Is Video-Based Analysis a Valid Method for Determining Mechanisms of Ankle Injuries During Gameplay in the National Basketball Association?

Peter Zeblisky,*† BS, Andrew P. Collins,† BS, Joshua Cassinat,† BS, Joel Riemenschneider,‡ DPT, Pierce Ebaugh,‡ DO, Mohamed K. Shaath,† MD, and Benjamin C. Service,†§ MD

Investigation performed at Orlando Health Jewett Orthopedic Institute, Orlando, Florida, USA

Background: In the National Basketball Association (NBA), lower extremity injuries account for over 70% of games missed, with ankle injuries being the most common. High-quality video analysis has been successful for studying injury mechanism.

Purpose: To (1) determine the validity of video-based analysis as a method to evaluate ankle injury mechanisms in NBA players and (2) analyze the circumstances associated with injury, games missed due to injury, and associated costs in player salary due to time missed.

Study Design: Case series; Level of evidence, 4.

Methods: Ankle injuries were identified using an injury report database, and corresponding videos were searched using YouTube.com to access high-quality video evidence of these injuries during the 2015-2020 NBA regular season. We reviewed 822 injuries, of which 93 had corresponding videos (video subset), in our final analysis. Variables including number of games missed, necessity for surgical treatment, and injury recurrence were reported for the entire cohort. In the video subset, the mechanism of injury and other corresponding situational data were evaluated.

Results: The most common mechanism of injury occurred via ankle inversion (83.9%; n = 78; \( P < .001 \)). These injuries were significantly associated with indirect contact with the player’s ankle (79.6%; n = 74; \( P < .001 \)). There were significant differences based on player position, within both the video subset (\( P = .008 \)) and the entire cohort (\( P < .001 \)), with guards being injured the most frequently. The average number of games missed due to injury was 7 games in the video subset and 5 games in the entire cohort (\( P = .14 \)). There were significant differences between the groups in average player salary per game ($133,878 [video subset] versus $87,577 [entire cohort]; \( P < .001 \)).

Conclusion: Despite its low yield of 11.3%, video analysis proved to be a useful tool to determine ankle injury mechanisms as well as the distribution of injuries based on player position. However, this methodology was subject to selection bias, as evidenced by a $50,000 increase in player salary among the video cohort. These findings should be considered when using video analysis in future studies.

Keywords:

Basketball is one of the most common sports played at the recreational, high school, and collegiate levels. Approximately 450 million people engage in the sport worldwide. Currently, 546 athletes are active in the National Basketball Association (NBA). Within this population, there was a reported a 12.4% increase in game-related injuries across a 10-year span. In the NBA, lower extremity injuries account for 62.4% of all injuries and 72.3% of games missed due to injury. In addition, the ankle is the most common joint injured, responsible for 14.7% of all injuries. The NBA is a multibillion-dollar industry generating $7.92 billion per season with the average player making $8.32 million per year. Therefore, injuries that cause missed game time can be very costly to these franchises. To develop an injury prevention program, the mechanism of injury must first be well understood. Traditional approaches to identify injury mechanisms include patient histories, detailed written reports, and cadaveric analysis. However, the value of these methods is limited due to their inherent subjective nature. Recently, several studies have employed video-based analysis to analyze injury mechanisms in various sports.
its use in other sports, no studies have assessed the validity of video analysis as a tool. Moreover, there is a paucity of studies utilizing video-based analysis among NBA athletes.

The purpose of this study was to determine whether using a video-based analysis is a valid methodology to evaluate ankle injury mechanisms in NBA players during the 2015-2020 seasons. Secondly, we aim to analyze the circumstances associated with injury, number of days missed due to injury, and associated costs in player salary due to time missed for players involved in this subset of videos.

METHODS

To identify potential ankle injuries for the study, a publicly available NBA injury data set that included all reported injuries from the 2015-2020 regular and postseason games were filtered by “ankle injury.” The SportsReference database reflects statistics reported by SportRadar, an official partner of the NBA. The database is frequently updated with reliable official injury data from the NBA. Ankle injuries were defined as any fractures, ligamentous injury, tendinous injury, or other soft tissue injuries to the ankle region. All acute ankle injury complaints were verified by NBA injury reports in this study. Once injured players were identified, the cohort was divided into 2 groups: (1) the entire cohort, which included all ankle injuries in the 5-year period to serve as a representative sample; and (2) the subset of ankle injuries that had corresponding video footage. A systematic verification process was implemented, whereby (1) injury footage was obtained from YouTube.com with the search engine terms “athlete name,” “year of injury,” and “NBA ankle injury”; (2) injuries with high-quality video footage and a clear mechanism of injury were compiled by 2 independent reviewers (P.Z. and A.P.C.); and (3) videos were cross-referenced with official NBA injury reports to ensure their validity.

Data collected surrounding the injury followed the protocol as defined by the International Olympic Committee Consensus Statement, which included the following: (1) scenario (planting/landing); in our study, we defined planting as any act where the player was grounded, mobile, and foot met the floor, and landing injuries were defined as those immediately following a jump; (2) laterality (left/right); (3) position of ankle (neutral, plantarflexion, dorsiflexion, inversion, eversion), as determined by naked eye video analysis; (4) indirect contact with the ankle (yes/no; defined as a force applied by another player that does not directly cause the injury to the ankle but is in the causal chain of events preceding the injury); (5) injury type (new vs recurrent); recurrent injuries were defined as injury to the same ankle within the 5-year review period; (6) player in control of basketball (yes/no); (7) team position (offense, defense, loose ball); (8) player position (guard, center, forward); (9) injury time during the game (stratified by quarter); (10) injury time during the season (before/after All-Star break); (11) shoe type (high-top vs low-top); (12) bracing (use of an external ankle stabilization device) at time of injury (yes/no); and (13) requirement of surgical treatment (yes/no). Additional data were collected regarding the number of games missed and player salary per game from the SportsReference database.

Of an initial 1098 injuries, 822 were included after screening for duplicates. Regarding the video subset, 104 of the 1098 original injuries contained videos of ankle injuries among 90 unique players. Of these, 11 videos were of poor-quality resolution; thus, the data remaining for statistical analysis included 93 videos (11.3% yield) of 90 unique players with high-quality coverage of the mechanism of injury unanimous agreement upon the reviewers. Three players had >1 injury video analyzed. Figure 1 shows the selection process for the study groups.

Statistical Analysis

Descriptive statistics were calculated to determine means and standard deviations. A chi-square goodness-of-fit analysis were performed to characterize the injuries and determine associations between variables within both the entire cohort and the video subset. Independent t test analysis was performed to calculate the difference in means between the entire cohort and the video subset analysis for quantitative
cannot be answered from the provided text.
Reinjury rates may be exacerbated by the fact that over half of basketball players do not seek professional treatment following ankle injury. This lack of clinical awareness may result in players returning to play prematurely. Markovic et al. reported that recurrence of ankle injuries strongly correlates with premature return to sport.

### TABLE 1
Characteristics of the Included Injuries in the Entire Cohort (N = 822) and within the Video Subset (n = 93)

| Variable                        | n (%) | χ² | P   | Variable                        | n (%) | χ² | P   |
|---------------------------------|-------|----|-----|---------------------------------|-------|----|-----|
| Laterality: entire cohort       |       |    |     | Had control of basketball       |       |    |     |
| Left                            | 437 (53.2) | 3.3 | .069| No                              | 42 (45.2) | 0.9 | .351|
| Right                           | 385 (46.8) |    |     | Yes                             | 51 (54.8) |    |     |
| Laterality: video subset        |       |    |     | Time during game                |       |    |     |
| Left                            | 57 (61.3) | 4.7 | .029| 1st quarter                     | 20 (21.5) | 1.1 | .786|
| Right                           | 36 (38.7) |    |     | 2nd quarter                     | 27 (29.0) |    |     |
| Ankle position                  |       |    |     | 3rd quarter                     | 23 (24.7) |    |     |
| Neutral                         | 1 (1.1) |    |     | 4th quarter                     | 23 (24.7) |    |     |
| Dorsiflexion                    | 3 (3.2) |    |     | Time during season: entire cohort| 86.1 < .001 |    |     |
| Plantarflexion                  | 3 (3.2) |    |     | Before All-Star break           | 544 (66.2) |    |     |
| Inversion                       | 78 (83.9) |    |     | After All-Star break            | 278 (33.8) |    |     |
| Eversion                        | 8 (8.6) |    |     | Injury recurrence: entire cohort| 36.8 < .001 |    |     |
| Contact injury                  |       |    |     | Before All-Star break           | 42 (45.2) |    |     |
| No                              | 19 (20.4) | 32.5 | < .001| After All-Star break           | 51 (54.8) |    |     |
| Yes                             | 74 (79.6) |    |     | Injury recurrence: video subset  | 54.2 < .001 |    |     |
| Scenario                        |       |    |     | No                              | 82 (88.2) |    |     |
| Planting                        | 45 (48.4) | 0.1 | .756| Yes                             | 11 (11.8) |    |     |
| Landing                         | 48 (51.6) |    |     | Surgery: entire cohort          | 807 (98.2) |    |     |
| Team position                   |       |    |     | No                              | 15 (1.8) |    |     |
| Loose ball                      | 15 (16.1) | 35.7 | < .001| Yes                             | 15 (1.8) |    |     |
| Offensive                       | 58 (62.4) |    |     | Surgery: video subset           | 81.4 < .001 |    |     |
| Defensive                       | 20 (21.5) |    |     | No                              | 90 (96.8) |    |     |
| Position: entire cohort         |       |    |     | Yes                             | 3 (3.2) |    |     |
| Guard                           | 326 (39.6) | 54.7 | < .001| No                              | 89 (95.7) |    |     |
| Forward                         | 322 (39.2) |    |     | Yes                             | 4 (4.3) |    |     |
| Center                          | 174 (21.2) |    |     | Shoe type                       | 16.4 < .001 |    |     |
| Position: video subset          |       |    |     | Low-top                         | 27 (29.0) |    |     |
| Guard                           | 45 (48.4) | 9.5 | .008| High-top                        | 66 (71.0) |    |     |
| Forward                         | 23 (24.7) |    |     | Bracing used                    | 77.7 < .001 |    |     |
| Center                          | 25 (26.9) |    |     | No                              | 89 (95.7) |    |     |

*Boldface P values indicate statistically significant difference within variable (P < .05).

**Statistically significant difference between positions (P < .01).**

**Statistically significant difference between positions (P < .01).**
TABLE 2
Comparison of Games Missed and Salary per Game between Study Groups

| Variable          | Video Subset | Entire Cohort | \( p \) |
|-------------------|--------------|---------------|------|
| Games missed      | 7.02 ± 13.2  | 4.95 ± 7.7    | .14  |
| Salary per game   | $133,878 ± $123,488 $87,577 ± $92,093 | <.001 |

*Boldface* \( p \) value indicates statistically significant difference between groups (\( p < .05 \)).

Previous work has indicated that ligament healing time can range from 6 weeks up to 3 months.\(^9\) Results from this study revealed that players in the video subset missed an average of 7 games (14 days) and players in the entire cohort missed an average of 5 games (10 days), indicating that players may be returning to play prematurely.

There were significant differences between the video subset and entire cohort in the average salary per game. Injuries within the video subset averaged $46,300 more per game. This increase is likely due to selection bias on behalf of the individuals uploading the videos. More popular players likely have increased coverage due to the fiscal and social ramifications surrounding their injury within the video analysis subset. This selection bias may limit the generalizability of video analysis within the entire NBA population and corroborates a recent finding evaluating the utility of public databases.\(^11\)

**Limitations**

This study has several limitations. Given that the study only analyzed injuries from the 2015-2020 seasons and dynamic nature of how athletes play the sport, our results may only be generalizable for recent NBA ankle injuries. Data were collected exclusively from NBA players and may not be generalizable to other areas of competitive and recreational play. In addition, utilizing publicly available videos, a subset of injuries was excluded due to poor video quality, which may have exacerbated selection bias both on the part of the study video reviewers and that of the individuals uploading the video.

As this was the first study to assess the validity of video analysis and it has been widely used in other sports,\(^2,3,5,10,14,19,20,27\) future work assessing the efficacy of video analysis in other sports may prove useful. In doing so, we will gain a better understanding of the strengths and weaknesses of video analysis and how we can appropriately employ this methodology in professional athletics.

**CONCLUSION**

Despite its yield of 11.3%, video analysis proved to be a useful tool to determine ankle injury mechanisms as well as the distribution of injuries based on player position by correctly identifying contact ankle inversion injuries, primarily to guards. In addition, this method was representative of the average number of games players missed due to ankle injury when compared with the entire cohort. However, this methodology was subject to selection bias as evidenced by a $46,300 increase in player salary per game among the video cohort injuries. Consequently, video analysis overrepresented high-status players within the NBA. All these findings should be considered when using video analysis in future studies.

**REFERENCES**

1. Atwell A. Players and Team Rosters. NBA, 2021. Updated July 20, 2021. Accessed July 20, 2021. https://www.nba.com/players.
2. Bere T, Mok K-M, Koga H, et al. Kinematics of anterior cruciate ligament ruptures in World Cup alpine skiing: 2 case reports of the slip-catch mechanism. *Amer J Sports Med*. 2013;41(8):1067-1073.
3. Cochrane JL, Lloyd DG, Buttfield A, Seward H, McGivern J. Characteristics of anterior cruciate ligament injuries in Australian football. *J Sci Med Sport*. 2007;10(2):96-104.
4. Drakos MC, Domb B, Starkey C, Callahan L, Allen AA. Injury in the National Basketball Association: a 17-year overview. *Sports Health*. 2010;2(4):284-290.
5. Erčulj F, Štrumbelj E. Basketball shot types and shot success in different levels of competitive basketball. *PLoS One*. 2015;10(6):e0128865.
6. Gough C. National Basketball Association (NBA) - Statistics and Facts. Accessed 14 July, 2021. https://www.statista.com/topics/967/national-basketball-association/#:~:text=In%201949%20%20the%2BAA%20merged,in%202019%20season.
7. Gribble PA, Bleakley CM, Cauffield BM, et al. Evidence review for the 2016 International Ankle Consortium consensus statement on the prevalence, impact and long-term consequences of lateral ankle sprains. *Br J Sports Med*. 2016;50(24):1496-1505.
8. Herzog MM, Mack CD, Dreyer NA, et al. Ankle sprains in the National Basketball Association, 2013-2014 through 2016-2017. *Am J Sports Med*. 2019;47(11):2651-2658.
9. Hubbard TJ, Hicks-Little CA. Ankle ligament healing after an acute ankle sprain: an evidence-based approach. *J Athl Train*. 2008;43(5):523-529.
10. Hulteen RM, Smith JJ, Morgan PJ, et al. Global participation in sport and leisure-time physical activities: a systematic review and meta-analysis. *Prev Med*. 2017;95:14-25.
11. Inclan PM, Chang PS, Mack CD, et al. Validity of research based on public data in sports medicine: a quantitative assessment of anterior cruciate ligament injuries in the National Football League. *Amer J Sports Med*. 2002;50(6):1717-1726.
12. International Olympic Committee Injury and Illness Epidemiology Consensus Group, Bahr R, Clarsen B, et al. International Olympic Committee consensus statement: methods for recording and reporting of epidemiological data on injury and illness in sports 2020 (including the STROBE extension for sports injury and illness surveillance (STROBE-SIIS)). *Orthop J Sports Med*. 2020;8(2):2325967120902908.
13. Johnston JT, Mandelbaum BR, Schub D, et al. Video analysis of anterior cruciate ligament tears in professional American football athletes. *Amer J Sports Med*. 2018;46(4):862-868.
14. Krosshaug T, Nakamae A, Boden BP, et al. Mechanisms of anterior cruciate ligament injury in basketball: video analysis of 39 cases. *Amer J Sports Med*. 2007;35(3):359-367.
15. Kubatko J. Basketball Reference. Sports Reference LLC, 2021. https://www.basketball-reference.com/. Updated July 18, 2021. Accessed July 18, 2021.
16. Kwon JY, Chacko AT, Kazielski JJ, Appleton PT, Rodriguez EK. A novel methodology for the study of injury mechanism: ankle fracture analysis using injury videos posted on YouTube.com. *J Orthop Trauma*. 2010;24(8):477-482.
17. Markovic G, Dizdar D, Jukic I, Cardinale M. Reliability and factorial validity of squat and countermovement jump tests. *J Strength Cond Res*. 2004;18(3):551-555.

18. McKay GD, Goldie PA, Payne WR, Oakes BW. Ankle injuries in basketball: injury rate and risk factors. *Br J Sports Med*. 2001;35(2):103-108.

19. Montgomery C, Blackburn J, Withers D, et al. Mechanisms of ACL injury in professional rugby union: a systematic video analysis of 36 cases. *Br J Sports Med*. 2018;52(15):994-1001.

20. Olsen O-E, Myklebust G, Engebretsen L, Bahr R. Injury mechanisms for anterior cruciate ligament injuries in team handball: a systematic video analysis. *Amer J Sports Med*. 2004;32(4):1002-1012.

21. Panagiotakis E, Mok KM, Fong DT, Bull AMJ. Biomechanical analysis of ankle ligamentous sprain injury cases from televised basketball games: understanding when, how and why ligament failure occurs. *J Sci Med Sport*. 2017;20(12):1057-1061.

22. Pasanen K, Ekola T, Vasankari T, et al. High ankle injury rate in adolescent basketball: a 3-year prospective follow-up study. *Scand J Med Sci Sports*. 2017;27(6):643-649.

23. Pashak R. Susceptibility to Ankle Sprain Injury between Dominant and Non-Dominant Leg During Jump Landings. Master’s thesis. University of Kentucky; 2019. https://doi.org/10.13023/etd.2019.451.

24. Plisky PJ, Rauh MJ, Kaminski TW, Underwood FB. Star Excursion Balance Test as a predictor of lower extremity injury in high school basketball players. *J Orthop Sports Phys Ther*. 2006;36(12):911-919.

25. Pope R, Herbert R, Kirwan J. Effects of ankle dorsiflexion range and pre-exercise calf muscle stretching on injury risk in Army recruits. *Aust J Physiother*. 1998;44(3):165-172.

26. Starkey C. Injuries and illnesses in the National Basketball Association: a 10-year perspective. *J Athl Train*. 2000;35(2):161-167.

27. Stuelcken MC, Mellifont DB, Gorman AD, Sayers MG. Mechanisms of anterior cruciate ligament injuries in elite women’s netball: a systematic video analysis. *J Sports Sci*. 2016;34(16):1516-1522.

28. Tummala SV, Hartigan DE, Makovicka JL, Patel KA, Chhabra A. 10-year epidemiology of ankle injuries in men’s and women’s collegiate basketball. *Orthop J Sports Med*. 2018;6(11):2325967118805400.