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Review Article

Movement Pattern Analysis of Layup, Jump Shot and Free Throw in Basketball

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ABSTRACT

Basketball sport originated as a non-contact sport but recently it has evolved into physically more challenging in which contact is accepted and expected. This transition of the sports has increased the injury rates substantially. Basketball includes multiple movements such as jumps, turns and change of direction, running and deceleration in its various movements of jump shot, free throw and layup shot. The complexities of these movements imposes various demands on basketball players, which makes it more important to know the health oriented aspects of the movement. This review explains the movement pattern analysis of these basketball specific movements in detail which can help the physiotherapist to plan the injury prevention strategies for their athletes.

KEY WORDS: Basketball, Basketball Movements, Jump Shot, Layup Shot, Basketball Free Throw.

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INTRODUCTION

Basketball originated as a non contact sports but it has evolved into physically challenging in which contact is accepted and expected [1]. Thus it is one of the most popular contact sports played globally. It is played on a rectangular wooden court, between 2 teams of 5 players each [2]. Each team aims to score maximum points by shooting a ball into a hoop of 18 inches of diameter which is mounted to the backboards at each end of the court at a height of 10 feet [2]. The team with highest score points wins the game. To score 3 points, the field goal shoots from behind the 3-point line, to score 2 points, the field goal shoots from in-front of the 3-point line. One point can be scored via free throws [2]. The ball is advanced on the court either by passing it to a teammate or by dribbling. Lifting, dragging the ball or pivoting foot without dribbling the ball is a violation [2].

Few orthopaedic studies have reported on injury epidemiology in professional basketball players [3]. The sport requires complex movements like jumps, turns and change of direction, running and deceleration which leads to frequent injuries consequently reduction in court time [2,4]. According to an integrative systemic review the common injury sites in basketball athletes were hand, wrist and fingers, knee and ankle [4]. The descriptive epidemiological study [1] performed in 2010 findings show that lower limb injuries

accounted for 62.4% of total injuries. These injuries were responsible for 72.3% of games missed because of injuries [1]. Biomechanical analysis of the various basketball movements will help the physiotherapists and strength and conditioning professionals to formulate injury prevention strategies. It helps to determine the strengths and weaknesses of an athlete. Incorrect movement habits developed due to the injury need to be identified and strategies need to be prepared to help the athlete develop proper movement patterns [5]. This article will be helpful to understand the various movement patterns that take place during a basketball game. Many articles [6,7,8] are available for the technical analysis of the game but they lack the review of all the movements of basketball. Thus, the aim of this article is to discuss the movements of the layup shot, free throw and the jump shot from injury prevention perspective to help physical therapists and strength and conditioning professionals develop sport specific injury prevention programs.

Movement pattern analysis of a lay-up shot: The lay-up shot (Figure 1 and 2) is one of the most basic and fundamental action in the basketball game [9]. This shot is preferred by players short in height and to avoid tall defender's block [10].

Fig. 1: Layup Shot.

Fig. 2: Preparatory Phase of a layup.

The layup is done by one hand, from a position under or beside the basket [10]. It consists of 3 phases:

1. Preparatory phase
2. Implementation phase
3. Follow through phase

Preparatory phase: A wide first step by right foot while performing right side layup, maintaining the balance and to gain distance, followed by a short 2nd step by left foot to jump high (Figure 3), shoulders are relaxed. Non- shooting hands under the ball, shooting hands behind the ball, elbows are inwards [11]. The ball is kept close to the chest to prepare for the shot [12].

Implementation phase: The right knee is flexed and pointed towards the basket to jump high vertically. The right arm is extended to shoot the ball, elbows are slightly bent [12]. The head is kept upright during the shot and while going for the lay-up. The ball is released by generating power in the fingertips, slightly rotating the wrist inwards creating a spin of the ball and aiming at a point slightly right to the center of the backboard [11,12].

Follow through: The player lands on both the feet equally with knees flexed and hands relaxed [13].

Fig. 3: Jump Shot.

Movement pattern analysis of a jump shot: According to researchers 2-legged jump shot (Figure 3) amounts to 70% of all the shots in a game.[7] Factors affecting the height of the shot are the shooter's body height, jump height and arrangement of body parts [8]. It consists of 5 phases:

1. Preparation Phase
2. Ball elevation Phase
3. Stability
4. Release
5. Follow through [14]

Preparation Phase: During the preparation phase, the athlete stands shoulder width apart, bearing the weight equally on both the feet. The foot of the shooting arm is placed slightly forward to increase stability also to reduce shoulder, trunk and pelvic rotation in the release phase [15-17]. The ankle, knee, hip joints go into flexion in preparation for the jump, resulting in a forward lean of the trunk [8]. The ball is held close to the body with the fingers of both the hands [14]. The hand under the ball is used to generate impulse [17]. The non- shooting hand is kept on the side of the ball for support during the preparatory motion [18].

Ball elevation phase: This phase begins with the shoulder and elbow flexion to prepare for ball release [14]. The shoulder flexes between 90-135 degrees, elbow in line with the basket [16-17]. Movement of the arm, forearm and hand takes place in a single plane of motion in order to improve shooting accuracy [16,19]. Extension of the ankle, knee and hip joints happens simultaneously as the ball is elevated to initiate the jumping motion and progress to the stability phase [14].

Stability Phase: During the stability phase, the lower limbs progress to flight phase from preparatory flexed position [14]. The wrist of the shooting arm is hyperextended to initiate ball release at the peak of the jump. The wrist muscles use elastic energy to initiate wrist flexion during ball release after the counter-movement of wrist hyperextension in the preparatory phase [6]. Wrist and elbow pre- stretch generate greater force and speed for ball release, hence, reducing the muscle effort for ball release for a successful shot [20-21].

Release Phase: This phase begins by extending the elbow and flexing the wrist ending with ball release [14]. According to the researches elbow extension, greater wrist flexion along with the application of rotation to the ball release is characteristic of expert shooting performance [15,17,19,20]. It has also been suggested that ball release must be performed through finger and wrist flexion to provide a parabolic trajectory and a backward rotation during the flight [17].

Follow-through phase: This phase begins with ball release, is characterised by sustained wrist flexion [17,22] reduced shoulder flexion and elbow extension [14].

The jump shot ends with the shooting elbow extended, the hand parallel to the floor and the fingers pointing towards the basket [6].

Movement pattern analysis of free throw: A free throw is an important shot in basketball especially during the last 5 mins of the game. (Kozar et al., 1994) It is one of the easiest shots, the player stands 15 feet from the basket all alone, no defence or close distractions [10]. The free throw is of 2 styles- the overhand push shot and the underhand loop shot, respectively. The push shot is more commonly used as it is used for many other shots in the game [10]. The free throw has 5phases as described in the level I NCCP Coach Certification Program (Coaching Association of Canada, 1980)

1. Preliminary movements
2. Backswing
3. Force producing movements
4. Critical instant
5. Follow through

Preliminary Movements: The athlete stands with a slight shoulder width apart from a staggered stance. The athlete keeps the wrist loose and fingers and hands relaxed while dribbling with the shooting hand. The shooter holds the ball with both hands, fingers placed directly behind the ball. The wrist is in extension to support the ball and provide propelling force for the shot [10]. (Figure 4)

Fig. 4: Free Throw.

Backswing: The ball is kept stationary at waist level, The shoulder of the shooting arm is parallel to the body and the forearm is placed along the trunk. Knees flexed to 90degrees and the trunk flexed to 50 degrees from neutral. From this position the trunk progresses to extension position, which pushes down on the lumbar vertebrae, which transfers the force on the sacro-iliac joints, which further transfers to the hip joints. This downward force will then be transmitted to the knee joints and greater knee flexion will be produced. The Centre of Gravity (COG) is lowered when a player executes knee and hip flexion and ankle dorsiflexion before a shot, this position produces a more forceful extension while jumping. The ball is raised by flexing the shoulder, extending the trunk and the knees flexing further to go in a deep crouch position. The non- shooting hand is kept on the side of the ball in order to allow the shooting shoulder to be forward in line with the basket [10]. The trunk is rotated to 45degrees to the basket and in a vertical position during the shot.

Fig. 5: Force Producing Movement in free throw.

Force producing movements: These movements produce upward and forward force to release the ball. The ball is kept in front of the body, the ball sits on the shooting hand's well spread fingers. The movement begins as the trunk reaches the vertical position and the ball is held above the shoulder level. The knees are in maximal flexion and the vertical velocity of the ball is zero, at this point (Figure 5). From this position the force producing movements are the extension of the knees and hips and the elevation of the ball by shoulder flexion. The knees and hips are extended first, followed by shoulder flexion, then elbow extension and wrist flexion. Errors observed are excessive shoulder elevation close to the ears, leading to excessive tension in trapezius and might interfere with smooth shoulder flexion during the shot. Excessive lumbar lordosis will lead to lower back strain from tightness in the spinal extensors.

Critical instant: The instant ball is released. The trunk and legs are fully extended. The trunk is in a vertical position during the release and follow through phase. The shooting shoulder is in 140-150 degrees of flexion, elbow extended to ensure full contribution in the release phase. The wrist is in mid flexion to ensure the hand is at maximum velocity during the release phase. Wrist flexion provides the final thrust for release of the ball and helps determine both the velocity and angle of projection of the ball (Hess, 1980; Martin, 1981).

Follow-through: All the joints continue to move through to the end of their full range of motion following release of the ball. The legs are fully extended and the ankles are plantarflexed (toes pointing to the floor). The trunk is vertical and the shooting hip is lined up vertically with the knee and ankle, as well as with the joints of the shooting arm. The shooting shoulder is in at least 140-150 degrees of shoulder flexion. The joints should not stop moving prior to release of the ball. The trunk should be rotated away from the shooting hand, to line up the shooting shoulder and arm more directly with the hoop. This trunk rotation should occur during the release of the ball from the hand, as it is facilitated by the dropping off of the non-shooting hand from the ball. After the ball has left the hand the elbow should reach full extension, the wrist should be fully flexed, the forearm should be in pronation and the fingers should be pointing slightly to the outside [10].

Implementing biomechanics knowledge in training and injury prevention: The information provided in this article about the movement analysis of various shots in basketball can be used as a layout for the development of sport specific strength and

conditioning programs. As lower limb injuries are high in basketball athletes, training should consider improving muscle balance between quadriceps and hamstrings along with the focus on hip, knee and ankle stability.

In basketball the power is generated by the lower limbs, the game involves explosive movements, accelerations, quick cuts and jumps. Learning a soft-landing technique is crucial for a basketball athlete as hard landing causes an excessive load on the lower limbs which may exceed the body weight by several times, which leads to local overload and injuries.

An earlier heel contact with the ground increases the impact force, that is why midfoot landing is preferred over landing with the whole foot. Incorporation of deceleration drills in the training will help athletes learn how to absorb the shock and reduce the risk of injuries while landing. Plyometrics for lower limbs is important to help athlete generate more power and transfer it along the kinetic chain [7].

In order to increase ball release Height conditioning of shoulder flexors and stabilizers is important. Developing core strength and stability will help in shot accuracy and ball release height. Exercises with sequential lower limb triple (ankle, knee, hip) extension must be included as a part of the advanced strength and conditioning program to develop a shooting pattern that results in a successful shot.

CONCLUSION

In conclusion, the ever-evolving rules of the game leads to high physical as well as physiological demands. Basketball players must be trained in a biomechanically correct way to prevent and minimize injuries. Understanding the movement analysis of various shots will help the coaches improve the training programs and be more sport specific.

Conflicts of interest: **None**

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