Chapter-I

INTRODUCTION

Football (soccer) is the world's most popular game. It played in more countries than any other sport. The minimal equipment requirement and simple rule have aided its spread and growth in popularity. Millions of people among professional and amateur level played it. According to a survey conducted by FIFA published in 2001, over 240 million people from more than 200 countries regularly play football. There are more than forty million registered players of this game around the world. The excitement and the passion generated to the football stadium around different part of the globe while billions more watch the game on their television sets.

The origin of football is vague. Games revolving around the kicking of a ball have been played in many countries throughout history. According to FIFA the “very earlier form of the game for which there is scientific evidence was an exercise of precisely this skillful technique dating back to the 2nd and 3rd centuries BC in China (the game of Cuju)”. In addition, the Roman game Harpastum may be a distant ancestor of football. Many other variants of the game was played in different part of medieval Europe though rules varied greatly both by period and location.
The efforts to standardise the varying forms of game started in the mid 19th century. One of the major event toward this standardization was the formation of Football Association (F.A.) in 1863. The International Football Association Board (IFAB), the law governing body of modern soccer was formed in 1886 in Manchester. The FIFA, the international football body, was formed in Paris in 1904 and declared that they would adhere to laws of the game of the football association.

The growing popularity of the game soon led to the induction of soccer to the Olympic game. In 1908 for the first time, soccer made it Olympic debut in London Olympic.

In India too the game is also very popular played and followed across length and breadth of the country. The Britishers introduced this game during the colonial period, it soon caught the fancy of the native masses, and Bengal becomes its strong foothold. Durand Cup, the third oldest football tournament in the world was started in 1898 in Shimla by the foreign secretary, Sir Mortimer Durand. Soon the number of tournaments and the spread of game both increased leading to the formation of All India Football Federation (A.I.F.A.) in 1937. The AIFF was affiliated to the world body FIFA in 1948 and was one of the founder members of Asian Football Confederation (AFC) in 1954.
The 1951 – 1962 decade was the golden age for Indian Football, as the country put up a commendable show in a number of international competitions. India won the gold medals in the 1951 and 1962 Asian Games at New Delhi and Jakarta respectively. In the 1956 Melbourne Olympic, India became first Asian nation to reach the Olympic football semi-final. However, since the game in the country has failed to keep place with the evaluation in other countries and currently we are languishing at the bottom of football ranking.

To gain the competitive edge required for success in soccer, one needs to fully understand and develop the various fundamental skills such as positional play, feints and pivots, running dribbling, passing throwing, heading and kicking which are frequently used by soccer player during the game. In a true sense, soccer is a game with a complex system of motor action.

The performances of soccer players for the developed nations of the world have advanced their research in motor action for the game of soccer. The player tries to exhibit different level of speed and trajectories of the ball, all with high level of precision in execution of their skills. The only way to reach these chosen objectives is by controlling the mechanical variables, the dynamics and motor coordination of various joints and body segments especially of lower limbs.
Many studies have been done to understand fundamental soccer skills, and some have especially focused on kicking. However, a full picture of an efficient kick remains incomplete owing to constraint of test designs and difficulties that arise in synchronizing and analyzing information generated by multiple assessment techniques. Previous scientific studies may be generally categorized as: two-dimensional kinematic analysis using high-speed cameras, muscle activity studies using electromyography, three-dimensional analysis of the kicking-leg using a partial-body model, and kinetic studies using force measurements and modelling.

Kicking movement in soccer is relatively an easy series of rotational movements. In this movement, the aim is to produce through the kinematic chain of body segment high angular velocity to the foot, the length of the body segments or the radius of traditional movements influences the line or velocity of the rotating foot. Thus, the body height and length of different body segment is an advantageous feature for players because the linear velocity of rotating levers is expressed as a product of radius of rotational movement and angular velocity.

The instep kick is the most powerful kick in the sports of soccer. Instep kicking is one of the most fundamental and frequently used skills. It requires coordination of rapidly moving body parts, and accurate foot placement, and body positioning, angled approach to the
ball. subsequent support foot contact with the ground accompanied by sequential transfer of moment from proximal to distal body segment in the swing of kicking limb.

The soccer instep kick is the kick, which is most advantageous in soccer because it is the most powerful kick. Players often use instep kick more effective for maximum force and distance i.e. a long pass or a shot at goal. The force for the long kick is gained from the run-up to the ball, and from the motion of maximum number of body parts. These include hip and trunk rotation, hip flexion, knee extension and ankle planter flexion from a rigid surface for impact.

The inside-instep kick is another most frequently used technique when a shorter and precise pass or shot is required, whereas the instep kick is used when a faster ball speed must be generated. According to (Grant, 1998) study that analyzed the techniques used to score the goals in the 1998 World Cup; these two kicks were most commonly used to score goals. In particular for the inside-instep kick, this technique was used to score 16 of 17 goals from penalty kicks.

According to the theoretical concept and soccer coaches, the soccer instep kick is more likely to result in maximum ball velocity and in greater accuracy compared to other forms of kicks such as toe-kick, inside-kick, or out-side-kick (Heyward, 1971).
The soccer instep kick and inside instep kick has received very little attention in the scientific literature till date, although it is the most frequently used during the game. Almost 60 percent of techniques used in a soccer game were instep kicks. Previous biomechanical studies focused upon calculating the peak velocity of instep kicks by elite performers and used timing lights to record velocity, and also to measure impact force of the instep kicks. Some researchers took video recording from the top and side, which were fitted into two-dimensional linkage models to analyze the injury potential of the instep kick with the three other kicks.

One of the main reasons for the lack of researches on the inside instep kick appears due to its rotational nature, the majority of videography studies have looked at the front kick (Instep) using a two-dimensional analysis (Huang, 1982), due to the front kick (instep) being essentially a single planner movement that involves minimal body rotation. Considering that the majority of soccer inside instep involves body rotation of some kind, and with the recent advance in technology, the logical progression appears to be to three-dimensional analysis.

Many researches dedicated their time to study the complex kicking motion of soccer by examining the relevant biomechanical variables. These includes kinematics studies concerning the importance of non-kicking leg position and knee joint angles (Burdan, 1955; Togari,
and also the orientation and angular displacement of the kicking leg and food at the contact (Aitchison and Lees, 1983) or before ball contact (Robert and Metcalfe, 1968; Copper et al. 1982) for successful kicking. Studies also elicited that there is relationship between the swing velocity of the kicking limbs, striking mass at impact and the ball velocity (Plagenhoef, 1971). Kicking governed by the motor characteristics of individual player (Rodano & Tavana 1993) and of different Level of players has a different swing motion kinematics (Togari, 1972). There seems to be a general developmental trend, which most children tend to follow when learning motor skills (Bloomfield et al. 1979).

BIOMECHANICS

Biomechanics of human movement is broadly defined, as the science involving the internal and external force acting on a human body and description of motion, including the pattern and speed of movement of body segments, it help understanding basic mechanical concepts methods and analysis technique for human motion.

Biomechanics is an applied form of mechanics and consequently the methods used to investigate mechanical principles. However, biomechanics have not developed in the wake of mechanics but as a
bordering science in other scientific discipline such as anatomy, physiology and technique of sports.

The basis for the field of biomechanics is that the laws of mechanics apply to living organisms just as well as they do to inanimate objects. In the human performance, biomechanics contributes to the description, explanation, and predication of the mechanical aspects of human exercise, sports and play.

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 can help to understand the critical point of technical performance thus helping coaches and athletes in their preparation. 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.

The biomechanical analysis are two types-Qualitative and Quantitative. The qualitative analysis includes the development of a theoretical model as a basis for identifying faults and judging their relative importance. In the qualitative analysis, the performance is evaluated subjectively based on direct visual observation and this method is widely used, as it is less expensive. To conduct qualitative analysis, some prior knowledge of the sports or activity is required particularly if the motor skill is to be analyzed.

A qualitative analysis includes visual and photographic observations, which usually result in a description or a judgment of the strong and the weak points of a given performance. Visual analysis has the obvious advantage of not requiring expensive equipment but suffers from limited accuracy and most effectively practiced by an expert coach with an experienced eye. With the luxury of film or videotape and the
time to view repeatedly a single performance, the chances for correctly diagnosing an error are enhanced.

The quantitative analysis is an objectively based technique depending upon measurements taken from recording (e.g. film, videotape, force-time curves’ etc.) of the movement. At any level of quantitative analysis, there is a need for interaction between the coach and biomechanist if maximum performance is to be achieved. Quantitative evaluation of movement requires that a permanent record should be collected and stored for a number of trials so that each can be viewed and analysed. Recording of permanent data of movement may take a number of different forms, for example cinematography, electromyography (EMG), accelerometry, dynamometry or electrogoniometry.

In quantitative analysis, the performance is first recorded and then it is evaluated objectively. This method is mainly used only for research purposes and is quite expensive. It involves the measurement and recoding of hard data about movement, gait analysis, sequential analysis in kicking and throwing, postural characteristics in relation to performance, and it goes well beyond qualitative analysis because of its emphasis to identify the mechanical principals that effect motion and movement patterns in numerical form.
A quantitative analysis can be conducted in two ways. The first is kinetics and second is kinematics. Kinetics is the area of study that examines the force acting on a system, such as on the human body, or on an 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. 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 equipments and significant expertise. Thus, for the novice movement analyst, concepts relating to maximizing or minimizing force produced in the body will be more important than evaluating the actual forces themselves. Kinetic analyses performed by researchers have identified weak and strong positions in various joint movements. Kinetics also identifies the important parts of a skill in terms of movement production.

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 kinematically, 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. Thus, further helps in understanding of human movements.

Examinations of both the kinematic and kinetic components are essential in understanding all the aspects of a movement. It is also important to study the kinematic and kinetic relationships, since any acceleration of a limb, an object or the human body is the result of a force applied at some point, at a particular time, of a given magnitude, and for a particular duration.

Image analysis techniques, including both movie photography and videography, provide the opportunity to capture complex movement sequences on film or videotape so that a detailed analysis can be performed. However, an understanding of sampling frequency relative to photography or videography is needed prior to discussing different image analysis techniques, as both are sampling processes that record information at discrete points in time during a continuous motion. The sampling rate needed for an accurate representation of movement must be at least twice the value of the highest frequency component contained in the movement, although many researchers believe sampling rates of 5
to 10 times the maximum frequency component are necessary. Excessive sampling either increases the cost when using high-speed photography or limits the choice of cameras when using high-speed videography. Under-sampling will cause vital movement characteristics to be missed, or distortions would arise. At the subjective level of analysis, film or video techniques may be use to record movement and allow general comments to be made on the observed characteristics. At an objective level it is not sufficient to just record and observe movement, as detailed measurements must be completed and inferences drawn with reference to the movement. Specific equipment and procedures must be used if accurate objective data to be collected using image analysis techniques.

In high-speed cinematography, a motor-driven camera capable of providing frame rates up to approximately 500 Hz (c.s-1) and exposure times up to approximately 1/10000s is needed to accommodate movement and sport skills of differing speeds. For an analysis of jogging, an exposure time of 1/800 s would provide a clear image of the leg, while a frame rate of 100 Hz is sufficient to sample leg movement at the required frequency.

The collection of data from film for analytical purposes (digitizing) is very time-consuming and tedious aspect of cinematographic research. A stop-action projector is needed to control
film movement so that an operator can move an X-Y coordinate system until a pointer, pen, light or cross hairs lie over the desired anatomical landmark to be digitized.

The co-ordinates of this point are then stored on a computer. In order to locate anatomical landmark to be located, it must be clearly marked on the subject being filmed, so that an accurate identification of the segment end point or joint centre is possible. These co-ordinate data are then smoothed prior to being mathematically manipulated in the calculation of kinematic and kinetic data.

Additional Information other than co-ordinates of the selected landmarks are required to get an exact numerical data. A large sweep-hand clock may be included in the photographic field to establish the actual frame rate of the camera. Alternatively, internal camera lights that flash at a set rate may be used to mark the film and allow film speed calculation. A spatial scale, such as a large metre rule, must also be filmed in the plane of action to convert film scale measures to real values.

This type of scientific analysis may be done at to the several levels, ranging from research that has immediate applicability to sports, scientist in the laboratory and theses are aided by various technical measurement and recording devices, including high-speed cameras, motion analyzers, force platform, computers, etc.
In motion analysis film or video is recorded, it must be analyzed to understand the patterns of movement. This usually entails digitizing points of a film or video using special software, or even using tracing paper overlaid on a monitor. Video can be captured directly on the computer and relevant segment or segmental points can be digitized directly using image analysis programs such as MAT, APAS, Simi, Motionpro, Protrainer and Measurement in Motion. In the motion analysis activity such as, QuickTime movies that are used to digitize points, which make up an angle between the leg, ankle and foot, etc. Videography is the most common objective data collection techniques used in biomechanics because they provide a permanent and visual record of performance.

There are the non-imaging measurement procedures that provide valuable biomechanical data for the objective analysis of movement. It may be preferable at times to measure some of the kinematics aspects of a movement directly, rather than derive the measurements from film or videotape in order to calibrate the videographic data.

**Two-Dimensional Analyses**

There are two-different types of video motion analysis i.e. two-dimensional (2D) and three-dimensional (3D) analysis. Two-
dimensional analysis is most commonly used method with one camera or more and markers on the subject than in complex 3-D analysis. Although two-dimensional, have limitations; however, two-dimensional method used by sport researchers and biomechanists, and is still used today by many research laboratories that utilize motion analysis.

Two-dimensional analysis method can be used to describe and record certain body movements. The 2D analysis method is typically used when movement are recorded by photography or described by line drawings. For instance, a still or motion picture camera can record a movement only in two-dimensions. When a movement is photographed in the frontal plane, either a front view or a back view of the body is obtained. Likewise, in the sagittal plane a side view is obtained and in the transverse plane, either a top view or a bottom view. Since standard photographic procedures give only a two-dimensional view.

Today many researchers are turning to videographic analysis that can shoot at a rate of 30 to 10,000 images per second. Some of the cameras used for high-speed video that can also be fit to "automatically" digitize markers. The time from filming or data collection to data analysis has been cut from weeks to days with such innovations. However, in today scientific endeavor, even the low speed camera in 30
frames per second (fps) can be used along software with much precision for motion analysis of sports performance.

Technology and associated science is now assuming a more important role in helping athletes to gain a competitive edge. As soccer raises its profile day-by-day, as demonstrated by the underdog’s performance level in world cup event. The advancements involved in sports technology and in particular motion analysis have enabled research to concentrate in detail on soccer movement, which may not have been possible in the past.

All above-mentioned researches that were conducted at either on instep or inside instep kick of one level of player with only few kinematic variables. There were no researchers conducted on different level players. More over in India until date no researches have been conducted in sports biomechanics in any field of sports, especially in soccer. In today’s computer era, the motion analysis software and programming made biomechanical research especially in kinematic analysis possible. Therefore, the present study have been proposed to examine different level soccer players for the kinematics variables of body segment’s influences on ball velocity in instep and inside instep soccer kicks.
Statement of the problem

“A study of linear and angular kinematic analysis of soccer instep and inside instep foot kicks of different level players.”

Delimitations

a. The study was confined to ninety-nine male soccer players (33 player of high level, 33 player of medium level and 33 player of low level).

b. The high-level players were of national and inter-university level; medium level players were state and college level and low-level players were district and regional level.

c. The study was confined to instep and inside instep soccer kicks.

d. The study was confined to right foot kicker’s only.

e. The study was delimited to two dimensional video motion analysis.
Limitations

The following limitations are acknowledged:

a. The changes in climatic conditions such as air, temperature, atmospheric pressure and relative humidity during the testing period could not be controlled and their possible influence on the results of this study was recognized as limitation.

b. Proper care has been taken to use the available standard equipments. The instruments errors may also be a limitation for this study, but consistent calibration has been attempted.

c. The accuracy of various software used and then ability to digitize the kinematic data.

d. The subjects maximum efforts corresponded with the greatest impact on the ball could not be controlled.

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

f. The various tools available in various motion analysis software used could not be enhanced and not in our controlled.
Hypotheses

The following null hypotheses were tested at .05 level of significance.

1) There will be no significant difference between different level male soccer player during:
   a) Initial phase of instep kick
   b) Contact phase of instep kick
   c) Follow through phase of instep kick

2) There will be no significant difference between different level male soccer player during:
   a) Initial phase of inside instep kick
   b) Contact phase of inside instep kick
   c) Follow through phase of inside instep kick

3) There will be no significant difference between displacement at various joints of different level players:
   a) Initial to contact phase of instep kick
   b) Contact to follow through phase of instep kick

4) There will be no significant difference between displacement at various joints of different level players:
   a) Initial to contact phase of inside instep kick
   b) Contact to follow through phase of inside instep kick.
5) There will be no significant difference between linear velocities at various joints for different level players of instep soccer kick.

6) There will be no significant difference between linear velocities at various joints for different level players of inside instep soccer kick.

7) There will be no significant difference between angular velocity at various joints for different level players of instep soccer kick.

8) There will be no significant difference between angular velocity at various joints for different level players of inside-instep soccer kick.

9) There will be no significant difference of ball velocity for different level players of instep soccer kick.

10) There will be no significant difference of ball velocity for different level players of inside-instep soccer kick.

11) There will be no significant mean different of ball velocity for instep and inside instep kicks of different levels of player independently (High v/s High) (Medium v/s Medium) (Low v/s Low).
PURPOSE OF STUDY

Purpose of the present study:

(a) To describe the kinematics of instep and inside instep soccer kicks of different level players.

(b) To determine those kinematical variables that closely related to resultant ball velocity.

(c) To gain better understanding of mechanics of the inside instep and instep kick in soccer.

(d) To identify the kinematical aspects of instep and inside instep soccer kick and to understand its different mechanics.

(e) To assess the effects of soccer kick at different joint.

To examine the release speed of ball in instep kicking of different level players and to relate ball speed to biomechanical differences observed during the kicking. Biomechanics research can be said to have two main facets within human performance: “basic science” and “applied science”. In its basic science facets, biomechanics tries to understand how the human body functions mechanically in a situation of maximum effort. The main objective of the basic science facet of
biomechanics is to understand the cause-effect mechanism that make some techniques better than others, and ultimately to find the optimum technique i.e. what sequence of movements would lead to the best possible performance. Applied science start with descriptions of the optimum technique. The numerical data and graphical information are used to describe the strong and weak aspect of each technique, and to give recommendations on possible changes that might lead to improvements in performance. Videotapes of solid figure computer animation that explain the effect of techniques accompany the reports. The animation also shows what the technique would look like after the implementation of changes to correct the defects. These videotape animations to visualize the changes that are needed for techniques to improve performance. (Dapena, 2000).

**Definition and explanation of terms**

**Biomechanics:** Study area where the knowledge and the methods of the mechanics are applied to the structure and function of the living human system.

**Kinematics:** It is the study of motion without any reference to force, i.e. time, distance, displacement, velocity and acceleration.
Linear kinematics deals with translation or linear movement and angular kinematics explains rotatory or angular movement.

**Instep kick:** A technique of soccer kick in which the dorsal surface of the foot strikes the ball. The foot segment is extended upon impact and effected in the sagital plane by forceful hip flexion and knee extension.

**Inside-Instep kick:** A technique of soccer kick in which the medial surface of the foot strikes the ball. The foot segment is rotated outwardly upon impact and effected in the vertical plane by forceful hip flexion and knee extension.

**Skill:** General pattern of movement that has been adapted to the limitations of a particular activity or deport.

**Initial Phase:** The start of the kick is defined as swing of the kicking leg until the point of hip hyperextension and maximum knee flexion.
Contact Phase: The contact phase defines as the ball contact with the kicking foot or the point of the maximum knee extension until the contact with ball.

Follow through

Phase: The follow through phase is explained as the point just after the ball contact until the kicking leg reach up to its maximum height or maximum hip flexion.

Ball Contact: The first instant of time when the kicking-foot contacts the ball.

Hip Angle: Defined as by anatomical lines of femur and drawing line between the shoulder joint to the hip joint.

Knee Angle: Defined as by anatomical lines of femur and tibia.

Ankle Angle: Defined as by anatomical lines between the tibia and foot at ankle joint.

Linear Velocity: The rate of change of an object’s position in a straight line with respect to time is known as linear velocity (m/s).
Angular Velocity: The rate of change of angular displacement with respect to time is known as angular velocity (deg/s).

Ball Velocity: The velocity of the ball is defined as the rate of change of displacement.

Displacement: The change in a body's location in space in a given direction.

Longitudinal axis: Imaginary line that runs throughout the length of a body or segment.

Plane of Motion: Imaginary surface created by a moving object. The two-dimensional space by a moving body.

Range Of Motion: The total amount of angular displacement through which two adjacent segments move.

Sagital: It refers to the plane that divides a body or segment into the right and left portions.
**Frontal:** It refers to the plane that divides a body or segment into the front and back portions.

**Horizontal:** It refers to the plane that divides a body or segment into the up and down portions.
Significance

The standard of technique/skill and sports performance is very poor of our athletes in comparison to international standard. The lack of scientific supports to the correction of technique/skill teaching or rectification of movements pattern etc. has lead to flawed movements, finally deterioration of the optimum performances. The ball velocity is the imperative and prerequisites in the modern soccer at international level and most used skill technique (kicks) for the purpose are inside instep and instep kicks. The divulged result of this study will be a turning factors for the Indian football/ soccer players to finest their movement patterns or performances. The study will be of significant in the following ways:

1) This study will assist in an attempt to understand the effect of soccer kicking mechanics.

2) This study will provide a mechanical area of skill movement and technique of different level soccer players.

3) This study will generalize the mechanical aspect kicks (instep and inside-instep) of soccer players and ball velocity.

4) This study will contribute to analyses the perfect skill movements, segmental positions and angle of the lower limbs to bring about the maximum ball velocity.
5) This study will contribute to understand the intricacies involve in coming up with best kick performances.

6) This study will provide to be acquainted with mechanical advantages of segmental movement in kicks.

7) This study will contribute to identify the variation of lower leg segment’s joint angle and joint displacement in particular to the level of player and explicit kick type.

8) This study will contribute to identify the variation of lower leg segment’s linear velocity and angular velocity in particular to the level of player and explicit kick type.

9) This study will offer principal variation of lower leg segment to the preferred level of player and kick type to optimize the ball velocity performances.

10) This study will offer principal variation in ball velocity performances, demanded at the instant of play situation and with the type of kick.

11) This study will offer with wide variation of application of these mechanical aspects of lower leg segments or the ball velocity performances in virtual circumstance.

12) This study will provide concept of mechanics of soccer kicks to Indian athletes, trainers, physical educators and coaches.
13) This study will provide understanding of mechanical aspect in soccer kicks to athletes, trainers, physical educators and coaches to exploit for the maximum advantages to boost kicking performance.

14) This study will provide well-defined mechanical aspect of segmental maneuvers to soccer kick performance for ball velocity to athletes, trainers, physical educators and coaches, and will be able to extract the flaws in technique/skill or ball velocity performance.