A Study on Biomechanical Analysis of Throwing Techniques in Cricket

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Abstract – The game of cricket is believed to have been played in the organized form hundreds of years ago. Cricket was introduced to North America by the English colonies in the 17th century probably before it had even reached the north of England. In the 18th century it started in other parts of the globe. It was introduced to the West Indies by colonists and to India by British East India Company mariners in the first half of the century. It commenced in Australia almost as soon as the colonization began in 1788. Afterwards, New Zealand and South Africa followed in the early 19th century.

INTRODUCTION

Bowling, batting and fielding are three fundamental skills in cricket. Significant biomechanical research has been focused on bowling and batting (Bartlett, Stoc kill, Elliott & Burnett).This study basically focuses on throwing skills of fielding. In fact, fielding incorporates three phases; namely, stop, pick-up and throw. Furthermore, the throwing technique can be classified into three categories: over arm, side arm, and under arm. These techniques have been widely studied in other sports, including track and field (Best, Bartlett, & Morriss, 1993 and Maeda, 2008), baseball (Escamilla, Fleisig, Barrentine, Zheng, & Andrews, 1998) and (Dun, Loftice, Fleisig, Kingsley, & Andrews, 2008). While, in cricket only one study has been found to have reported the computation of biomechanical parameters (Cook & Strike, 2000).

Throwing is a fundamental movement skill that forms the cornerstone of many games (Elliott & Anderson, 1990) the development of this skill could be of paramount importance for some athletes. Not only appropriate physical movements are important in ball throwing, but proper breathing also plays an important role. There are different types of throws that a thrower must be able to execute accurately. There are numerous aspects of throwing, making it a complex skill to gain expertise in, such as ball velocity, ball movement, arm velocity, arm movement, distance, approach angle, target angle, etc. However these aspects have little effect if the thrower cannot aim their throws precisely. Throwing accuracy can be increased by improving the technique and practicing muscle memory (Husain & Bari, 2011) and (Simons, Wilson, Wilson, & Theall, 2009). Like other sports, cricket is also mentally challenging; hence, mental and physical strengths improve the skill of the game.

The success of a cricket player in throwing is determined primarily by the velocity, target angle and approach angle of the cricket ball at the instant of release, as these factors determined the speed and location of the cricket ball. All these significant factors, it can be urged that speed is of greater importance, as there exists an inverse relationship between the speed of the ball and the time that the better has to respond and ultimately to swing and make contact with the ball. A better understanding of the factors that affect the speed of the cricket ball could ultimately be used to introduce modifications into the technique of the thrower in order to improve value of the performance.

The velocity and accuracy of the cricket ball at the instant of release is a function of the motion of the body segment prior to the instant. Of the various body action that comprise the throwing, the motion of the throwing arm are of particular grandness, as previous studies have shown a relationship between the motion of the throwing arm, and the dramatic increase in the speed of the ball prior to the instant of release. Thus, by understanding the factor that affect the motion of the throwing arm it should be possible to gain an increased understanding of the mechanisms that produce the increases in the velocity of the cricket ball.

After the ball leaves the player's hand and elbow has been raised to the level of the shoulder (near the instant when the stride foot of the thrower contacts the ground). First, an extreme external rotation of the upper arm occurs while the elbow joint is in a flexed position, and this bodily function ultimately results in the hand pointing away from the intended direction of the throw with the forearm nearly parallel to the ground during side arm throwing; from this position, the upper arm is then internally moved through the instant of ball release. Secondly, a rapid elbow extension begins prior to the instant when the upper arm reached its position of maximum external rotation, and this elbow extension continues during the subsequently internal rotation of the upper arm until near the instant of release (Feltner & Dapena).

The rapid elbow extension that occurs during the throwing is also a good example of a whip or flail-like motion. The flail like motion of a linked chain of body segment are characterized by a sequential pattern in which the proximal segment start the movement but then decrease their speed or even reverse their direction of motion as the more distal adjacent segment undergo large increases in angular velocity (Phillips, Elizabeth, Roberts, & Huang).

Biomechanical analysis of throwing techniques have been the basis for many studies across a range of sports; these have served to identify important variables and characteristics of throwing performance to facilitate analysis and understanding, many researchers have divided the throwing action into specific phases, each with its own biomechanical function as we discuss previously (Elliott & Anderson). Although the throw can be divided into specific phases, this does not infer a discontinuous action but serves only to aid subsequent analysis (Elliott & Anderson).

STATEMENT OF THE PROBLEM

The present study was focus on the selected kinematical parameters i.e. segmental angles, linear velocity of different segments, angular velocity of different segments, ball velocity and accuracy of different throwing techniques at different distances and approach angles; it may also help to find the differences and relationship between different throwing techniques. Therefore, the present empirical investigation has been entitled as "Biomechanical Analysis of Throwing Techniques in Cricket".

REVIEW OF LITERATURE:

The purpose of this study was to attempt to examine any inter segmental similarities that exist between the under-arm, side-arm and over-head throws used in the sport of cricket. The purpose of the review of literature was to examine any previous research that is related to throwing mechanism.

The throwing motion is identical complex. This has led to many different methodologies being used to analyze, the biomechanics of the Biomechanical analysis of throwing techniques. Different temporal, kinematic, and kinetic parameters are selected based upon their necessity for each individual study. Also forms of methods are being used to collect the motion data including varying numbers and locations for 2D and 3D motion analysis research.

Hussain & Bari, (2011) have studied on "Biomechanical Analysis of Cricket Ball Throwing Techniques". This research article looks at the kinematic characteristics of different throwing techniques (under-arm, side-arm and over-head) with particular stress on the techniques of throwing in cricket. The technique is subdivided into: (1) Wind up phase, (2) late cocking Phase and (3) arm acceleration phases. The study was used to form the samples as, sixty (60) elite cricket players. The mean age of the cricket players were (21.82±3.08) years, height – (62.38±7.22cm), weight (168.07±6.68kg). Each throwing techniques successful attempt for throwing distances 30m with 450 approach angle at 45^0, 90^0 and 180^0 target angle from the stump were recorded using Canon Legaria SF-10, 8.1 Mp cameras in a field setting with (1/2000 shutter speed and at 60 fps). 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 coordinate.

The location of camera were chosen so that the optical axes of camera intersected perpendicularly to the designated plane .The accuracy of throwing performances were considered in identify the footage for addition and were subjected to analysis. Result revealed that the significant mean difference were found among different throwing kinematics as well as ball velocity and accuracy and the ball speed had to be high to carry the full distance of the throw in the shortest time.

Hussain & Bari, (2011) have studied on "Mechanical Analysis of Overhead Throwing in Cricket". This paper considers the kinematic characteristics of over arm throwing with particular emphasis on the techniques of throwing in cricket. The technique is subdivided into: (1) Wind up phase, (2) late cocking Phase (3) arm acceleration and (4) instant of ball release. The study was used to form the samples as, 10 elite cricket players. The ages of the players were (mean ± 23.50). The physical characteristics of height (Mean: 169.4-172.4cm)), weight (57.8-61.3). Each over head maximal and sub maximal successful attempt for each throwing distances 20m and 10m with 180^0,112^0 and 45^0

approach angle at 90^0 target angle from the stump were recorded using Sony DV cameras in a field setting with (1/2000 shutter speed and at 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 coordinate. The location of camera were chosen so that the optical axes of camera intersected perpendicularly to the designated plane.

RESEARCH METHODOLOGY:

In the cricket Bowling, batting and fielding are three key skills, and much of the biomechanical research has focused on bowling and batting (Bartlett, Stockill, Elliott, & Burnett, 1996).The third skill that of fielding incorporates both a pick-up and throwing phase, highlighting the importance of the throwing skill in cricket. Throwing, or comparable over arm techniques, has been widely studied in other sports, including track and field (Best, Bartlett, & Morriss) and baseball (Escamilla, Fleisig, Barrentine, Zheng, & Andrews). The limited research into the basic mechanisms underlying specific cricket throws highlights the need for more information directly applicable to the `elite' cricketer. Only (Elliott & Anderson) have tried to quantify, in three dimensions, the throwing technique adopted in cricket. They were concerned essentially with age-related differences in over arm throwing, not specifically the mature pattern of throwing in cricket. It has been shown that throwing is an important aspect of many sports and that a sound understanding of throwing technique can facilitate improvements in throwing performance (Fleisig, Barrentine, Escamilla, & Andrews).

There is an increasing emphasis on good fielding in cricket; it could be that three or four quality fielders are as important as two bowlers who have the ability to take wickets. (Fleisig, Escamilla, Barrentine, Zheng, & Andrews) contended that, although there are similarities in all overhand throws, there are quantifiable differences in the mechanics for various sports.

Throwing may occur along an overhead, sidearm, or underarm pattern as utilized in cricket. Critical fundamental throwing characteristics are common across the cocking, acceleration, and deceleration phases. The deceleration phase blocks the horizontal momentum of the trunk and provides an accurate release in addition to protecting against injury. Throwing is a fundamental movement skill that forms the cornerstone of many games (Elliott & Anderson) the development of this skill could be paramount for all cricket players. Biomechanics have helped in the development of throwing by analyzing and evaluating specific throwing techniques and identifying important characteristics of various types of over arm throw. When throwing from any area of the cricket field, the fielder must be able to project the ball with accuracy and speed if aiming for a run-out and saving run, a prerequisite that may rely heavily on throwing technique, as suggested by (Elliott & Anderson). Analysis of throwing techniques in cricket has been the basis for many studies across a range of sports; these have served to identify important variables and characteristics of throwing performance.

In India, no researches have been undertaken till that in sports biomechanics. In the computer era, the motion analysis software and programming made biomechanical research especially in kinematics, possible to read the sports motion.

HYPOTHESES

1. It was hypothesized that approach angle will not affect the ball velocity and accuracy.

2. It was hypothesized that different distance of throw will not affect the ball velocity and accuracy.

3. It was hypothesized that different throwing technique will not affect the ball velocity and accuracy.

OBJECTIVES

In order to realize the goal of the present object, the following objectives have been summarized:

1. Efforts were made to focus on the traditional formation used by elite/ inter varsity player expert and the errors committed by them during the execution of movements. Subsequent remedial doses were prescribed, with the aim to bring about the desirable improvement in the process of executing movement.

2. Approach angles were analyzed from three different distances from the stumps (i.e. 10 mtr, 20 mtr and 30 mtr) and there were three different throwing angles (i.e. 45^0, 90^0, and 180^0) at each distance point.

3. Ball velocity was analyzed at different distance and different approach angle.

4. Accuracy of the ball throw was analyzed for each throwing technique i.e. over head throw, side arm throw, under arm throw from different distance and different approach angles.

5. A number of effective variations in taking cricket throw, with different directions and approaches were searched out for possibility run-out of the batsman.

6. Throwing possibility was determined for enhancing the ball velocity, accuracy and mechanical basis of body segments.

7. The objective of the work plan was evolved to measure for improving the ball velocity, accuracy at stump/target and their contributions.

BIOMECHANICAL ANALYSIS

A biomechanical analysis evaluates the motion of a living organism and the effect of forces on the living organism. The biomechanical approach to movement analysis can be qualitative, with movement observed and described, meaning that some aspect of the movement measured. The use of the term biomechanics in this text incorporates qualitative components with a more specific quantitative approach. In such an approach, the motion characteristics of a human or an object are described using such parameters as speed and direction, how the motion is created through application of forces both inside and outside the body, and the optimal body positions and actions for efficient, effective motion.

The biomechanical analysis of different events can help understand the critical point of technical performance; thus helping coaches and athletes in their preparation. One area of major concentration over the past few years is that of biomechanical analysis. Human motion analysis is frequently used today for both clinical and research application the art and science of motion analysis has expanded beyond basic descriptions of ambulatory patterns to include front line clinical roles in rehabilitation, surgery, prosthetics, orthotics, Ergonomics and Athletics.

A biomechanical analysis conducted from either of two perspectives, kinematics and kinetics. Kinematics is concerned with motion characteristics and examines motion from a spatial and temporal perspective without reference to the forces causing the motion. A kinematic analysis involves the description of movement to determine how fast an object is moving, how high it goes, or how far it travels.

Thus, position, velocity, and acceleration are the components of interest in a kinematic analysis. By examining an angular or linear movement kinematics, one can identify segments of a movement that require improvement, obtain ideas and technique enhancements from elite performers, or break a skill down into identifiable parts. By each of these, further understanding of human movement. Pushing on a table may or may not move the table, depending upon the direction and strength of the push. A push or pull between two objects that may or may not result in motion is termed a force.

Kinetics is the area of study that examines the forces acting on a system, such as the human body, or any object. A kinetic movement analysis attempts to define the forces causing a movement. A kinetic movement analysis is more difficult than a kinematic analysis both to comprehend and to evaluate, by a significant amount if the weight of the body lifted and the speed of the bar were not considered. The forces produced during human movement are very important, since they are responsible for creating all of our movements and for maintaining positions or postures having no movement. The assessment of these forces represents the greatest technical challenge in this field, since it requires sophisticated equipment and significant expertise. Thus, for the novice movement analyst, concepts relating to maximizing or minimizing force production in the body will be more important than evaluating the actual forces themselves. A kinetic analysis can provide the teacher, therapist, coach, or researcher with valuable information about how the movement produced or how a position maintained. This information can direct conditioning and training for a sport or movement. For example, kinetic analyses performed by researchers have identified weak and strong positions in various joint movements. Thus, one knows that the weakest position for starting an arm curl is with the weights hanging down and the fore-arm straight. If the same exercise started with the elbow slightly bent, more weight can lifted. Kinetics also identifies the important parts of a skill in terms of movement production. Examinations of both the kinematic and kinetic components are essential to full understanding of all aspects of a movement. It is also important to study the kinematic and kinetic relationships, since any acceleration of a limb, of an object, or of the human body is a result of a force applied at some point, at a particular time, of a given magnitude, and for a particular duration. While it is of some use merely to describe the motion characteristics kinematically.

DELIMITATION

1. Study was delimited to the sixty male cricket players (National and All India inter-varsity players).

2. Biomechanics variable was confined to kinematic variables (Segmental angle, approach angle) target angle at stump, distance, velocity, and accuracy.

3. The study was confined to right hand cricket throwers only.

4. The study was delimited to two dimensional video motion analyses of cricket throws.

LIMITATION

1. The changes in climatic condition like, air, temperature, atmospheric pressure, and relative humidity during the testing period could not be controlled. Their possible influence on the result of this study was recognized as a limitation.

2. The changes of the psychological, social as well as physiological condition of the cricket player during the period of data collection could not be controlled and their possible influence on the result of this study of biomechanical analysis of throwing techniques

3. Certain factors like daily routine, life style and food habits, which would have an effect on the performance of the cricket throw, could not be controlled.

4. The proper care has been taken to use the available appropriate equipment. The equipment errors may throughout the period of data collection could not be controlled and their possible influence on the result of this study.

5. The various tool and equipment available in motion analysis software used could not be enhanced and not in our controlled.

6. The accuracy of various equipment or software used and then ability to digitize the kinematic data.

SIGNIFICANCE OF STUDY

Man confined as a social animal cannot fly, run faster than cheetah; jump longer than kangaroo or swim faster than dolphin. But we can throw farther, stronger, and better than any other animal. Some anthropoids such as chimpanzees and gorillas are known to throw, but their motion is mainly underhand. They are very weak creatures, and physical ability is very limited. But throwing is one given talent. Only humans can throw in more accurate sense, man is the only creature who can throw with underarm, sidearm and overhand motion. The most effective method to the how mechanical factors affect ball velocity and accuracy is through the study of the biomechanical analysis of throwing techniques in cricket.

The present study of the biomechanical analysis of throwing technique would contribute to the society in the following ways –

1. Biomechanical analysis of technical aspect of throwing movement will help player to integrate the technical component of the sports and in so doing invigorate their needed sports skills.

2. The study will provide best throwing technique in particular distance with respect to angle of approach. The study will also disclose the mechanical aspect of entire movement pattern.

3. Players, coaches and experts of the cricket would be greatly benefited with the feedback provided to them regarding their appropriate execution of the throwing movement.

4. This study would equip the player as well as trainers, physical educator and coaches to get the maximum advantage of mechanical aspect in cricket ball throw.

CONCLUSIONS

Considering the scope the limitations and the result of the study, the following conclusions have been drawn.

1) The all joints (wrist, elbow, shoulder, hip, knee and ankle) angles have an important role in different types of throwing techniques at different approach and throwing angles of different distances at wind-up phase as well as at acceleration phase. The elbow and wrist joints angles were found to be significantly influence the ball velocity at difference distance as well as different throwing techniques.

2) The wrist and elbow joints angle have an important role in underarm throws at shorter distance at different approach and throwing angles at wind-up to late-cocking phase as well as at late-cocking to acceleration phase for maximum ball velocity. The joints angles were found to significantly influence the ball velocity at different approach and throwing angles.

3) The ankle, knee, hip, and ankle joints have an important role in different throwing techniques at wind-up to late-cocking phase at 112^0 approach angle and different throwing angles of different distances. The joints angles were found to significantly influence the ball velocity and accuracy.

4) The shoulder and hip joints angle have an important role in sidearm, and over-head throwing technique during late-cocking to acceleration phase at different approach and throwing angles of different distances. The joints angles were found to significantly influence the ball velocity.

5) The shoulder joint angle have an important role in under-arm throwing techniques during wind-up to acceleration phase at different approach and throwing angles of longer distances.

6) The angular velocity of hip, shoulder, elbow, and wrist joints angle contributes significantly in different throwing techniques at different approach and throwing angles of different distances to causes variation in ball velocity.

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