

Acromioclavicular Joint Injuries in the National Football League

Epidemiology and Management

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Background: Previous studies investigating acromioclavicular (AC) joint injuries in professional American football players have only been reported on quarterbacks during the 1980s and 1990s. These injuries have not been evaluated across all position players in the National Football League (NFL).

Purpose: The purpose of this study was 4-fold: (1) to determine the incidence of AC joint injuries among all NFL position players; (2) to investigate whether player position, competition setting, type of play, and playing surface put an athlete at an increased risk for this type of injury; (3) to determine the incidence of operative and nonoperative management of these injuries; and (4) to compare the time missed for injuries treated nonoperatively to the time missed for injuries requiring surgical intervention.

Study Design: Descriptive epidemiological study.

Methods: All documented injuries of the AC joint were retrospectively analyzed using the NFL Injury Surveillance System (NFLISS) over a 12-season period from 2000 through 2011. The data were analyzed by the anatomic location, player position, field conditions, type of play, requirement of surgical management, days missed per injury, and injury incidence.

Results: Over 12 NFL seasons, there were a total of 2486 shoulder injuries, with 727 (29.2%) of these injuries involving the AC joint. The overall rate of AC joint injuries in these athletes was 26.1 injuries per 10,000 athlete exposures, with the majority of these injuries occurring during game activity on natural grass surfaces (incidence density ratio, 0.79) and most often during passing plays. These injuries occurred most frequently in defensive backs, wide receivers, and special teams players; however, the incidence of these injuries was greatest in quarterbacks (20.9 injuries per 100 players), followed by special teams players (20.7/100) and wide receivers (16.5/100). Overall, these athletes lost a mean of 9.8 days per injury, with quarterbacks losing the most time to injury (mean, 17.3 days). The majority of these injuries were low-grade AC joint sprains that were treated with nonoperative measures; only 13 (1.7%) required surgical management. Players who underwent surgical management lost a mean of 56.2 days.

Conclusion: Shoulder injuries, particularly those of the AC joint, occur frequently in the NFL. These injuries can result in time lost but rarely require operative management. Quarterbacks had the highest incidence of injury; however, this incidence is lower than in previous investigations that evaluated these injuries during the 1980s and 1990s.

Keywords: National Football League (NFL); professional football; football (American); shoulder; AC joint; shoulder separations

In the sport of American football, shoulder injuries account for 10% to 20% of all musculoskeletal injuries and are only less common than injuries of the hand, ankle, and

knee.^{1-3,5,6,9,12,13,16} Acromioclavicular (AC) joint injuries commonly occur in contact sports via a direct blow to the shoulder or indirectly when the player is hit or tackled and lands on the affected shoulder. Kaplan et al⁸ found that AC joint injuries accounted for 41% of all shoulder injuries in a cohort of intercollegiate football players. The AC joint is a diarthrodial joint stabilized by the AC and coracoclavicular ligaments. The superior and posterior AC ligaments prevent motion in the anteroposterior plane, while the more robust coracoclavicular ligaments provide static checkreins in the vertical plane. Despite the frequency of shoulder injuries, few studies have reported the incidence and treatment of these injuries in high-level football players.^{4,8,10,15}

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In one of the first epidemiological investigations of shoulder injuries in the National Football League (NFL), Kelly et al¹⁰ found that AC joint injuries were the most common shoulder injuries and accounted for 40% of all shoulder injuries sustained by quarterbacks over a 22-season period (1980-2001). Because of the nature of the position, quarterbacks were believed to be particularly prone to these injuries, with the majority of injuries occurring during game competition rather than in the practice setting. The most common mechanism of injury was from either being tackled onto the playing surface or colliding with another player. Utilizing the Rockwood classification system for AC joint injuries, Kelly et al reported that 44% of these injuries were type I injuries, 24% were type II, 20% were type III, and 12% were not specified.¹⁰ The mean time lost from play after an AC joint injury was 22 days with a median of 12.5 days.¹⁰ The majority of these injuries were treated without surgery.

The purpose of this study was 4-fold: (1) to determine the incidence of AC joint injuries among all NFL position players; (2) to investigate whether player position, competition setting, type of play, and playing surface were associated with an increased risk for this type of injury; (3) to determine the incidence of operative and nonoperative management of these injuries; and (4) to compare the time missed for those injuries treated nonoperatively versus the time missed for those injuries requiring surgical intervention.

MATERIALS AND METHODS

After approval by the NFL Physician's Society, a retrospective epidemiological review of all AC joint injuries between 2000 and 2011 (12 seasons) was performed using the NFL Injury Surveillance System (NFLISS). This database was established in 1980 and includes data such as the date of injury and return to play, type of injury, type of field surface, and type of injury management. These data were collected and managed by Outcome Sciences Inc (Cambridge, Massachusetts). The NFL records all injuries through the NFLISS, with an injury being documented if (1) it resulted in the player being removed from practice or a game or (2) if it caused a loss of at least 1 practice, game, or training session. Injuries that met inclusion for this study were the following: distal clavicle contusions, AC joint sprains/separations, and AC joint inflammation.

The AC joint separations were classified by the team physician based on the Rockwood classification scheme (see Appendix 1, available in the online version of this article at <http://ajsm.sagepub.com/supplemental>). We evaluated each injury for player position, playing conditions (game vs practice, grass vs artificial surface), type of play (passing play vs running play), type of management, and total days lost due to the injury. Data were available for whether the patient had nonoperative or surgical treatment of the injury; however, specific details on the type of surgery or surgical findings were not documented. For those athletes treated without surgery, the database did not give specific information about what

measures were utilized (eg, corticosteroid or local anesthetic injections).

Information regarding each injury was based on the primary clinical diagnosis made by the team physician. The trainer for each individual NFL team was responsible for collecting and submitting these data to the NFLISS. The collected information includes the diagnosis and evaluation of all injuries that occurred during preseason training camp, 4 preseason games, the regular 17-week regular season (16 games and 1 "bye week"), and postseason-related activities (practices, games, and scrimmages). Injuries were either listed as occurring during the preseason or regular season (which included the playoffs). Injuries that took place during off-season workouts were not collected by the database. There were no follow-up examinations available for this review. Additionally, data were analyzed for treatment and return to play for each injury. Finally, the mechanism of injury, type of play (running vs passing), and playing conditions (games vs practice, natural vs artificial surface) were documented.

It should be noted that the special teams' data required special analysis because the only players officially listed in this unit are punters, placekickers, and long snappers. The NFL rosters do not delineate players from other positions that might also be playing on the special teams' unit to get additional playing time. An analysis of NFL team rosters from 2000 to 2011 revealed that there were 202 punters, placekickers, and long snappers designated on official NFL team rosters. During any given special teams situation, there are 9 other athletes on the field with this unit. As a result, it was determined that 9 "special teams" players should be added to each of the NFL teams during these 12 seasons.

Categorical variables were compared with the χ^2 test. Positional exposure risk (PER) was calculated to correct the total injury count for the number of exposures (player-games) for a particular player position. Incidence density ratio (IDR) was also calculated to compare the rates of AC joint injuries during passing versus rush plays, game play compared with practice competition, and natural surface compared with artificial surface.⁷ A 95% confidence interval (CI) was calculated for each IDR. When the IDR value is >1 , the observed injury rate is greater during "exposed" events (passing plays, game play, or artificial surface); when the IDR value is <1 , the observed injury rate is greater during "unexposed" events (rush plays, practice competition, or natural surface). If the 95% CI for the IDR does not include 1, this reflects a statistically significant difference between the 2 observed injury rates. A *P* value of $<.05$ was considered significant.

RESULTS

Over 12 consecutive NFL seasons from 2000 to 2011, there were a total of 30,304 injuries reported to the NFLISS, with 2486 (8.2%) shoulder injuries. Of these shoulder injuries, 727 (29.2%) involved the AC joint during 278,758 athlete exposures. The overall rate of AC joint injuries in NFL

TABLE 1
Distribution of AC Joint Injuries, 2000-2011^a

Injury	Total AC Joint and Distal Clavicle Injuries
Clavicle AC sprain, unspecified	319
Clavicle AC sprain, type I	210
Clavicle AC sprain, type II	79
Clavicle AC contusion	66
Clavicle AC sprain, type III	40
Clavicle AC inflammation	9
Clavicle AC dislocation	3
Clavicle AC dislocation/recurrent	1

^aAC, acromioclavicular.

TABLE 2
AC Injuries by Player Position, 2000-2011^a

Position	Total (N = 727)
Defensive back	117
Wide receiver	114
Special teams player	99
Defensive lineman	82
Offensive lineman	80
Linebacker	69
Running back	67
Quarterback	57
Tight end	42

^aAC, acromioclavicular.

TABLE 3
Incidence of AC Injuries by Player Position, 2000-2011^a

Player Position	Incidence (per 100 Players)
Quarterback	20.9
Special teams player	20.7
Wide receiver	16.5
Tight end	12.1
Running back	11.5
Defensive back	11.0
Linebacker	9.8
Offensive lineman	9.4
Defensive lineman	8.7

^aAC, acromioclavicular.

TABLE 4
Positional Exposure Risk of AC Injuries by Player Position, 2000-2011^a

Player Position	Positional Exposure Risk (Injuries per 1000 Player-Games)
Special teams player	7.6
Quarterback	7.4
Wide receiver	4.1
Running back	2.7
Tight end	2.5
Defensive back	2.3
Linebacker	2.0
Offensive lineman	1.8
Defensive lineman	1.8

^aAC, acromioclavicular.

football players was 26.1 per 10,000 athlete exposures. The most common injuries were 319 unspecified AC joint sprains (43.9%), 210 type I AC joint sprains (28.9%), 79 type II AC joint sprains (10.9%), and 40 type III AC joint sprains (5.5%). Over the period of the study, no type IV, V, or VI injuries were reported (Table 1).

Of those players reported to have sustained an AC joint injury, 360 were offensive players, 268 were defensive players, and 99 were special teams players ($P < .001$ for all comparisons). The position players that most regularly sustained the largest number of AC joint injuries were the defensive backs (117 injuries, 16.1%), followed by wide receivers (114 injuries, 15.7%). The total number of AC joint injuries in defensive backs were significantly greater than the total number of injuries in quarterbacks ($P < .001$) (Table 2).

In terms of incidence, quarterbacks were most susceptible to an AC joint injury (20.9 injuries per 100 players), followed by special teams players (20.7/100) and wide receivers (16.5/100) ($P < .001$ for quarterbacks and special teams players vs other positions) (Table 3). The calculations for special teams players were performed while considering the total number of players on the field for special teams' play and not just the athletes who were only designated special teams players (punters, kickers, and long snappers), as discussed in the Materials and Methods section. With PER, special teams players had the highest risk of injury with 7.6 injuries per 1000

player-games. Quarterbacks had the next highest PER of 7.4 injuries per 1000 player-games (Table 4).

A review of the NFL data from 2000 to 2011 showed that there were 3952 games (7904 team games). Specifically, 4750 team games were played on grass (60.1%), and 3154 team games were played on an artificial surface (39.9%). Four hundred seventy-eight AC joint injuries occurred during plays on natural surfaces (64.7%) versus 249 AC joint injuries occurring during plays on artificial surfaces (33.8%) ($P < .001$). Eleven AC joint injuries occurred on unknown surfaces (1.5%). The IDR for injuries occurring on artificial surfaces was calculated to be 0.79 (95% CI, 0.67-0.92), indicating that the observed injury rate is greater on grass than on artificial surfaces ($P < .001$) (see Appendix 2, available online).

Finally, 602 AC joint injuries were sustained during game play (81.5%), while 125 injuries occurred during practice (18.5%) ($P < .001$). During game play over the 12-season study period, there were 259,666 passing plays (54.2%) and 219,634 rush plays (45.8%). Passing plays accounted for 199 AC joint injuries (33.1%), while running plays made up 170 AC joint injuries (28.2%) ($P = .0926$). Other/unknown plays accounted for 233 AC joint injuries (38.7%). The IDR for injuries occurring on passing plays was calculated to be 0.99 (95% CI, 0.80-1.20) (see Appendix 3, available online). Meanwhile, the IDR for injuries

TABLE 5
Days Lost to AC Joint Injuries, 2000-2011^a

Injury	Mean Days Lost	Median Days Lost	Range of Days Lost
Clavicle AC dislocation (n = 3)	77.7	35.0	29.0-169.0
Clavicle AC sprain, type III (n = 40)	26.4	16.0	1.0-130.0
Clavicle AC inflammation (n = 9)	12.4	4.0	1.0-81.0
Clavicle AC sprain, type II (n = 79)	10.3	6.0	1.0-50.0
Clavicle AC sprain (n = 319)	9.3	4.0	1.0-163.0
Clavicle AC dislocation/recurrent (n = 1)	8.0	8.0	8.0-8.0
Clavicle AC sprain, type I (n = 210)	7.3	3.0	1.0-158.0
Clavicle AC contusion (n = 66)	6.2	3.0	0.0-57.0
All AC joint injuries (N = 727)	9.8	4.0	0.0-205.0

^aAC, acromioclavicular.

TABLE 6
Days Lost to AC Joint Injuries by Player Position, 2000-2011^a

Position	Mean Days Lost	Median Days Lost	Range of Days Lost
Quarterback (n = 57)	17.3	9.0	1.0-145.0
Defensive back (n = 117)	14.8	4.0	0.0-169.0
Running back (n = 67)	11.0	4.0	1.0-158.0
Offensive lineman (n = 80)	10.0	4.0	1.0-117.0
Wide receiver (n = 114)	9.7	3.0	1.0-205.0
Special teams player (n = 99)	9.5	4.0	1.0-94.0
Tight end (n = 42)	8.6	7.0	1.0-30.0
Defensive lineman (n = 82)	7.7	3.0	1.0-81.0
Linebacker (n = 69)	6.9	4.0	1.0-40.0

^aAC, acromioclavicular.

occurring during game competition was calculated to be 17.7 (95% CI, 14.7-21.5), indicating a significantly greater rate of injury during game play compared with practice competition ($P < .001$).

The overall mean time loss for these injuries was 9.8 days (range, 0-205 days). The injuries that required the most time lost were AC joint dislocations (mean days lost, 77.7) and AC sprains, type III (mean days lost, 26.4) (Table 5). Quarterbacks (mean days lost, 17.3) and defensive backs (mean days lost, 14.8) lost the most days to injury (Table 6).

Surgical management was performed for 13 of these AC joint injuries (1.7%). Details of the procedures were not available; however, the most common diagnosis requiring surgery was a type I AC joint sprain (n = 4). The other diagnoses that required surgery were an unspecified AC joint sprain (n = 3), type II AC joint sprain (n = 2), type III AC joint sprain (n = 2), and AC joint inflammation (n = 2). Offensive linemen underwent the most surgical procedures for this injury (n = 3), followed by quarterbacks, special teams players, wide receivers, defensive backs, and defensive linemen (all with n = 2).

DISCUSSION

Injuries frequently occur in contact sports such as American football. Shoulder injuries are the fourth most common injury sustained by football players,^{1-3,5,6,9,12,13,16} and AC joint

injuries are the most common shoulder injury sustained by these athletes.^{8,10} We observed that injuries to the AC joint accounted for 30% of all shoulder injuries that occurred over 12 consecutive NFL seasons from 2000 to 2011. Previous studies have reported that AC joint injuries account for 37.2% to 41% of all shoulder injuries in football players.^{4,8,10} These injuries typically result from contact plays in which a direct blow to the shoulder is sustained or when the player is tackled to the ground onto his shoulder.

One possible explanation for the slightly lower rate of AC joint injuries in the present study is changes to practice regimens that have been implemented over the past decade. For example, quarterbacks wear red jerseys during all practices and scrimmages, and direct contact with the quarterback is prohibited during these activities. In the senior authors' (M.K.B., G.W.N.) experience as NFL team physicians, the number of full contact practices and the number of 2-a-day workouts during preseason training have also decreased considerably since the initial investigation by Kelly et al,¹⁰ thus resulting in less opportunities for these injuries to occur.

Kelly et al¹⁰ also reported that shoulder injuries were overall the second most common injury sustained by quarterbacks, with AC joint injuries being the most common of these shoulder injuries. Our study differs from Kelly et al in that we evaluated players across all playing positions and not just quarterbacks. We found that AC joint injuries were most commonly sustained by defensive backs, followed by wide receivers and special teams players.

However, the incidence of these injuries was greatest in quarterbacks, followed by special teams players and wide receivers. In addition, the mean time lost to injury in this study was 17.3 days for quarterbacks compared with 22 days in the study by Kelly et al. This difference may be because the Kelly et al study defined an injury as one in which the athlete was restricted for at least 2 days, while our study defined an injury as one in which the athlete left the game or practice or if the injury resulted in a loss of at least 1 practice, game, or training session. The more inclusive definition of injury in this study likely captured more occurrences of shoulder injuries and may provide a truer sense of the number and distribution of the type of AC joint injury over the course of the football season.

Of the AC joint injuries analyzed in the current study, all were unexpectedly type III or less according to the Rockwood classification system. One explanation for this finding is that severe AC joint injuries (types IV-VI) rarely occur in NFL athletes in part because of the protective effect of shoulder pads. Moreover, grade V injuries may have been misclassified as type III injuries because of the low interobserver and intraobserver reliability of this classification system.^{11,14} Finally, injuries classified as “clavicle AC dislocations” may include higher (type IV-VI) AC joint injuries.

Interestingly, the majority of AC joint injuries included in this study were treated nonoperatively, with only 1.7% of these injuries requiring surgery. This is substantially less than a prior report by Kaplan et al⁸ in which 12% of prospective NFL players underwent surgical treatment for these injuries. However, Dragoo et al⁴ reported a similar operative rate of 2.4% for these injuries. Although the NFLISS database lacks specific surgical information such as the type of surgical intervention or acuity of the procedure, in the experience of the senior authors, the operative intervention for these types of injuries is typically a distal clavicle excision for chronic symptoms.

The strengths of this study are that we investigated AC joint injuries over 12 seasons. We also evaluated these injuries in all NFL players during all facets of play including all games, practices, and scrimmages, and as a result, our data may provide a more accurate incidence of AC joint injuries in the NFL than prior studies. Despite an increase in player size over this time, we did not see an increase in the number or severity of AC joint injuries.

There are several important limitations to our study. The NFLISS is a well-established and highly regarded reporting system, but as with any large database, there is a possibility of inclusion of incomplete or inaccurate information. For example, the database allows the trainer to select “unspecified AC joint sprain.” This relatively vague category was the most commonly entered diagnosis, and it would have been preferable to have these cases classified as a more specific diagnosis. Additionally, clinical follow-up and specific details on the surgical procedures were not available for review. Clearly, these variables would have allowed for better insight into how these injuries are managed and how players perform after surgical

treatment. Finally, it is possible that injuries were unreported or underreported by the medical team. Despite these limitations, we were able to show that AC joint injuries account for approximately one third of all shoulder injuries in NFL players and that the vast majority of these injuries are treated without surgery. The data in the present study represent the most complete and current data on AC joint injuries in NFL players.

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