Fosbury-flop technique in high jump.
3. Angle of Left Knee joint Variables at final Take-off in Fosbury-flop technique in high jump.

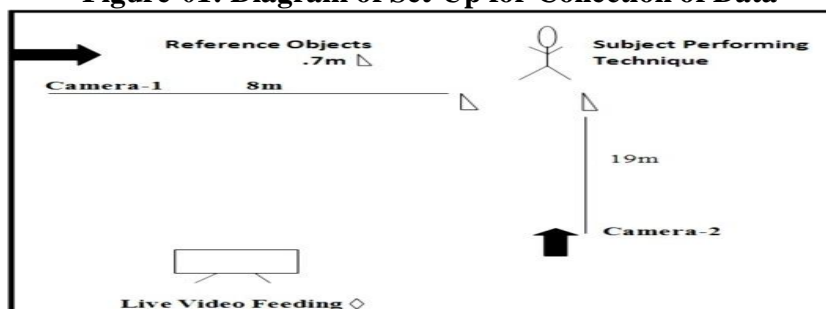
Criterion Measures:

The following criterion measures were adopted for the present study: Angle of Left Knee joint variables of different phases of take-off skill in Fosbury-flop technique was measured by Silicon Coach Pro-7 Motion Analysis Software in degree.

Filming Protocol

The video graphic technique was used for collecting raw data. The video graphs would taken by a professional photographer under the supervision of an expert. According to availability of two Casio EX-F1 high speed camera was used, which have frequency from 60 to 300 frames per second (f/s). The data were recorded from sagittal plane and frontal plane. Camera-01 was placed perpendicular from the subject at a distance of eight meters and above from ground one meter height. Camera-02 placed perpendicular to camera-01 and in front of subject performing the Take-off in Fosbury-flop technique at the distance nineteen meters and above from ground one meter. For the purpose of the analysis of this study three phases were selected was initial, during and final Take-off in Fosbury-flop technique in high jump. The subjects had given two trials for Take-off in Fosbury-flop technique in high jump and the best trial was used for analysis. The set up of collecting data was showed in figure-01.

Figure-01: Diagram of Set-Up for Collection of Data



Procedure for Collecting Angular kinematic Data

On the basis of the video recording, the scholar marked various angular kinematic variables with the help Silicon coach pro-7 motion analysis software i.e. Left knee joint Angle at selected Joints was measured as shown in figures 02, 03 and 04 as follow.

Figure-02: Side View of Initial Take-off (Touch the Ground of Take-off Foot) in Fosbury-flop Technique

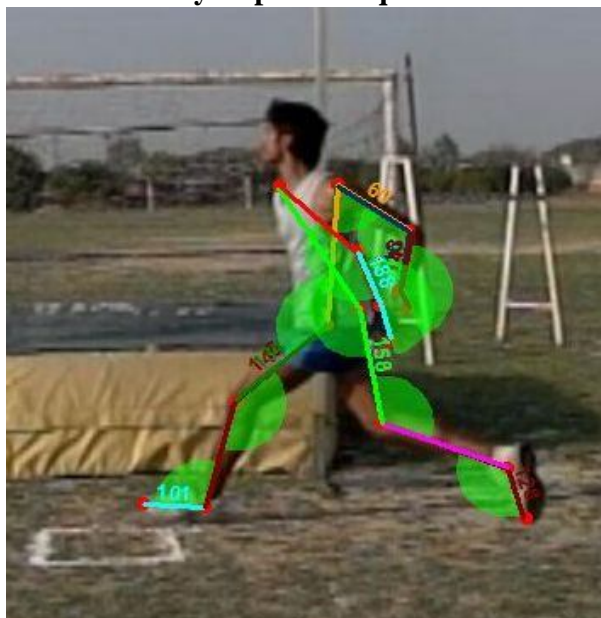
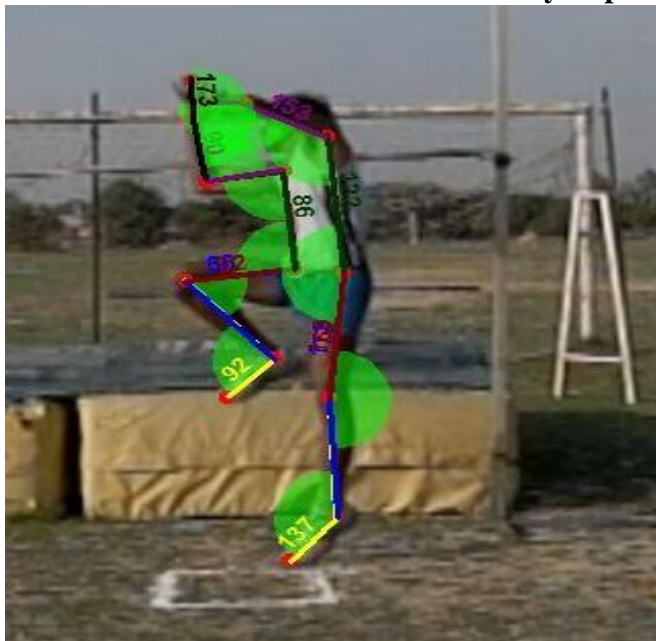


Figure-03: Side View of During Take-off (Total Body Weight on the Take-off Foot) in Fosbury-flop Technique



Figure-04: Side View of Final Take-off in Fosbury-flop Technique



Statistical Technique

1. To Angular kinematical analyze (Left Knee Angle) Take-off skill in Fosbury-flop technique in high jump and to determine the key components of Take-off in Fosbury-flop technique, descriptive statistic was used.
2. To Angular kinematical compare (Left Knee Angle) the different phase of Take-off skill in Fosbury-flop technique in high jump, analysis of variance (ANOVA) was used.
3. The level of significance was set at 0.05.

RESULTS OF THE STUDY

The findings pertaining to descriptive statistics, one way analysis of variance (ANOVA) as well as post hoc test for the Angle of Left knee joint variable of Eight male (national / inter university level) high jumpers of Sub Centre Sports Authority of India, Lucknow and Guru Gobind Singh Sports College, Lucknow have been presented in table no. 01 to 03.

Table-01: Descriptive Statistics of Male High Jumpers in Relation to Left Knee Angle in different phases of (Initial, during and Final) Take-off in fosbury –flop technique

Variables	Initial Take-off	during Take-off	Final Take-off
Mean	147.88	140.25	162.88
Standard Deviation	12.26	05.01	05.91
Standard Error	04.34	01.77	02.09
Range	41.00	14.00	20.00
Minimum	119.00	134.00	154.00

Maximum	160.00	148.00	174.00
Sum	1183.00	1122.00	1303.00

It is evident from table - 01 that mean, standard deviation, scores of angle of Left Knee joint in different phases of (Initial, during and Final) take-off in fosbury –flop technique in high have been found as follow: Left Knee joint in initial take-off (147.88 ± 12.26), Left Knee joint in during take-off (140.25 ± 05.01) and Left Knee joint in final take-off (162.88 ± 05.91), respectively.

Table-02: Analysis of Variance of High Jumpers in Relation to Left Knee Angle of Initial Take-off, During Take-off and Final Take-off in Fosbury Flop Technique

Source of Variation	Sum of Squares	df	Mean Square	F-Value
Between Groups	2120.08	2	1060.04	15.11*
Within Groups	1473.25	21	70.16	

* Significant at 0.05 level of significance

F 0.05 (2, 21) = 3.47

Table- 14 revealed that there was significant difference among initial Take-off, during Take-off and final Take-off of male high jumpers in fosbury flop technique in relation to Left Knee Angle, as obtained F-ratio was (15.11), which was higher than the tabulated value of (3.47), at 0.05 level with (2, 21) degree of freedom.

Since the one way analysis of variance was found significant in relation to Left Ankle Angle, the LSD test was applied to find out the differences of the paired means among initial Take-off, during Take-off and final Take-off of male players in Fosbury-flop technique.

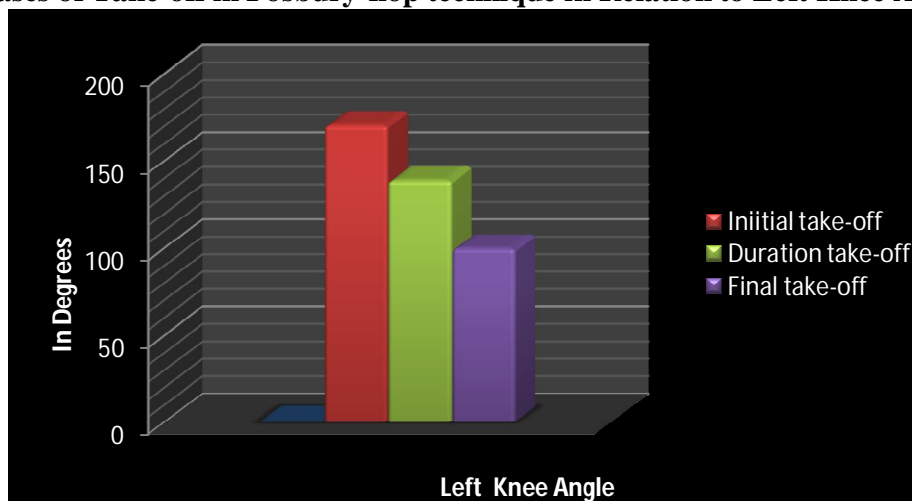
Table-03: Least Significant Difference (LSD) Post Hoc Test for the Paired Means among Initial Take-off, During Take-off and Final Take-off of Male high jumpers in Fosbury-flop Technique in Relation to Left Knee Angle

Left Knee Angle at Initial Take-off	Left Knee Angle During Take-off	Left Knee Angle at Final Take-off	Mean Difference	Critical Difference
147.88	140.25		7.63	08.71
147.88		162.88	15.00*	
	140.25	162.88	22.63*	

* Significant at 0.05 level of significance

Table- 15 revealed that there was insignificant difference between initial Take-off and during Take-off of male high jumpers in fosbury flop technique in relation to Left Knee Angle, as mean difference was (7.63), which was lower than the critical difference value of (8.71) Further, significant difference was found between initial Take-off and final Take-off; during Take-off and final Take-off of male high jumpers in Fosbury-flop technique in relation to Left Knee Angle, as mean differences were (15.00) and (22.63) respectively which were higher than the critical difference value of (8.71).

Figure-05: Graphical Representation of Comparison of Means of Jumpers at Different Phases of Take-off in Fosbury-flop technique in Relation to Left Knee Angle



The Left Knee Angle of initial Take-off was found greater than during Take-off as well as final Take-off in Fosbury-flop technique.

DISCUSSION AND FINDING

The findings of the study revealed that the In case of angular kinematical variable (Left Knee Angle) significant difference was found among initial Take-off, during Take-off and final Take-off of male high jumpers in Fosbury-flop technique in relation to left knee angle. Further, insignificant difference was found between initial Take-off and during Take-off of male high jumpers in Fosbury-flop technique in relation to left knee angle, as mean difference was lower than the critical difference value. Further, significant difference was found between initial Take-off and final Take-off; during Take-off and final Take-off of male high jumpers of Fosbury-flop technique in relation to left knee angle, as mean differences were higher than the critical difference value. This may be attributed to the fact that at initial Take-off the position of the left knee was slightly flexed with mean knee angle of (147.88°) while during Take-off, the knee was flexed with angle of (140.25°) and at final Take-off the knee was extended with angle of (162.88°) to obtain vertical CM velocity and to achieve the maximum high jump. The present study is also supported by **Michiyoshi Ae, Ryu Nagahara et. al. (2008)** conducted the study on the top three male high jumpers at the 2007 World Championships the results indicate (Thomas) effectively used the rotation of the body as well as the strong knee extension to obtain vertical CM velocity during the take-off phase. However, it reveals that they all inclined the shank steeply forward, regardless of the degree of the knee flexion during the support phase of the last stride. In sprint running, it is said that the forward lean of the support shank in the first half of the support phase is a critical factor for decreasing the negative braking force. The technique of inclining the shank forward may be a reason why the three jumpers could minimise the decrease in the horizontal CM velocity during the final phase of the approach. It was reported that the knee joint angle was 127.9° in the develop great force of the abductors and the ground reaction forces and contribute to raising Thomas' body upward.

Finally, the sequence of performance was found that the left knee angle of initial Take-off was found greater than during Take-off as well as final Take-off in Fosbury-flop technique.

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