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Biomechancal analysis of pitching in baseball

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Abstract
The purpose of the present study was to investigate the relationships between the kinematic analysis and performance of pitchers. Total six pitchers were selected as a sample: Indian international male pitchers who had represented at international level were selected as a sample on the basis of performance in preceding competition. The age of all the subjects was ranged above 22 to 26 years. The kinematic variables were knee angle, ankle angle at the time of pitching and performance of pitchers. The Kinematic Analysis of pitchers mean, standard deviation and Karl Pearson's product moment coefficient correlation were employed with the help of statistical package of SPSS. The level of significance was set at 0.05. The outcome of the study shows that significant relationship with performance (.772, .971) of pitchers in all variables.

Keywords: Kinematic, knee angle, ankle angle

Introduction
The biomechanics of pitching are studied extensively. The phases of throwing embrace windup, early cocking, late cocking, early acceleration, late acceleration, speed, and follow-through. Pitchers throw a spread of pitches, every of that features a slightly totally different rate, trajectory, movement, hand position, radiocarpal joint position and/or arm angle. These variations are introduced to confuse the batter in varied ways in which, and ultimately aid the defensive team in obtaining the batter or base runners out. To get selection, and so enhance defensive baseball strategy, the pitcher manipulates the grip on the ball at the purpose of unleash. Variations within the grip cause the seams to "catch" the air otherwise, thereby dynamic the flight of the ball, creating it more durable for the batter to hit. The choice of that pitch to use will rely on a good kind of factors together with the kind of hitter, who is being long-faced, whether or not there are any base runners, what percentage outs are created within the play, and also the current score.

Methodology and Procedure
The present study was entitled as "Biomechanical Analysis of Pitching in Baseball". Total six pitchers were selected as a sample: Indian international male pitchers who had represented at international level were selected as a sample on the basis of performance in preceding competition. The age of all the subjects was ranged above 22 to 26 years. The kinematic variables were knee angle, ankle angle at the time of pitching and performance of pitchers. The criterion measure for this study was the performance of the pitcher. Total of fifteen attempts were given to each subject. The performance of each pitch was judged accurately and performance was recorded.

Filming protocol: Digital videography was used to analysis the kinematic variables of male pitcher. Motion capture technique was used in this study. To recorded the video of the pichers, while they performing the pitch digital video camera (50 fps) was used by a professional photographer. After obtaining the recorded video, the video will be analyzed through quintic coaching v-17 software approved by Human kinetics.

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First video was digitized through quintic coaching v-17 software. After the procedure of digitizing, the video was calibrated. The calibrated video gives us the results through makers, stroboscopic effect technique, stick figures, stopwatch programming, angle manual (horizontal, vertical, draw angles), linear and angular analysis manual etc. with the help of "quintic coaching v-17 software." Motion capture technique Digital video camera CASIO EX-FH 100 (50 fps) was used for videography of pitcher performance. The performance of the subject was recorded with stroboscopic effect from approach to landing. Digital Video camera was placed 7 meter away at the side of pitching plate (lateral axis) of the pitcher.

Administration of the test: SIX Indian international male pitchers who had represented at international level were selected as a sample. All the selected subjects were asked to perform the pitching with their full potential and accurate technique. The pitchers were well directed, informed and prepared for the study. Fifteen chances were given to every pitcher. They were asked to perform the pitching in the natural way as they actually perform. Ten marks were given for each accurate pitch and zero marks were given for wrong pitch. It was ascertain that subjects possess reasonable level of technique. Players were video graphing with systematic filming method as required. Motion capture technique was used in this study. To recorded the video of the pitchers, while they performing the pitch, digital video camera (50 fps) will be using by a professional photographer. Digital Video camera was placed 7 meter away at the perpendicular to the plane of motion. The height of the camera was 1.49 metres.

Analysis of film and collection of data: Motion capture technique was used in this study. The films were analyzed by used standard "Quintic Coaching v-17 software" approved by Human kinetics. Videos analyzing through strobed photo sequence / stroboscopic effect, stick figure analysis, Quick snap shots with the help of software for analysis of selected variables are presented below

- Angle of knee joint at the time of pitching
- Angle of ankle joint at the time of pitching

Measurement of body angles: Angles were measured through videography technique. The videos of the pitchers were traced with the help of "quintic coaching v-17 software" by using auto tracking markers on the selected body joints of pitcher. Using auto tracking markers in "quintic coaching v-17 software" we diagram the video of pitcher at pitching. In order to receive the complete segmental diagram 'angle finding' option was selected in the software and marks of demanded joints were connected. After completing the marking by joining different highlighted marks on the selected body joints software automatically present the measurements of required angles. Different segments were drawn to find out different angles of the body e.g. knee angle, angle of ankle joint.

Statistical procedure: With regard to purpose of the study Karl Pearson's product moment coefficient correlation statistical technique was calculate between selected kinematical variables with performance of male pitchers. In order to check the significance, level of significance was set at 0.05.
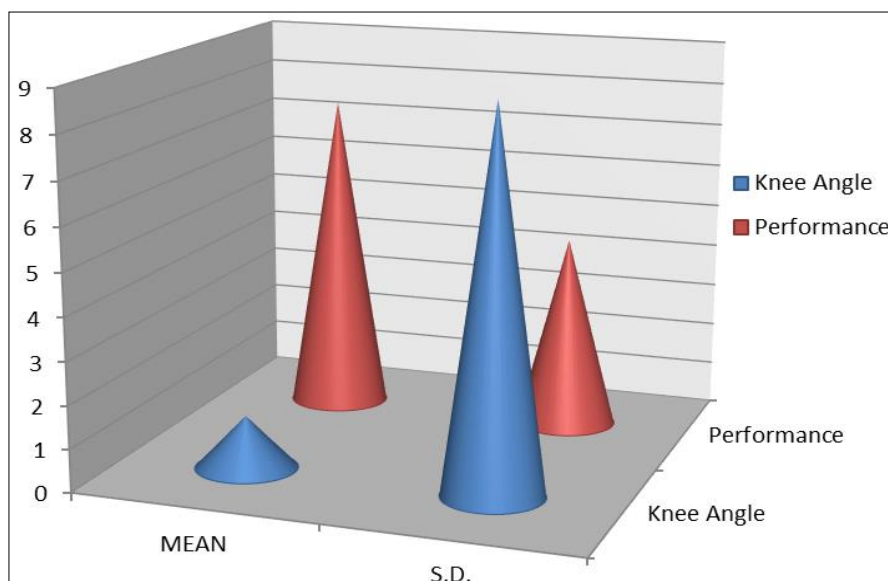
Results of the Study

Table 1: Relationship between Angle of knee joint in pitching with performance

Trials	Variables	Mean	Standard Deviation	Correlation (r) Value
15	Angle of knee joint	1.24	8.20	.984*
15	Performance	7.77	4.18	

'r'0.05(13)=.576 *=significant at .05 level of significance

Table and figure 1 shows that the mean value of angle of knee joint of pitchers was 1.24, whereas the standard deviation (SD) of angle of knee joint of pitchers was 8.20 respectively. At the time of calculation of the relationship between Angle of knee joint with performance of pitcher the r value was .984. The data does suggest that there was significant relationship between Angle of knee joint of pitcher with performance.

Fig 1: Mean and standard deviation values of pitcher angle of knee joint and performance
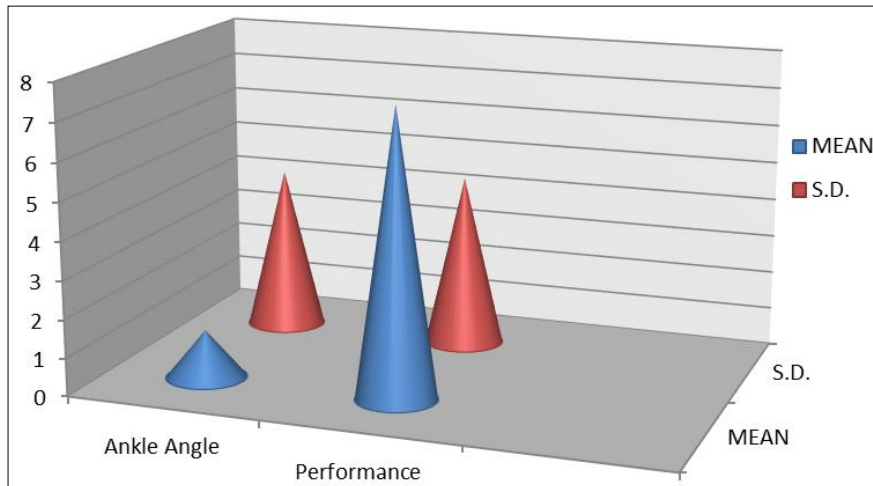
Table 2: Relationship between Angle of Ankle joint in pitching with performance

Trials	Variables	Mean	Standard Deviation	Correlation (r) Value
15	Angle of Ankle joint	1.26	3.98	.975*
15	Performance	7.77	4.18	

'r'0.05(13)=.576 *=significant at .05 level of significance

Table and figure 2 shows that the mean value of angle of ankle joint of pitchers was 1.26, whereas the standard deviation (SD) of angle of ankle joint of pitchers was 3.98 respectively. At the time of calculation of the relationship between Angle of ankle joint with performance of pitcher the r value was .975. The data does suggest that there was significant relationship between Angle of ankle joint of pitcher with performance

Fig 2: Mean and standard deviation values of pitcher angle of ankle joint and performance

Conclusion
Based on the analysis and within the limitations of the study following conclusions were drawn:
1. There was significant relationship between angle of Knee joint and performance of Indian international male pitchers.
2. There was significant relationship between angle of ankle joint and performance of Indian international male pitchers.

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