Journal of Society of Indian Physiotherapists 2020;4(2):65–69

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Journal of Society of Indian Physiotherapists

Journal homepage: www.ipinnovative.com

Narative Review

Overview of biomechanics and movement patterns of cricket spin bowlers

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ARTICLE INFO

Article history:
Received 26-06-2020
Accepted 30-08-2020
Available online 31-08-2020

Keywords:
Cricket
Spin bowling
Biomechanics
Bowling
Offspin
Legspin

ABSTRACT

Cricket has gained huge popularity in Asia in recent years, but unfortunately, the research about the spin bowling is yet at infancy level. Much of the available research is based on our knowledge of ball kinematics such as ball flight, drift, and dive, etc. Less is known about the link between spin bowling biomechanics and injury prevention strategies and training programs needed for the optimal performance of a spin bowler. The performance of the spin bowler is currently more targeted to his/her technique of ball delivery and skill parameters. To overcome these challenges, we need to first understand the biomechanics in detail and the movement patterns of each phase of spin bowling. This article gives an overview of spin bowling movement patterns involved in each phase. This will help in developing new training strategies for injury prevention. Also, physical therapists and strength and conditioning professionals will be able to format sports specific workout plans for spin bowlers.

1. Introduction

Cricket is a global sport of bat and ball, played between two teams with 11 players in each. The International Cricket Council (ICC) is the world governing body that organizes various world championship events. There are three established event formats namely (T20) Twenty - Twenty event (game ranges from 20 overs per team), (ODI) One Day International event (game ranges from 50 overs per team), and Test match (approximately 100 overs per day with the match lasting 4-5 days).[1] The team comprises of six specialist positions such as batsmen, a wicketkeeper and four specialist bowlers, and one of which is usually a spin bowler.

Bowlers are an integral part of any cricket team.[2] In cricket, bowlers can be classified as fast bowlers and spin bowlers. All bowlers propel a 5.5 oz ball towards a batsman or his wickets, but a spin bowler imparts rotation to the cricket ball, which makes the ball deviate from its original direction of flight when it hits the ground.[3] A ball bowled with spin, affects the flight and bounce of the ball, making it more challenging for the batsman to play.[2] Thus, Spin bowlers play an important role in bowling attack against the batting team. Therefore, to improve the team's performance, we need to focus on improving the performance of the team's spin bowlers along with other positions. To achieve this, understanding the biomechanics of spin bowling is very crucial.

Although cricket spin bowling specific literature is available related to ball kinematics such as ball drift, flight, and dive, etc,[4–6] articles on spin bowling biomechanics and injury prevention are not as readily available. Australian injury surveillance data encompassing the years 1995–2001, demonstrates that shoulder injury prevalence among batters was 0.3%, fast bowlers 0.9%, and spin bowlers as 1.1%.[7] This means that the injury rates in spin bowlers are increasing. It is prudent to understand the biomechanics of spin bowling in detail, to format injury prevention strategies for spin bowlers. This article focuses on movement pattern analysis of each phase of spin bowling technique, to help physical therapists and strength and conditioning professionals in the development of spin bowling specific training programs.

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https://doi.org/10.18231/j.jsip.2020.009

2. Biomechanics of Spin Bowling

Spin bowlers deliver the ball at a relatively slower speed as compared to fast bowlers. To deceive the batsman, spin bowler use multiple skills like controlling the flight of the ball such as the drift, dip and side spin, etc. Depending on the method of adding spin to the ball, Spin bowlers are classified as finger spin (Off –spin) bowlers and wrist spin(Leg spin) bowlers.

2.1. Finger spin (FS) bowling

The finger spin bowler grips the cricket ball firmly across the seam, with slight flexion at interphalangeal joints of the index and middle fingers. The thumb is held clear of the ball (Figure 1). The ball leaves from the radial side of the hand controlled by first and second phalanges, while the wrist flexes and deviates to ulnar side with the elbow supination and extension.[2] It is documented that the spinning of the ball does not specifically depend only on finger action but, majorly on the supination of the forearm and the body's kinetic chain mechanism.[2]

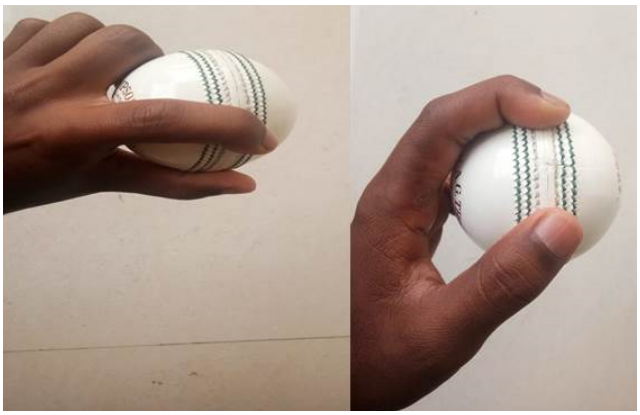

Fig. 1: Grip for finger spin bowling (left handed bowler)

2.2. Wrist spin (WS) bowling

(Figure 2) The wrist spin bowler grips the cricket ball in the palms in between the index and middle finger with the seam of the ball parallel to palm. The index and middle finger are spread apart to firmly grip the ball. The proximal interphalangeal joint flexion of the ring finger (also known as the third finger, excluding the thumb) grasps the seam. In this type of bowling, the ball is released from the ulna/fifth phalange side of the hand, under the influence of elbow pronation and extension with radially deviating wrist.[2] The ring finger imparts the spin to the ball.

As described throughout coaching manuals and books,[8–10] the complete bowling action is broken into five distinct positions or phases;

1. Back foot impact

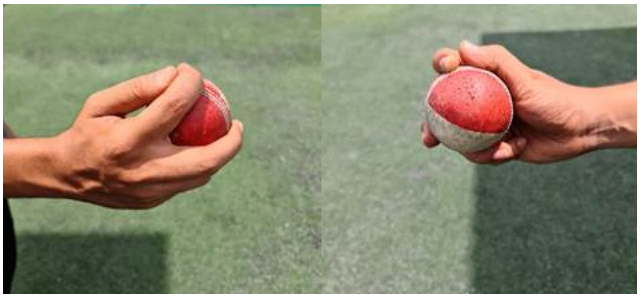

Fig. 2: Grip for wrist spin bowling (right handed bowler)

2. Delivery stride / Front Foot Impact
3. Cradle position
4. Ball release
5. Follow-through

2.2.1. Back foot impact (BFI)

Spin bowlers have very small run-up. BFI is a phase from the run-up to the landing on the ipsilateral foot before the delivery of the ball. E.g. it is the right foot for a right-handed bowler. It is documented that elite athletes, demonstrate side on bowling position at BFI (Figure 3) with the trunk in 25-degree hyperextension[11] as the front arm points out and stretches towards the batsman. The hip joint of landing leg moves from the external rotation to neutral as the weight-bearing happens, with lumbar vertebrae laterally flexed and extending ipsilaterally, which results in a combination of movement.

Fig. 3: A male professional spin bowler demonstrating back foot impact (BFI) phase

2.2.2. Delivery stride/ front foot impact (FFI)

(Figure 4) The delivery stride is characterized by the bowler being in a side-on position with trunk hyperextended and away from the batsman. The front foot lands pointing in the direction of the batsman with an angle of about 30 degrees to the leg side of the target(batsman), with a shorter stride length compared to a fast bowler. In this phase, bowlers rotate (approximately 30 degrees)their shoulder girdle clockwise, in the transverse plane, resulting in dissociation between shoulder to pelvis alignment.[11] Also, the bowling arm is abducted and externally rotated with humerus which is approximately parallel to ground, termed as upper arm horizontal position of the balling extremity.

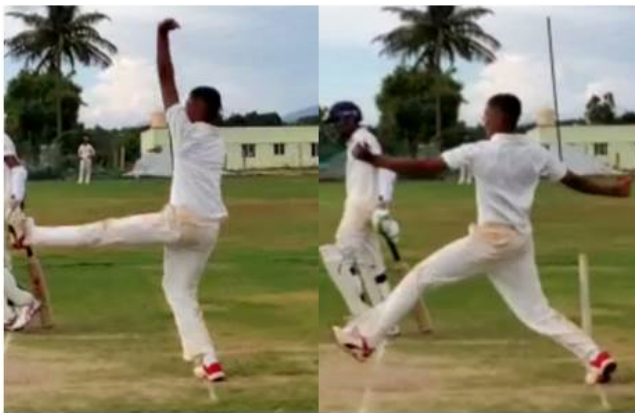

Fig. 4: A male professional spin bowler demonstrating delivery stride phase / FFI

2.2.3. Cradle position

(Figure 5) This is a preparatory phase for releasing the ball from balling extremity. In this phase, hips begin to rotate forward to reduce shoulder pelvic separation at the ball release phase. Thus, the weight gets transferred from the back foot to the front foot with internal rotation of rear foot, while maintaining the side-on position, as the front foot is in slight internal rotation and adduction. Furthermore, just before ball release phase when the bowling arm begins to drop in its final swing, bowlers undergo quick acceleration at the wrist joint which is then transferred to the hand segment for ball delivery.

2.2.4. Ball release

(Figure 6) At the time of the delivery, the bowler pivots his body on the metatarsophalangeal joint of the front foot with trunk forward flexion of approximately 55 degrees.[11] This helps the bowler to rotate his rear leg hip joint to increase ball revolutions[5,6] by kinetic chain mechanism, resulting in more deviation of the ball from the pitch.

In FS and WS bowling, wrist joint movement mechanics play a crucial role in imparting spin to the ball.[9,10,12]

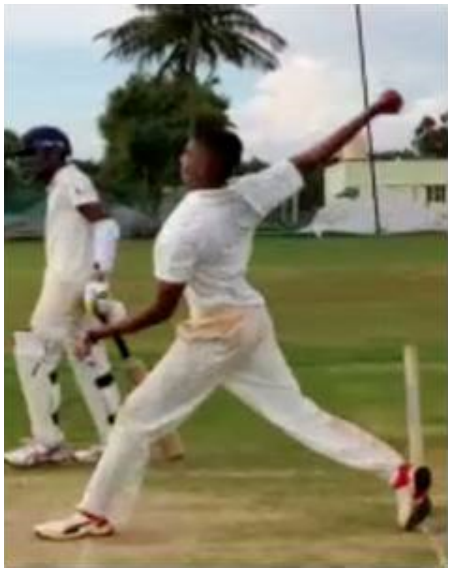

Fig. 5: A male professional spin bowler demonstrating cradle phase

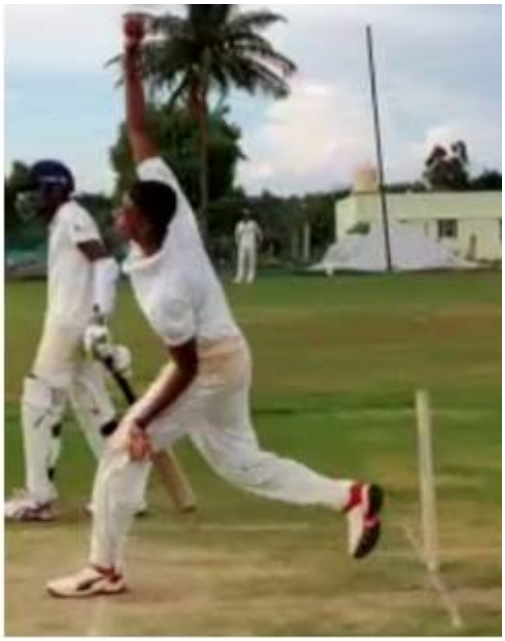

Fig. 6: A male professional spin bowler demonstrating ball release phase

In particular, wrist joint undergoes flexion and adduction during ball release phase to increases axis of rotation of the ball in finger spin bowlers, whereas wrist cocking (a combination of hyperextension and radial deviation at wrist joint)takes place in wrist spinners to help them to apply greater revolutions[3] to the ball.

2.2.5. Follow through

(Figure 7) After the ball delivery, the bowler continues to pivots on the front foot at the metatarsophalangeal joint while changing the forward loading of the body.

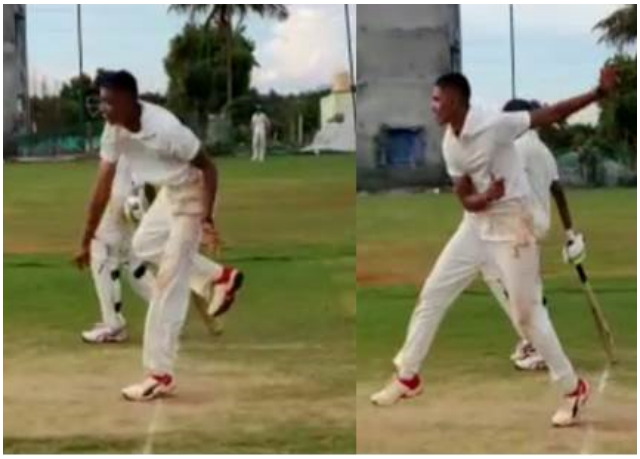

Fig. 7: A male professional spin bowler demonstrating follow through phase

Above mentioned are generalized movement patterns, but as spin bowling is a tactical art, these biomechanical movements may change slightly depending upon the technical maturity of the athlete. The study done by A. Chin et al 2009,[11] has compared elite and sub-elite spin bowlers on various kinematic domains to judge its influence on ball speed and spin. They concluded that there are several key mechanical characteristics that international spinners employ to maximize ball velocity and rotation as compared to sub-elite athletes.

2.3. Implementing biomechanics knowledge in training and injury prevention

The information presented earlier in this article can be used as a framework for the development of strength and conditioning programs specific to cricket spin bowler.

In Figure 3, BFI requires more stability and summation of forces sequenced largely proximal to distal (legs, trunk, bowling arm) fashion. This requires a coordinated sequence of movements with the proper timing of each body segment. Therefore, including power exercises in training programs for improving the rate of force development in addition to sport-specific plyometrics to train spin bowlers for force absorption and teaching them proper landing mechanics, will be helpful.[13]

In Figure 4, FFI/Delivery stride is characterized by side on bowling action which shows lateral flexion and hyperextension at the trunk. The rotational emphasis of the bowling action means that the training programs should focus on developing core musculature strength and stability. Therefore core exercises predominantly training explosive trunk action through sagittal and transverse planes must be prescribed to the spin bowler.

The front foot contact creates an impact force that is absorbed by soft tissues and lower back.[14] This means that the FFI phase requires a spin bowler to have maximal strength to absorb ground reaction forces and effectively transfer them up to bowling arm through the kinetic chain. This supports, the inclusion of closed chain exercise prescription which strengthens the knee joint and increases its stability. Also, exercises with sequential lower limb triple (ankle, knee, hip) extension must be included as a part of the advanced strength and conditioning program.

In Figure 5 and Figure 6, we can observe, vigorous shoulder internal rotation while the arm circumducts during the ball release phase. Repetitive pitching at high velocities over time leads to chronic adaptations of soft and osseous tissues that comprise the glenohumeral joint.[15] Internal rotation difference between dominant and non-dominant side is documented suggesting glenhumeral joint posterior capsule tightness in overhead athletes.[16] This means that glenhumeral joint capsule stretches must be an integral part of the flexibility programs of spin bowlers.

The muscles in front of the chest and trunk (pectorals, abdominals, quadriceps, and biceps) act as the primary accelerators of the bowling arm and therefore increase the spin of the ball, while the muscles in the back of the body (rotator cuff, trapezius, rhomboids, and back extensors) act to decelerate this balling arm during the follow-through.[17] This indicates that the training must be such that muscles surrounding the glenohumeral joint must be trained concentrically as well as eccentrically.

Finally, muscles responsible for controlling wrist movements such as flexion, extension, and radial / ulnar deviation must also be conditioned for repeated high-velocity performance.

3. Conclusion

Nowadays the matches are shorter which leads to high physical as well as physiological demands. Spin bowlers must be trained in a biomechanically correct way to prevent or minimize injuries. Spin bowling performance must not be considered only based on the technique of spinning but coaches should consider strength and conditioning aspects also and the training programs should include exercises that are simulating the spin bowling movement patterns.

4. Source of Funding

None.

5. Conflict of Interest

None.

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Cite this article: Mathankar A. Overview of biomechanics and movement patterns of cricket spin bowlers. *J Soc Indian Physiother* 2020;4(2):65-69.