

Javelin Throwing Technique: A Biomechanical Study

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Abstract:

The purpose of this study was to analyze by correlational methods the biomechanical factors involved in achieving the maximal distance thrown in the javelin event. Six athlete from Aligarh Muslim University, Aligarh India were filmed by a two high speed Canon Legaria SF-10, 8.1 Mp cameras in a field setting with (1/2000 shutter speed and at 30-60fps). The cameras were set-up on a rigid tripod and secured to the floor in the location. First camera was located to obtain maximum accuracy and second camera located to view the throwing performances, at given specified distance in the reconstruction of the two dimensional co-ordinate. The locations of camera were chosen so that the optical axes of camera intersected perpendicularly to the designated plane. Results of this study shows positive significant correlation was found between the throwing distance and the initial velocity, insignificant correlations were found between the throw distance and the release angle, attitude angle, attack angle and release height of javelin at the moment of javelin release. The results suggest that in order to attain maximal distance thrown the javelin thrower should achieve positive acceleration during the running approach, effective thrusting with the right leg on the penultimate stride and carry the javelin during the last strides at the optimal angle of release.

Keywords: *Javelin, Mechanics, Trajectory, Kinematics, body segment*

1. Introduction:

The throwing techniques in javelin, the velocity at which the thrower releases the implement is by far the most important factor (Morris and Baruev., 1996). This high percentage shows just how important the movements of the smaller body segments are to the acceleration of the implement. Because the movements of the athlete are so fast during the delivery action, biomechanical analysis equipment (normally high speed cameras) is often used to provide an objective measure of the throwing techniques of elite athletes. Biomechanical Analysis of javelin throw has been carried out maximum on the basis of release parameters such as the initial velocity, release angle, attitude angle, attack angle and release height of javelin (Bartlett R. et al., 1988;). These papers have argued that the most important factor necessary for achieving a performance was a high initial velocity at the moment of javelin release. However, the papers did not clarify the throwing movement in detail. Mero et al.(1994) have investigated the body segment contribution to javelin throwing of male and female finalists in the 1992 Olympic Games in Barcelona. They compared the mean values of many kinematic parameters between male and female finalists and find out the differences of both groups. However, relationships between the javelin throw movements and throw distance were not clarified. The purpose of the present study was to investigate the relationships between the throw distance and the kinematic parameters of javelin throw to clarify the characteristics of the throwing movement of A.M.U, Aligarh Javelin throwers.

2.Methodology:

2.1 Materials and Methods:

2.2 Subjects:

The six male javelin throwers analyzed in this study were representative Aligarh Muslim University, Aligarh in All- India Athletic meets from 2008 to 2010. All javelin throwers were randomly selected for the purpose of the study. The entire selected thrower have readily agreed and volunteered to act as subject for the study during practice session at Aligarh Muslim University, Aligarh Athletic ground. Their age, height, and body mass were 21.87 ± 1.64 yrs., 1.69 ± 0.35 m, and 67.33 ± 6.21 kg, respectively.

2.3 Videography Techniques

The video graphic technique was further organized into two sections. These are:

- (i) Video Graphic Equipments and Location
- (ii) Subject and Trail Identification

(i) Videographic Equipments and Location

The subject's throwing motion were recorded using Legaria Canon SF-10, 8.1 Mp video camera in a field setting operating at a nominal frame rate of 50 Hz and with a shutter speed of 1/2000 s and at 60fps camera were set up 08 m away from the subject in a field setting. The camera was set-up on a rigid tripod and secured to the floor in the location. The camera was positioned perpendicular to the sagittal plane and parallel to the mediolateral axis (camera optical axes perpendicular on the sagittal plane) as their thrower's arm giving approximately a 90° between their respective optical axes. The camera was also elevated to 95 cms and tilted down in order to get the image of the subject as large as possible while that all points of interested remained totally within.

(ii) Subject and trail Identifications

To identification the subject in the video graph, each subject was given a number as to separate in the data recorded. For identification purposes of a best performance, the trails were viewed on the computer system and exarter on the subject (thrower) demarketed the trail for the data acquisition.

2.4 Data reduction:

After video recording sessions were over, the video recording was loaded into the researcher's personal computer (PC) for trail identification. The identified trails were played with the help of Silicon Coach Pro-7 software to make separate clips of each badminton player. The separate clips were then opened on to the Silicon Coach Pro-7 software. We calculated the release parameters (velocity, release angle, attitude angle and attack angle), the approach run velocity calculated from the body center of gravity (B.C.G) immediately before the rear foot contact in the final phase of javelin throwing, the pull distance and pull time (distance and time of javelin movement from the rear foot contact to javelin release, respectively), the joint and segment angles at the instant of javelin release. Further, the theoretical distance was calculated by the following estimate equation.

$$D = \frac{1}{g} v \cos \theta \{v \sin \theta + \sqrt{(v \sin \theta)^2 + 2gh}\} \text{---- (1)}$$

$$x = (u \cos \theta) \cdot T \text{---- (2)}$$

$$y = (\tan \theta)x - 1/2 \cdot g/u^2 \cos^2 \theta X^2 \text{---- (3)}$$

Where D; the theoretical distance

Y; displacement into vertical direction

X; displacement into horizontal direction after time t

v; the initial velocity at the moment of javelin release

θ; the release angle

g; the acceleration due to gravity

h; the release height

This equation is quadric in X and linear in y.

Significance level was set at 5% (Pearson's product-moment correlation coefficient) in this study.

3. Results:

Consequence of the study shows, although a convinced significant correlation was determined between the initial velocity of javelin throughout throws and the throwing distance ($r = 0.764$, $p < 0.05$ as well as 0.01), insignificant correlation were found between the javelin throw distance and the different release angle, position angle, attack angle, and release height of javelin during performance. A significant direct correlation was obtained between the throwing distance and the calculated theoretical distance of the javelin throwing performance ($r = 0.879$, $p < 0.01$ as well as 0.05). The pull distance was positively correlated and significant with the throw distance ($r = 0.415$, $p < 0.01$ as well as 0.05), but the pull time was negatively correlated ($r = -0.401$, $p < 0.01$ as well as 0.05). The significant direct correlation among the throwing distance and the approach run velocity was mentioned ($r = 0.722$, $p < 0.01$ as well as 0.05).

Segment angles of the throwing arm at the moment of javelin release, although the negatively significant correlations were determined between the throw distance and the elbow joint angle ($r = -0.451$, $p < 0.01$ as well as 0.05) and adduction/abduction angle of the shoulder joint ($r = -0.458$, $p < 0.01$ as well as 0.05), the horizontal adduction/abduction angle of the shoulder joint observed insignificant correlation with the throw distance.

Trunk angle and fore leg knee joint at the time of moment of javelin release, although a throw distance positively significant correlated with forward trunk rotation angle ($r = 0.457$, $p < 0.01$ as well as 0.05), insignificant positive correlation was found between the throw distance and the lateral rotation angle of the trunk during javelin throwing. The throw distance and the fore leg knee joint angle depicted the significant positive correlation ($r = 0.279$, $p < 0.05$).

4. Discussion

The purpose of this study was to elucidate the kinematic features of the javelin throwing movements of Aligarh Muslim University (A.M.U), Aligarh Javelin throwers and following findings were found: the evaluation of release parameters of A.M.U, Athlete were mechanically consistent not in performance aspect those of males athlete reported by Mero et al. (1994). The pattern of motion used in the javelin throw is similar to other movements used when striking or throwing an object (Atwater, 1979; Menzel, 1987). Although a positive significant correlation was found between the throwing distance and the initial velocity, insignificant correlations were found between the throw distance and the release angle, attitude angle, attack angle and release height of javelin at the moment of javelin release. These results were logical with other studies that point the initial velocity of javelin release is the most significant factor for accomplishing a high performance (Gregor R.J., 1985; Bartlett R. et al., 1988).

A positive significant correlation was found between the throwing distance and the theoretical distance. And almost all throw distances of others were let down than their theoretical distances. The results propose that the environmental factors interfered with the trajectory of javelin; e.g. atmospheric pressure, weather, atmospheric temperature, wind speed and direction, and so on. However, the athlete represent A.M.U, Aligarh in All- India Athletic meet did almost same or mostly even higher throw distance than the theoretical. The results suggest that the A.M.U representative in All- India Athletic meet had no ability to receive the environmental information and react efficiently to it due to non-professional attitude of the athlete. The results suggest that performer performed the large and fast throwing motion during the final phase, and the motion is crucial to the javelin throw. The finalists had a tendency towards a decreased elbow joint angle at the moment of javelin release of which value was similar to that reported by Mero et al. (1994). The internal rotation velocity of the shoulder joint can be transferred to the grip velocity most effectively when the elbow joint is right angle, theoretically. Further, the finalists had a course towards an

increased forward rotation angle of the trunk and an extension of the front knee angle at the moment of javelin release. The present results very essential, for the enhancement and betterment of their performance.

5. Conclusion.

The lead component for accomplishing an eminent performance was the initial velocity of javelin during the throwing performance. And the features of throwing movement of representative A.M.U, Aligarh in All-India Athletic Meet to find quicker initial velocity of javelin were as follows. They approach with faster velocity and keep the fore knee angle in the extended position throughout the final phase of throwing to change the approach velocity into the forward rotation of trunk.

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