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Kinematic Analysis of the Final Release position of elite Archer

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Abstract: The purpose of the study was kinematical analysis of an Elite archers. In present study total sample five Indian International level male Recurve category Archers was selected by Purposive sampling technique from SAI Archery training Center Sonipat. The age of the subjects was between 24 (± 5) years, hight of the subjects 6.0` (± 5 Inch), participation year between 2016-2022, shooting FITA score between 650-720 in archery was selected as a subjects for the study. According to Casio EX-F1 high speed camera was used, which have frequency from 60-300 frames per second (f/s). The data were recorded from Superior view, Lateral view, Anterior view and Medial view. The distance between shooting line and target is 70 meter. Shooting line is passed horizontally through the Center of Gravity box, Center of Gravity box is a square box drown with the measurement of 1×1 m, Center of Gravity box is equally divided into 4 parts. A straight line is passed vertically on it and a horizontal line which is shooting line and is drawn 70 meter apart from the target. The distance between bull eye of the target and the floor surface is 5 feet. Siliconcoach Pro8 update motion analysis software and Tracker motion analysis software was used for kinematical analysis of at the time of final release position in archery. Descriptive statistic was used. To find out multi correlation between dependent variable performance on target 1-10 (bull eye) in points and independent variables (selected linear variables). The significant correlation was found between Height of body Center of Mass, Height of body Center of Gravity, Height of Projectile and obtained value (-.893), (.878), (-.945) is greater than tabulated value of (.878) therefore it shows significant relationship of this independent variable with performance in archery. Whereas, in case of Body force aliment right medial, Body force aliment left medial the obtained values (.360) and (.770) are lower than tabulated value of (.878) therefore it shows insignificant relationship of these independent variable with performance in archery. The significant correlations with height variables suggest that certain aspects of an archer's body positioning, such as the height of the center of mass, center of gravity, and projectile, play a crucial role in archery performance. The negative correlation with the height of the center of mass implies that a lower center of mass is associated with better performance. The insignificant correlations with body forced alignment variables suggest that, at least within the parameters measured, the lateral alignment of the body (right and left medial) does not significantly influence performance in archery. Since the significant relationship was found between Height of body Center of Mass and Height of body Center of Gravity, Height of Projectile and Body force aliment left medial of the subject among independent variables as calculated “r” (-.960), (.887), (-.959) is found greater than the required tabulated value of (.878) at .05 level of significance. In case be seen the significant relationship was found between Height of body Center of Gravity and Body force aliment left medial of the subject among independent variables as calculated “r” (.935), is found greater than the required tabulated value of (.878) at .05 level of significance. The strong correlations among these variables indicate a close relationship between the height-related kinematic variables (center of mass, center of gravity, and projectile) and the lateral alignment of the body (body forced alignment left medial). The negative correlations suggest that as the height of the center of mass decreases, the height of the center of gravity and the height of the projectile tend to decrease, and as the height of the projectile decreases, the body forced alignment left medial tends to increase. The study concludes that there is a statistically significant and positive relationship between the height of the center of gravity and body forced alignment on the left medial side in archery. This finding implies that variations in the height of the center of gravity are associated with corresponding changes in the lateral alignment of the body, specifically towards the left medial side.

Keywords: Kinematic, Release position, elite Archer

X

INTRODUCTION

With limbs that curve away from the archer when the bow is unstrung, a recurve bow is one of the primary forms an archer might use. The arrow has more energy and speed when shot from a recurve bow because it stores and releases energy more effectively than an identical straight-limbed bow. For a given amount of arrow energy, a recurve allows for a shorter bow than a standard straight limb bow; hence, archers frequently favoured this form when using long weapons, such as in bush and woodland terrain or while mounted.

Additionally, recurved limbs may produce more noise during a shot and put more strain on the components that make up the bow. When strung, the bow becomes unstable due to extreme recurves. Many Native American weapons were mistakenly strung backwards and broken when attempts were made to shoot them after being isolated from their original owners and cultures. An unstrung recurve bow might have an unclear shape. (Gladys and Reginald Laubin, 1980) A preparation made from bovine tendon and pearl glue, which is used in traditional Asiatic recurve bows, was tested by Hepworth and Smith in 2002. The results showed that the composite "was found to absorb 18 MJ/m3 of energy to failure, comparable to carbon fibre composites, spring steel, and butyl rubber."(D.G. Hepworth and J.P., 2002)

Because the trigger mechanism located close to the release's head makes it easy to operate the calliper open and closed quickly and effectively, wrist trigger releases are the most common type of calliper style releases. This release is easy to use and reliable because it has just one or a few moving parts. (Alyssa L. Haukom, 2014)

The measurement of the kinematic quantities needed to characterise motion is known as kinematic analysis. For example, in engineering, kinematic analysis can be used to determine a mechanism's range of motion, and kinematic synthesis can be used to create a mechanism with a desired range of motion. McCarthy, J. M., and Soh, G. S. (2010) Furthermore, the mechanical advantage of a mechanical system or mechanism is studied by kinematics through the application of algebraic geometry.

The human body is viewed as a machine in macro scale modelling. Muscles are cables that exert forces to support the skeleton, joints are hinges, and bones are structural parts in this machine. The skeletal system is capable of supporting loads in both tension and compression (pulling and pushing). Bones can support a bending moment about a joint by acting as levers. However, in order to support the basic structure of these bones as well as any misalignment, moment, or movement, muscles are needed.

The kinematic analysis of linear motion is known as linear kinematics. When an object is moving linearly, all of its particles follow parallel pathways and travel the same distance in the same period of time. Due to angular motion occurring at the body's joints, this kind of motion is extremely rare in human movement. Exercises like walking and running, for instance, resemble linear motion at the level of the entire body, but they are not considered pure linear motion because the arms and legs rotate.

METHODOLOGY

The selection of subjects

Sampling is a crucial research procedure, particularly when data collection from a specific or limited population is required. In present study total sample five Indian International level male Recurve category Archers was selected by Purposive sampling technique from SAI Archery training Center Sonipat. The age of the subjects was between 24 (± 5) years, hight of the subjects 6.0` (± 5 Inch), participation year between 2016-2022, shooting FITA score between 650-720 in archery was selected as a subjects for the study. (**H. Ertan et al. 2005**)

Collection of Data

The following describes the subjects' performance in the archery, filming protocol, and analysis. To see the effect of accurate pull push technique of archery on the scoring of the performance of the each subject measured by using the standard procedures of (WAF). Three trials given to each subject and after that all attempt considered.

Filming Protocol

Raw data was gathered using the video graphic technique. Under the guidance of an expert, a professional photographer would capture the video graphics. A high-speed camera, the Casio EX-F1, with a frequency of between 60 -300 frames per second (f/s), was reportedly employed. (**Saptadeep debnath et. Al., 2016**) The data were recorded from Superior view, Lateral view, Anterior view and Medial view. The distance between shooting line and target is 70 meter. Shooting line is passed horizontally through the Center of Gravity box, Center of Gravity box is a square box drown with the measurement of 1×1 m, Center of Gravity box is equally divided into 4 parts. A straight line is passed vertically on it and a horizontal line which is shooting line and is drawn 70 meter apart from the target. The distance between bull eye of the target and the floor surface is 5 feet (figure no. 1). (**Euro NCAP, 2020**)

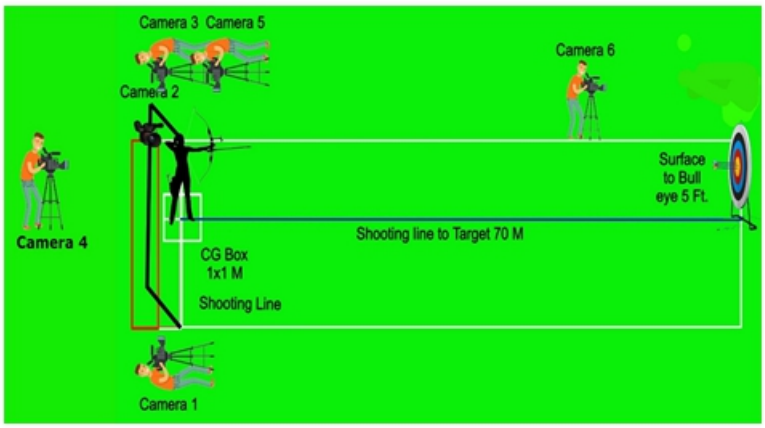


Figure 1: Diagram of the set-up of collecting data was showed in three-dimensional coordinate system is described.

6 cameras are used

Camera 1- camera 1 is fixed anterior and according to the height of the subject particularly focusing eye contact of the subject. A videographer was operating this camera. **Camera 2** -camera 2 is fixed upside with automated recording itself to capture the view from the cephalic side of the subject. The distance between

camera and subject was 2 meter apart from shoulder height of subject.

Camera 3- camera 3 is fixed Posterior to the subject with 6 m distance and height of the subject shoulder level with the purpose of focusing of the subject. **Camera 4**- camera 4 is permanently fixed on the Anterior of the subject and the purpose of the camera is to film the bow vertical alignment. The distance between camera 4 and floor surface is 5.7 feet.

Camera 5 - camera 5 is placed parallel to the Archer's clicker level and is placed 6 m apart from Center of Gravity box. The purpose of the camera is to focus the height of the projectile and projectile angle.

Camera 6- camera 6 is placed 30° lateral from the target with the distance of 10 m. It is placed precisely the bull eye level of the target particularly for focusing the accuracy.

For the purpose of the analysis of this study one phase were selected was final release position in archery. The subject is said to stand inside the Center of Gravity box with equipment. On the first whistle subject can aim the target. Second whistle was blown two times, the subject cam shoot 6 arrows with in time taken to shoot an arrow/100 second after this whistle is blown and stop the arrow shooting. (**Saptadeep debnath et. Al., 2016**)

Analysis of Data

Siliconcoach Pro8 update motion analysis software and Tracker motion analysis software was used for kinematical analysis of at the time of final release position in archery. To analyze kinematical aspect of at the time of final release position in archery, Descriptive statistic was used. Pearson multi correlation was used to determine the multi correlation between the dependent variable—performance on targets 1–10 (bull eye) in points—and the independent variables—selected linear variables—at the moment of the archer's final release position. In order to determine the regression equation between the independent factors (chosen linear variables) and the dependent variable (performance on targets 1–10, or bull eyes), in points, at the moment of the archery final release position, We employed the linear regression entry method. The statistical significance was determined by setting the level of significance at 0.05. Social science statistical software (SPSS 20.0 Version) were used to analyse the data.

Figure 2: Linear kinematics analysis at the time of final release position in archery.

RESULTS

Here, the findings are displayed in tabular form. Three sections, Section 1, and Section 2, include the

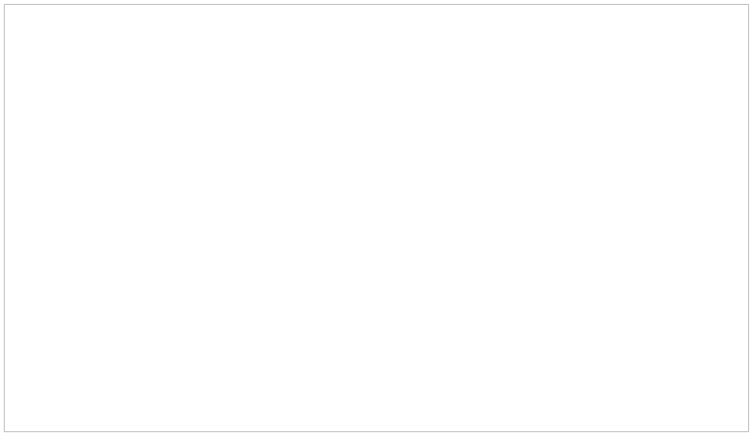
findings related to the study that was presented. Descriptive statistics, such as mean, standard deviation, minimum, maximum, and total, are covered in Section 1. Section 2 deals with multi correlation statistics in case of the present study has been presented as bellow:

Section- I

Table 1: Descriptive Statistic of Performance and Linear Variables at the time of final release position of elite archers.

Table 01 makes clear that the scores' mean and standard deviation of performance and Linear parameters was found as follow: Performance in points (9.97 ± 0.044), Height of body Center of Mass in cm (100.46 ± 0.57), Height of body Center of Gravity in cm (100.79± 0.80), Height of Projectile in cm (170.93 ± 0.64), Body force aliment right medial in percentage (43.58 ± 0.18), Body force aliment left medial in percentage (56.61 ± 1.55) respectively whereas Minimum and Maximum of scores was found as follow: Performance in points (9.9 & 10), Height of body Center of Mass in cm (100 & 101.11), Height of body Center of Gravity in cm (99.91 & 101.70), Height of Projectile in cm (170.33 & 171.83), Body force aliment right medial in percentage (43.38 & 43.86),Body force aliment left medial in percentage (54.48 & 58.13) respectively.

Graphical representation of mean and standard deviation scores of Performance and Linear Variables at the time of final release position of elite archers.



Section-2

to ascertain the correlation between the archery performance at the final release location and the linear and angular kinematical factors. The multi correlation statistics (Pearson Correlation) was used to analyse the collected data, and the resulting data has been given.

Table 2: Relationship of Linear kinematical variables with the performance at the time of final release position in archery.

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Coefficient of correlation required to be significant at 3 degree of freedom = (.878)

Table -2 reveals that in case of Height of body Center of Mass, Height of body Center of Gravity, Height of Projectile and obtained value (-.893), (.878), (-.945) is greater than tabulated value of (.878) therefore it shows significant relationship of this independent variable with performance in archery. Whereas, in case of Body force aliment right medial, Body force aliment left medial the obtained values (.360) and (.770) are lower than tabulated value of (.878) therefore it shows insignificant relationship of these independent variable with performance in archery.

Since the significant relationship was found between Height of body Center of Mass and Height of body Center of Gravity, Height of Projectile and Body force aliment left medial of the subject among independent variables as calculated "r" (-.960), (.887), (-.959) is found greater than the required tabulated value of (.878) at .05 level of significance.

In case be seen the significant relationship was found between Height of body Center of Gravity and Body force aliment left medial of the subject among independent variables as calculated "r" (.935), is found greater than the required tabulated value of (.878) at .05 level of significance.

DISCUSSION OF FINDING

In case of linear kinematical variable. The significant correlation was found between Height of body Center of Mass, Height of body Center of Gravity, Height of Projectile and obtained value (-.893), (.878), (-.945) is greater than tabulated value of (.878) therefore it shows significant relationship of this independent variable with performance in archery. Whereas, in case of Body force aliment right medial, Body force aliment left medial the obtained values (.360) and (.770) are lower than tabulated value of (.878) therefore

it shows insignificant relationship of these independent variable with performance in archery.

The significant correlations with height variables suggest that certain aspects of an archer's body positioning, such as the height of the center of mass, center of gravity, and projectile, play a crucial role in archery performance. The negative correlation with the height of the center of mass implies that a lower center of mass is associated with better performance.

The insignificant correlations with body forced alignment variables suggest that, at least within the parameters measured, the lateral alignment of the body (right and left medial) does not significantly influence performance in archery.

Since the significant relationship was found between Height of body Center of Mass and Height of body Center of Gravity, Height of Projectile and Body force aliment left medial of the subject among independent variables as calculated "r" (-.960), (.887), (-.959) is found greater than the required tabulated value of (.878) at .05 level of significance.

The strong correlations among these variables indicate a close relationship between the height-related kinematic variables (center of mass, center of gravity, and projectile) and the lateral alignment of the body (body forced alignment left medial).

The negative correlations suggest that as the height of the center of mass decreases, the height of the center of gravity and the height of the projectile tend to decrease, and as the height of the projectile decreases, the body forced alignment left medial tends to increase.

In case be seen the significant relationship was found between Height of body Center of Gravity and Body force aliment left medial of the subject among independent variables as calculated "r" (.935), is found greater than the required tabulated value of (.878) at .05 level of significance.

The study concludes that there is a statistically significant and positive relationship between the height of the center of gravity and body forced alignment on the left medial side in archery.

This finding implies that variations in the height of the center of gravity are associated with corresponding changes in the lateral alignment of the body, specifically towards the left medial side.

CONCLUSION

On the basis of the findings of the study, the following conclusions are drawn: -

There is a significant negative correlation between the height of the center of mass and performance, and significant positive correlations between the height of the center of gravity and height of projectile with performance in archery. The negative sign indicates an inverse relationship for the height of the center of mass.

There is an insignificant positive correlation between body forced alignment right medial and performance in archery. There is an insignificant positive correlation between body forced alignment left medial and performance in archery.

There is a highly significant negative correlation between the height of the center of mass and the height of the center of gravity in archery. The negative sign indicates an inverse relationship, suggesting that as the height of the center of mass decreases, the height of the center of gravity tends to decrease as well.

There is a highly significant positive correlation between the height of the center of mass and the height of the projectile in archery. This indicates that as the height of the center of mass increases, the height of the projectile also tends to increase.

There is a highly significant negative correlation between the height of the center of gravity and the height of the projectile in archery. This suggests that as the height of the center of gravity decreases, the height of the projectile tends to increase.

There is a highly significant negative correlation between the height of the projectile and body forced alignment left medial in archery. This implies that as the height of the projectile decreases, the body forced alignment left medial tends to increase.

There is a highly significant positive correlation between the height of the center of gravity and body forced alignment left medial in archery. The positive correlation suggests that as the height of the center of gravity increases, there is a tendency for the body to be forced toward the left medial side.

SECTION TITLE 6

SECTION TITLE 7

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