

Research Article

Concussions and Crime in the National Football League

Brandon J. Erickson^{1*}, Christopher Gross², Neil Kumar³,
Brandon Shallop³, Jeffery Mjaanes¹, Anthony A. Romeo¹, Bernard
R. Bach¹, and Selene Parekh²

¹Midwest Orthopaedics at Rush, Rush University Medical, USA

²Department of Orthopaedic Surgery, Duke University Medical Center, USA

³Department of Orthopaedic Surgery, Drexel University College of Medicine, USA

***Corresponding author**

Brandon J Erickson, Midwest Orthopaedics at Rush
University Medical Center 1611 West Harrison Street, Suite
300 Chicago, IL 60612, USA, Tel: 312-243-4244; Fax: 312-
942-1517 ; Email: berickso.24@gmail.com

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- Arrest
- Crime
- Injury
- Case-control

Abstract

Background: Concussions are a common problem affecting a multitude of National Football League (NFL) players. Media attention surrounding criminal offenses among NFL players is increasing

Purpose: To determine whether NFL players who sustained a concussion are at higher risk for committing a crime and becoming arrested in the first few years' post-injury as compared to age matched NFL control players who did not sustain a concussion.

Methods: NFL players with history of at least one documented concussion were collected via on line search from 2008-2012. Matched controls for age, position, draft year, and NFL experience were selected during the same years with no documented concussion. Arrests were recorded via online search from 2000-2014 for both cases and controls, including the type of crime for which they were arrested and date of arrest.

Results: Overall, 56 individual players (average age 22.79+/- 0.95 years) with a concussion were arrested, some on multiple occasions for 67 total arrests; 35 arrests occurred prior to concussion while 32 occurred after. The most common reason for arrest was driving under the influence (31%). 55 control players were arrested, some on multiple occasions, for 71 total arrests. For the 56 cases, no significant difference existed for the number of arrests prior to vs. after concussion ($p=0.885$). No difference existed between offensive and defensive players for arrests following concussions ($p=0.203$). No difference existed between the overall number of arrests between cases and controls ($p=0.885$). When comparing cases after their concussion date to controls, significantly more controls were arrested ($p=0.002$).

Conclusion: NFL players who suffered a concussion were no more likely to be arrested than those who did not. Suffering a concussion did not increase a player's risk of being arrested post- injury.

INTRODUCTION

American football, as represented by the National Football League (NFL), is one of, if not the most popular sport amongst the American public, posting a \$9 billion revenue in 2011 [1]. Although the sport provides significant entertainment value through jarring hits, player safety has become a significant concern for both the NFL and National Football League Players Association (NFLPA). The concern regarding the adverse side effects, both short and long-term, of concussions in NFL athletes has been rising in recent years [2,3]. For this reason, prevention strategies and protocols have been implemented to attempt to mitigate

the effect of concussions, and decrease the risk of permanent damage from a concussion [2,4]. Recent studies have evaluated the on-field performance of NFL and major league baseball (MLB) players following concussions and have found that, although NFL players do not have a change in their performance following a concussion, MLB players have decreased batting performance (batting average, slugging average, and on-base percentage) following a concussion [3,5].

The concern regarding the effects of concussions on NFL players extends beyond their immediate on-the-field performance. A major issue surrounding concussions in NFL

players is the long-term effects on their behavior and well-being. [2,6]. Recent evidence has shown that repetitive head injuries can have long-term effects, most notably mental health issues including depression [7,8]. However, no studies to date have evaluated the intermediate time period following concussions in NFL players to determine if these players are at increased risk for engaging in aggressive and/or illegal behaviors that result in being arrested for a criminal offense.

The primary purpose of this study was to determine whether NFL players who have sustained a concussion are at higher risk for committing a crime and becoming arrested in the first few years post-injury as compared to age matched NFL control players who did not sustain a concussion. The authors hypothesize that there will be no difference in criminal acts committed by NFL players who sustained a concussion and matched controls who had no history of a concussion.

METHODS

All NFL players active during the 2008 to 2012 seasons were considered for this study. An Internet search was performed and players were identified through NFL team websites, publically available Internet-based injury reports, player profiles and biographies, and weekly press releases. As this was all publically available data, institutional review board approval was not necessary. This search methodology has been utilized in several previously published manuscripts [3,9-13]. Two orthopedic surgery residents conducted the search. Players who were listed as injured from a concussion or head injury, or those who were reported by sports news media as having sustained a concussion were included in this study. Player demographic data including year drafted, round in which the player was drafted, age at the time of draft, draft position as well as draft year were recorded. In order to determine whether or not the player had been arrested, and if so, on what charge(s), an Internet search using a publically available database with information on every NFL player arrest from 2000-2014 was utilized: <http://www.usatoday.com/sports/nfl/arrests/>. This information was cross-referenced with internet searches of the players name and the word "arrest" and "crime."

A matched control group was selected to allow comparison of the criminal data from the concussion group to that of the rest of the concussion-free NFL. Controls were matched to cases based on draft year age, sex, position, draft position, and draft round (within 2 rounds) in which the player was drafted. Control players did not have a documented concussion during the study period.

Players who were arrested more than one time were recorded so that a total number of overall arrests was present, in addition to the number of individual players who were arrested. Instances in which players were arrested on multiple charges at the same time were tabulated as one arrest, but the individual charges on which they were arrested were recorded.

STATISTICAL ANALYSIS

Descriptive statistics were calculated for the pre-specified demographic variables (age, draft round, draft year and position) used to match the control and concussion groups across the total

cohort as well as for the individual groups. Continuous variables were summarized using means, standard deviations, and ranges, while categorical variables were presented using counts and percentages. McNemar's test for matched pairs was performed to determine if the number of arrests by the cases before and after concussion were similar (marginal homogeneity), as well as to compare the number of arrests post-concussion to the control group. All analyses were performed using SAS version 9.2 with statistical significance established at $p < 0.05$.

RESULTS

Between 2008-2012, 477 NFL players experienced a concussion (average draft age 22.79+/- 0.95 years). Most players who sustained a concussion were drafted after 2007, but there was no correlation with draft round and number of concussions (Tables 1,2). No significant difference existed between cases and control players in regards to draft age, sex, draft round, position, or NFL experience (all $p > 0.05$). Most concussions were sustained by wide receivers (14.68%), linebackers (13.00%), and cornerbacks (12.79%) (Figure 1). Of the players who sustained a concussion, 399 sustained one concussion, 63 sustained two concussions, 13 sustained three concussions, and two sustained four concussions.

Fifty-six individual players were arrested, some on multiple occasions for 67 total arrests. Of these players, 43 were arrested once, five were arrested twice, three were arrested three times, and one was arrested four times. Of these arrests, 35 arrests occurred prior to the date when the player sustained their initial NFL concussion while 32 occurred after the initial concussion was diagnosed. No significant difference was seen in the number of pre-concussion arrests compared to post-concussion arrests in the case group ($p = 0.885$). Most arrests occurred in wide receivers, cornerbacks, linebackers, and safeties (Table 3). The most common reason for arrest was driving under the influence

Table 1: Number of concussions sustained by National Football League players by draft year.

Draft Year	Number of Players with a Concussion	Percentage
1991	1	0.21%
1994	1	0.21%
1995	1	0.21%
1996	2	0.42%
1997	2	0.42%
1998	4	0.84%
1999	5	1.05%
2000	8	1.68%
2001	14	2.94%
2002	22	4.61%
2003	26	5.45%
2004	28	5.87%
2005	41	8.60%
2006	40	8.38%
2007	51	10.69%
2008	59	12.37%
2009	60	12.58%
2010	56	11.74%
2011	36	7.55%
2012	20	4.18%

(31%) (Table 4). Fifty-five individual control players were arrested from 2008-2012, some on multiple occasions, for 71 total arrests (Table 4). The overall number of arrests were not significantly different between controls and cases ($p=0.885$). However, significantly fewer cases were arrested following their concussion than control players ($p=0.002$). For position specific analysis, the highest percentage of arrests following a concussion

was seen in wide receivers, linebackers, and cornerbacks (Table 5). Furthermore, although 7.1% of defensive players were arrested following their concussion compared to 4.4% for offensive players, this difference was not statistically significant ($p=0.203$) (Table 6).

DISCUSSION

The short and long term effects of concussions in NFL players have become a major concern in recent years. The purpose of this study was to determine whether NFL players who sustained a concussion were at higher risk for committing a crime and being arrested than control players who had no documented history of a concussion. The authors' hypothesis was confirmed in that there was no difference in criminal acts committed by NFL players who sustained a concussion and matched controls that had no history of a concussion, nor was there a difference between crimes committed between offensive and defensive players. Furthermore, of the players with a history of a concussion who were arrested, a large number were arrested prior to sustaining their concussion.

Given the recent interest in the effects of concussion on NFL players, studies have evaluated the effects of concussions on performance as well as concomitant musculoskeletal injuries, but not on legal issues [3, 14]. Kumar et al found no difference in on-field performance in NFL players who had sustained a concussion, regardless of recovery time [3]. Interestingly, younger and more inexperienced players were found to be more likely to miss a game due to a concussion than older, more experienced players. Brooks et al recently found higher incidence of acute lower extremity injuries among recently concussed athletes (17%) compared with matched controls (9%) [15]. Pietrosimone et al surveyed 3,647 retired NFL players and found that players who had a history of a concussion had a significantly higher likelihood of reporting musculoskeletal injuries than players with no concussion history [14]. The findings of our study are interesting in that, when compared as an overall group, cases who suffered a concussion and controls had no significant difference in the

Table 2: Number of concussions sustained by National Football League players by draft round.

Draft Round	Number of Players with a Concussion	Percentage
1	72	15.09%
2	85	17.82%
3	67	14.05%
4	52	10.90%
5	31	6.50%
6	32	6.71%
7	32	6.71%
Undrafted	106	22.22%

Table 3: Number of arrests by position for National Football League Players who sustained a concussion.

Position	Number of Individual Arrests
Cornerback	11
Center	1
Defensive End	3
Defensive Tackle	6
Guard	1
Linebacker	11
Long Snapper	0
Quarterback	2
Running Back	4
Safety	10
Offensive Tackle	3
Tight End	2
Wide Receiver	13

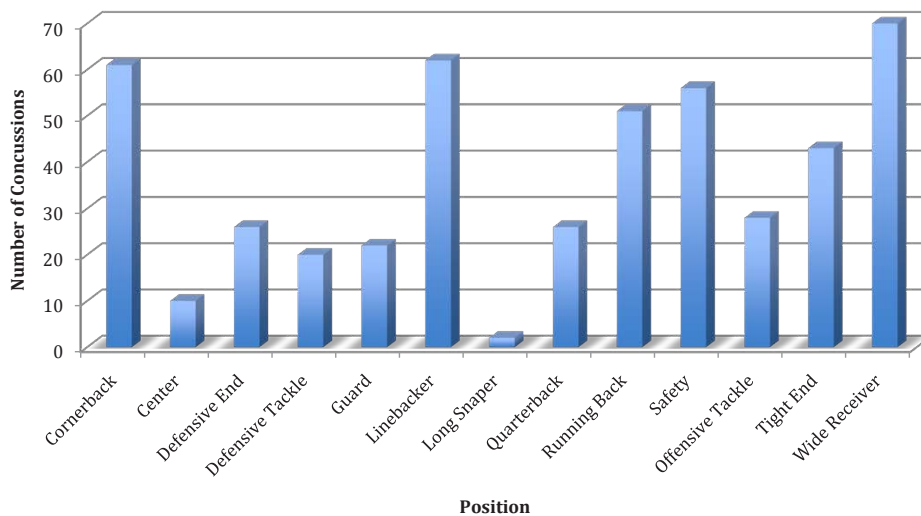


Figure 1 Chart demonstrating the number of concussions sustained by National Football League players by position.

Table 4: Charges brought against National Football League (NFL) cases and controls who were arrested. Some players were charge with multiple crimes for a single arrest.

	DUI	Drug use or possession		Assault /Battery	Domestic Violence	Theft	Murder	Gun-related incident (non-murder)	Incidents with any weapon	
Cases	22	6	8	4	0	2	4	0		
Controls	16	6	8	8	2	1	4	3		
	Child Abuse	Sexual Abuse	Reckless Driving	Careless Driving	Public Intoxication	Public Urination	Dogfighting	Trespassing	Fraud	Disorderly Conduct
Cases	1	2	4	5	7	1	1	1	1	3
Controls	0	3	5	0	3	0	0	0	0	12

Table 5: Breakdown of arrests, both before and after concussion, by position. The “frequency” row is the number of players who were either arrested (yes column) or not arrested (no column) in each specific position. The “percent” row is the percentage of overall number of cases based on that position that were wither arrested (yes column) or not arrested (no column). The “row percent” row is the percent of players in each specific position who were arrested or who were not arrested post-concussion. Finally, the “column percent” row is the percentage of players in the arrest (yes column) or no arrest column (no column) who were arrested based on position.

Position	Arrest Post-Concussion		
	No	Yes	Total
Cornerback:			
Frequency	56	5	
Percent	11.74%	1.05%	61
Row Percent	91.80%	8.20%	12.79%
Column Percent	12.44%	18.52%	
Center:			
Frequency	9	1	
Percent	1.89%	0.21%	10
Row Percent	90.00 %	10.00%	2.10 %
Column Percent	2.00%	3.70%	
Defensive End:			
Frequency	25	1	
Percent	5.24%	0.21%	26
Row Percent	96.15 %	3.85 %	5.45%
Column Percent	5.56%	3.70%	
Defensive Tackle:			
Frequency	17	3	
Percent	3.56%	0.63%	20
Row Percent	85.00 %	15.00 %	4.19%
Column Percent	3.78%	11.11%	
Guard:			
Frequency	21	1	
Percent	4.40%	0.21%	22
Row Percent	95.45%	4.55%	4.61%
Column Percent	4.67%	3.70%	
Linebacker:			
Frequency	59	3	
Percent	12.37 %	0.63%	62
Row Percent	95.16%	4.84 %	13.00%
Column Percent	13.11%	11.11%	
Long Snapper:			
Frequency	2	0	
Percent	0.42%	0.00%	2
Row Percent	100.00 %	0.00 %	0.42%
Column Percent	0.44%	0.00%	

Quarterback:			
Frequency	26	0	
Percent	5.45%	0.00%	26
Row Percent	100.00 %	0.00%	5.45%
Column Percent	5.78%	0.00%	
Running Back:			
Frequency	49	2	
Percent	10.27%	0.42 %	51
Row Percent	96.08%	3.92%	10.69%
Column Percent	10.895	7.41%	
Safety:			
Frequency	52	4	
Percent	10.90%	0.84 %	56
Row Percent	92.86%	7.14%	11.74%
Column Percent	11.56%	14.81%	
Offensive Tackle:			
Frequency	27	1	
Percent	5.66%	0.21%	28
Row Percent	96.43%	3.57%	5.87%
Column Percent	6.00%	3.70%	
Tight End:			
Frequency	43	0	
Percent	9.01%	0.00%	43
Row Percent	100.00%	0.00%	9.01 %
Column Percent	9.56%	0.00%	
Wide Receiver:			
Frequency	64	6	
Percent	13.42%	1.26%	70
Row Percent	91.43%	8.57 %	14.68%
Column Percent	14.22%	22.22%	
Total Frequency	450	27	477
Total Percent	94.34%	5.66%	100.00%

Frequency Percent Row Pct Col Pct	Arrest Post-Concussion		
	No	Yes	Total
Defense			
Frequency	209	16	
Percent	44.00	3.37	225
Row Percent	92.89	7.11	47.37
Column Percent	46.65	59.26	
Offense			
Frequency	239	11	
Percent	50.32	2.32	250
Row Percent	95.60	4.40	52.63
Column Percent	53.35	40.74	
Total	448	27	475
	94.32	5.68	100.00

2 players were excluded as they were long snappers and therefore play both offense and defense

Table 6: Breakdown of arrests, both before and after concussion by offense vs. defense. Long snappers were excluded from this analysis as they are considered both offensive and defensive players.

Frequency Percent Row Pct Col Pct	Arrest Post-Concussion		
	No	Yes	Total
Defense			
Frequency	209	16	225
Percent	44.00	3.37	47.37
Row Percent	92.89	7.11	
Column Percent	46.65	59.26	
Offense			
Frequency	239	11	250
Percent	50.32	2.32	52.63
Row Percent	95.60	4.40	
Column Percent	53.35	40.74	
Total	448	27	475
	94.32	5.68	100.00

2 players were excluded as they were long snappers and therefore play both offense and defense.

number of arrests. However, when looking at the date of the player's concussion and their arrest date in the case group and comparing this to the controls, significantly fewer cases were arrested following their concussion than control players were overall. Hence, a concussion does not appear to increase a player's risk of an arrest in the first few years post-injury. Furthermore, when evaluating offensive vs. defensive players overall, as well as each position individually, no statistically significant differences were seen in rates of post-concussion arrests between groups. This finding is interesting as new rules have come into effect that discourages large blindsided hits to protect receivers and other players. However, there is no difference based on position as it relates to risk of arrest following a concussion.

There has been a recent interest in the long-term effects of concussions in NFL players as studies have shown that players who sustain a concussion are at increased risk of developing clinical depression later in life [7,8]. Furthermore, magnetic resonance imaging (MRI) studies have shown that retired NFL players who have sustained a concussion have signal changes in the regions of the brain associated with aggression and impulsivity (frontotemporal cortical network), demonstrating that these players are at increased risk for aggressive behaviors. However, no study to date has looked at the real-life implications of concussions in NFL players as it relates to some of risk-taking behaviors. The current study found no increased risk of arrests in NFL players who have sustained a concussion compared to control players.

One of the driving forces behind the recent interest in concussions of NFL players is chronic traumatic encephalopathy (CTE). CTE was initially described as a neurodegenerative disorder in boxers secondary to repetitive brain trauma [16]. However, this pathologic condition has also been described in other sports, including football, where players sustain repetitive blows to the head [16]. The condition is characterized by behavioral changes, personality dysfunctions, and cognitive deficits, with or without aggressive, violent outbursts and

dementia. CTE is typically seen in patients around the age of 40 [16]. Recent stories of NFL players suffering from CTE involving acts of gun violence have been reported. This study attempted to determine if some of the players who sustained a concussion would show early signs of illegal violent and aggressive behavior prior to developing any evidence of CTE based on their concussion history, but this was not the case. Hence, while players included in this study who have sustained a concussion may be at risk for CTE, there is no suggestion that this diagnosis can be made earlier based on a history of arrests. An interesting finding in this study was that even though there were 67 individual arrests of players who sustained a concussion, only 32 of these arrests occurred after the player in question sustained their concussion. Hence, whether or not a player has a concussion does not appear to have any bearing on their risk for being arrested.

LIMITATIONS

Although this study evaluated concussions in a large number of players and matched each player to a control, it does have some limitations. Despite countless studies using publically available data prior to this study, the use of publically available data could have missed some NFL players who sustained a concussion, or a missed a player who had been arrested [9,11-13,17,18]. We also focused on players who had a diagnosed concussion although, since diagnosis depends on an athlete's willingness to admit the presence of symptoms, some true concussions may have been missed. The cases in this study were not followed long-term to determine if their rate of arrests increased with time, nor were the controls, so we cannot draw long-term conclusions. Future studies are necessary to follow these players over longer periods of time (more than 10 years) to determine the long term outcomes. It is unclear if the number of arrests would increase as the players age after sustaining their concussion. Furthermore, the study did not evaluate whether the players had a history of a concussion in high school or college. Hence, it is possible that a control player did have a history of a concussion and was mislabeled as not having a history of a concussion, or that a case had a concussion before the specified date and so they were mislabeled as having been arrested before they sustained a concussion. However, the goal was to look at short term arrests, not at long term outcomes.

CONCLUSION

NFL players who suffered a concussion were no more likely to be arrested than those who did not. Suffering a concussion did not increase a player's risk of being arrested post- injury.

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