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## Biomechanical analysis of quarterback throw in American soccer

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### Abstract

**Introduction:** American football, referred to as football in the United States and Canada, and also known as "gridiron football" or simply "gridiron", is a sport played by two teams of eleven players on a rectangular field with goalposts at each end. The aim of the study was to analyse quarterback throw of All India Inter-University level player in American Soccer.

**Methodology:** For the purpose of the study, 10 All India Inter-University level American Soccer players were selected from Jadavpur University. The actions of throwing technique of ten American Soccer players ( $20.70 \pm 1.16$  year,  $171.70 \pm 7.97$  cm,  $73.77 \pm 11.53$  kg) were recorded by two fixed video cameras. By using the Kinovea-0.8.25 motion analysis software. The video was digitised and analysed to measure the selected kinematics parameters such as ball release height, ball release angle and ball release velocity. Throwing distance of the ball was measured manually by the measuring tape. Mean, standard deviation and Pearson Product Moment Correlation test were employed to analyze the data statistically.

**Results and Discussions:** The result of the statistical analysis of the data revealed that ball release height ( $159.31 \pm 18.29$  cm) and ball release velocity ( $59.81 \pm 9.90$  km/h) were positively related ( $r = 0.339$  &  $0.665$ ) with the ball throwing distance ( $29.90 \pm 5.46$  m), where ball release angle ( $36.60 \pm 4.90^\circ$ ) was negatively related ( $r = -0.344$ )

**Conclusions:** From the study, it may be concluded easily that, for quarterback throw of All India Inter-University American Soccer players, higher the ball release height and ball release velocity, there will be a greater throwing distance whereas, higher the ball release angle lower will be the throwing distance.

**Keywords:** American Soccer, quarterback, throw, biomechanical analysis

### Introduction

American football, referred to as football in the United States and Canada, and also known as "gridiron football" or simply "gridiron", is a sport played by two teams of eleven players on a rectangular field with goalposts at each end. The offense, the team with control of the oval-shaped football, attempts to advance down the field by running with or passing the ball, while the team without control of the ball, the defense, aims to stop their advance and take control of the ball for themselves. The offense must advance at least ten yards in four downs, or plays, or else they turn over the football to the opposing team; if they succeed, they are given a new set of four downs. Points are primarily scored by advancing the ball into the opposing team's end zone for a touchdown or kicking the ball through the opponent's goalposts for a field goal. The team with the most points at the end of a game wins.

American football has origins within England through the 19th century, where a Soccer player decided he was sick of being constrained to only using his feet in the game, he then proceeded to pick up the ball and run it down the field. Obviously this was against the rules in Soccer, but this made way to the development in the game of rugby (Embassy, US. 2010). This new sport became a worldwide success and reached America during the 1800's, it was mainly popular in north-eastern colleges, but then found its way across the countries other main universities. Over time the round ball changed form to an 'egg shape', at this time the game of football was very different to the game played now.

In modern American football, the quarterback is usually the leader of the offense. The quarterback touches the ball on almost every offensive play, and his successes and failures can have a significant impact on the fortunes of his team. Accordingly, the quarterback is among the most glorified and scrutinized positions in team sports.

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Prior to each play, the quarterback will usually tell the rest of his team which play the team will run. After the team is lined up, the center will pass the ball back to the quarterback (a process called the snap). Usually on a running play, the quarterback will then hand or pitch the ball backwards to a half back or full back. On a passing play, the quarterback is almost always the player responsible for trying to throw the ball downfield to an eligible receiver downfield. Additionally, the quarterback will often run with the ball himself, which could be part of a designed play like the option run or quarterback sneak, or it could be an impromptu effort to avoid being sacked by the defense.

The position of the 'quarterback' is derived from the positions in the game of rugby, where positions of half and full back existed. This is where NFL manipulated the rules of their game to allow for a forward pass, which the quarterback is responsible. The quarterback has one of, if not the most important job within the team and game of NFL. The quarterback receives the ball, and in a split decision must make an accurate pass to another receiving player. The quarterback must absorb a number of changing variables, make a decision, and make the pass. With millions of viewers, fans, and economic parties across the globe the quarter back must make their decisions and passes, or risk their multi-million dollar contracts. An example of this is Ben Roethlisberger a quarterback for the Pittsburgh Steelers, he is the eleventh highest paid athlete for 2015, earning \$48.9 million a season (Badenhausen, K. et. al. 2015). This illustrates the importance of good technical form within the skill and a technical comprehension of the game play.

There are a number of variable factors that can influence the play within the game of NFL from defensive, offensive, or special plays. The coaches offensive play tactic will influence what the quarterback is to do from the 'snap' (beginning each play), the quarterback will usually then proceed with a passing or running play. Depending on the defensive play chosen from opposing team will influence the decision of the quarterback in the offensive play. It is important for the quarterback to receive and release the ball as quick as possible so as to not get sacked (tackled before releasing the ball) as this can result in negative yards or a ball turnover, which can alter the overall result of the game. From the snap the quarterback must then analyse the changing conditions on the field and make the pass to one of their receivers in order to gain yards in order to get into the end zone.

American Soccer is popular in much in America but as an international game it has not created the enough space. The research work on American Soccer especially the movement analysis of the game is very likely to see. In a study, Anthony Beeman worked on A Kinematic and Dynamic Analysis of the American Football Overhead Throwing Motion. Therefore, considering on the present state of the game, the researchers were intended to do a biomechanical analysis of the quarterback throw in American Soccer.

## Objectives

- To measure the release angle of the ball of quarterback throw in American Soccer.
- To measure the release height of the ball of quarterback throw in American Soccer.
- To measure the release velocity of the ball of quarterback throw in American Soccer.
- To measure the throwing distance of quarterback throw in American Soccer.
- To find out the relation in between release parameters and throwing distance of quarterback throw in American Soccer.

## Methodology

**Selection of Subjects:** For the present study, 10 male All India Inter-University level American Soccer players have been randomly selected from Jadavpur University. Anthropometric Characteristics of the subjects were: age  $20.70 \pm 1.16$  year, height  $171.70 \pm 7.97$  cm, weight  $73.77 \pm 11.53$  kg. All of them were the active participants at the time of data collection for the present study.

**Selection of Variables:** The kinematic variables, such as ball release height, ball release angle, ball release velocity and the distance covered by the ball have been selected as variables of the present study.

**Instruments and Tools:** For the collection and the analysis of the data, two cameras with tripod stand [Nikon D3300 (60fps: Camera-1) and Nikon D3300 (60fps: Camera-2)], Kinovea-0.8.25 motion analysis software, computer system, stadiometer, steel tape, weighing machine, standard Cricket balls, well equipped Cricket pitch, measuring tape, lime dust and nails were used.

**Procedure for Data Collection:** For recording the throwing actions, camera-1 was placed at the sagittal right plane of the throwing direction and perpendicular to the approach line. Camera-2 was placed at the sagittal left plane of the throwing direction and perpendicular to the approach line. Both the cameras were at a distance of 5m from the approach line and at a height of 120cm from the ground. A reference scale (a hurdle: 1m) was placed on the execution spot and also recorded by both the cameras followed by the all execution for calculating and converting the recorded distance into real distance. Every subject got three chances each to make quarterback throw and the best one was taken for the purpose of analysis. The recorded video was transferred to the computer and it was digitized and analyzed by using Kinovea 0.8.24 motion analysis software. In order to investigate the existence of the relationship of ball throwing distance and ball release parameter in American Soccer, Product Moment Correlation was applied and the level of significance was chosen at 0.05.

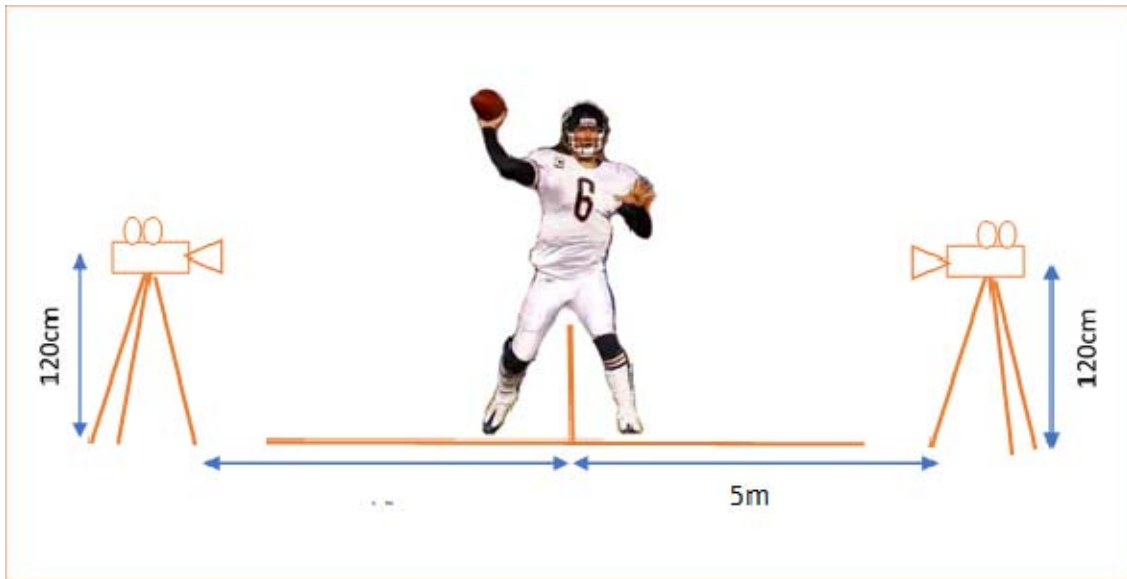


Fig 1: Filming Environment for Recording the Throwing Action.



Fig 2: Photographs of the video analysis of release parameters

**Results & Discussions**

The means and standard deviations of the all kinematic parameters are represented in the below table (Table 1)

**Table 1:** Means and SD of the release parameters and throwing distance of quarterback throw in American Soccer

Sl. No.	Kinematic variables	Mean	SD
1.	Throwing distance (m.)	29.90	5.46
2.	Ball Release Height (cm.)	159.31	18.29
3.	Ball Release Angle (°)	36.60	4.90
4.	Ball Release Velocity (km/h.)	59.81	9.90

From the above table, it is clear that the mean and standard deviation of throwing distance, ball release height, ball release angle and ball release velocity of All India Inter-University level American Soccer player are respectively 29.90±5.46 m, 159.31±18.29 cm, 36.60±4.90° and 59.81±9.90 km/h. The statistical analysis of the data on kinematic variables collected on 10 male All India Inter-University level American Soccer players have been presented in Table 2. The

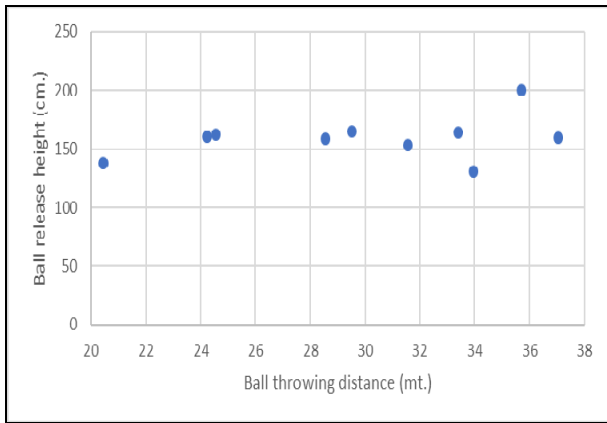
correlations of ball throwing distance with the release parameters are presented in the following tables and graphs.

**Table 2:** Correlation of throwing distance with selected release parameters

Sl. No.	Release Parameters	Coefficient of Correlation (r)
1.	Ball Release Height	0.339
2.	Ball Release Angle	-0.344
3.	Ball Release Velocity	0.665*

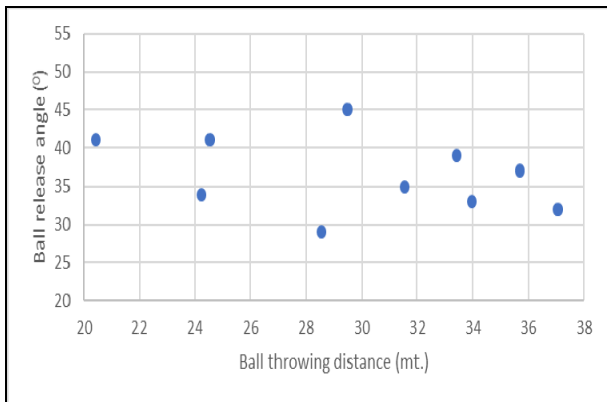
\*Significant at 0.05 level  $r_{0.05(8)} = 0.632$

From the above table it is observed that, there is a significant relationship of ball release velocity with ball throwing distance ( $r = 0.665$ ). There is another parameter, ball release height, which also indicates a positive relation ( $r = 0.339$ ) with throwing distance, but this was not statistically significant. Ball release angle is the parameter which had a negative relation to throwing distance ( $r = -0.344$ )



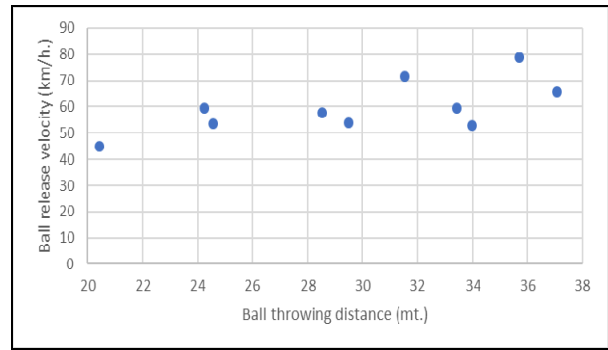
**Fig 3:** Graphical presentation of correlation between ball release height and ball throwing distance.

From the above table and graph, it is clear that, there is a positive relation ( $r = 0.339$ ) between ball release height and ball throwing distance. That means, with the heightening of ball release point, the ball will cover more distance horizontally. It simply falls under the principle of Projectile motion, where height of release is a strong factor to determine the horizontal distance. If all other factors remain same and if you increase the height of release, the distance covered by the object will increase proportionally. In spite of that scientific base of support, the correlation is not statistically significant. The reason may be the small sample size, individual difference etc.



**Fig 4:** Graphical presentation of correlation between ball release angle and ball throwing distance.

From Table 1 and Fig. 3 it is also cleared that ball release angle and throwing distance have a negative correlation. It indicates that with the increase of ball release angle, throwing distance will decrease and vice versa. This correlation is bound within the upper value and lower value. That means throwing distance is negatively correlated with ball release angle when the angle is bounded in 30-45. According to the principle of Projectile motion, if the release and landing height are same, then  $45^\circ$  is the right angle to gain maximum horizontal distance. But, if the release height is higher than the landing height then the release angle should be less than  $45^\circ$  to gain the maximum horizontal distance. Here, as the players throw the ball from a height, the release angle should be always less than but near to  $45^\circ$ .



**Fig 5:** Graphical Presentation of Correlation between Ball Release Velocity and throwing distance.

From the above table (Table 1) and graph (Fig. 4) it is shown that, in case of ball release velocity and throwing distance, there is strong positive correlation ( $r = 0.665$ ) which is statistically significant at 0.05 level. This correlation test revealed that higher the ball release velocity results in greater throwing distance. The reason of this result is only the mathematical proportional relation between them. From the formula of velocity ( $V=D/t$ ), it can be known that the displacement of a body is directly proportional to average velocity of that body and similarly average velocity is leaded by initial or release velocity.

**Conclusion**

From the results of the present study the following conclusions were drawn:

1. Ball release height has a positive effect on the ball throwing distance in All India Inter-University level American Soccer player (Statistically not significant).
2. Ball release angle has a negative effect on the ball throwing distance in All India Inter-University level American Soccer player (Statistically not significant).
3. Ball release velocity has a positive effect on the ball throwing distance in All India Inter-University level American Soccer player (Statistically significant).

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