Validity of Video-Based Analysis for Analyzing Shoulder Injuries in the National Basketball Association

Andrew P. Collins,*† BS, Sabah Ali,† BS, Douglas Zaruta,‡ MD, Nichole Perry,‡ MD, Joel Riemenschneider,‡ DPT, and Benjamin C. Service,†‡§ MD

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

Background: Shoulder injuries are very common in athletes playing in the National Basketball Association (NBA). With increasing injury video uploads available online, we may be able to identify and systematically describe the mechanism of these injuries in these athletes.

Purpose: To (1) determine the validity of video-based analysis to evaluate mechanisms of shoulder injuries in NBA players during the 2010-2020 seasons and (2) report on commonly sustained injuries, circumstances associated with injury, and number of games missed owing to injury.

Study Design: Cross-sectional study; Level of evidence, 3.

Methods: An injury report data set was queried for shoulder injuries among NBA players between the 2010-2011 season and the 2019-2020 season, and results were cross-referenced using YouTube.com to identify high-quality videos of the injuries. Out of 532 shoulder injuries in this time frame, video evidence from 39 (7.3%) were evaluated for mechanism of injury and other corresponding situational data. From the remaining shoulder injuries, a randomly selected control cohort of 50 injuries occurring in the same interval was assessed for descriptive injury data, incidence of recurrence, necessity for surgery, and number of games missed, to compare with corresponding data from injuries in the videographic evidence cohort.

Results: In the videographic evidence cohort, the most common mechanism of injury was lateral contact to the shoulder (41%; $P < .001$), which was associated with an injury to the acromioclavicular joint (30.8%; $P < .001$). Injuries occurred more often when the team was on offense (58.9%; $P < .001$) versus defense. Players who required surgery missed 33 more games on average than players who did not require surgery ($P < .001$). For the injured players, a 33% incidence of reinjury was identified in the 12 months after their initial injury. As compared with the control cohort, no significant differences were noted in injury laterality, recurrence rates, necessity for surgical management, time in the season, or number of games missed.

Conclusion: Despite its low yield of 7.3%, video-based analysis may be a useful tool to determine the mechanism of shoulder injuries in the NBA, given the similarities of injury characteristics as compared with the control group.

Keywords: injury mechanism; video analysis; shoulder injury; NBA

Basketball is one of the most popular sports in the United States, with robust participation at all ages and competition levels.[16,23,24] At the professional level, the popularity of the National Basketball Association (NBA) has led to a global appreciation for the sport and increased participation worldwide.[26] This increased participation has been associated with an increase in the incidence of injuries in basketball athletes. Upper extremity injuries have been less examined in the literature yet make up 15% of NBA injuries and games missed.[4] The shoulder is a commonly injured joint in professional basketball players, with 1 study reporting nearly 30 shoulder injuries per season in the NBA alone between 1988 and 2005.[7] Given the high prevalence of shoulder injuries, it is important to identify the common mechanisms by which these injuries occur.

Much of what is known about the injury mechanisms has historically come from biomechanical cadaveric studies,[3] case reports,[5] and patient histories.[9,26,27] However, these methodologies may have inaccuracies and are susceptible to limitations, such as recall bias. Expansion of digital media has provided opportunities to study injuries through video analysis. High-quality videographic evidence may help surgeons better elucidate the mechanism of injury sustained by the athlete.[28]

Knowledge gained from video analysis has the potential to mitigate future injuries by identifying situations that place players at high risk for injury. Prior studies utilizing this approach of video-based mechanism of injury analysis

The Orthopaedic Journal of Sports Medicine, 11(3), 23259671231157768
DOI: 10.1177/23259671231157768

were able to identify characteristics of injuries in other populations and sports.[11] Ettlinger et al[8] used video-based analysis to determine a common mechanism of anterior cruciate ligament sprains in alpine skiers, which led to a 62% decrease in anterior cruciate ligament injuries after implementation of an injury prevention program, as compared with a control group without intervention. However, to our knowledge, there are no other video-based studies analyzing injuries in the NBA. Furthermore, the validity of video-based mechanism-of-injury analysis has not been verified.

The purpose of this study was to identify and classify shoulder injury mechanisms among NBA players during the 2010-2020 seasons using a video-based analysis. We also aimed to determine if using a video-based analysis is a valid methodology to evaluate mechanisms of shoulder injuries in NBA players. To our knowledge, this is the first trial assessing the validity of video analysis for shoulder injuries and describing the mechanisms by which these injuries occur.

METHODS

We used a publicly available online NBA injury data set named "NBA Injuries From 2010-2020,"[14] which included all reported injuries from the 2010-2020 regular and postseason games. Players with shoulder injuries between the 2010-2011 season and the 2019-2020 season were identified by adjusting the interval between 2010 and 2020 and filtering the results by "shoulder."[1,2,14] A search was then conducted on YouTube (https://www.youtube.com) for sites in the public domain that included the athlete's name (as obtained from the data set) and "NBA shoulder injuries."

Video exclusion criteria were as follows: (1) ambiguous injury mechanism, (2) poor-quality videographic evidence, and (3) unclear injury mechanism. Inclusion criteria consisted of (1) participants playing in an NBA game at the time of injury, (2) injuries that took place between 2010 and 2020, (3) adequate video visualization, and (4) videos available through the public domain. Most cases did not have a high-quality video available and therefore were not included in the mechanism of injury analysis. Injury events that had an associated video were compiled and cross-checked with injury reports accessed from official NBA injury reports, official team injury reports, news article websites, and statistical websites, to confirm the date of injury and collect variables of interest.[20]

Overall, 532 shoulder injuries were recorded in the NBA injury data set during the study period. Related videos were found for 44 injuries in 36 players. Five videos were excluded from analysis: 2 for poor quality, 2 because of an ambiguous injury, and 1 that was a mischaracterization of a neck injury (Figure 1). The analysis included 39 videos with high-quality visualization of the mechanism of injury (video cohort). From the remaining NBA shoulder injuries recorded, a control cohort consisting of 50 random injuries occurring in the same period was created with single-sequence randomization.

Key data from the video cohort were recorded regarding the injury: (1) shoulder laterality, (2) team, (3) team position at injury (offense, defense, or loose ball situation), (4) with or without the ball in the player's possession, (5) anatomic structure injured, (6) number of games missed, (7) need for surgery, and (8) reinjury within 12 months from return to play. Identified injuries included acromioclavicular joint (ACJ) sprains, glenohumeral joint (GHJ) subluxations/dislocations (and associated glenoid labral tears), rotator cuff tears, and pectoralis tears. This information was obtained from the official NBA injury reports, official team injury reports, and news article websites.[20] Data were collected regarding the position of the shoulder, the presence of direct trauma, the mechanism of the injury, and the action performed by the player when the injury occurred. The mechanism of injury was classified as in previous studies, using 7 descriptors: anterior contact, lateral contact, posterior contact, force through elbow, hyperflexion/abduction, traction, and eccentric injuries.[6,19,31] The definition for each mechanism is listed in Table 1, with images in Figure 2. Data collection from the control cohort consisted of injury laterality, recurrence, surgical necessity, time in the season, and number of games missed.

Descriptive statistics, chi-square analysis, and the Mann-Whitney U test were performed to characterize the injuries and determine categorical proportions. Continuous metrics with >2 variables were compared using analysis of variance testing. Comparison of data between and within the cohorts was conducted with chi-square and analysis of variance tests for categorical and continuous variables, respectively. An alpha level of 0.05 was utilized to determine statistical significance. All statistical tests were conducted with SPSS Statistics (Version 27.0; IBM Corp).

RESULTS

Characteristics of the Video Cohort

Of the 39 shoulder injuries, 59.0% occurred before the halfway point of the season, 28.2% after, and 12.8% during the

*Address correspondence to Andrew P. Collins, BS, College of Medicine, University of Central Florida, 6850 Lake Nona Blvd, Orlando, FL 32827, USA (email: andrewcollins@knights.ucf.edu).
†College of Medicine, University of Central Florida, Orlando, Florida, USA.
‡Orlando Health Jewett Orthopedic Institute, Orlando, Florida, USA.
§College of Medicine, Florida State University, Tallahassee, Florida, USA.
Final revision submitted September 28, 2022; accepted November 9, 2022.
One or more of the authors has declared the following potential conflict of interest or source of funding: D.Z. has received education payments from Fones Marketing Management. B.C.S. has received honoraria from Wright Medical, consulting fees from FarmaceuticalRx and Stryker, and hospitality payments from Arthrex. B.C.S. also has stock/stock options in OXOS, Revive Therapeutics, and ProBox Recovery Partners. AOSSM checks author disclosures against the Open Payments Database (OPD). AOSSM has not conducted an independent investigation on the OPD and disclaims any liability or responsibility relating thereto.
Ethical approval was not sought for the present study.

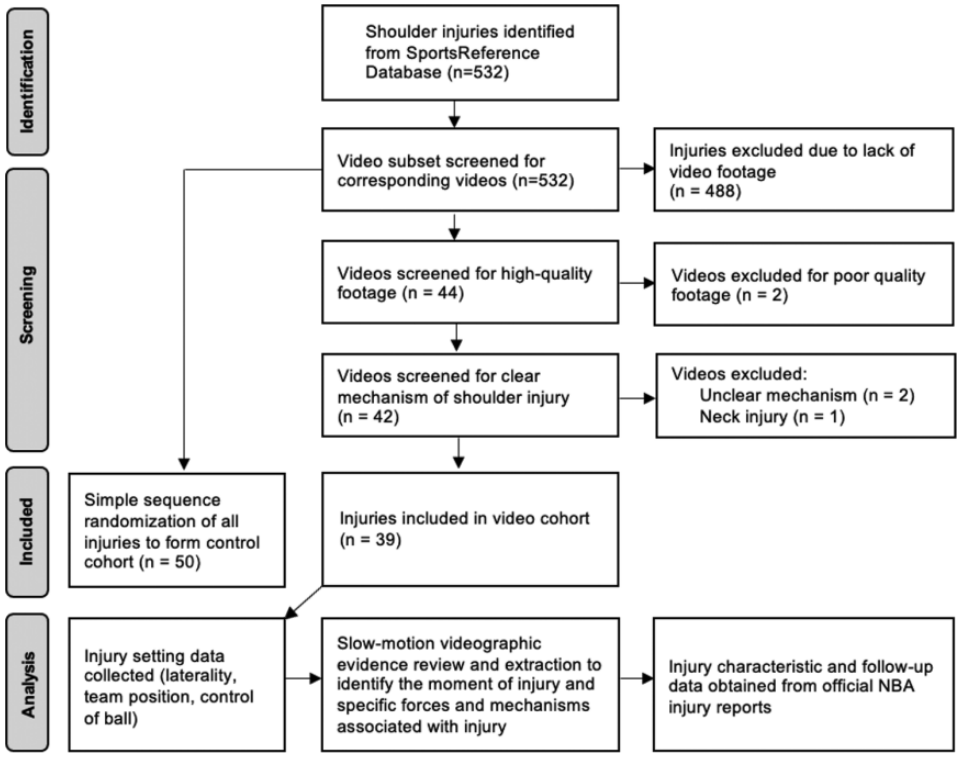

Figure 1. Selection process of video cohort (n = 39) and control cohort (n = 50). NBA, National Basketball Association.

TABLE 1
Definitions of Mechanisms of Shoulder Injuries[6,19,31]

Mechanism	Definition
Anterior contact	A posteriorly directed force against the anterior aspect of the shoulder joint complex
Lateral contact	A medially directed force against the lateral aspect of the shoulder joint complex
Posterior contact	An anteriorly directed force against the posterior aspect of the shoulder joint complex
Force through elbow	Axial loading to an internally rotated shoulder through a flexed elbow along the shaft of the humerus
Hyperflexion/ abduction	Arm is forced beyond the end range of flexion and/or overhead abduction
Traction	A pulling or distracting force applied to the shoulder by an opposing player
Eccentric	A horizontally adducted shoulder with resistance and maximum eccentric muscle contraction

playoffs. The majority of shoulder injuries (89.7%) resulted from direct trauma ($P < .001$). The ACJ was the most common overall joint/ligament injury, accounting for nearly 70% of injuries in the video-based analysis. The most common mechanism of injury was a medially directed force to the lateral aspect of the shoulder (41%), which had a strong association with an injury to the ACJ (35.9%; $P < .001$) (Figure 3).

The most common shoulder positioning during injuries were flexion/hyperflexion (28.2%) and horizontal extension/abduction (28.2%) (Figure 4). Injuries occurred more frequently when the player's team was on offense (58.9%; $P < .001$). Driving to the basket was the most common action performed at the time of injury (20.5%; $P < .001$) (Figure 5).

There were 7 players in the video cohort who underwent surgery; all had heterogeneous injury characteristics (Table 2). Only 1 of the 7 players who underwent surgery had a recurrent injury within the follow-up period.

Comparison Between the Video and Control Cohorts

There were no significant differences between the video and control cohorts in the injury characteristics that were compared (Table 3). In the video cohort, players missed a mean 11.6 games after a shoulder injury, and players who underwent surgery missed 38.7 games, significantly more than players who did not undergo surgery, who missed 5.7 games ($P < .001$). In the control cohort, there were no significant differences in games missed between injuries requiring nonoperative versus surgical management. A recurrent shoulder injury within 12 months from return to play was seen in 13 of the 39 injuries in the video cohort and 21 of the 50 injuries in the control cohort. In both cohorts, injuries were more likely to occur during the first half of the season ($P \leq .002$).

DISCUSSION

This is the first study to describe the mechanism of shoulder injuries in NBA players using a video-based analysis

Figure 2. Video images demonstrating the 7 mechanisms of injury classifications (red arrows). (A) Anterior contact: posteriorly directed force to the anterior shoulder. (B) Lateral contact: medially directed force to the lateral shoulder. (C) Posterior contact: anteriorly directed force to the posterior shoulder. (D) Force through elbow: force to an internally rotated shoulder through a flexed elbow. (E) Hyperflexion/abduction: arm forced beyond the end range of flexion and abduction. (F) Traction: pulling force applied to the shoulder by an opposing player. (G) Eccentric: maximum eccentric muscle contraction on a horizontally adducted shoulder.

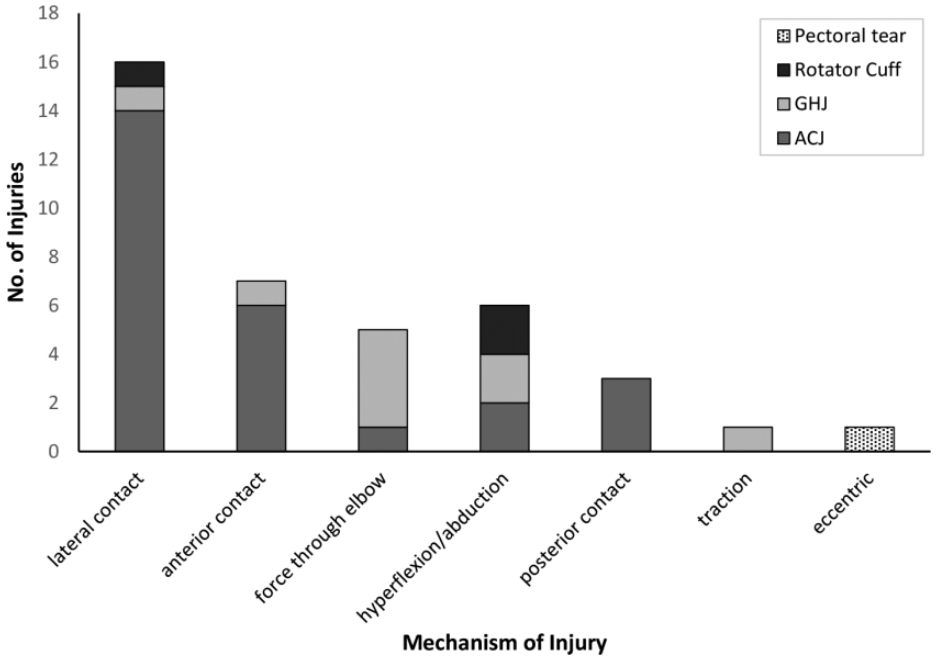

Figure 3. Mechanism of shoulder injury and diagnosis. ACJ, acromioclavicular joint; GHJ, glenohumeral joint.

and to validate the technique for these injuries. Video analysis was able to capture 7.3% of all shoulder injuries occurring in the NBA during the study period. The video analysis group demonstrated that the most common mechanism of injury was lateral contact to the shoulder, which often resulted in ACJ injuries. These findings are consistent with

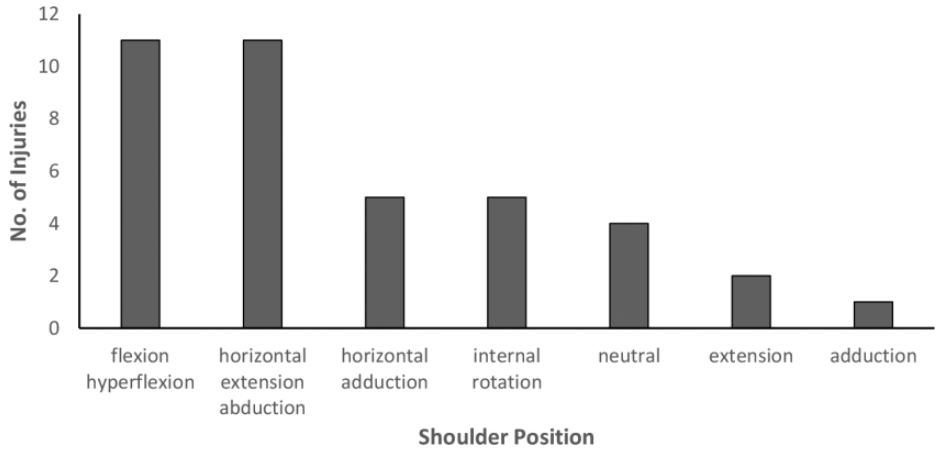

Figure 4. Position of the shoulder during injury.

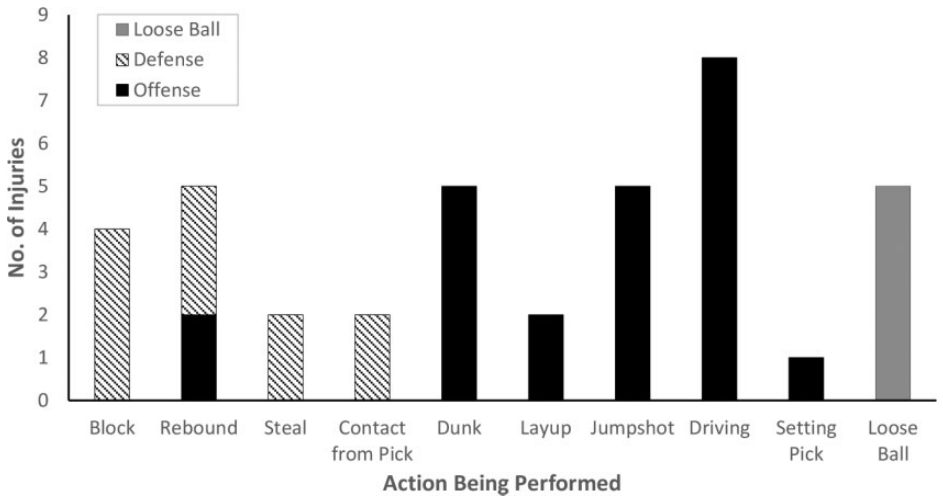

Figure 5. Team position (offense, defense, or loose ball retrieval) and action during injury.

TABLE 2
Injury Characteristics of the Players in the Video Cohort Who Underwent Surgical Treatment (n = 7)[a]

Player	Injured Joint/Ligament	Mechanism of Injury	Games Missed	Time of Injury	Reinjury?
1	GHJ	Traction	16	Playoff	No
2	ACJ	Posterior contact	10	Late	No
3	Rotator cuff	Hyperflexion/Abduction	39	Early	Yes
4	ACJ	Posterior contact	68	Early	No
5	Pectoralis	Eccentric	60	Early	No
6	GHJ	Force through elbow	40	Playoff	No
7	GHJ	Force through elbow	38	Early	No

[a]ACJ, acromioclavicular joint; GHJ, glenohumeral joint.

large-scale epidemiologic studies of shoulder injuries within the NBA.[7,16]

Inward turning of the shoulder may frequently be performed to improve the likelihood of a successful outcome (eg, turning the shoulder during a drive past an opposing defender to score at close range). Practicing this maneuver in offensive, defensive, and loose ball situations may lead to potential direct blows to the lateral shoulder from opposing players or the court floor.

Mechanistically, these direct traumas lead to ACJ injuries by tearing the acromioclavicular ligament, coracoclavicular ligaments, or both. ACJ injuries were the most common in this study and are also the most common shoulder injuries in other professional sports leagues, including

TABLE 3
Comparison of Injury Characteristics for the Video and Control Cohorts[a]

	Video Cohort (n = 39)	Control (n = 50)	*P* (Between Groups)
Side affected			.842
Right	19 (48.7)	25 (50.0)	
Left	20 (51.2)	25 (50.0)	
P (within groups)	.749	>.999	
Injury recurrence			.068
Yes	13 (33.3)	21 (42.0)	
No	26 (66.7)	29 (58.0)	
P (within groups)	.055	.258	
Surgical treatment			.692
Yes	7 (17.9)	10 (20.0)	
No	32 (82.1)	40 (80.0)	
P (within groups)	**<.001**	**<.001**	
Time injured in season			.482
Before All-Star break	23 (59.0)	31 (62.0)	
After All-Star break	11 (28.2)	15 (30.0)	
During playoffs	5 (12.8)	4 (8.0)	
P (within groups)	**.002**	**<.001**	
Games missed, mean			.057
All injuries	11.6	11.4	
Surgical treatment	38.7	17.4	
Nonoperative treatment	5.7	10.0	
P (within groups)	**<.001**	.415	

[a]Data are reported as No. (%) unless otherwise indicated. Bold *P* values indicate a statistically significant difference ($P < .05$).

the Australian Football League, National Football League, and National Hockey League, but are reportedly more common in these sports owing to direct tackling contact with the ground or walls.[17,18,29,31] Lateral contact injuries are difficult to avoid in professional basketball, as players do not typically avoid contact on offense in order to incite a foul from the opposing team. This may aid in the explanation that a larger number of injuries occurred when the team was on offense, with most happening when the player in possession of the ball was driving to the basket. Strategies to reduce the instances of offense-initiated contact are limited, as they would require systematic changes in basketball rules to discourage the player on offense from provoking contact or to further discourage fouling by the defensive team.

Although ACJ injuries were the most common, GHJ injuries required surgery for instability at a higher rate: 3 of 9 GHJ injuries versus 2 of 26 ACJ injuries required surgery. The difference in surgical treatment frequency for GHJ and ACJ injuries is most likely due to the preferred management of these injuries. Rockwood classification type I and II ACJ injuries are commonly treated nonoperatively.[21,30] For type III ACJ injury, many surgeons may utilize nonoperative management, while a surgical approach is sometimes considered for acute injuries in young elite athletes.[12,25] Nonoperative management consists of 4 phases: pain control with motion-limited isometrics, strengthening and neuromuscular facilitation, functional movement strengthening, and sport-specific drills and training.[10] Conversely, GHJ injuries are more likely to be managed operatively, especially in the case of shoulder instability, as described by Lu et al.[20] In their study, the authors found that NBA players undergoing operative management for glenoid labral tears (often involving arthroscopic repair) had a longer interval to recurrent shoulder instability than those who underwent nonoperative treatment for subluxations and dislocations. In the current study, all 3 players who underwent operative management for their glenohumeral instability did not have a recurrent injury within the next 12 months from their return to play. No data were publicly available regarding the type of surgery the players underwent. Overall, only 1 of the 7 players who required surgery had a recurrent injury within the 12-month follow-up period and within 12 months after return to play. This is consistent with a previous study that showed that NBA players have a greater success rate of return to play from shoulder surgery than Achilles tendon and knee surgery.[22] Players who had surgery later in the season, after the All-Star break, missed fewer games than those who had surgery earlier in the season. This may be due to having the off-season to recover and rehabilitate after the surgery.

In total, the video cohort utilized surgical management for 7 of 39 injuries, while the control cohort necessitated surgery in 10 of 50 injuries. Furthermore, games missed among players with operative and nonoperative management in both cohorts were similar. These similarities in rates of operative management and games missed may indicate that video analysis of injuries provides a consistent representation of injury severity and type. Both cohorts had a greater proportion of injuries occurring in the first half of the season, though these rates were similar between them. This may also indicate that the video cohort was a representative sample when compared with the control.

Our analysis demonstrated that players who sustained a shoulder injury had a 33.3% rate of recurrent shoulder injury over the subsequent 12 months after return to play. Players in the control cohort also experienced a high recurrent injury rate of 42.0%, demonstrating that video analysis may provide a representative sample of injury types attributed to these similarities. This high rate of repeat injury is important to highlight the need for additional shoulder health optimization after injury. Athletic trainers, strength and conditioning coaches, as well as physical and occupational therapists should be alerted to these data so that additional treatment can prevent reinjury in this at-risk group of players.[13,15,32] Alternatively, these data could be interpreted from a different perspective: players with a shoulder injury may continue to repeat at-risk actions on court, such as driving to the basket, given their in-game demands. Further analysis of players may provide a better understanding of this subgroup of NBA players with reinjury.

Video-based analysis of injuries has been used widely across many sports, though no previous studies have assessed the validity of this tool outside the NBA. Future work assessing the efficacy of video analysis across other sports may prove useful to determine the value of these studies. By doing so, we may more accurately employ this methodology in professional sport.

Limitations

The primary limitation to this study is the small sample size and low yield of injuries with high-quality video evidence. One possibility for this may be a lack of attention to minor injuries attributed to minimal reaction from the player and a lack of game stoppage. This study did not include injuries that were not reported to the official NBA injury report database. This can lead to the analysis of the most severe injuries while missing more benign injuries and their mechanisms, though our comparison with the control cohort did not indicate this. Furthermore, the relatively small sample size may have introduced some biases to our data. The use of public domain videos and exclusion of injuries with poor video quality may have exacerbated selection bias among reviewers and uploaders of the videos. Additionally, the analysis of this homogeneous population may reduce the generalizability of our results.

CONCLUSION

While video-based analysis of shoulder injuries in the NBA may provide a low yield of 7.3% of all shoulder injuries, it may still accurately describe injury occurrence, recurrence, severity, necessity for operative management, and number of games missed because of injury. However, this methodology is largely subject to selection and reporting biases. Video-based analysis of injuries should consider these findings in the future to determine the value of this methodology.

REFERENCES

1. Amin NH, Old AB, Tabb LP, Garg R, Toossi N, Cerynik DL. Performance outcomes after repair of complete Achilles tendon ruptures in National Basketball Association players. *Am J Sports Med*. 2013; 41(8):1864-1868. doi:10.1177/0363546513490659
2. Anakwenze OA, Namdari S, Auerbach JD, et al. Athletic performance outcomes following lumbar discectomy in professional basketball players. *Spine (Phila Pa 1976)*. 2010;35(7):825-828. doi:10.1097/BRS.0b013e3181d3cf45
3. Bey MJ, Elders GJ, Huston LJ, Kuhn JE, Blasier RB, Soslowsky LJ. The mechanism of creation of superior labrum, anterior, and posterior lesions in a dynamic biomechanical model of the shoulder: the role of inferior subluxation. *J Shoulder Elbow Surg*. 1998;7(4):397-401.
4. Borowski LA, Yard EE, Fields SK, Comstock RD. The epidemiology of US high school basketball injuries, 2005-2007. *Am J Sports Med*. 2008;36(12):2328-2335. doi:10.1177/0363546508322893
5. Ciccone R, Richman RM. The mechanism of injury and the distribution of 3000 fractures and dislocations caused by parachute jumping. *J Bone Joint Surg Am*. 1948;30A(1):77-97.
6. Crichton J, Jones DR, Funk L. Mechanisms of traumatic shoulder injury in elite rugby players. *Br J Sports Med*. 2012;46(7):538-542. doi:10.1136/bjsports-2011-090688
7. 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. doi:10.1177/1941738109357303
8. Ettlinger CF, Johnson RJ, Shealy JE. A method to help reduce the risk of serious knee sprains incurred in alpine skiing. *Am J Sports Med*. 1995;23(5):531-537. doi:10.1177/036354659502300503
9. Ferreira AP, de Wet IS, Dommisse GF. Fractures and dislocations of the ankle joint. *S Afr Med J*. 1978;54(26):1095-1100.
10. Gladstone J, Wilk K, Andrews J. Nonoperative treatment of acromioclavicular joint injuries. *Oper Tech Sports Med*. 1997;5:78-87.
11. Grassi A, Smiley SP, Roberti di Sarsina T, et al. Mechanisms and situations of anterior cruciate ligament injuries in professional male soccer players: a YouTube-based video analysis. *Eur J Orthop Surg Traumatol*. 2017;27(7):967-981. doi:10.1007/s00590-017-1905-0
12. Gstettner C, Tauber M, Hitzl W, Resch H. Rockwood type III acromioclavicular dislocation: surgical versus conservative treatment. *J Shoulder Elbow Surg*. 2008;17(2):220-225. doi:10.1016/j.jse.2007.07.017
13. Hootman JM, Dick R, Agel J. Epidemiology of collegiate injuries for 15 sports: summary and recommendations for injury prevention initiatives. *J Athl Train*. 2007;42(2):311-319.
14. Hopkins R. NBA injuries from 2010-2020. 2020. Accessed November 20, 2020. https://www.kaggle.com/datasets/ghopkins/nba-injuries-2010-2018
15. Hsu WK, McCarthy KJ, Savage JW, et al. The professional athlete spine initiative: outcomes after lumbar disc herniation in 342 elite professional athletes. *Spine J*. 2011;11(3):180-186. doi:10.1016/j.spinee.2010.12.009
16. 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. doi:10.1016/j.ypmed.2016.11.027
17. Jang ES, Park CN, Levine WN, Popkin CA. A current concepts review of clavicle injuries in ice hockey from sternoclavicular to acromioclavicular joint. *Orthop J Sports Med*. 2020;8(9):2325967120951413. doi:10.1177/2325967120951413
18. Kelly BT, Barnes RP, Powell JW, Warren RF. Shoulder injuries to quarterbacks in the National Football League. *Am J Sports Med*. 2004;32(2):328-331. doi:10.1177/0363546503261737
19. Longo UG, Huijsmans PE, Maffulli N, Denaro V, De Beer JF. Video analysis of the mechanisms of shoulder dislocation in four elite rugby players. *J Orthop Sci*. 2011;16(4):389-397. doi:10.1007/s00776-011-0087-6
20. Lu Y, Okoroha KR, Patel BH, et al. Return to play and performance after shoulder instability in National Basketball Association athletes.

J Shoulder Elbow Surg. 2020;29(1):50-57. doi:10.1016/j.jse.2019.05.035
21. Mazzocca AD, Arciero RA, Bicos J. Evaluation and treatment of acromioclavicular joint injuries. *Am J Sports Med*. 2007;35(2):316-329. doi:10.1177/0363546506298022
22. Minhas SV, Kester BS, Larkin KE, Hsu WK. The effect of an orthopaedic surgical procedure in the National Basketball Association. *Am J Sports Med*. 2016;44(4):1056-1061. doi:10.1177/0363546515623028
23. National Collegiate Athletic Association. Student-athlete participation 1981-82–2016-17: NCAA sports sponsorship and participation rates report. Accessed October 20, 2020. https://ncaaorg.s3.amazonaws.com/research/sportpart/Oct2018RES_2017-18SportsSponsorshipParticipationRatesReport.pdf
24. National Federation of State High School Associations. 2016-17 High school athletics participation survey results. Accessed October 20, 2020. https://www.nfhs.org/media/1020204/2016-17_hs_participation_survey.pdf
25. Nissen CW, Chatterjee A. Type III acromioclavicular separation: results of a recent survey on its management. *Am J Orthop (Belle Mead NJ)*. 2007;36(2):89-93.
26. 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. doi:10.1111/sms.12818
27. Perry CR, Rice S, Rao A, Burdge R. Posterior fracture-dislocation of the distal part of the fibula: mechanism and staging of injury. *J Bone Joint Surg Am*. 1983;65(8):1149-1157.
28. Schreiber JJ, Warren RF, Hotchkiss RN, Daluiski A. An online video investigation into the mechanism of elbow dislocation. *J Hand Surg Am*. 2013;38(3):488-494. doi:10.1016/j.jhsa.2012.12.017
29. Schwab LM, McGrath T, Franettovich Smith MM, Mendis MD, McGhee D, Hides J. Mechanisms of traumatic injury to the shoulder girdle in the Australian Football League. *J Sci Med Sport*. 2019;22(9):987-991. doi:10.1016/j.jsams.2019.05.019
30. Stucken C, Cohen SB. Management of acromioclavicular joint injuries. *Orthop Clin North Am*. 2015;46(1):57-66. doi:10.1016/j.ocl.2014.09.003
31. Usman J, McIntosh AS, Quarrie K, Targett S. Shoulder injuries in elite rugby union football matches: epidemiology and mechanisms. *J Sci Med Sport*. 2015;18(5):529-533. doi:10.1016/j.jsams.2014.07.020
32. Wilroy J, Hibberd E. Evaluation of a shoulder injury prevention program in wheelchair basketball. *J Sport Rehabil*. 2018;27(6):554-559. doi:10.1123/jsr.2017-0011