Elbow Injuries in National Collegiate Athletic Association Football Players

An Epidemiological Study Spanning 5 Academic Years

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Background: National Collegiate Athletic Association (NCAA) football players are at a high risk of injuries. Elbow injuries are uncommon, but there are insufficient data specifically on elbow injuries sustained in NCAA football players.

Purpose: To define the epidemiology of elbow injuries in NCAA football players during the 2009-2010 to 2013-2014 seasons using data from the NCAA Injury Surveillance Program (NCAA-ISP).

Study Design: Descriptive epidemiology study.

Methods: Using the NCAA-ISP database, a convenience sample of NCAA football athletes was reviewed to determine the types, rates, and trends in elbow injuries. Several factors were examined, including the diagnosis, injury setting, time lost from sport, surgical necessity, and injury recurrence. Raw injury data were obtained as well as weighted totals from the NCAA-ISP to generate national estimates and adjust for underreporting. Injury rates were calculated by dividing the number of injuries by the total number of athlete-exposures (AEs). The rate ratios of injuries during competition versus practice were compared, as were the rate ratios of preseason, regular-season, and postseason injuries by type.

Results: We identified 4874 total elbow injuries from the 2009-2010 to 2013-2014 seasons. The rate of injuries overall was 1.892 per 10,000 AEs. The rate for competition was 9.053 per 10,000 AEs and 1.121 per 10,000 AEs for practice. The rate ratio between competition and practice was 8.08 (95% CI, 6.04-10.80). Injury rates for the preseason, regular season, and postseason were 1.851, 1.936, and 1.406 per 10,000 AEs, respectively. Acute elbow instability was the most common injury type (65.43%). The most common mechanism was a contact injury (86.77%); 96.82% of injuries did not require surgery, and most elbow injuries required less than 24 hours of participation restriction (67.33%).

Conclusion: Although elbow injuries in NCAA football players are uncommon, it is important to recognize and treat these injuries appropriately. Dislocations and ulnar collateral ligament injuries caused athletes to miss extended periods of play. Fortunately, a majority of injuries resulted in less than 24 hours of participation restriction. Particular attention should be given to preventing elbow injuries, especially ulnar collateral ligament strains, hyperextension injuries, and acute instability.

Keywords: NCAA; elbow; epidemiology; football; athlete; sports

Over 73,000 athletes participate in National Collegiate Athletic Association (NCAA) football,[11] and the fast-paced, heavy-contact nature of the sport leads to very high injury rates. Elbow injuries, although uncommon, remain a significant source of morbidity for athletes.[13] The elbow is a complex modified hinge joint composed of the ulnohumeral, radiocapitellar, and radioulnar joints covered by a capsule.[20] Stability is a key component of proper elbow function. The primary static stabilizers to varus and valgus stress are the lateral collateral ligament and medial collateral ligament, respectively.[20] Dynamic stability is imparted predominantly by 4 muscle groups crossing the joint, including the elbow flexors and extensors and the wrist flexors and extensors.[12]

Elbow injuries have previously been reported to cause significant loss of playing time. A 10-year review of all documented upper extremity injuries in the National Football League (NFL) (1996-2005) found 859 injuries, 58% of which

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involved the elbow. These injuries led to an average of 22 days lost from sport.[1]

There is a paucity of detailed data on elbow injuries in NCAA athletes, particularly in football players. Many studies have investigated injuries at the high school level and in the NFL, but information specific to elbow injuries in the collegiate athlete is scarce in the literature.[4-7,10,13,23] The purpose of our study was to define the epidemiology of elbow injuries in NCAA football players during the 2009-2010 to 2013-2014 seasons using data from the NCAA Injury Surveillance Program (NCAA-ISP) database. Our goal was to present injury rates for elbow injuries in NCAA football players, define risk factors, and determine trends, including the specific diagnosis, setting of injury, time lost from sport, need for surgery, and injury recurrence.

METHODS

Institutional review board exemption status was obtained as well as approval to use data from the NCAA-ISP database for this study. The NCAA-ISP was developed in 1982 to provide injury data and trends in all collegiate athletics. Kerr et al[14] detailed the methods of the NCAA-ISP database collection well, and details of the data collection are outlined below. We reviewed information from the 2009-2010 to 2013-2014 academic seasons.

Data Collection

The NCAA-ISP collects a sample of data voluntarily from any NCAA institution that wishes to participate. Twenty-five teams participated in this data set, roughly 4% of all eligible teams. This is deemed a convenience sample, which is then used to extrapolate data to the entire NCAA student-athlete population. Athletic trainers (ATs) input the data, including but not limited to injury type, location, mechanism, setting, and participation restriction. Information was recorded on a daily basis and could be updated throughout the season. Data were processed through the NCAA-ISP's automated verification system, checking for consistency and outliers before placement in the cumulative data set.

Data for the study were obtained from the Datalys Center, the organization responsible for distribution of the NCAA-ISP data. We focused on the data over the 5 seasons from 2009-2010 to 2013-2014 to remain current with updated injury trends. Specific data were obtained utilizing the sport code "men's football" and an injury location of "elbow" to filter our results.

Definitions

Injury. Reportable injuries included injuries that "(1) occurred as a result of participation in an organized intercollegiate practice or competition, and (2) required attention from an AT or physician."[14] Injuries in this data set were reported regardless of the time lost from play, unlike in prior data sets.[14] Athletic training and medical team expertise were utilized to collect data in an accurate manner.

Injury Mechanism. The mechanism was the manner in which the student-athlete sustained his or her injury. In the NCAA-ISP, ATs chose from a set list of options including player contact, surface contact, equipment contact, contact with an out-of-bounds object, noncontact, overuse, illness, infection, and other/unknown. All contact events were condensed under the title "contact." Missing, unknown, or unreported data were indicated as "missing."

Athlete-Exposure. An athlete-exposure (AE) was defined as "1 student-athlete participating in 1 NCAA-sanctioned practice or competition in which he or she was exposed to the possibility of athletic injury, regardless of the time associated with that participation."[14]

Season of Play. Season of play was defined as the time of the season during which the injury took place. These were categorized as either preseason, regular season, or postseason.

Event Type. The event type was the event where the injury took place: practice or competition.

Injury Recurrence. Recurrence was defined as the repetition of the same injury that occurred previously in the student-athlete's career.

Participation Restriction. Participation restriction was the number of days that participation was restricted (the difference between the date of return and the date of injury). Injuries resulting in participation restriction less than 24 hours were also included. Severe injuries were defined as injuries resulting in participation restriction over 3 weeks, the student-athlete choosing to prematurely end his or her season (for medical or nonmedical reasons associated with the injury), or a medical professional having the student-athlete prematurely end his or her season.

Raw data contained the following categories of injury: acute instability with dislocation/subluxation, elbow dislocation, elbow hyperextension, elbow contusion, elbow impingement, elbow infection, elbow laceration, elbow osteochondritis dissecans, elbow subluxation, elbow tendinitis, lateral epicondylitis, medial epicondylitis, olecranon bursitis, ulnar collateral ligament (UCL) strain, and ulnar nerve subluxation. We combined acute instability with dislocation/subluxation, elbow dislocation, elbow

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TABLE 1
Elbow Injury Rates[a]

	Nonweighted Injuries, n	Weighted Injuries, n	Weighted Exposures, n	Injury Rate/10,000 AEs
Instability	124	3189.53	25,767,730.90	1.238
Elbow impingement	2	50.60	25,767,730.90	0.020
Elbow infection	3	63.20	25,767,730.90	0.025
Elbow laceration	2	47.31	25,767,730.90	0.018
Elbow osteochondritis dissecans	1	21.28	25,767,730.90	0.008
Tendinitis	4	91.96	25,767,730.90	0.036
Olecranon bursitis	10	270.54	25,767,730.90	0.105
Ulnar collateral ligament strain	36	1081.66	25,767,730.90	0.420
Ulnar nerve subluxation	2	58.47	25,767,730.90	0.023
Total	184	4874.55	25,767,730.90	1.892

[a]AE, athlete-exposure.

hyperextension, and elbow subluxation into a single category labeled "instability." This was in an effort to reduce errors in reporting similar injuries under different categories that overlapped significantly. We also combined elbow tendinitis, lateral epicondylitis, and medial epicondylitis into "elbow tendinitis" to simplify the results, given the similarity of symptoms and overlap of the presentation and cause.

Computing National Estimates

Poststratification sample weights based on sport, division, and academic year were applied to each reported injury and AE. These were utilized to calculate national estimates of the number of elbow injuries. Poststratification sample weights were calculated with the following formula:

$$sample\ weight_{abc} = \left(\frac{number\ of\ teams\ participating\ in\ ISP_{abc}}{number\ of\ teams\ in\ NCAA_{abc}}\right)^{-1}.$$

where $weight_{abc}$ is the weight for the ath sport of the bth division in the cth year. Weights for all data were corrected for underreporting to account for an estimated 88.3% capture rate of all time-loss medical care injury events with the NCAA-ISP previously reported in the literature.[14]

Statistical Analysis

The NCAA-ISP uses sample weights to extrapolate data from the convenience sample to the entire NCAA student-athlete population. These weights allowed us to make inferences regarding athletes' exposure to injuries on a larger scale. Injury rates were calculated per 10,000 AEs. In addition to injury rates, rate ratios were calculated by dividing the injuries in competition by the injuries in practice. An example is as follows:

$$\frac{\left(\frac{\sum competition\ elbow\ injuries}{\sum competition\ athlete\text{-}exposures}\right)}{\left(\frac{\sum practice\ elbow\ injuries}{\sum practice\ athlete\text{-}exposures}\right)}.$$

An increased risk of a particular injury in competition versus practice, or vice versa, was analyzed using rate ratios. Also, 95% CIs were calculated, assuming normally distributed data for elbow injuries by event type and by season, and unweighted numbers were used for statistical accuracy. Additional descriptive data were evaluated including injury mechanism, injury by position, playing surface, and time loss. Data were analyzed using SPSS (IBM) and Excel (Microsoft).

RESULTS

Injury Rates and Frequencies

Over the course of our 5-year study, 184 elbow injuries were recorded, yielding a weighted estimate of 4874.55 total elbow injuries. The total weighted estimate of AEs during this time period was approximately 25,767,731, producing an injury rate of 1.892 per 10,000 AEs (Table 1). Overall, acute elbow instability was the most common injury type (65.43%), followed by UCL strain (22.20%) and olecranon bursitis (5.56%).

Event Type

Table 2 demonstrates elbow injury rates by event type (competition vs practice). The overall injury rate was 9.053 per 10,000 AEs in competition and 1.121 per 10,000 AEs in practice. The rate ratio between competition and practice was 8.08 (95% CI, 6.04-10.80).

Season of Play

Tables 3 and 4 demonstrate that 3265 injuries occurred in the regular season, compared with 1475 in the preseason and 131 in the postseason, based on weighted estimates. Injury rates for the preseason, regular season, and postseason were 1.851, 1.936, and 1.406 per 10,000 AEs, respectively. Figure 1 shows that the rate ratios for elbow injuries are as follows: postseason/preseason was 0.76 (95% CI, 0.33-1.76), postseason/regular season was 0.73 (95% CI, 0.31-1.64), and preseason/regular season was 0.96 (95% CI, 0.70-1.31).

Injury Mechanism

Contact elbow injuries were the most common mechanism, comprising 86.77% of all injuries, while only

TABLE 2
Elbow Injury Rate Ratios by Event Type[a]

	Weighted Competition Injuries, n	Weighted Practice Injuries, n	Total, n	Competition Exposures, n	Practice Exposures, n	Competition Injury Rate/ 10,000 AEs	Practice Injury Rate/10,000 AEs	Competition/ Practice Rate Ratio	95% CI
Instability	1491	1698	3189	2,502,993	23,264,738	5.957	0.730	8.16	5.73-11.62
Elbow impingement	0	51	51	2,502,993	23,264,738	0.000	0.022	0.00	N/A
Elbow infection	0	63	63	2,502,993	23,264,738	0.000	0.027	0.00	N/A
Elbow laceration	28	19	47	2,502,993	23,264,738	0.112	0.008	13.70	0.86-219.00
Elbow osteochondritis dissecans	21	0	21	2,502,993	23,264,738	0.084	N/A	N/A	N/A
Tendinitis	0	92	92	2,502,993	23,264,738	0.000	0.040	0.00	N/A
Olecranon bursitis	190	81	271	2,502,993	23,264,738	0.759	0.035	21.80	6.15-77.26
Ulnar collateral ligament strain	536	546	1082	2,502,993	23,264,738	2.141	0.235	9.12	4.74-17.55
Ulnar nerve subluxation	0	58	58	2,502,993	23,264,738	0.000	0.025	0.00	N/A
Total	2266	2608	4874	2,502,993	23,264,738	9.053	1.121	8.08	6.04-10.80

[a]AE, athlete-exposure; N/A, not applicable.

TABLE 3
Distribution of Elbow Injuries by Season of Play[a]

	Postseason	Preseason	Regular Season	Total
Instability	38	973	2177	3189
Elbow impingement	0	28	22	51
Elbow infection	0	44	19	63
Elbow laceration	0	19	28	47
Elbow osteochondritis dissecans	0	0	21	21
Tendinitis	0	43	49	92
Olecranon bursitis	19	61	190	271
Ulnar collateral ligament strain	74	307	701	1082
Ulnar nerve subluxation	0	0	58	58
Total	131	1475	3265	4874

[a]Data are shown as No.

5.85% were noncontact injuries. The remaining 3.04% were divided between infections and overuse injuries. Among contact injuries, acute elbow instability with dislocation/subluxation was most common (36.27%), followed by elbow hyperextension (26.58%). There was 4.29% of injury mechanisms of unknown cause (Table 5).

Injury Recurrence

Nearly all injuries were new onset (96.25%), with the remainder of injuries recorded as recurrent (3.71%). The only injury type with a higher recurrence rate than the new injury rate was elbow impingement (54.90% recurrent) (Table 6).

Surgery

A total of 1.64% of all elbow injuries that required surgery. Injuries necessitating surgical correction are listed in Table 7.

Participation Restriction

Regarding participation restriction, 67.33% of elbow injuries resulted in less than 24 hours of time lost from participation (Table 8): 19.32% of elbow injuries caused 1 to 6 days of time lost from participation, 7.23% lost 7 to 21 days, and only 6.11% lost more than 21 days. Notably, 423 cases were missing from the data set (8.68%). Of those injuries that led to restriction from participation for longer than 21 days, most were either elbow dislocations (37.87%) or hyperextension injuries (34.93%). In any participation restriction scenario of less than 3 weeks, acute elbow instability with dislocation/subluxation was the most common injury (38.74%). If an elbow dislocation occurred, the minimum time lost from participation was 3 weeks.

Injury by Position

Figure 2 breaks down injuries by position. Defensive linemen had the highest rates of elbow injuries, comprising 31.05% of the total injuries. Overall, acute elbow instability with dislocation/subluxation was the most common type among a majority of position players. In contrast, quarterbacks most commonly experienced elbow tendinitis (26.67%), and running backs had a high incidence of UCL strains (34.33%).

TABLE 4
Rates of Elbow Injuries by Season of Play[a]

	Postseason Exposures, n	Preseason Exposures, n	Regular-Season Exposures, n	Postseason Injury Rate/10,000 AEs	Preseason Injury Rate/10,000 AEs	Regular-Season Injury Rate/10,000 AEs
Instability	931,960	7,969,763	16,866,008	0.408	1.221	1.291
Elbow impingement	931,960	7,969,763	16,866,008	N/A	0.035	0.013
Elbow infection	931,960	7,969,763	16,866,008	N/A	0.055	0.011
Elbow laceration	931,960	7,969,763	16,866,008	N/A	0.024	0.017
Elbow osteochondritis dissecans	931,960	7,969,763	16,866,008	N/A	N/A	0.012
Tendinitis	931,960	7,969,763	16,866,008	N/A	0.054	0.029
Olecranon bursitis	931,960	7,969,763	16,866,008	0.204	0.077	0.113
Ulnar collateral ligament strain	931,960	7,969,763	16,866,008	0.794	0.385	0.416
Ulnar nerve subluxation	931,960	7,969,763	16,866,008	N/A	N/A	0.034
Total	931,960	7,969,763	16,866,008	1.406	1.851	1.936

[a]AE, athlete-exposure; N/A, not applicable.

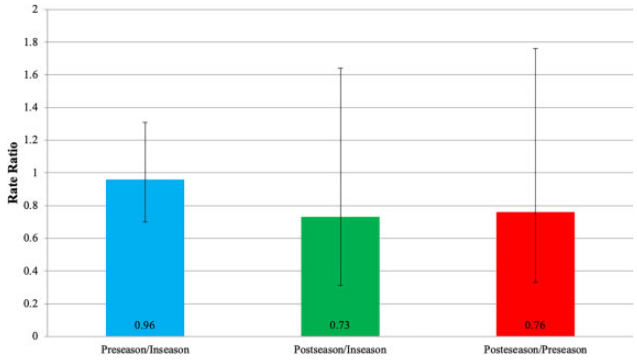

Figure 1. Rate ratios of elbow injuries by season of play. Error bars indicate 95% CIs.

Injury Surface

Overall, injuries occurred at similar rates on turf (53.14%) compared with natural grass (45.69%). UCL strains occurred at nearly twice the rate on turf versus natural grass, with 708 injuries on turf compared to 373 on natural grass. There were more than twice as many elbow infections on turf than natural grass (44 vs 19, respectively), while a majority of the other injury types had similar injury rates on both surfaces (Table 9).

DISCUSSION

American football is a physical sport with a rate of injuries reported as high as 50% of all players during a season.[21] In a 2015 study by Kerr et al,[15] NCAA football had the fourth highest injury rate overall (9.2/1000 AEs), only behind men's wrestling (13.1/1000 AEs), women's gymnastics (10.4/1000 AEs), and men's ice hockey (9.5/1000 AEs). The sport provides a blend of high-intensity upper body and lower body exertion that leads to high rates of injuries throughout several major body areas. Different positions lend themselves to varying injury patterns. For example, quarterbacks may be at an increased risk of upper body injuries due to throwing compared with running backs who make quick cuts down the field and avoid tacklers and may be more prone to lower body injuries. The full-contact nature of football likely increases injury rates, despite the use of protective pads and helmets.

In our review of the NCAA-ISP from 2009-2010 to 2013-2014, we illustrated several key findings: (1) acute instability was the most common elbow injury, followed by UCL strain and olecranon bursitis; (2) elbow injuries occurred at a rate of 1.892 per 10,000 AEs; (3) competition injury rates were significantly higher, with an 8.08 rate ratio of elbow injuries in competition versus practice; (4) a vast majority of elbow injuries occurred during direct contact with another player (86.77%); (5) linemen were by far the most commonly injured players, especially defensive linemen; and (6) most injuries (67.33%, n = 2997) resulted in less than 24 hours of time lost from participation, and only 1.64% of elbow injuries required surgery.

Instability and Ligamentous Injuries

The most common mechanism of an elbow dislocation is a fall on an outstretched hand, with the arm in abduction and the elbow in extension. In young patients, high-energy mechanisms such as motor vehicle accidents and sport injuries account for the majority of elbow dislocations. Dislocations of the elbow make up 10% to 25% of all elbow injuries in adults. It is the second most commonly dislocated large joint (shoulder dislocations are first).[3] One retrospective study[22] looking at injuries in the National Electronic Injury Surveillance System (NEISS) estimated 36,751 acute elbow dislocations in the United States from 2002 to 2006. The overall incidence was reported as 5.21 dislocations per 100,000 person-years; 43.5% of injuries were in people 10 to 19 years old, and 44.5% of dislocations in patients older than 10 years were sustained during sports. For male patients, the most common sports for dislocated elbows were football, wrestling, and basketball.[22] Another study

TABLE 5
Distribution of Elbow Injuries by Injury Mechanism[a]

	Contact	Infection	No Apparent Contact	Overuse/Gradual	Unknown	Total
Instability	2930	0	133	19	107	3189
Elbow impingement	0	0	22	0	28	51
Elbow infection	0	44	19	0	0	63
Elbow laceration	47	0	0	0	0	47
Elbow osteochondritis dissecans	21	0	0	0	0	21
Tendinitis	0	0	28	64	0	92
Olecranon bursitis	270	0	0	0	0	271
Ulnar collateral ligament strain	961	0	46	0	74	1082
Ulnar nerve subluxation	0	0	37	21	0	58
Total	4229	44	285	104	209	4874

[a]Data are shown as No.

TABLE 6
Distribution of Elbow Injuries by Recurrence[a]

	New Injury	Recurrent Injury	Total
Instability	3134	56	3189
Elbow impingement	22	28	51
Elbow infection	63	0	63
Elbow laceration	47	0	47
Elbow osteochondritis dissecans	21	0	21
Tendinitis	92	0	92
Olecranon bursitis	248	22	271
Ulnar collateral ligament strain	1006	75	1082
Ulnar nerve subluxation	58	0	58
Total	4691	181	4874

[a]Data are shown as No.

TABLE 7
Distribution of Elbow Injuries by Surgical Necessity[a]

	No Surgery	Unknown	Surgery	Total
Instability	3146	0	43	3189
Elbow impingement	51	0	0	51
Elbow infection	63	0	0	63
Elbow laceration	47	0	0	47
Elbow osteochondritis dissecans	21	0	0	21
Tendinitis	92	0	0	92
Olecranon bursitis	271	0	0	271
Ulnar collateral ligament strain	1007	74	0	1082
Ulnar nerve subluxation	21	0	37	58
Total	4719	74	80	4874

[a]Data are shown as No.

TABLE 8
Participation Restriction in Elbow Injuries[a]

	<24 h	1-6 d	7-21 d	>21 d	Total
Instability	2130	495	153	226	3004
Elbow impingement	51	0	0	0	51
Elbow infection	22	21	19	0	62
Elbow laceration	28	19	0	0	47
Elbow osteochondritis dissecans	0	21	0	0	21
Tendinitis	92	0	0	0	92
Olecranon bursitis	251	0	0	0	251
Ulnar collateral ligament strain	402	304	150	46	902
Ulnar nerve subluxation	21	0	0	0	21
Total	2997	860	322	272	4451
Percentage total	67.33	19.32	7.23	6.11	100.00

[a]Data are shown as No. unless otherwise indicated. There were 423 cases missing from the data set.

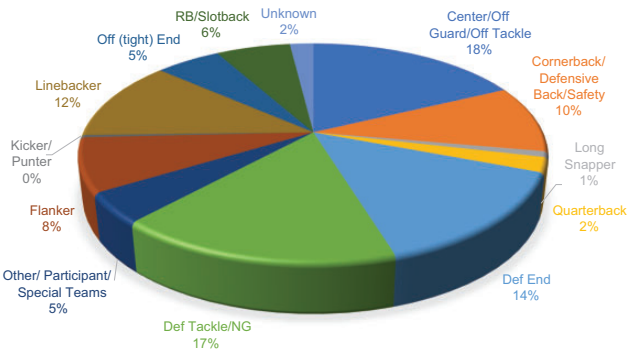

Figure 2. Distribution of elbow injuries by position. Def, defensive; NG, nose guard; RB, running back.

looking at elbow dislocations in the NFL from 2000 to 2011 found 62 elbow dislocations of 35,324 total injuries (0.2%).[2] The study found that 64.5% of the dislocations occurred in defensive players and that 53.2% of injuries were sustained as a result of tackling. Furthermore, 6.5% of the elbow dislocations required surgical treatment, and 75.8% of players

TABLE 9
Distribution of Elbow Injuries by Field Surface[a]

	Field Turf	Natural Grass	Unknown	Total
Instability	1529	1661	0	3189
Elbow impingement	28	22	0	51
Elbow infection	44	19	0	63
Elbow laceration	28	19	0	47
Elbow osteochondritis dissecans	0	21	0	21
Tendinitis	43	49	0	92
Olecranon bursitis	173	42	55	271
Ulnar collateral ligament strain	708	373	0	1082
Ulnar nerve subluxation	37	21	0	58
Total	2590	2227	55	4874

[a]Data are shown as No.

were able to return to sport during the same season as their injury.[2]

Overall, our results were similar to those in the study of NFL players by Chang et al.[2] In our study, elbow dislocations were lumped with elbow subluxations and acute elbow instability to create more homogeneous data. Our results showed that defensive linemen were most likely to suffer from elbow instability. In addition, we recorded an even higher rate than Chang et al of 1.46% of all players with elbow instability. Our data set extrapolated from previous data not present in the literature, and we determined that acute elbow instability was by far the most common type of elbow injury in NCAA football players (65.43%).

Similarly, in a 10-year retrospective study of all upper extremity injuries in the NFL, ligamentous and joint instability injuries were the most common injury diagnoses in the elbow.[1] These represented 51% of all injuries involving the elbow. The second most common injury mechanism to the elbow was hyperextension.[1] This instability injury rate is less than what our data set unveiled; however, the difference could once again be caused by 2 different study populations (NCAA athletes vs NFL athletes). Regardless, it is important to note that these were once again most common in the elbow.

It seems plausible that instability is the most common elbow injury type simply by examining the major strategies in football. Most injuries occur from tackling and contact, often with several players converging at once. These players are not only trying to tackle a player but also trying to strip the football loose and are typically fighting off one another with stiff arms. It is plausible that the impact of hitting another player or the torque of someone trying to pry a football loose from an arm could cause instability, a dislocation, a subluxation, or a ligamentous tear.

Setting

The setting in which football injuries occur has been documented previously, but there is sparse literature focusing on elbow injuries specifically.[16] In our study, we found that the rate ratio of injuries in competition compared with practice was 8.08 (95% CI, 6.04-10.80), meaning that players were over 8 times more likely to be injured in a game than in a practice event. However, there was a minimal difference in injury rates in the preseason compared with the regular season and postseason. The regular-season injury rate was highest at 1.936 per 10,000 AEs, compared with 1.851 in the preseason and 1.406 in the postseason. The rate ratios comparing these rates were not statistically significant (Figure 1). Although the absolute rate of injuries in the preseason and regular season was not drastically different, the overall higher rate of injuries in these 2 settings versus the postseason was notable. It is possible that injury rates earlier in the year could be elevated because of players' inadequate conditioning or increased effort and determination to make the team. The postseason injury rate decline may be caused by a combination of improved conditioning throughout the season as well as player awareness of the importance of the postseason and injury avoidance.

Interestingly, there was not a significant difference in injuries on turf compared with natural grass (53.14% vs 45.69%, respectively). Prior literature has examined turf versus grass conditions. One study in American football players suggested no difference in injury rates,[19] whereas a large study on soccer players demonstrated a higher rate of upper extremity injuries on turf compared with grass.[8] Although overall rates between the 2 surfaces were similar in our study, it is notable that there was also a higher overall elbow infection rate and olecranon bursitis rate on turf compared with grass. Perhaps natural grass is more forgiving to the soft tissues with contact compared with artificial turf. Turf may be more abrasive and less compressible; therefore, contact with the ground may make players more prone to injuries, but this is just a speculation.

Player Position

Our study clearly demonstrated the distribution of elbow injuries by position, shown in Figure 2. One of the most significant findings was that linemen accounted for approximately 50% of all elbow injuries, with defensive linemen accounting for about one-third of the injury total. A vast majority of their injuries were instability related, likely because of the amount of torque and force through the elbow, as they are constantly using their upper bodies. As defensive linemen use their hands to fight off offensive linemen, their arms are at an increased risk for injuries. During these events, a significant amount of force is transmitted through the elbow, possibly leading to an increased risk of instability-type injuries.

Time Lost From Participation

There is limited information in the literature specific to elbow injuries in NCAA athletes. A study by Goodman et al[9] determined that among players with elbow dislocations or subluxations, 0% returned to play within 1 week, and 68.7% were not playing for more than 2 weeks. In contrast, our study found that 67.33% of players with an elbow instability injury had less than 24 hours of time lost from

play. Differences may be caused by our grouping all of the instability injuries into 1 category, whereas their study looked at dislocations and subluxations individually. Furthermore, Carlisle et al[1] described an average of 22 days lost from participation because of elbow injuries in NFL players. This is a stark difference from our data. One of the major reasons for this difference could be that the NFL study defined elbow injuries based on players missing 1 practice event or game. This would likely eliminate injuries with as less than 24 hours of time lost and could account for this large discrepancy. In addition, Goodman et al found that 95.2% of elbow instability injuries were managed nonoperatively, which correlates with our rate of nonoperative management (96.82%).

Limitations

Our study has several limitations. First, our data were from a convenience sample from the NCAA-ISP, which by definition extrapolates a smaller pool of data to estimate the larger NCAA football population. These data are therefore subject to inaccurate estimations by either overestimating or underestimating injury rates because a large portion of schools was not sampled. Another challenge with the data source is that information is not verified by a physician. Injury information is entered by the AT and is not necessarily verified by any other source. This leaves the data subject to human error from diagnostic inaccuracies and/or data entry errors. In addition, there is the potential for errors in diagnosis, specifically with regard to "elbow instability." A subluxation episode that did not present as a frank dislocation would be a challenging diagnosis, and errors could occur in this regard. We attempted to counter some of these potential errors by combining injury groups that had significant overlap, such as all elbow tendinopathies and all instability injuries, including dislocations, subluxations, and ligamentous injuries causing acute instability. However, treatments may vary with these injuries, and combining these data can potentially skew the results toward a more conservative treatment route, given the larger number of less significant injuries in the data set versus gross dislocations. Despite some of these limitations, the NCAA-ISP has been utilized and validated in other sports, and we firmly believe that the data are a good representation of the NCAA athlete population.[17]

CONCLUSION

Elbow injuries are a significant source of morbidity in NCAA football players and occurred at a rate of 1.892 per 10,000 AEs. Previous studies have demonstrated that elbow injuries can be challenging problems for NCAA athletes in many sports.[13,18] Our study demonstrates that most injuries resulted in less than 24 hours of time lost from play; however, some injuries, including dislocations and UCL injuries, caused athletes to miss extended periods. We hope that this epidemiological study will provide team physicians with valuable information to better understand elbow injuries in NCAA football players.

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