RESEARCH ARTICLE

Isokinetic Knee Strength Profile of Indian State-level Cricket Fast Bowlers

Sai A Raman[1], Suresh Perumal[2], Vikram Rao M[3], Thiagarajan K Alwar[4], Sivaraman Arumugam[5]

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Abstract

Background and aim: Cricket is the most commonly played and followed sport in India and demands a high level of performance from the fast bowler. Large ground reaction forces generated at front foot contact put fast bowlers at high risk of lower limb and lumbar spine injury. Precise dynamic coordination of lower body segments is needed to absorb these forces and transfer the energy via the core to the upper limb to propel the ball at faster speeds. Thus, knowledge of lower quadrant strength, especially dynamic knee strength, can be useful for injury prevention and better performance in fast bowlers. There is a lack of literature on this subject in Indian fast bowlers despite the popularity of the sport. This study aims to evaluate isokinetic knee strength and determine the relevant asymmetries and strength imbalances in relation to injury risk in cricket fast bowlers.

Methods: A total of 42 male Indian state-level fast bowlers underwent isokinetic knee strength testing. Peak torques (PT) normalized to body weight (BW) were obtained for quadriceps concentric (Qconc), quadriceps eccentric (Qecc), hamstring concentric (Hconc), and hamstring eccentric (Hecc). Bilateral strength asymmetries (BSA) and dynamic control ratio (DCR) (hamstring DCR (H-DCR) = Hecc/Qconc and quadriceps DCR (Q-DCR) = Qecc/Hconc) were evaluated. Descriptive statistical analysis of data was done.

Results: Around 67% of bowlers had significant Qecc strength asymmetry. In addition, 40% had poor hamstrings DCR and 19% had poor Q-DCR on the front limb.

Conclusion: A significant proportion of fast bowlers have unfavorable strength asymmetry and DCR and could be at risk of injury. Improving dynamic knee strength through plyometric training could help optimize performance and reduce injury risk.

Clinical significance: This study highlights key areas of possible injury risk that can be targeted with strength and conditioning to prevent lower limb and lumbar spine injuries in fast bowlers.

Keywords: Cricket, Cricket injuries, Fast bowling, Isokinetic strength.

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Introduction

Fast bowlers are an integral part of the modern-day cricket team but their demanding role makes them the most vulnerable to injuries.[1] The biomechanical technique of the fast bowling action is a crucial factor affecting both performance and injury occurrence.[2] The leap phase of the fast bowling action generates large ground reaction forces, especially via the front limb. The lower quadrant, particularly the knee joint plays a vital role in absorbing and dissipating the ground reaction forces. Knee extensors (quadriceps group) work eccentrically during landing to decelerate and control knee flexion which helps absorb ground reaction forces.[3] This is followed by extension which improves ball release height. To measure this dynamic knee strength (a combination of concentric and eccentric actions), the isokinetic dynamometer has been largely used.[4,5] There are very few studies in this regard among Indian fast bowlers. The present study focuses on Isokinetic knee strength assessment in Indian cricket fast bowlers in relation to performance and injury risk.

Methods

The present study was of cross-sectional design. A total of 42 Indian state-level male fast bowlers were assessed at the Sri Ramachandra Institute of Higher Education and Research (Deemed to be University), Chennai, Tamil Nadu, India after required Ethical Committee approval.

[1–5]Department of Arthroscopy & Sports Medicine, Sri Ramachandra Institute of Higher Education and Research (Deemed to be University), Chennai, Tamil Nadu, India

Corresponding Author: Sai A Raman, Department of Arthroscopy & Sports Medicine, Sri Ramachandra Institute of Higher Education and Research (Deemed to be University), Chennai, Tamil Nadu, India, Phone: +91 9940119000, e-mail: drsaiaditya@csstrucoach.in

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Conflict of interest: None

Selection of Subjects

Male fast bowlers from the state level aged 18–30 years were included. Bowlers with active musculoskeletal injuries or injuries in the immediate preceding 6 months that required more than a week's rest from training were excluded.

Isokinetic Assessment

After 24 hours of complete rest to allow for physiological recovery, the testing was carried out at a fixed scheduled time with written informed consent. Subjects were made to perform warm-up exercises and

dynamic stretches. Following this, Isokinetic testing was performed using an isokinetic dynamometer (Biodex System 4 Pro) in the seated position. Subjects were secured using body belts to prevent sliding. Limb weight and gravity calibration were carried out. Trial repetitions for familiarization were given. Concentric and eccentric actions were carried out for knee extensors and flexors. The speed chosen was 60° per second with a total range of movement of about 65° allowed during the test (Figs 1 and 2). The highest (of eight repetitions) obtained peak torque (PT) was recorded as a ratio with body weight (BW) for all the movements. This was used to determine the concentric and eccentric strengths for the knee extensors [quadriceps concentric (Qconc) and quadriceps eccentric (Qecc)] and knee flexors [hamstring concentric (Hconc) and hamstring eccentric (Hecc)] (Figs 1 and 2).[6]

Data Processing

The same testing team tested all subjects. For right-arm fast bowlers, the left lower limb was considered as the front limb, and the converse was considered for left-arm bowlers. Bilateral strength asymmetries (BSA) were calculated as follows: [1– (PT left/PT right)] × 100].[3] Functional strength ratios[3,7] or dynamic control ratios were calculated as follows: The ratio of Hecc/Qconc strength was taken as hamstring dynamic control ratio (H-DCR) and the ratio of Hconc/Qecc strength was taken as quadriceps dynamic control ratio (Q-DCR).[6]

Fig. 1: This figure shows isokinetic knee strength testing on the Biodex System 4 Pro isokinetic dynamometer

Statistical Analysis

Statistical data processing was done using the IBM Statistical Package for the Social Sciences® (version 23.0) statistical package. For injury risk analysis, >10% BSA was considered clinically relevant, and 0.8–1.2 was considered the ideal range of strength ratios based on previous literature.[6]

Results

Table 1 shows subject demographics. There were five left-handed and 37 right-handed bowlers. Table 2 shows mean quadriceps and Hconc and eccentric PTs, strength asymmetries, and functional strength ratios.

Around 67% of bowlers had high Qecc asymmetry and 36% had high Qconc asymmetry whereas only 19% of bowlers had high Hecc and Hconc asymmetry. On the front limb, 40% of bowlers had poor H-DCR whereas only 21% had poor Q-DCR. On the rear limb, 52% had poor H-DCR whereas only 19% had poor Q-DCR (Flowchart 1).

Discussion

This is among the first studies that elucidate the isokinetic dynamic knee strength in elite Indian fast bowlers and hence is a contribution

Table 1: Demographic data

Parameter	*Mean*	*Standard deviation*
Age (years)	20.80	3.01
Height (cm)	178.95	6.18
Weight (kg)	72.55	8.92

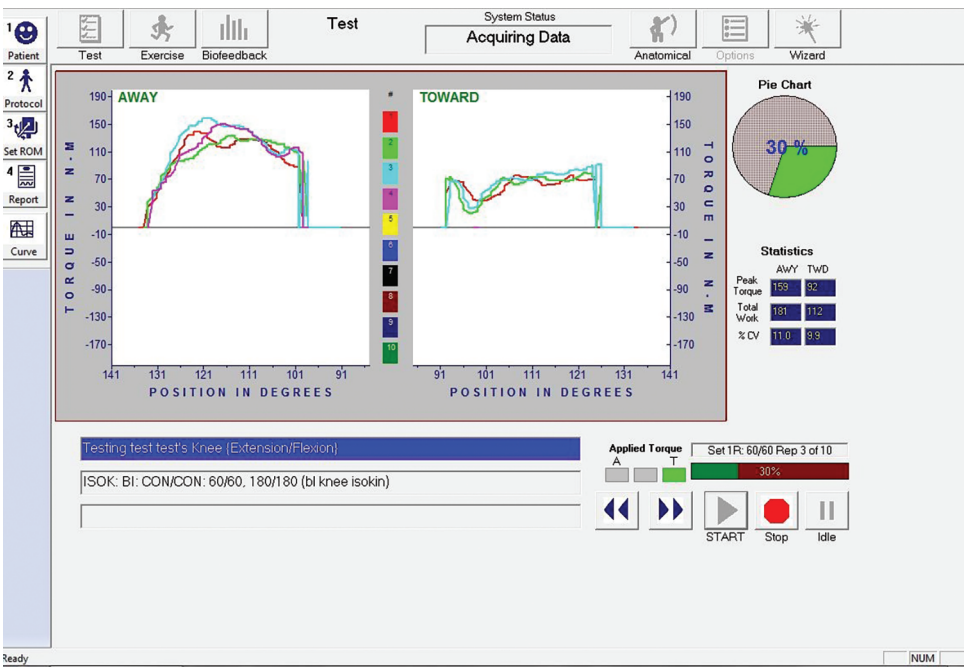


Fig. 2: This figure shows measuring PT during testing on the Biodex System 4 Pro isokinetic dynamometer software which also allows for graphical visual feedback for the subjects during testing

toward preliminary reference values. Important areas of injury risk highlighted in this study can be targeted by focused strength and conditioning programs to reduce injury risk.

Quadriceps and hamstring muscle torques of fast bowlers in this study are higher than those observed in other sports that involve jumping and landings such as volleyball[3] but lower than basketball.[8] This could be attributed to anthropometric differences in and the biomechanical uniqueness of the fast bowling technique.

An "optimum" front knee action has been purported to be one that lands slightly flexed, flexes to an acceptable extent to help dissipate impact forces, and then again extends to improve the height and efficiency of ball release; termed the "flexor-extensor."[9] Good dynamic knee strength in which rapid changes in concentric and eccentric movements can happen is key to achieving the flexor-extensor front knee action. The "bound" during the leaping phase of bowling requires explosive power from the quadriceps, that is, Qconc strength, whereas Hecc strength optimizes the movement.[3,8] The high-ground reaction forces generated at the front foot require force absorption to prevent injury.[2,10] If not adequately absorbed, these forces have been proven to cause repetitive torsional stresses to the pars interarticularis of the contralateral side, leading to lumbar spine stress injuries.[11,12] The front leg is the main shock absorber to help dissipate these ground reaction forces. To achieve this, Qecc strength is crucial to absorb impact forces upon landing.[3]

Increased BSA can cause musculoskeletal injuries.[3,5,8,13] In this study, the mean BSA Qecc was nearly 20% and a high proportion of fast bowlers had increased Qecc asymmetry, which is a risk of injury.

Functional strength ratios represent the efficient actions of the quadriceps and hamstrings in executing rapid dynamic muscle actions, while also indicating the balance between agonist and antagonist movements.[7] The front limb Hamstrings bear high loads during ball release to help in deceleration during follow through thus making the fast bowler prone to Hamstring strains.[1,9,14] Nearly 50% of bowlers had an unfavorable H-DCR on both limbs, thus implying injury risk and sub-optimal performance. Q-DCR was unfavorable in about 20% of bowlers in both limbs which can be considered clinically significant when looked at from the injury risk perspective.

In summary, Indian fast bowlers in this study have a dynamic knee strength profile that is not ideal for performance and also puts them at possible risk of injury. Key areas highlighted in this study can be targeted by focused strength and conditioning interventions. Plyometric training aimed at improving the eccentric thigh strength and the quality of the landing could reduce asymmetry and improve the overall strength profile.[15–19] This could reduce the risk of injury and possibly improve performance.

Table 2: Mean PTs, BSA, and DCR

Parameter	*Mean*	*Standard deviation*
Front limb Qecc PT/BW (%)	249.40	71.71
Front limb Qconc PT/BW (%)	283.37	47.84
Front limb Hecc PT/BW (%)	235.10	55.70
Front limb Hconc PT/BW (%)	240.40	44.28
Rear limb Qecc PT/BW (%)	260.87	69.79
Rear limb Qconc PT/BW (%)	293.28	44.99
Rear limb Hecc PT/BW (%)	223.58	71.22
Rear limb Hconc PT/BW (%)	244.15	51.71
Front limb H-DCR	0.84	0.18
Front limb Q-DCR	1.02	0.26
Rear limb H-DCR	0.77	0.24
Rear limb Q-DCR	0.97	0.22
BSA Qconc (%)	8.95	8.54
BSA Qecc (%)	19.95	14.17
BSA Hconc (%)	8.27	9.42
BSA Hecc (%)	7.71	7.84

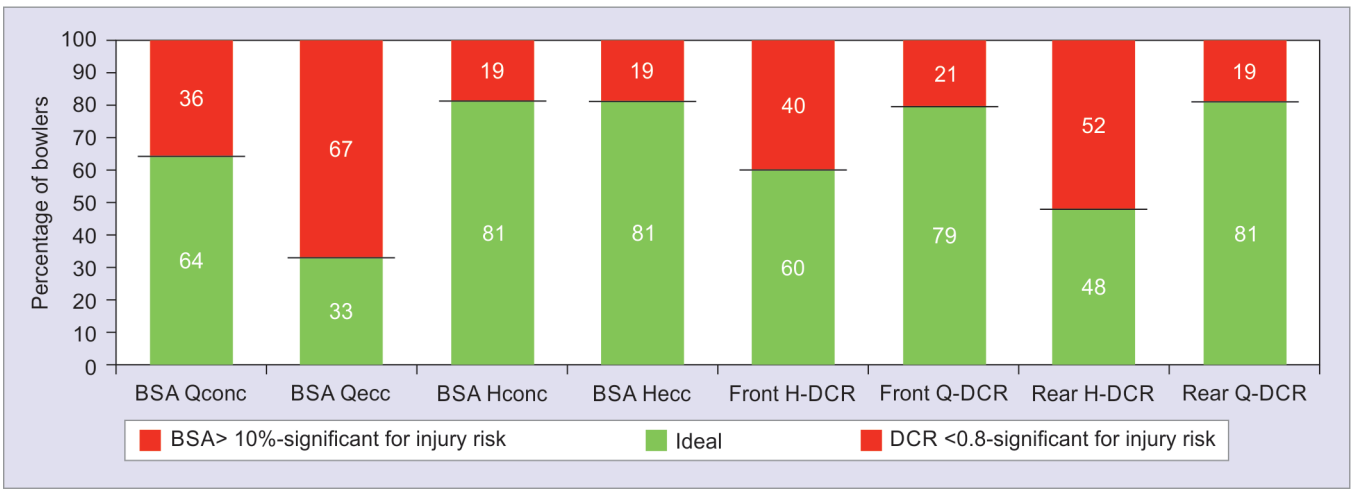
Conclusion

In this study, Indian fast bowlers exhibited strength ratios and strength asymmetries outside acceptable limits, indicating a potential risk of injuries. Plyometric training to improve dynamic knee strength could lower the possible injury risk and improve performance.

Clinical Significance

This study sheds light on areas of potential injury risk with regard to isokinetic knee strength among Indian elite fast bowlers which can be targeted by specific plyometric-based training. This study could help in developing focused fast bowling strength and conditioning programs.

Flowchart 1: Injury risk analysis of bowlers with respect to BSA and DCR



Orcid

Sai A Raman https://orcid.org/0009-0009-9553-3929

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