CHAPTER – I

INTRODUCTION

The most powerful nations of the world namely USA, Russia, France, Australia, China etc are strong enough not only in world economics, arm-forces or in science technology but these are also advanced in the field of sports, therefore it is quite apparent that to exist strongly on world map nation has to be advance in the field of sports also. To achieve the same adoption of new techniques and methodology is highly required in sports sciences and physical education. Kim L. (1993) studied the kinematical analysis of the flight phase in the long jump. It was found that many kinematical variables like Knee and elbow joints contributes in gaining good flight phase in long jump. Mr. Muralitharan’s spin bowling action was analyzed in the Biomechanical Laboratory of the school of Human Movement and Exercise sciences of Western Australia. It was also viewed that wrist abduction was seemed to be the major reason for production of impressive ‘Dusra’. Motoyasu, Koshiyama and Katsumata (2009) examined the effects of joint movement on the accuracy of 3-point shooting in basketball and found that the distance between a ball and the center of the ring showed significant positive correlations with the ball release velocity, ball release angle, the ankle plantar flexion angle, hip angular acceleration, knee angular acceleration and ankle angular acceleration. Ikai M. and Matsumoto Y. (1984) made scientific investigations on the principles underlying the various techniques used in Judo, first analyzed the techniques,
and made observations on their kinematics, and further wished to synthesize by adding psychological and physiological investigations. It was found that in the Hiza-guruma velocity was the lowest with 1.95 m/s. Sciences of applied mechanism are fulfilling these demands of high technological knowledge for the enhancement of performance in the field of sports. Physical education reaching new heights and providing equal to expectations of the demand of this profession but still lot more is to be done. Inspite of our hectic efforts in the formation of the front line to achieve excellence in sports, the performance level has not been seen up to the mark. Therefore, in the latter part of this century, our experts are concentrating on scientific research to providing adequate information and proper training along with an effective system of providing better human resources for future India.

As we know that for enhancement in game and sport its techniques should be mastered. For improving the techniques or to work upon it, it is very important to analyze it, so as to know what are the motor and mechanical variables of the techniques which must be given due attention for improving that particular technique. This study had been taken to analyze the technique of set shot while attempting free throws, so that those effective variables could be known which contributes to the effectiveness of the technique in male categories. Depending upon those contributing variables, effective training can be given to players. To identify a movement as an economic one, it is very essential to analyze the movement first. Sometimes, it is very difficult for a human eye to analyze all the movements of various body segments and joints at
the same time. So, various instruments like still camera, video camera, markers etc are used to analyze various movements. Further the technology moved the analysis processes to software also. This is a quantitative method which is very accurate but at the same time it is very costly and time consuming. The role of videography and use of motion analysing softwares in biomechanical research is getting enriched day by day. The role of videography or cinematography in biomechanical research involved from a simple form of recording motion to a sophisticated means of computer analysis of motor efficiency.

Biomechanics can be defined as ‘the science that examines forces acting upon and within a biological structure and effects produced by such forces’. The ‘biological structure’ in this context can be wide spread and covers systems of different levels: cells, tissue, joints, segments, the entire body or even a complex system consisting of several bodies or the human body in combination with the surroundings (water, air, equipment, floor etc.). The main focus of applied sport biomechanics research is primarily directed to the entire human body in the complex sport discipline or sport specific situation. Among others, biomechanical research primarily deals with the following issues:

- gaining a better understanding of human posture, locomotion and movement
- increasing the understanding of the mechanics, structure and function of biological structures
- establishing biomechanical principles
- studying the biological response of mechanical loading.
The main goals of biomechanical research are to enhance performance in movement and to improve subject specific comfort in movement and locomotion. Biomechanical research is characterized by its interdisciplinary approach with other related fields such as medicine, neuroscience, physics and engineering. The content of biomechanics can be separated in three main areas with substantial overlapping: medicine, engineering as well as movement and sport science. The area of movement and sport science covers important interactions with motor control, training science, exercise physiology and orthopaedics. Due to the wide scope of application, sport biomechanics represents one of the main subcategories of biomechanics. The sports biomechanical research primarily covers issues of-

- performance enhancement
- comfort
- injury prevention and
- safety.

As in other scientific disciplines, sports biomechanics can be separated into basic and applied fields. Basic research deals with aspects to better understand the mechanics and control mechanisms of human sport movement and to investigate the response of loading in sport movements on biological structures. The applied field in sports biomechanics is very wide due to the manifold of characteristics of movement and locomotion in sports. The most important issues of the applied research are
• the application of biomechanical knowledge provided from basic research to sports in general,
• the biomechanical description and analysis of sport movements,
• the development of specific measurement and analysis methodology,
• the development and design of sport equipment,
• the effect of mechanical intervention (e.g. material, surface, equipment) on movement and motor control.

Due to its specificity, the research of applied sports biomechanics is confronted with significant and substantial challenges. The specific and partly very complex circumstances of sport and sport disciplines (e.g. competition area, surface, material, equipment, partners and/or opponents, etc.) have to be considered and necessitate the development of appropriate biomechanical measurement and research methodologies. In close cooperation between biomechanical research groups and appropriate companies a large number of measurement devices and software packages have already been developed and are available on the market. For many very specific research questions and applications, however, these standard packages often are not adequate and not sufficient. In these cases innovative and appropriate hardware and software solutions have to be developed. A large number of sophisticated and useful solutions to these challenges have already been reported for many sport disciplines. Worth to mention is that these innovatively developed methods as a matter of course also have to cover the scientific demands of validity, reliability and accuracy. Furthermore, the more practical issues like range of usage,
transfer, complexity, range of motion to be analyzed, expenditure of time for
data collection and data analysis, handling of the equipment, costs and the
amount of interference of the measuring devices with the athletes have to be
considered if the methodology should be used as a standard tool for training
support and competition preparation. One of the most important challenges in
applied sports biomechanics is to overcome the discrepancy between reliability
and validity of the collected data sets. In general, reliability (accuracy of
determining or measuring the parameter value) and validity (degree to which a
test or system measures what it was designed to measure) are independent from
each other. In applied research fields like sports biomechanics, however, an
interaction between reliability and validity might occur. This conflict often
 corresponds to the issue of collecting data in a lab or field situation. Usually,
data collected in the lab are more accurate and reliable, but the validity can be
substantially restricted. This should be explained by an illustrative example.
Simulated take-offs in ski jumping performed on force plates provide very
accurate and reliable data regarding the kinematics and dynamics of the take-off
movement. It has to be considered, however, that in the lab situation the
mechanical conditions are substantially different from hill jumps due to the
differing friction and aerodynamic force situation. In simulated take-offs the
friction between the boots and the surface is high and no aerodynamic forces act
on the jumper. In hill jumps the conditions are vice versa (low friction between
skis and track, high aerodynamic forces). Thus, the validity of the collected data
might be substantially restricted. This has to be considered when the data are
interpreted with respect to performance and coordination abilities. Data collected in the field typically provide the opposite situation: high validity, but the accuracy and reliability might be restricted due to the lack of appropriate measurement devices. Up to now no measuring system is available, for example, to determine the ground reaction forces in hill jumps in three dimensions. In competitive sport, the highest level of validity can only be guaranteed when data are collected during competitions; however, the regulations hamper the usage of biomechanical methodology in competitive conditions substantially. To overcome these problems data can be collected in semi-competitive situations. This can be performed in field studies providing conditions as close as possible to competitive situations, but also by mimicking competitions using simulation and/or imitation conditions. The ‘golden standard’ is to establish measurement methods and conditions providing a combination of high validity, reliability and accuracy. Consequently, sport biomechanists should perform detailed error estimation in each specific situation of data collection for providing detailed information on data accuracy. Hence, specifically in complex situations, differentiated error estimation is challenging due to overlapping of errors from different sources. It can be distinguished between systematic errors (e.g. image distortion, calibration errors, placement of markers and electrodes, level of model abstraction) and random errors (e.g. errors due to signal resolution and sampling frequency, digitizing errors, cross talk etc.). In general, systematic errors are harmless when data sets are compared relatively. Although random errors can be severe, substantial reduction can be achieved by using appropriate
filter and/or frequency analysis routines. Careful attention should be given to the issue of biovariance. As it is well known that repeated movements never can be performed identically, repeated movements have to be interpreted within a meaningful range of deviation. Hence, these deviations must not be assessed as errors. Nevertheless, the range of deviation has to be discussed along with the optional errors in data acquisition and data analysis. Surprisingly, the report of accuracy, reliability, error estimation and validity is rather humble in papers dealing with applied biomechanics topics. These aspects, however, are very important to prevent researcher, coaches and athletes from misleading or misinterpretation of collected data.

Biomechanical principles are applied by scientists and professional in a number of fields in addressing problems related to human health and performance. Knowledge of basic biomechanical concepts is also essential for the competent physical education teacher, physical therapist, physician, coach, personal trainer or exercise instructor. An introductory course in biomechanics provides foundational understanding of mechanical principles and how they can be applied in analyzing movements of the human body. The knowledgeable human movement analyst should be able to answer many basic questions related to biomechanics like what are the mechanical principles behind variable resistance exercise machines? What is the safest way to lift a heavy object? Which movement is more/less economical? At what angle should a ball be thrown for maximum distance? From what distance and angle is it best to observe a patient walk down a ramp or a volleyball player execute a service?
What strategies can an elderly person or a football lineman employ to maximize stability?

Sport biomechanists have also directed efforts at improving the technique components of athletic performance. They have learned, for example, that factors contributing to superior performance in the long jump, high jump and pole vault include large horizontal velocity going into takeoff and a shortened last step that facilitates continued elevation of the total-body center of mass. Examples of well known athletes easily display the importance of biomechanical technology in improving performance. In 1996 Summer Olympics held at Atlanta, Michael Johnson used the golden shoes because of Biomechanical reasons. Actually he was prepared for the 1988 Summer Olympics in Seoul, but developed a stress fracture of his left fibula before the U.S. Olympic Trials began. He did not qualify in the 400 meters and he withdrew from the 200 meters. In fact his feet are different in size. Johnson entered the Olympic finals donning a custom-designed pair of golden-colored Nike racing spikes made with Zytel. Biomechanists preferred some specifications in his running spikes. They preferred spikes weighed 3 ounces (85 g) and the left shoe was a size 10.5 while the right shoe was a US size 11, to account for Johnson's shorter left foot. Finally he became the first man to win the 200 m and 400 m in the same Olympics and took 0.34 seconds off his own 200m world record, which he set two months earlier on the same track at the Olympic trials. Sport biomechanists have directed efforts at improving technique components of a player to enhance performance. They have learned, for example, that factors contributing to
superior performance in the long jump, high jump and pole vault include large horizontal velocity going into takeoff and a shortened last step that facilitates continued elevation of the total-body center of mass. One example of performance improvement, partially attributed to biomechanical analysis, is the case of four-time Olympic Discuss champion Al Oerter. Mechanical analysis of the discus throw requires precise evaluation of the major mechanical factors affecting the flight of the discus. These factors are the speed of the discus when it is released by the thrower, the projection angle at which the discus is released, the height above the ground at which the discus is released and the angle of attack. By using computing simulating techniques, researchers can predict the needed combination of values for these four variables that will result in a throw of maximum distance for an athlete. High-speed cameras can record performances in great deal and when the film or videotape is analyzed, the actual projection height, velocity and angle of attack can be compared to the computer-generated values required for optimal performance. At the age of 43, oerter bettered his best Olympic performance by 8.2 meters. Although it is difficult to determine the contributions of motivation and training to such an improvement, some part of oerter’s success was a result of enhanced technique following biomechanical analysis.

P T Usha finished first in the semi-finals of the 400 metres hurdles in the 1984 Los Angeles Olympics, but faltered in the finals. In almost a repeat of Milkha Singh’s 1960 feat, there was a nail-biting photo finish for the third place. Usha lost the bronze by 1/100th of a second. She became the first Indian
woman (and the fifth Indian) to reach the final of an Olympic event. It should not be misunderstood if said that had Biomechanical analysis done on these Indian Athletes, India would not have lost by $1/100^{th}$ of seconds. If a biomechanical technology can put some contribution in the performance improvement i.e., 0.34 seconds and 8.2 meters of Olympians. Then, we have to accept that biomechanics would have improved over Olympians with atleast a few seconds and distance. Other concerns of sport biomechanists relate to minimizing sport injuries through both identifying dangerous practices and designing safe equipment and apparel. In recreational runners, for example, research shows that the most serious risk factors for overuse injuries are training errors such a sudden increase in running distance and intensity, running on cambered surfaces and improper footwear. The complexity of safety-related issues increases when the sport is equipment-intensive. An area of biomechanical research with implications of both safety and performance is sport shoe design. Today sport shoe are designed to prevent excessive loading and related injuries and to enhance performance. Biomechanics is contributing to the knowledge base on the full gamut of human movement, from the gait of the physically challenged child to the technique of the elite athlete. Because of continuing advances in scientific analysis, the role of biomechanics in contributing to performance improvements is likely to be increasingly important in the future.

Kinematics is the study of bodies in motion without regard to the causes of the motion. It is concerned with the describing and quantifying both the linear
and angular positions of the bodies and their time derivatives. Kinematics is the preferred analytical tool for researchers interested in questions such as, who is faster? What is the range of motion of a joint? How do two motion patterns differ? Kinematic analysis may be an end in itself or an intermediate step that enables subsequent kinetic analysis. The most common method for collecting kinematic data uses an imaging or motion-caption system to record the motion of markers affixed to a moving subject, followed by manual or automatic digitizing to obtain the coordinates of the makers. These coordinates are then processed to obtain the kinematic variables that describe segmental or joint movements. Biomechanist interested in improving athletes. It is ideal for the analysis of single movements or intervals of exercise lasting up to minutes. The most cost-effective method is qualitative analysis, in which the athletes, coach or sport scientist simply view the video together and decide immediately how technique could be improved. The athlete can then attempt any recommended changes and the filmed for a further round analysis.

Basketball is a team sport in which two teams of 5 active players each try to score points against one another by placing a ball through a 10 foot (3.048 m) high hoop (the goal) under organized rules. Basketball is one of the most popular and widely viewed sports in the world. Points are scored by throwing (shooting) the ball through the basket from above, the team with more points at the end of the game wins. The ball can be advanced on the court by bouncing it (dribbling) or passing it between teammates. Disruptive physical contact (foul) is penalized and there are restrictions on how the ball can be handled (violations).
time, basketball has developed to involve common techniques of shooting, passing and dribbling, as well as player’s positions and offensive and defensive structures. Typically, the tallest members of a team will play center or one of two forward positions, while shorter players or those who possess the best ball handling skills and speed, play the guard positions. While competitive basketball is carefully regulated, numerous variations of basketball have developed for casual play. In some countries, basketball is also a popular spectator sport. While competitive basketball is primarily an indoor sport, played on a basketball court, less regulated variations played in the outdoors have become increasingly popular among both inner city and rural groups. Dr. James Naismith was instrumental in establishing college basketball. He coached at the University of Kansas for six years, before handing the reins to renowned coach Forrest Phog Allen. Naismith's disciple Amos Alonzo Stagg brought basketball to the University of Chicago, while Adolph Rupp, a student of Naismith's at Kansas, enjoyed great success as coach at the Kentucky. On February 9, 1895, the first intercollegiate 5-on-5 game was played at Hamline University between Hamline and the School of Agriculture, which was affiliated with University of Minnesota. The School of Agriculture won in a 9-3 game. In 1901, colleges, including the University of Chicago, Columbia University, Dartmouth College, the University of Minnesota, the U.S. Naval Academy, the University of Utah and Yale University began sponsoring men's games. In 1905, Theodore Roosevelt formed a governing body for colleges, resulting in the creation of the Intercollegiate Athletic Association of the United States (IAAUS). In 1910, that
body would change its name to the National Collegiate Athletic Association (NCAA). In 1892, the University of California and Miss Head's School played the first women's inter-institutional game. Berenson's freshmen played the sophomore class in the first women's intercollegiate basketball game at Smith College, March 21, 1893. The same year, Mount Holyoke and Sophie Newcomb College (coached by Clara Gregory Baer) women began playing basketball. By 1895, the game had spread to colleges across the country, including Wellesley, Vassar, and Bryn Mawr. The first intercollegiate women's game was on April 4, 1896.

Shooting is the act of attempting to score points by throwing the ball through the basket. While methods can vary with players and situations, the most common technique is outlined as follows: The player faces the basket with feet about shoulder-width apart, knees slightly bent, and back straight. The player allows the ball to rest on the fingertips of the dominant hand (the shooting arm) slightly above the head, with the other hand supporting the side of the ball. To aim the ball, the player's elbow should be aligned vertically, with the forearm facing in the direction of the basket. The ball is shot by extending the bended knees and straightening the shooting arm; the ball rolls off the finger tips while the wrist completes a full downward flex motion. The shooting arm, fully extended with the wrist fully bent, and the fingers pointing downward, is held stationary for a moment following the release of the ball, this is known as a follow-through, which when properly done, enhances the accuracy of the shot. Generally, the non-shooting arm is used only to guide the shot, not to power it.
Players often try to put a steady backspin on the ball to deaden its impact with the rim. The ideal trajectory of the shot is somewhat arguable, but generally coaches recommend a proper arch. Players may shoot directly into the basket or may use the backboard to redirect the ball into the basket.

The two most common shots that use the above described set up are the set shot and the jump shot. The set shot is taken from a standing position, with neither foot leaving the floor, typically used for free throws. The jump shot is taken while in mid-air, when the ball is released near the top of the jump. This provides much greater power and range, and it also allows the player to elevate over the defender. Failure to release the ball before the feet return to the ground is considered a traveling violation. Another common shot is called the layup. This shot requires the player to be in motion toward the basket, and to ‘lay’ the ball ‘up’ and into the basket, typically off the backboard (the backboard-free, underhand version is called a finger roll). The most crowd-pleasing, and typically highest-percentage accuracy shot is the slam dunk, in which the player jumps very high, and throws the ball downward, straight through the hoop. Another shot that is becoming common is the "circus shot". The circus shot is a low-percentage shot that is flipped, heaved, scooped, or flung toward the hoop while the shooter is off-balance, airborne, falling down, and/or facing away from the basket.

In basketball not only fast skills, but also technical needs, tactics, agreement, experience and the potential for contest is shown in a game. The ratio of aerobic to anaerobic in basketball is 1:9; this show that basketball is an
anaerobic and high intensity exercise. Because of the high intensity and anaerobic property of basketball, one has to give best performance with in the short period of the game. These performances include the shooting action, dribbling skill, defense etc. When the coach trains athletes they need to improve basketball player’s power, muscle endurance, and cardiovascular endurance to adapt to the high intensity exercise. Shooting is the basic way to get in basketball and for this reason it is the most frequently used technical action (HAY, 1978). The free shot is distinguished as the most important of all the shooting actions. In 2002 the international Basketball Federation (FIBA) decided to decrease the shot clock violation to 24 seconds that required players to improve their fitness level and that ultimately lead coaches and sport scientists to find new techniques and strategies to avoid fatigue and to perform the skills efficiently.

In basketball Players have to execute many techniques i.e., throwing, passing, shooting, dribbling and holding. Shooting is basically divided into two main techniques that is jump shot and set shot. In the jump shot players lift his body in the air and then attempt for the basket. Jump shot is mainly used to avoid any opponent’s direct restriction while shooting, so in jump shot shooter tries to overcome the resisting height of the opponent. Set shot is the technique commonly used for a free throw - an unopposed shot awarded after an opposing foul, and taken from the free-throw line. Set shot is a shot taken at stationary position or without jumping. Until the invention of the jump shot (1940) the most-used shot in basketball was the two-handed set shot. Among the greatest executors of this shot were Bobby McDermott, Eddie Sailor and Dick Kinder.
This shot is used when you are standing still and mainly without an opponent. Set shot is an uncontested shot commonly taken from free throw line, 15 feet -4.60 meters- distant from the backboard. A successful free throw is worth one point. It is no compulsion to use set shot in free throws only, set shot can be used from anywhere in the ground, but now a days the game is so fast and skilled that hardly a player get opportunity to deliver set shot before a tall opponent. On the other hand, set shot therefore mainly used for the free throw attempts. Now a day’s competition level is very high and no one willing to loose a single point and here raises the importance of set shot technique. While attempting for the free throw every player use set shot technique only. The main reason for using set shot in free throws is the stability and comfort in delivering the skill. The player while using the set shot also gets optimum opportunity to overcome the tensed movements of the game and feel some relaxation, as in set shot body requires very less energy expenditure if compared with jump shot. In set shot the player stands still and then with the required linear and angular movement attempts for basket without an opponent. Ultimately all the comfort, less energy expenditure and easy skilled movement raises the chances of successful attempt, therefore the importance of set shot can not be avoided. In the set position, player’s feet were spaced and aligned for balance and comfort and then use that position for attempt. Set shot is taken without leaving the ground, such as a free throw. The ball should be 'shot' and not 'thrown', with body balance maintained throughout the shot. Here are some instructional points to remember while shooting - Good body balance, Focus on the basket as the bulls-eye picture in the
eye, Concentrate and think the ball into the target, follow through, rhythm and smoothness of motion. While attempting the set shot player easily gains the given instructions which assists in gaining good successful attempts. Therefore set shot attempt is a highly skilled movement. Importance of set shot raises more when the competition becomes neck to neck level and teams even fight for single points. Importance of set shot or free throw is obviously high, no matter what the level of tournament or the players. Free throws are taken by adopting the skill of set shot. Free throw is an unchallenged shot at the basket. Set shot adopted in free throws is an undefended shot taken from the free throw line. Players from the two teams line up alternately on both sides of the free throw line. Free throw is the privilege given to a player to score one, two, or three points under rule by unhindered throw for a goal from within the free throw circle and behind the free throw line. Two hand set shot is mainly considered as effect as in the running game of basketball set shot is typically used free throw attempts. Free throw shot is therefore also considered as set shot. When a personal foul is called and the penalty is the awarding of free throw(s), the player against whom the foul was committed shall be designated by the official to attempt the free throw. It is on the attempting players to choose the technique of shooting, but the most preferred is set shot. The free throw shooter shall take a position behind the free throw line and attempt for the goal.

Players of this game need to possess the suitable biomechanical techniques which may give greater advantage in executing skills. Biomechanists are interested in improving athletes. It is ideal for the analysis of single
movements or intervals of exercise lasting up to minutes. The most cost-
effective method is qualitative analysis, in which the athletes, coach or sport
scientist simply view the video together and decide immediately how technique
could be improved. The athlete can then attempt any recommended changes and
the filmed for a further round analysis. The C.G. of the body is involved in all
consideration of equilibrium. The position of C.G. of the body is a major factor
in determining the soundness of the stance that is advocated in any technique in
any sports in order to accomplish the desired objective most effectively.
Therefore, this factor must receive more careful attention. Motion pictures and
video have been used for years to study athletic performances. They have
provided to be a tremendous assistance to scientific analysis of the technique
employed by athletics in all phases of sports, as well as an effective means of
demonstrating the mechanical principles involve in athletics competition. The
direction of movement, related body movements, sequence of movements,
speed, force, distance, angles, conditions of equilibrium and so far may be
directly or indirectly determine the means of analysis of motion. However in
order to obtain accurate results from a cinematographic analysis of an activity,
certain basic principals must be followed. Dr. Thomas K. Cureton, has made a
notable contribution in athletic research through cinematography.

During this technical and advanced century, advances in the sciences of
human motions seem to have been not only due to improvements in
instrumentation, but also to be development of better and more creative methods
of using theses instruments. Fundamental to the study of human motion is
measurement of the displacement of the body and its segments. Today, advances in kinematics analysis have been greater than in most other aspects of research. Traditionally, cinematography analysis of relative high speed films has been the technique used to obtain kinematic data. However, the raw displacement of data thus acquired usually contains inherent error that can cause large inaccuracies in the velocities and accelerations determined by direct differentiation. For this reason, various methods of smoothing the displacement data have been employed. The two most successful are digital filtering and use of spline function by Wood and Jennings, Zernicke. Methods of three dimensional cinematographic analysis have been developed and refined during the 1970s to improve the accuracy of studying complex human motions, but these techniques not yet been implemented completely according to Miller.

The use of optoelectronic devices to acquire displacement data is a particularly promising development that may replace cinematography in the near future and it will be good to say is slowly becoming popular. Among these new techniques that have emerged in the recent years are (1) automatic image analysis in which a television image or a cine film is scanned by computer to determine the X and Y coordinates of anatomical landmarks and (2) light spot position measurements, which uses optoelectronic devices such as the selspot to obtain the information about the three dimensional coordinates of small, active light sources attached to the human body or the Human Markers. Although considerable progress has been made in the descriptive (kinematic) analysis of human motion, the area of kinetics has received relatively limited attention.
Miller expressed the belief that future research must expand its concern with the kinetic and kinematic analysis of human motion. Cinematography and now a day digital videography is the most frequently used in sports biomechanics research for obtaining a record of human movements. These film records are quantitatively analyzed to obtain linear and angular displacement, time data and segmental movements. Typically, the basic displacement time, functions of a motion do not provide sufficient information to describe fully the activity thus these data are further treated mathematically to determine the respective velocity and acceleration functions.

The sciences of kinesiology and bio-mechanics have grown from applied anatomy and mechanics. It is recommended that the coach should take time to study these sciences. Recently videography has begun to replace conventional motion picture for teaching and coaching purpose. Since video recordings are enabling, reusable does not require any developing, it is more economical than film. The relatively inexpensive portable recorders have significant potential for instruction. Pictures taken of students performing motor skill can provide them with further insight into their own actions, a greater appreciation of the mechanics of sports skill and increased interest in improving their performance. Quantitative analysis involves digitization of the video images to permit calculation of spatial and temporal relationships in the movement. Several hardware software packages are available for the purpose. Simple but effective digitizing is also possible with minimal extra hardware and software. This procedure is the time consuming and loses the benefit of immediate feedback to
the athlete, but it allows detailed comparisons of one athlete with another or of one athlete before and after an intervention. Video has also been used for time motion or rotational analysis, in which times spent in various modes of activity or in moving at various speeds are estimated from time and distance measurements taken from the video. Biomechanics is of fundamental importance to analyze and evaluate the technique or skill of an athlete with proper application and implementation of applicable mechanical principles for the enhancement of performance in sports and games. Various body angles on ground and in space, center of gravity of an athlete in specific positions, velocity of the released object, angle of release, height of release etc plays an importance role in the performance hence true mastery comes only after serious study of the mechanical principles involved. Sport does not simply involve physical activities but components of physics, mathematics, biology, psychology, sociology and many more. It is actually engineering, which needs regular updated scientific approaches in all the factors. Standard video graphic motion analysis is preferably used in biomechanical analysis process. Special computers capture the human motion and then analyze the motion patterns.

STATEMENT OF THE PROBLEM

The purpose of the study is two dimensional kinematical analysis of set shot among basketball players.

DELIMITATIONS

1. The study was delimited to the male Basketball players of three different height groups i.e.,
Group I: Five feet five inches to five feet eight inches (5’5” to 5’8’’).

Group II: Five feet nine inches to six feet (5’9” to 6’).

Group III: Six feet one inch to six feet four inches (6’1” to 6’4”).

2. The study was delimited to male national and inter-varsity players only.

3. The study was delimited to right handed basketball players of 18 to 30 years of age.

4. The study was delimited to set shot while performing free throws only.

5. In the study digital video cameras or camcorders was used for the determination of the technique.

6. The selected Kinematical variables at moment of stance and moment of release of ball were as follows:

A.i. Angle at right ankle joint.

A.ii. Angle at left ankle joint.

A.iii. Angle at right knee joint.

A.iv. Angle at left knee joint.

A.v. Angle at right shoulder joint.

A.vi. Angle at left shoulder joint.

A.vii. Angle at right hip joint.

A.viii. Angle at left hip joint.

A.ix. Angle at right elbow joint.

A.x. Angle at left elbow joint.

A.xi. Angle at right wrist joint.

A.xii. Angle at left wrist joint.
A.xiii. Angle of release of the ball.

A.xiv. Height of center of gravity of the shooter at moment of stance.

A.xv. Height of center of gravity of the shooter at moment of release of ball.

A.xvi. Time to perform the course.

A.xvii. Displacement of center of gravity.

LIMITATIONS

1. Non-availability of sophisticated devices was the major limitation of the study.

2. The factors like environment, temperature, atmosphere pressure etc were beyond the control of the investigator, which might have affected the performance of the subjects.

OBJECTIVES OF THE STUDY

1. To find out the correlation between the selected kinematical variables and the performance of the subjects in set shot.

2. To study the significance of difference in selected kinematical variables among three different height groups while performing set shot.

3. The study was designed to prepare an ideal model for the technique of the skill of set shot in basketball.

DEFINITIONS AND EXPLANATIONS OF THE TERMS

Kinematics: It is that branch of Biomechanics i.e. concerned with describing the motion of body. Thus, Kinematics deals with such things as how far a body moves, and how consistently it moves. It is not concerned at all with
what causes a body to move in the way it does. Kinematics analysis motion in terms of time, displacement, velocity or acceleration.

**Videography:** It refers to the process of capturing moving images. The term involves methods of electronic production. It is equivalent of cinema autography, but with images recorded on electronic media instead of film stock. The word ‘videography’ consists by combination of two Greek words, ‘video’ and ‘graphy’. The Greek word ‘video’ means ‘I see’ or ‘I apprehend’ and the word ‘graphy’ means, ‘to write’. Videography covers many more fields than just shooting videos with a camera. It includes digital animation, gaming, web streaming, video blogging, still slideshows, spatial imaging, medical imaging and in general the production of most bitmap and vector based assets.

**Set Shot:** The two most common shots used in basketball are the set shot and the jump shot. The set shot is taken from a standing position, with neither foot leaving the floor, typically used for free throws. Set shot is mainly attempted from the line of 5.80mtrs for free throw shot in basketball and for each conversion one point is awarded to the converter. In this study, set shot is analyzed when attempted as free throw.

**Center of Gravity:** The center of gravity of any object is that point at which all of the weight of an object may be concentrated. The center of gravity is referred as the point of balance of a body and it is either stated or implied that it is possible for it to be balanced or supported.
SIGNIFICANCE OF THE STUDY

The results of the study would be significant to biomechanists, Sport scientists, physical education teachers, players and coaches in the following ways:

1. The results may indicate the variables, which might be considered as factors affecting the performance of basketball players while shooting.
2. The results may provide a model for the technique of skill for analyzing the performance of the players.
3. Results will be helpful in the preparation of training schedules for basketball players more effectively.
4. The study may add a new dimension in literature of basketball.
5. The results will be helpful in preparing how effectively and efficiently the free throw shot has been made.
6. The knowledge of the scientific basis of set shot may help in teaching and coaching of set shot.