Biomechanics and situational patterns associated with anterior cruciate ligament injuries in the National Basketball Association (NBA)

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ABSTRACT

Objectives Perform a comprehensive video analysis of all anterior cruciate ligament (ACL) injuries in National Basketball Association (NBA) athletes from 2006 to 2022 to determine the associated biomechanics, injury mechanism and game situation.

Methods NBA players diagnosed with an ACL tear from 2006 to 2022 were identified and videos of each injury evaluated by two reviewers. Visual evaluation included assessment of joint kinematics at three time points: initial contact of the injured leg with the ground (IC), 33 milliseconds later (IC+33) and 66 milliseconds later (IC+66). Game situation was assessed qualitatively.

Results Videos of 38 out of 47 (80.9%) ACL tears were obtained. 9 injuries were non-contact, while 29 involved indirect contact. Between IC and IC+33, average knee valgus increased from 5.1° to 12.0° and knee flexion increased from 12.6° to 32.6°. At all time points, the majority of injuries involved trunk tilt and rotation towards the injured leg, hip abduction and neutral foot rotation. The most common game situations for injury included the first step when attacking the basket following picking up the ball (n=13), landing following contact in the air (n=11) and jump stop (n=5).

Conclusion Three major mechanisms predominated ACL tears in NBA players: the first step following picking up the ball when attacking, landing and jump stops. None of the injuries reviewed demonstrated direct contact to the knee, emphasising the importance of body kinematics in this injury pattern. The increase in knee valgus and knee flexion between IC and IC+33 should be noted as a possible precipitant to injury.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Motion analysis studies in a lab setting have identified biomechanical factors predisposing anterior cruciate ligament (ACL) rupture in athletes. However, little research has looked at the biomechanics of professional basketball players during ACL rupture in game settings.

WHAT THIS STUDY ADDS

⇒ This study found that no ACL injury during National Basketball Association games involved direct contact to the knee, emphasising the importance of player biomechanics in ACL injury patterns. Biomechanics were similar to previous studies on basketball and soccer players, with an initially abducted hip, trunk tilt and rotation towards the injured leg, and notable increases in knee flexion and knee valgus across the movement.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Injury prevention programmes in basketball athletes should focus on training techniques to decrease hip abduction and knee valgus change with an attacking step and when landing, core stability to avoid excessive trunk tilt and rotation, and evaluating the kinematics on initial contact of the foot with the ground. This study highlights relevant biomechanical variables in these athletes, laying the groundwork for future research to develop technology solutions to routinely assess these variables in game and practice settings.

INTRODUCTION

Anterior cruciate ligament (ACL) injuries are becoming increasingly common for athletes of all levels across the globe.1 2 These injuries have particular implications for professional basketball players with both performance and financial consequences.3 Clinical biomechanical analyses in controlled settings have found that increased hip abduction, hip internal rotation, knee flexion and knee valgus likely all play a role in increasing risk for ACL injury.4 6

Understanding injury biomechanics within game situations can inform the development of injury prevention programmes and interventions.7 Systematic video reviews have previously examined the biomechanical and contextual factors behind ACL injuries in game situations.8 Notably, they have been used to analyse ACL injuries in a variety of sports, including soccer, football, rugby, skiing, handball and basketball.9–17 However, previous studies that evaluated basketball injuries included players of different competitive levels and sexes.16 17 Additionally, other studies provide limited data on playing situations and biomechanics over time.18 There is a need for comprehensive analysis of ACL tears specifically within National Basketball Association (NBA) players as they have an elevated risk for ACL injuries due to the fast pace of the game, unpredictable movement patterns and decreased recovery between competitions.19 20

The purpose of this study was to analyse video footage to describe the biomechanics, injury mechanism, game situation and player demographics of ACL injuries within the NBA.
Original research

METHODS
This was a retrospective study using publicly available videos and materials.

Injury identification and video processing
Pro Sports Transactions (prosportstransactions.com), an online database of all NBA activity, was queried to identify all NBA players who suffered a knee injury between October 2006 and February 2022. This database has been previously used in several NBA-related studies. Each knee injury was then independently verified by secondary reports from verified news outlets to determine the type and date of each injury. Injuries were included only if there was an official press report communicated by the medical staff of the team which stated that the player had suffered a complete or partial ACL tear.

Video analysis
The processed videos were uploaded to KMPlayer (PandoraTV, South Korea) for analysis. Additionally, screenshots of each injury were taken at three time points: IC of the injured leg’s foot with the ground, 33 milliseconds following IC (IC+33) and 66 milliseconds following IC (IC+66). Predefined time points were used to minimise any reviewer bias. Previous studies, both lab-based and video reviews, have suggested that ACL tears tend to occur between 0 and 67 ms following IC. These time points were chosen because the processed videos each had a 30 frames per second frame rate, thus 33 ms corresponded to one frame. Each video was independently evaluated by two reviewers. The reviewers were medical trainees with over 2 years of sports analysis experience. Each reviewer was closely monitored by the senior author, a board-certified sports medicine surgeon with over 20 years of experience taking care of ACL injuries in high-level athletes. To ensure accuracy and reproducibility of measurements, analyses were randomly evaluated by the senior authors in this study for quality control. The reviewers were blinded to each other’s data throughout the entire data collection process.

Biomechanical outcomes
The reviewers were instructed to evaluate specific biomechanical variables, as determined by a predefined checklist based on recent video reviews on other sports (online supplemental table S1). Angle measurements were performed using an online protractor software (Universal Desktop Ruler, Aequo, Barcelona, Spain). Each variable of interest was assessed at all three time points (IC, IC+33, IC+66). Biomechanical assessment was performed when an unobstructed sagittal and/or frontal view of the injured player was available.

Game situation and other outcomes
Non-biomechanical variables related to game situation and player demographics were assessed based on a predefined checklist (online supplemental tables S2, S3). Basketball Reference (basketball-reference.com) was queried to determine demographics, play time and game information for each injury. Basketball Reference is a database sourced by Sportradar US (Sportradar AG), the official stats partner of the NBA, that has been used in numerous studies.

When assessing for the presence of contact in the injury mechanism, the following definitions were used: direct contact, defined as another player contacting the injured knee during IC, IC+33 or in the two frames leading up to IC; indirect contact, defined as another player contacting the injured player anywhere but the injured knee during those same frames; non-contact, defined as an injury occurring without any contact with another player during those frames. These definitions of direct and indirect contact were based on previous video reviews on ACL biomechanics in basketball, soccer and rugby athletes.

Equity, diversity and inclusion
Basketball is a global sport played by millions of people of different ages, genders and backgrounds. The study population allowed for the assessment of only male professional athletes participating in the NBA and may not be generalisable to other athlete populations. Future research should examine other populations, including athletes, youth and amateur basketball athletes, and athletes in leagues outside of North America.

Patient and public involvement
Patients and the public were not involved in the design, conduct or reporting of the research due to the study methodology.

Statistical analysis
All data were stored on a Microsoft Excel spreadsheet (Microsoft Excel 2016, Redmond, Washington, USA). All descriptive statistics were presented in terms of frequency. Following individual analysis, categorical variables were reviewed and finalised through consensus by the two reviewers. Continuous variables were presented as the mean value between the reviewers. Inter-rater reliability was examined using the intraclass correlation coefficient (ICC, two-way mixed for absolute agreement) for all continuous numerical variables and Cohen’s kappa for all categorical variables. Analyses were performed using R (R Core Team, 2022).

RESULTS
A total of 47 in-game ACL injuries were identified in the given study duration. Video footage was obtained for 38 cases (80.9%). All nine injuries where video could not be obtained occurred between October 2006 and October 2010. Three camera angles were available for 10 (26.3%) injuries, two camera angles were available for 18 (47.4%) injuries and only one camera angle was available for 10 (26.3%) injuries.

Biomechanical analysis
Tables 1 and 2 list the number of players which were able to be assessed for each variable. On average, at IC, players had minimal knee flexion (12.6°), an early flexed hip (39.3°) and knee valgus (5.1°). Between IC and IC+33, there was an increase in knee flexion (12.6°–32.6°) and knee valgus (5.1°–12.0°). These trends continued to IC+66 (table 1). Most injuries involved the trunk being tilted towards the injured leg (n=23), hip abduction (n=30), trunk rotation towards the injured leg (n=13) and a neutral ankle (n=23) (table 2).
Of the 19 injuries where knee flexion was assessed, 12 (63.2%) had a knee flexion at IC of less than 15°. Fourteen (73.7%) injuries presented with an increase in knee flexion of at least 8° between IC and IC+33, while nine (47.4%) demonstrated an increase over 20°. Fifteen of the 21 (71.4%) injuries where knee valgus was assessed had an increase in knee valgus of greater than 4° between IC and IC+33, while 10 (47.6%) had an increase over 9°.

**Game situation, play type and contact**

Thirty-two (84.2%) injuries took place on offence, three (7.9%) on defence, two (5.3%) during a rebound and one (2.6%) during a dead ball (table 3). Twenty-nine injuries (76.3%) involved indirect contact while nine (23.7%) were considered non-contact. None of the injuries involved direct contact with the injured leg (table 3). Of the 11 injuries which involved contact in the air, 10 (90.9%) resulted in the player landing on one leg and each involved injuring the landing leg.

Five play types were identified as precipitating ACL injury. Gather steps (n=16), jump step (n=5), landing (n=14), dribble move (n=2) and defensive close-out (n=1) (table 3). Gather steps are defined as the two steps when attacking the basket following picking up the ball. This was separated into traditional forward drives to the basket and ‘Euro steps’, which involve a side-stepping technique. Jump steps include an action where a player performs a two-legged jump and lands after picking up the ball. Dribble move includes any forward or lateral movement while dribbling. Defensive close-out involves the player running up to an opposing player who is currently in possession of the ball. Both injuries that took place during a dribble move involved no contact, while only 1 of the 16 injuries duringgather steps was found to be non-contact.

**Demographic details**

The position that had the greatest frequency of injury was the point guard (n=15, 39.5%), while shooting guards had the second greatest frequency (n=9, 23.7%). Two injuries were retears, both involving the player tearing their left ACL twice. Twenty-five (65.8%) injuries involved the left ACL, while 13 (34.2%) involved the right ACL.

**Inter-rater reliability**

The average ICC across all continuous variables was 0.84. Specifically, the ICC was found to be good (0.75–0.90) or

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**Table 1** Biomechanical angles

<table>
<thead>
<tr>
<th></th>
<th>IC (°)</th>
<th>IC+33 (°)</th>
<th>IC+66 (°)</th>
<th>Total count (n*)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (SD)</td>
<td>Range</td>
<td>Mean (SD)</td>
<td>Range</td>
</tr>
<tr>
<td>Hip flexion (+ flexion, – extension)</td>
<td>39.3 (25.2)</td>
<td>0–92.5</td>
<td>44.4 (23.6)</td>
<td>1.5–91.5</td>
</tr>
<tr>
<td>Knee flexion (+ flexion, – extension)</td>
<td>12.6 (8.8)</td>
<td>0–28.5</td>
<td>32.6 (17.7)</td>
<td>9.5–66.0</td>
</tr>
<tr>
<td>Ankle dorsiflexion (+ flexion, – extension)</td>
<td>31.4 (16.1)</td>
<td>55.0–3.0</td>
<td>15.6 (20.9)</td>
<td>56.0–20.5</td>
</tr>
<tr>
<td>Knee varus (+ varus, – valgus)</td>
<td>5.1 (6.1)</td>
<td>17.0–4.5</td>
<td>12.0 (10.3)</td>
<td>32.5–5.0</td>
</tr>
</tbody>
</table>

Note: All angle data are presented as the mean value between the reviewers.

*Total count (n) represents how many injuries had a clear visualisation for that given variable.

IC, initial contact.

**Table 2** Biomechanical categories

<table>
<thead>
<tr>
<th></th>
<th>IC</th>
<th>IC+33</th>
<th>IC+66</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Abduction (n=30)</th>
<th>Adduction (n=1)</th>
<th>Neutral (n=1)</th>
<th>Unclear (n=6)</th>
<th>Abduction (n=27)</th>
<th>Adduction (n=1)</th>
<th>Neutral (n=0)</th>
<th>Unclear (n=10)</th>
<th>Abduction (n=26)</th>
<th>Adduction (n=1)</th>
<th>Neutral (n=1)</th>
<th>Unclear (n=10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foot rotation</td>
<td>External (n=9)</td>
<td>Internal (n=2)</td>
<td>Neutral (n=11)</td>
<td>Unclear (n=16)</td>
<td>External (n=7)</td>
<td>Internal (n=3)</td>
<td>Neutral (n=9)</td>
<td>Unclear (n=19)</td>
<td>External (n=6)</td>
<td>Internal (n=3)</td>
<td>Neutral (n=10)</td>
<td>Unclear (n=19)</td>
</tr>
<tr>
<td>Trunk rotation</td>
<td>Towards injured (n=13)</td>
<td>Towards uninjured (n=8)</td>
<td>Neutral (n=11)</td>
<td>Unclear (n=6)</td>
<td>Towards injured (n=13)</td>
<td>Towards uninjured (n=8)</td>
<td>Neutral (n=7)</td>
<td>Unclear (n=10)</td>
<td>Towards injured (n=13)</td>
<td>Towards uninjured (n=8)</td>
<td>Neutral (n=7)</td>
<td>Unclear (n=10)</td>
</tr>
<tr>
<td>Ankle eversion</td>
<td>Eversion (n=1)</td>
<td>Inversion (n=2)</td>
<td>Neutral (n=23)</td>
<td>Unclear (n=12)</td>
<td>Eversion (n=1)</td>
<td>Inversion (n=1)</td>
<td>Neutral (n=21)</td>
<td>Unclear (n=15)</td>
<td>Eversion (n=1)</td>
<td>Inversion (n=1)</td>
<td>Neutral (n=20)</td>
<td>Unclear (n=16)</td>
</tr>
<tr>
<td>Trunk tilt</td>
<td>Towards injured (n=23)</td>
<td>Towards uninjured (n=4)</td>
<td>Neutral (n=6)</td>
<td>Unclear (n=5)</td>
<td>Towards injured (n=24)</td>
<td>Towards uninjured (n=3)</td>
<td>Neutral (n=4)</td>
<td>Unclear (n=7)</td>
<td>Towards injured (n=25)</td>
<td>Towards uninjured (n=2)</td>
<td>Neutral (n=4)</td>
<td>Unclear (n=7)</td>
</tr>
<tr>
<td>Footstrike (IC only)</td>
<td>Flat (n=14)</td>
<td>Toe (n=8)</td>
<td>Heel (n=7)</td>
<td>Unclear (n=9)</td>
<td>Flat (n=14)</td>
<td>Toe (n=8)</td>
<td>Heel (n=7)</td>
<td>Unclear (n=9)</td>
<td>Flat (n=14)</td>
<td>Toe (n=8)</td>
<td>Heel (n=7)</td>
<td>Unclear (n=9)</td>
</tr>
</tbody>
</table>

IC, initial contact.


**Table 3** Play type and game situation

<table>
<thead>
<tr>
<th>Variable</th>
<th>No of cases (n, %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contact</td>
<td></td>
</tr>
<tr>
<td>Direct</td>
<td>0</td>
</tr>
<tr>
<td>Indirect</td>
<td>29, 76.3</td>
</tr>
<tr>
<td>Non-contact</td>
<td>9, 23.7</td>
</tr>
<tr>
<td>Contact description</td>
<td></td>
</tr>
<tr>
<td>Arm-to-trunk</td>
<td>19, 65.5</td>
</tr>
<tr>
<td>Arm-to-arm</td>
<td>5, 17.2%</td>
</tr>
<tr>
<td>Trunk-to-trunk</td>
<td>5, 17.2%</td>
</tr>
<tr>
<td>Contact location</td>
<td></td>
</tr>
<tr>
<td>Air</td>
<td>11, 37.9</td>
</tr>
<tr>
<td>Ground</td>
<td>18, 62.1</td>
</tr>
<tr>
<td>Game situation</td>
<td></td>
</tr>
<tr>
<td>Offence</td>
<td>32, 84.2</td>
</tr>
<tr>
<td>Half-court</td>
<td>19, 59.4</td>
</tr>
<tr>
<td>Fast break</td>
<td>13, 40.6</td>
</tr>
<tr>
<td>Defence</td>
<td>3, 7.9</td>
</tr>
<tr>
<td>Rebound</td>
<td>2, 5.3</td>
</tr>
<tr>
<td>Deadball</td>
<td>1, 2.6</td>
</tr>
<tr>
<td>Play type</td>
<td></td>
</tr>
<tr>
<td>Gather steps</td>
<td>16, 42.1</td>
</tr>
<tr>
<td>1st step</td>
<td>13, 34.2</td>
</tr>
<tr>
<td>Traditional drive</td>
<td>8, 21.1</td>
</tr>
<tr>
<td>Euro step</td>
<td>4, 10.5</td>
</tr>
<tr>
<td>Unclear</td>
<td>1, 2.6</td>
</tr>
<tr>
<td>2nd step</td>
<td>3, 7.9</td>
</tr>
<tr>
<td>Traditional drive</td>
<td>2, 5.3</td>
</tr>
<tr>
<td>Unclear</td>
<td>1, 2.6</td>
</tr>
<tr>
<td>Jump step</td>
<td>5, 13.2</td>
</tr>
<tr>
<td>Landing</td>
<td>14, 36.8</td>
</tr>
<tr>
<td>Following air contact</td>
<td>11, 28.9</td>
</tr>
<tr>
<td>No air contact</td>
<td>3, 7.9</td>
</tr>
<tr>
<td>Dribble move</td>
<td>2, 5.3</td>
</tr>
<tr>
<td>Defensive close-out</td>
<td>1, 2.6</td>
</tr>
<tr>
<td>Location on court</td>
<td></td>
</tr>
<tr>
<td>Paint or baseline behind paint</td>
<td>31, 81.6</td>
</tr>
<tr>
<td>Outside paint but inside 3-point line</td>
<td>5, 13.2</td>
</tr>
<tr>
<td>Between 3-point lines</td>
<td>2, 5.3</td>
</tr>
</tbody>
</table>

excellent (0.90–1.0) for all measurements except knee valgus, where it was moderate (0.55–0.75) (online supplemental table 5). The Fleiss kappa was greater than 0.80 for all categorical measurements.

**DISCUSSION**

The main findings of this study are that (1) none of the injuries between 2006 and 2022 with video available for review involved direct contact to the knee; (2) the majority of injuries involve an increase in knee valgus between IC and IC+66, as well as knee flexion, hip abduction, trunk tilt and rotation similar to that of athletes tested in laboratory settings; (3) three major play-types predominate ACL tears in NBA players: the first step following picking up the ball when attacking the basket, landing following a jump and jump stops and (4) ACL injuries are most common in guards.

Previous video analyses of in-game ACL injuries of athletes of various sports have found biomechanical patterns similar to this study. Within 107 professional male soccer players, injured players were identified to have a flexed hip (35°), reduced knee flexion (17.5°) and hip abduction (88%) on IC with an increase in knee flexion and knee valgus on the predicted moment of injury.9 Similarly, we identified an initially abducted hip, increase in knee flexion and increase in knee valgus throughout the movement predisposed players to ACL injury. There was minimal change in hip flexion within the injured soccer players (35°–37.5°), which corresponds well to our findings (39.29°–44.38°). Although there are inherent differences between the two sports in terms of motion and playing surface, there are contextual similarities in rapid change of direction, physical contact and jumping. A previous study examining basketball athletes of various competitive levels identified an increase in knee flexion from 9° at IC to 19° at 33–50 ms following IC. They also identified an increase in hip flexion from 19° to 22° and knee valgus from 3° to 4°.16 This study identified a similar trend but found larger average values of knee flexion, hip flexion and knee valgus change. That could potentially be attributed to differences in video quality, and to the fact that their study did not quantifiably measure biomechanical angles using formal tools. A more recent study on NBA athletes identified IC knee flexion angle to be slightly greater than this study (21.3° vs 12.6°).18 However, that study measured some kinematics at the time of whole foot ground contact, rather than any ground contact like this study. Further, that study did not evaluate frontal plane knee kinematics or change in kinematics following IC, both of which have previously been shown to be significant risk factors for ACL.16 17 32

Recent literature examining kinetics and kinematics of ACL injury risk using motion analysis has found that trunk displacement, knee valgus, foot pronation, hip rotation, knee flexion and ipsilateral arm position may all contribute to ACL tear risk.33–36 These studies use precision motion capture systems which require multiple cameras and body markers, providing a level of accuracy that is not possible when examining in-game injuries through video analysis. The nature of basketball entails rapid changes of motion, instinctual jumping and physical contact, all of which cannot be entirely replicated within a controlled lab setting.

No injuries with video available for review involved direct contact with the injured knee. More specifically, no injury since 2011, including a total of 33 injuries, involved direct knee contact. This contrasts with all previous video analyses conducted across basketball and other sports. Only 23.7% of the injuries examined were non-contact. This is a significantly lower prevalence than multiple other studies.16 17 37 38 but similar to a recent study on NBA athletes.18 This lower prevalence could be due to different definitions of ‘contact’ between studies. Most other studies of ACL tears in basketball athletes are epidemiological in nature, depending on patient recollection of the injury to determine whether it was non-contact.17 37 38 One video analysis of basketball injuries defined contact as any contact with a different player during the IC frame and immediate moment preceding that, while others included minimal contact as being non-contact.16 17

This study found that ‘driving to the basket’ was associated with the highest number of ACL tears (42.1%). This is consistent with a recent study which found that driving tendency is associated with an increased risk of ACL tears in NBA players.19 39 This aligns with previous studies on handball, which found an offensive attacking play by the ball carrier to be the most common injury scenario, but different from studies on soccer which find defensive pressing to be most common. Driving to the basket often inherently involves a slight side-stepping technique, similar to attacking in handball, which has been shown to result in increased valgus and internal rotation moments on the
knee. The ‘Euro step’, which involves a more significant side-stepping technique, accounted for 30.7% of first step driving to the basket injuries. This may help account for the reason why ACL tears were most prevalent within guards (63.2%). Guards tend to play a style that involves driving to the basket more than other positions. Additionally, this study found that 60.5% of injuries involved the player with current possession of the ball. Previous research has found that guards spend the most playing time in possession of the ball and perform more activities at all intensities. This could be an area of focus for future ACL injury prevention strategies. Previous research has shown that a 6-week training programme designed to modify sidestep cutting technique, an action similar to the ‘Euro step’, can result in significantly reduced knee loading. Similarly, other training regimens focused on agility training, plyometric exercises and balance training have been shown to improve knee joint biomechanics. A joint effort between coaches and players should be made to design a successful injury prevention programme that does not require significant changes to a player’s style of play.

A recent study by Petway et al evaluated the kinematics of ACL injuries in NBA players from 1975 to 2022. Petway et al obtained 35 videos for review, of which 5 were excluded since they involved direct contact to the knee. The ACL injuries with direct contact in the Petway et al study likely occurred prior to 2011 as our study included video analysis of every in-game ACL injury from January 2011 to February 2022 finding no injury involving a direct contact mechanism. Further, our study also included injuries from October 2006 to December 2010, similarly, finding no instances of direct knee contact, although video for every injury during that period was unable to be obtained. This highlights a potential sampling bias of this study which was limited to injuries over the past 15 years, as other unique mechanisms from earlier injuries or instances without video may not have been identified.

Future research should focus on continuing to identify movements associated with injury and developing targeted training regimens to modify those movements. Specifically, future research should include comparisons to non-injured players performing similar movements so specific injury precipitating movements can be better identified. Not only is a better understanding of biomechanics at the time of injury needed, but patient demographics, training load and events leading up to the injury situation may play a significant role in determining risk. Various models ranging from biomechanical predictors to anthropometric, physical fitness and motor coordination measurements have been developed which have shown promise in creating targeted injury prevention protocols.

There are multiple limitations to a systematic video review study of this nature. The utilisation of publicly obtained data has been shown to result in underreporting of the true incidence of injuries in other sports. This study attempted to mitigate this risk by using a public database which has previously been used and shown to be robust, but there remains a possibility that ACL injuries may have been missed. The dependence on video quality, number of camera angles and lack of obstructions for analysing each video led to variation in the number of variables which could be assessed in each video. This limited the sample size of specific factors such as ankle dorsiflexion and foot rotation. Additionally, assessment was completed by the reviewers visually which has been shown to result in underestimation of certain biomechanical angles. Due to the unique nature of basketball plays and moves, it was not possible to create a comparison cohort of videos of athletes who did not tear their ACL performing similar actions. This limits the generalisability of the risk factors identified within this study.

CONCLUSION

Indirect contact accounts for the majority of ACL tears in NBA players, while direct contact to the knee was not observed in the videos that were available to review. Hip abduction and trunk tilt towards the injured leg on IC of the foot with the ground, as well as increases in knee valgus and knee flexion, following IC, may precipitate ACL injury situations in NBA athletes. The most common situations patterns observed include attacking the basket and landing following a jump. This data may be helpful in developing injury prevention programmes specific to the unique biomechanics and playstyles of basketball athletes.

Contributors All authors contributed to study conceptualisation. VSG and SPB completed data collection. SVT, ICB, KSM and AC assisted with confirmation and original draft preparation. SVT, ICB, KSM and AC performed thorough manuscript reviewing and editing. VSG is the guarantor of this study.

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Patient and public involvement Patients and/or the public were not involved in the design, conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval Given the methodology of the study, which involved the use of publicly available videos and materials, an IRB review was deemed unnecessary by our institution.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available on reasonable request made to the corresponding author.

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