Shoulder Injuries in National Collegiate Athletic Association Quarterbacks

10-Year Epidemiology of Incidence, Risk Factors, and Trends

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Background: Up to 50% of National Collegiate Athletic Association (NCAA) football players have a history of shoulder injuries. The quarterback position has been shown to have a high prevalence of these injuries because of its unique exposures. There is little information regarding the shoulder injury type and mechanism in NCAA quarterbacks.

Purpose: To understand the 10-year epidemiology of specific shoulder injury rates in NCAA quarterbacks.

Study Design: Descriptive epidemiology study.

Methods: Shoulder injury data for collegiate football quarterbacks from the 2004 through 2014 academic years were analyzed using the NCAA Injury Surveillance Program (ISP) data set.

Results: Over the 10-year study period, a total of 133 shoulder injuries to collegiate quarterbacks were reported, with 157,288 quarterback exposures. There was approximately 1 shoulder injury per 1221 exposures. The most common injuries noted were acromioclavicular sprains (45.1%, n = 60), followed by shoulder contusions (9.0%, n = 12), clavicular fractures (7.5%, n = 10), and anterior instability (5.3%, n = 7). The majority of injuries were caused by contact with a player (60.2%, n = 80) or contact with a playing surface (28.6%, n = 38), and 88% (n = 117) were deemed nonsurgical in nature.

Conclusion: NCAA ISP data analysis suggests that collegiate quarterbacks sustain acute contact injuries 89% of the time and that they typically occur while being tackled, resulting in a time loss of less than 2 weeks. These injuries are commonly treated nonsurgically.

Keywords: shoulder injury; quarterback; AC joint; shoulder contusion; football-related shoulder injuries; positional injuries

Because of the prevalence of collisions and high levels of impact, football is a sport with an increased risk for injuries.[5,7-9] Shoulder injuries are among the most common because of the significant axial force and load placed on the joint during play.[5,8,13] Further, injury patterns are unique by position because of varying risk factors.[3]

A study by Kaplan et al[13] indicated that up to 50% of National Collegiate Athletic Association (NCAA) football players have some history of shoulder injuries, comprising roughly 10% to 20% of total injuries. Because of its unique vulnerability on the football field, the quarterback position has been shown to have a high prevalence of shoulder injuries.[3,8,13,14]

Previous studies have investigated the incidence of shoulder injuries in professional quarterbacks, but factors such as style of play, level of competition, length of season, and increased physicality in the National Football League (NFL) warrant different exposures than found in the collegiate game.[9,14] Furthermore, studies have evaluated the risks for a shoulder injury in collegiate football players but none specific to the quarterback position.[5,8,13] The purpose of this investigation was to understand the 10-year epidemiology of specific shoulder injury rates in NCAA quarterbacks by evaluating the anatomic structure injured, mechanism of injury, time to return to play, and treatment obtained, among other factors. The goal was to be able to provide information to players, coaches, and athletic

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trainers (ATs) about the nature of shoulder injuries in collegiate quarterbacks to recognize patterns and develop prevention strategies.

METHODS

Sampling and Methods

This investigation utilized data from the NCAA Injury Surveillance Program (ISP) for the 10-year period between the 2004-2005 and 2014-2015 academic years. The combined 10-year data set was composed of two 5-year sets (2004-2009 and 2009-2014) from the NCAA surveillance program, which had slightly different variables, collection methods, and number of participating teams. The NCAA Injury Surveillance System (ISS) was created in 1982 in a pen-and-paper format to provide a foundation for evidence-based decision making regarding the health and safety concerns of NCAA athletes for all NCAA divisions.[15] It has since served as a basis for NCAA policy and monitoring of sports-related injuries. From this, it transitioned into a fully web-based collection program in 2004-2005, and in 2009, the NCAA ISS was updated to improve process flow and renamed the ISP. This new program implemented a common data element, allowing data to be gathered from different electronic medical records and injury-documenting applications.[15]

NCAA ISP data are dependent on a convenience sampling of teams, with ATs voluntarily reporting injury and exposure data to an online database. The ISP data only include injuries sustained in games and sanctioned practices. Because these data are obtained from volunteering institutions, participation from year to year has varied, with an average of 60 teams from 2004 to 2009 and 25 teams from 2009 to 2014.[15] The discrepancy between the years is likely secondary to the shift from handwritten records from 2004 to 2009 to electronic input from 2009 to 2014. While electronic input can be more cumbersome, it provides more consistent data. To ensure the quality of data, ATs received training material via mail, participated in training sessions at national conferences, and could contact NCAA data-control staff. Data were only collected from organized practices and competitions from preseason through postseason. For each injury, ATs and/or physicians completed a detailed report on the injury itself as well as the circumstances surrounding it. They further tallied the number of student-athletes participating in each practice or competition to maintain exposure counts. While the ISP represents data on only a small sample of NCAA football programs, we believe the sampling is accurate of the overall picture of NCAA football.

Once submitted, data were de-identified in accordance with the Health Insurance Portability and Accountability Act (HIPAA) and passed through a review by data-control staff to ensure quality in all variables such as exposure counts and time loss, among others. All invalid values were reviewed and excluded from final data. Data sets were further weighted after stratification to generate

TABLE 1
Variable Differences in Data Sets

2004-2009	2009-2014
Type of play (passing, running, etc)	Competition versus game
Home versus away competition	Academic year of participant
	Medical staff performing assessment (physician vs athletic trainer)

national estimates and account for potential underreporting of injuries.

Definitions

A "reportable injury" in the data set was defined as one that (1) occurred in an organized intercollegiate practice or competition, (2) required attention from an AT or physician, and (3) resulted in restriction of the student-athlete from football activities for any time.[15] An "athlete exposure" was defined as 1 student-athlete participating in 1 NCAA-sanctioned practice or competition regardless of time of participation; competition exposures only included athletes with playing time in the competition. "Time loss" was defined as the number of days between the injury date and the date on which the athlete returned to scheduled team activities even with limitations. The quarterback position was defined as per the roster listing.

Combination of Data Sets

The NCAA ISP provided 2 injury data sets (one from 2004-2009 and the other from 2009-2014). To combine them to determine trends, each data set was analyzed individually by variable, and then both sets were compared for overlapping variables. These overlapping variables were then consolidated into a single data set, combining all quarterback shoulder injuries from 2004 to 2014 (a total of 133 injuries), which was used in this study. Differences in the variables studied were noted between the data sets (Table 1).

Quarterback Exposures

The NCAA ISP further provided exposure data sets indicating the total athlete exposures, defined as 1 athlete per 1 event (practice or competition). To be included in the competition or practice athlete exposure counts, the player must have played in competition or participated in practice. These exposures included data for the total number of exposures for all football players included in the study not specific to individual positions. A further calculation was required to determine the exposures for NCAA quarterbacks. NCAA participation analysis sheets, detailing the number of athletes and teams in NCAA Division I to III football, were used to find the average size of football teams during the years corresponding to the 2004-2009 and

TABLE 2
Calculation of Exposure[a]

	2004-2009			2009-2014		
	No. of Teams	Average No. of Quarterbacks per Team	Total No. of Quarterbacks per Year	No. of Teams	Average No. of Quarterbacks per Team	Total No. of Quarterbacks per Year
Division I	28	5.24	146.72	16	5.24	83.84
Division II	10	5.04	50.40	5	5.04	25.20
Division III	23	6.16	141.68	10	6.16	61.60
Total	60	5.48	328.80	25	5.48	137.00

[a]Total number of calculated quarterbacks in the study: 2329. Average number of quarterbacks per season: 232.90.

2009-2014 data sets.[19] To estimate the number of quarterbacks per roster, a sampling of 30 NCAA football teams (10 from each division) was randomly taken from the 2010 to 2014 seasons. Each roster from these 5 years was analyzed for the number of quarterbacks on the roster each year, and the average was taken over the time span. Football Bowl Subdivision and Football Championship Subdivision were both included in Division I. These calculations yielded an estimate for the average roster size and number of quarterbacks on an NCAA roster that could be used in further data analysis.

We then calculated the total number of quarterbacks in each data set by multiplying the number of teams in each set (60 in 2004-2009 and 25 in 2009-2014) by the previously estimated quarterbacks per roster. We could then calculate the estimated total number of quarterbacks in the study (Table 2).

Using the average team size, the estimated number of exposures per player on each team was then determined regardless of position. The average number of exposures per player per year in each data set was multiplied by the estimated total number of quarterbacks calculated. Using the total number of quarterbacks and the total number of exposures for quarterbacks, we could now extrapolate the shoulder injuries per quarterback and per exposure. The potential downside of this technique is that it can overestimate the number of athlete exposures and therefore underestimate injury rates, as the quarterback position typically has only 1 individual play in an entire game compared with other positions on the team.

RESULTS

Over the 10-year period from 2004 to 2014, there were a total of 3,121,380 exposures for all NCAA football players in our database, 157,288 of which were calculated quarterback exposures. A total of 133 shoulder injuries in collegiate quarterbacks were reported over this time period, approximately 1 shoulder injury per 1221 exposures. The majority of injuries were caused by contact with a player (60.2%, n = 80) or contact with a playing surface (28.6%, n = 38) (Figure 1). A total of 118 injuries (88.7%) occurred during competition, and 15 (11.3%) were in practice settings. Furthermore, the most common player activity during the
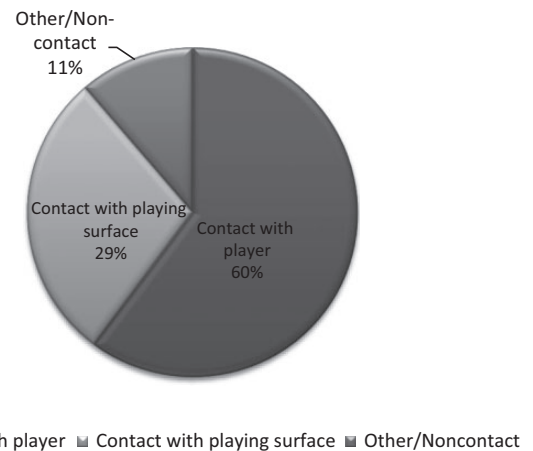

■ Contact with player ■ Contact with playing surface ■ Other/Noncontact

Figure 1. Contact versus noncontact injury.
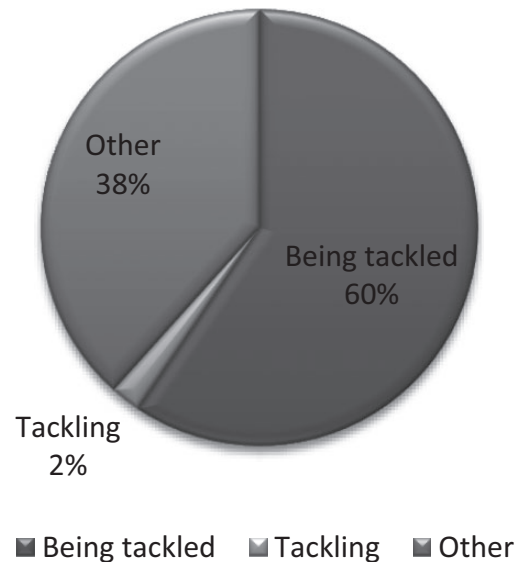

■ Being tackled ■ Tackling ■ Other

Figure 2. Activity during injury.

injury was being tackled, with 59.4% (n = 79) (Figure 2). New injuries accounted for 89.5% (n = 119) of the injuries (Figure 3), and 88% (n = 117) were deemed nonsurgical in nature (Figure 4). Further, 96.2% (n = 128) of injuries were
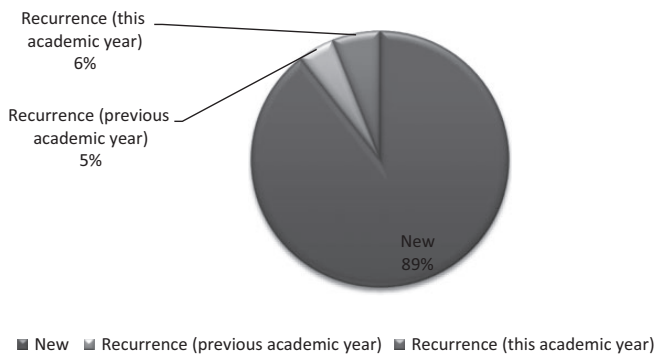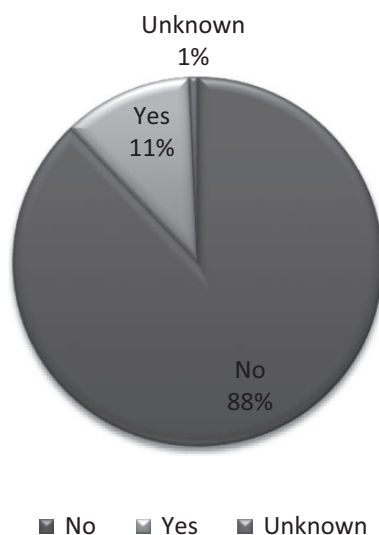
Figure 3. New versus recurrent injury.

Figure 4. Surgery required from injury.

isolated injuries. The majority (43.6%, n = 58) of injuries resulted in a time loss of 0-6 days, 17.3% (n = 23) in a time loss of 7-13 days, and 13.5% (n = 18) in a time loss of 14-29 days. Overall, 61% (n = 81) of injuries resulted in a time loss of <14 days (Figure 5).

The most common injuries noted were acromioclavicular (AC) sprains (45.1%, n = 60), followed by shoulder contusions (9.0%, n = 12), clavicular fractures (7.5%, n = 10), and anterior subluxations (5.3%, n = 7). Other notable injuries included rotator cuff tears (4.5%, n = 6), posterior subluxations (3.8%, n = 5), shoulder impingement (3.8%, n = 5), and sternoclavicular joint subluxations (3%, n = 4) (Table 3).

AC sprains were caused by contact with a player 56% (n = 34) of the time and contact with a playing surface 40% (n = 24) of the time. Overall, 96.7% (n = 58) of AC sprains were associated with a contact injury. The majority of AC sprains (40%, n = 24) were associated with a time loss of 0-6 days, 25% (n = 15) with a time loss of 7-13 days, and 20% (n = 12) with a time loss of 14-29 days. This indicates that 65% (n = 36) resulted in a time loss of <14 days and that 85% (n = 51) of AC sprains resulted in a time loss of <30 days (Table 4).

Shoulder contusions were caused by contact with a player 83% (n = 10) of the time and contact with a playing surface 17% (n = 2) of the time. Contusions were associated with a time loss of 0-6 days 83% (n = 10) of the time and a time loss of 7-13 days 8.3% (n = 1) of the time.

All clavicular fractures were caused by contact with a player (70%, n = 7) or contact with a playing surface (30%, n = 3). Further, 20% (n = 2) of these injuries required surgery. All reported clavicular fractures (n = 4) resulted in the player's losing >29 days (Table 4).

DISCUSSION

This study suggests that the majority of collegiate shoulder injuries in quarterbacks are acute contact injuries (89%) that are more likely nonsurgical (88%) and result in a time loss of less than 2 weeks (61%). The most common injuries noted were an AC sprain (45%), shoulder contusion (9%), clavicular fracture (7%), and anterior instability (5%). These data are largely supported by the previous literature and demonstrate that collegiate quarterback injuries have similarities to injuries in professional players.[14]

The shoulder joint has a large range of motion that is largely dependent on soft tissues for flexibility and stability.[6] This intrinsic vulnerability, combined with repetitive contact and stress applied to the joint, increases the risk of shoulder injuries among NCAA football players.[5,7-9] Further, there is an increased prevalence of shoulder injuries among quarterbacks, with up to 76% of NCAA quarterbacks having some type of shoulder injury in their playing career.[3,13] The findings in our study indicate this number to be much lower; however, it is important to remember, only shoulder injuries requiring medical attention were reported in our database. Shoulder strains or sprains that the quarterback was able to play through would be missed in our database. For the purposes of our study, we hoped to investigate injuries that caused time loss.

The results indicated that 88.7% of all shoulder injuries in quarterbacks were related to contact with another player or surface, which is consistent with the mechanism of shoulder injury in NFL quarterbacks that occur during competition (82.3% as reported by Kelly et al[14]), as contact with a quarterback is typically not allowed during practice.[3,8] This study further demonstrated that the majority of shoulder injuries sustained by NCAA quarterbacks are acute contact injuries with a time loss of less than 2 weeks. The majority of injuries were reported to be new (89.5%), with 61% reported as having a time loss of <14 days. Further, only 11% of injuries required surgery. These findings are also supported by Kelly et al[14] in their study on NFL quarterbacks.

The rate of shoulder injuries among NCAA quarterbacks was 1 per 1222 athlete exposures. The average rate of injuries among football players is varied.[1,7,8] A study by Dick et al[8] found that the competition injury rate was 36 injuries per 1000 athlete exposures, indicating that shoulder injuries among quarterbacks are relatively rare.

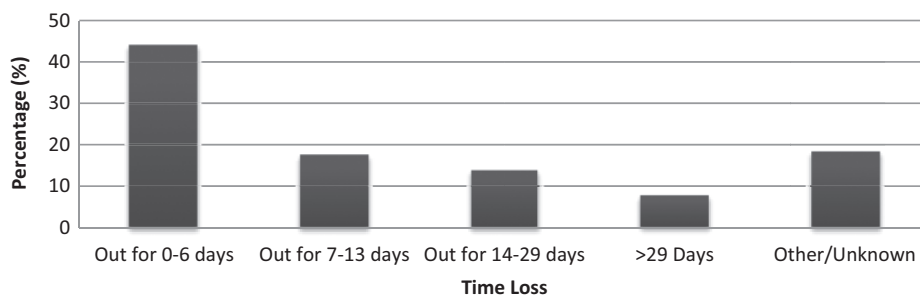AC sprains (45%, n = 60) were the most common shoulder injuries in NCAA quarterbacks. This confirms previous

Figure 5. Time loss.

TABLE 3
Shoulder Injuries[a]

Injury Type	n (%)
Acromioclavicular sprain (partial or complete)	60 (45.1)
Shoulder contusion	12 (9.0)
Clavicular fracture	10 (7.5)
Anterior subluxation	7 (5.3)
Rotator cuff tear (partial or complete)	6 (4.5)
Posterior subluxation	5 (3.8)
Shoulder impingement	5 (3.8)
Sternoclavicular joint subluxation	4 (3.0)
Anterior dislocation	3 (2.3)
Brachial plexus injury (stinger)	3 (2.3)
Other shoulder injury	3 (2.3)
Scapular fracture	3 (2.3)
Biceps tear (partial or complete)	2 (1.5)
Glenoid labrum tear (non-SLAP lesion)	2 (1.5)
Glenoid labrum tear (SLAP lesion)	2 (1.5)
Biceps tendinitis	1 (0.8)
Clavicle bone bruise	1 (0.8)
Latissimus dorsi partial tear	1 (0.8)
Other shoulder injury	1 (0.8)
Serratus anterior tear (partial or complete)	1 (0.8)
Shoulder neuroma	1 (0.8)
Total	133 (100.0)

[a]SLAP, superior labrum from anterior to posterior.

research with similar findings by Kaplan et al[13] (56%) and Kelly et al[14] (40%). The increased risk for AC injuries in quarterbacks could be because of a higher incidence of shoulder contact with the ground, the type of shoulder padding used, or vulnerability during contact, among other factors.[18] Despite being the most common injury, we found that 65% (n = 39) of AC sprains had a time loss of <14 days. Lynch et al[18] also noted that the mean time loss for AC injuries among all football players was 9.8 days, and Kelly et al[14] noted a median of 12.5 days lost for AC injuries in NFL quarterbacks. However, a number of these players may have returned to play before complete recovery.

The other major injuries found were shoulder contusions (9.0%, n = 12) and clavicular fractures (7.5%, n = 10). All of these injuries (100%) were found to be associated with a contact injury in this study. Shoulder contusions proved to be a minor injury overall, with 83.3% of injured quarterbacks (n = 10) missing <7 days and 91% (n = 11) missing

<14 days. Patients who demonstrate complete active range of motion without bony-point tenderness may not require a further evaluation and can be treated with ice and oral analgesia. Clavicular fractures were a much more serious injury, with all reported injuries (n = 4) indicating that the player was out for the season and 20% (n = 2) requiring surgery. Treatment often involves extended leave from athletics and may be surgical depending on a number of factors, including location of the fracture, stabilization of fragments, and neurological damage.[2,22]

Beyond the risk of shoulder injuries from contact, the quarterback position is also at risk for injuries secondary to the throwing motion itself.[4,11,14] Athletes in other sports with large overhead-throwing, demands, such as baseball, have been shown to be at risk for overuse injuries.[21] Although football quarterbacks do have elevated overhead-throwing demands, Kelly et al[14] discovered that less than 15% of shoulder injuries in professional quarterbacks were related to chronic overuse from a throwing motion and that a majority were contact related. This can be explained by the differences in biomechanical stress applied on the shoulder as compared with baseball. A study by Fleisig et al[10] noted that baseball pitchers have increased elbow extension and shoulder internal rotation, greater compressive force at the elbow and shoulder, and faster rotational velocity. It was previously postulated that shoulder injury patterns in younger quarterbacks may be different from those in NFL quarterbacks because of inferior muscle strength or altered throwing mechanics.[14] This study found that collegiate quarterbacks were at no increased risk for chronic overuse injuries to the shoulder. The majority of injuries were contact related (88.7%, n = 118), and only 6.8% (n = 9) were related to a chronic injury from overhead throwing defined as shoulder impingement, biceps tendinitis, superior labrum from anterior to posterior (SLAP) lesions, and shoulder neuromas. Further research is indicated in high school and youth quarterbacks.

Prevention

The study findings indicate that the majority of shoulder injuries in quarterbacks occurred during contact (88.7%, n = 118), specifically while being tackled (59.4%, n = 79). Other studies have indicated that quarterbacks most commonly sustain injuries during competition.[3,8,12,14] Although

TABLE 4
Most Common Shoulder Injuries

Injury Type	Percentage of Total Injuries	Contact Mechanism of Injury, %	Time Loss/Outcome, %
Acromioclavicular sprain (partial or complete)	45.1	96.7	0-6 d: 40; 7-13 d: 25; 14-29 d: 20; >29 d: 5
Shoulder contusion	9.0	100.0	0-6 d: 83.3; 7-13 d: 8.3; 14-29 d: 0; >29 d: 0
Clavicular fracture	7.5	100.0	0-6 d: 0; 7-13 d: 0; 14-29 d: 0; >29 d: 40 (all reported)

this may not be feasible, these results suggest that the most effective way to prevent quarterback injuries is to prevent contact exposures in competition. Further, increased padding around the shoulder girdle, inhibiting the quarterback from being tackled in an open field, and sliding when out of the pocket may also be preventative measures.

Alternative methods for preventing quarterback shoulder injuries include preseason shoulder testing to identify at-risk athletes. A study by Pontillo et al[20] found that a battery of strength, fatigue, and functional testing (the closed kinetic chain upper extremity stability test [CKCU-EST]) may be predictive in identifying players in the preseason who are at an increased risk for shoulder injuries. That study showed that athletes who had lower CKCU-EST scores were at an increased risk for in-season injuries.[20] Implementing strategies that identify at-risk quarterbacks and working to resolve shoulder vulnerabilities may result in positive outcomes.[16,20] However, it should be noted that rehabilitation programs may be more likely to prevent gradual-onset injuries than acute traumatic injuries. Further research is indicated.

Limitations

There were some potential limitations to this study. All injuries may not have been reported because this was a convenience sampling and certain schools may have entered more data than others; however, a study by Kucera et al[17] found that 88.3% of all time-loss injuries were recorded in the NCAA ISP for soccer athletes, ensuring data capture by ATs and physicians. While not entirely transferable to football because of the sheer increase in players, as well as the relative increase in injury rates, in football compared with soccer, we believe that it gives a good indication as to the database's accuracy. Further, rates of injuries are most likely higher than reported because of the inclusion of quarterbacks in the exposure set, who may have had minimal playing time in practice and/or competitions. Also, the amount of contact that quarterbacks see in practice situations is unknown but is felt to be limited.

Other limitations include that we did not confirm the injury diagnoses and that in the data analysis, the slight difference in data collection from the 2004-2009 and 2009-2014 data sets may have affected results. Further, the calculation of quarterbacks per roster using a sampling of teams and averages could have altered data. Additionally, the small sample size of the database compared with the entirety of NCAA football as well as its inability to capture off-season injuries are inherent limitations of the database.

Further research is indicated to understand factors associated with quarterback injuries, such as style of the quarterback (running vs pocket passer, etc), predisposing risk factors, and the impact of surgery on long-term outcomes and recurrence.

CONCLUSION

NCAA ISP data analysis suggests that collegiate quarterbacks most commonly sustain acute contact injuries while being tackled, which typically result in nonsurgical treatment and a time loss of less than 2 weeks. These players further sustained roughly 1 shoulder injury per 1222 athlete exposures, with the most common injuries being an AC sprain (45%), shoulder contusion (9%), clavicular fracture (7%), and anterior instability (5%).

ACKNOWLEDGMENT

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