

Surgically Treated Pectoralis Major Tears Impact the Play and Performance of National Football League Athletes



Hassan Farooq, M.D., Nickolas G. Garbis, M.D., Ryan Moossighi, B.S., Rachel Lam, B.S., Elizabeth Cho, M.D., and Dane H. Salazar, M.D., M.B.A.

Purpose: To evaluate the return-to-play rate and performance level changes in National Football League (NFL) athletes after a surgically treated pectoralis major muscle (PMM) tear. **Methods:** A descriptive epidemiologic study was conducted. All NFL players from 1933 to 2013 were reviewed for surgically treated PMM tears. Age at injury, height, weight, body mass index, date of injury, position played, draft selection, and total seasons played were recorded. Return to play was assessed for the entire cohort, as well as by position. Performance analysis before and after injury was also conducted for the entire cohort, as well as by position and draft selection. Data analysis was performed with the paired-samples *t* test, with $P < .05$ considered statistically significant. **Results:** Our review of 80 NFL seasons from 1933 to 2013 provided a total of 55 instances of PMM tears. All instances occurred between the time frame of 2004 and 2012. After exclusions, 24 instances unique to 24 NFL athletes were confirmed by 2 separate investigators and these athletes were included as our final study cohort. Of the 24 players identified to have a surgically repaired PMM tear, 20 (83%) returned to play. The mean return-to-play period was 302 ± 128 days. The mean difference in performance scores before versus after PMM injury was 171.33 and was statistically significant, with $P = .0330$. **Conclusions:** In this study, there was an 83% return-to-play rate after surgical repair of PMM tears. Although we found a statistically significant decrease in player performance after surgery, this difference was no longer seen after players were stratified by position type and draft selection. **Level of Evidence:** Level IV, therapeutic case series.

Injury to the pectoralis major muscle (PMM) is infrequent, with 1 study reporting an incidence of just under 400 injuries over a 200-year period.¹ However, this injury has become more common recently.^{2,3} Previous epidemiologic studies have described this injury to mostly impact middle-aged men who partake

in vigorous activities such as weightlifting or contact or collision sports.^{4,5} The mechanism of injury (MOI) usually involves the arm in an eccentric position and under maximum amounts of tension.⁵ A less commonly reported MOI has been associated with direct trauma to the chest or arm region. The injury can commonly be isolated to the muscle insertion site or myotendinous junction of the PMM.^{1,2,6} Because high-performance athletes routinely participate in training regimens designed to optimize strength and speed, they may be at a greater risk for PMM tears that subsequently require surgical repair.^{2,3,5}

The PMM plays an important role in elevation and internal rotation of the arm, which commonly are the planes of motion required to push and tackle during competitive football play.¹ Consequently, the integrity and preservation of PMM function are crucial for National Football League (NFL) athletes to perform at their best and meet the highly physical demands of their sport.²

Injury to the PMM has different implications for an athlete depending on the position played—for example, players who rely on repetitive movements from their

From the Department of Orthopaedic Surgery and Rehabilitation, Loyola University Health System, Maywood, Illinois, U.S.A. (H.F., N.G.G., E.C., D.H.S.); and Stritch School of Medicine, Loyola University, Maywood, Illinois, U.S.A. (R.M., R.L.).

The authors report the following potential conflicts of interest or sources of funding: N.G.G. receives honoraria from DJO and Arthrex. D.H.S. is a paid consultant for Zimmer Biomet and Stryker/Tornier. Full ICMJE author disclosure forms are available for this article online, as [supplementary material](#).

Received April 28, 2022; accepted July 25, 2022.

Address correspondence to Hassan Farooq, M.D., Department of Orthopaedic Surgery and Rehabilitation, Loyola University Health System, 2160 S First Ave, Maywood, IL 60153, USA. E-mail: hassanfar009@gmail.com

© 2022 THE AUTHORS. Published by Elsevier Inc. on behalf of the Arthroscopy Association of North America. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>). 2666-061X/22563

<https://doi.org/10.1016/j.asmr.2022.07.009>

Table 1. Cohort Descriptive Statistics

Patient No.	Date of Injury	Total Seasons	Specific Position	Draft Selection
1	September 26, 2004	5	LB	111
2	November 3, 2004	20	LB	5
3	August 31, 2004	10	DG	33
4	November 6, 2005	12	DE	86
5	October 25, 2005	6	DB	62
6	November 14, 2005	11	DG	111
7	October 11, 2006	14	LB	36
8	November 28, 2007	11	RB	5
9	April 25, 2008	9	DG	33
10	September 10, 2008	9	DG	128
11	October 20, 2009	10	LB	34
12	October 18, 2009	6	LB	45
13	August 31, 2010	9	OG	176
14	December 7, 2010	12	LB	98
15	October 25, 2011	3	RB	42
16	October 12, 2011	11	DE	1
17	November 19, 2011	12	DT	33
18	August 30, 2011	4	DL	52
19	December 6, 2011	11	DT	6
20	May 10, 2012	4	DL	21
21	October 24, 2005	8	DB	22
22	July 16, 2007	2	DB	178
23	December 21, 2009	8	LB	106
24	October 3, 2010	4	LB	Undrafted

DB, defensive back; DE, defensive end; DG, defensive guard; DL, defensive lineman; DT, defensive tackle; LB, linebacker; OG, offensive guard; RB, running back.

upper extremities and are significantly impaired by an injury to their PMM. These injuries may have implications beyond athlete performance, affecting career longevity and thus potential earnings for the athlete.

Although return to play and performance after injury to the anterior cruciate ligament and ulnar collateral ligament have been thoroughly studied, to date there is a paucity of literature on PMM injuries. In 2014, Tarity et al.⁷ evaluated the incidence of complete PMM ruptures in NFL athletes and reported a total of only 10

incidents. However, a subsequent study published in 2021 reported 58 incidents in NFL athletes.⁸ This study, by Wise et al., also assessed incidence, return to play, and performance of athletes after PMM injury.

The purpose of this study was to evaluate the return-to-play rate and performance level changes in NFL athletes after a surgically treated PMM tear. We hypothesized that the return-to-play rate would be high and that the performance level, before and after injury, would not differ in patients with surgically treated PMM tears.

Methods

A descriptive epidemiologic study was conducted of all athletes who played in the NFL from 1933 to 2013 (80 seasons). All player movements to and from the injury reserved list and those who were reported to have missed games specifically because of injuries were reviewed for PMM tears using a publicly available archive, <https://www.prosportstransactions.com>. After the identification of PMM tears, all injuries were reviewed for treatment management, and only athletes whose injuries were surgically treated were included in the final study cohort. Confirmation was sought through other reputable sources that included but were not limited to reports and articles conveyed by [ESPN.com](https://www.espn.com), [NFL.com](https://www.nfl.com), and [pro-football-reference.com](https://www.pro-football-reference.com). This methodology has been adopted and used in other published studies on return to play and athletic performance after a musculoskeletal injury.⁹⁻¹² All searches were conducted and confirmed by 2 independent blinded investigators (H.F. and R.M.) to limit bias.

For each surgically treated PMM tear, the following data were collected: age at injury, height, weight, body mass index, date of injury, position played, draft selection, and total seasons played. Players who returned to play were defined as those who played at least 1 regular-season NFL game after surgical treatment of

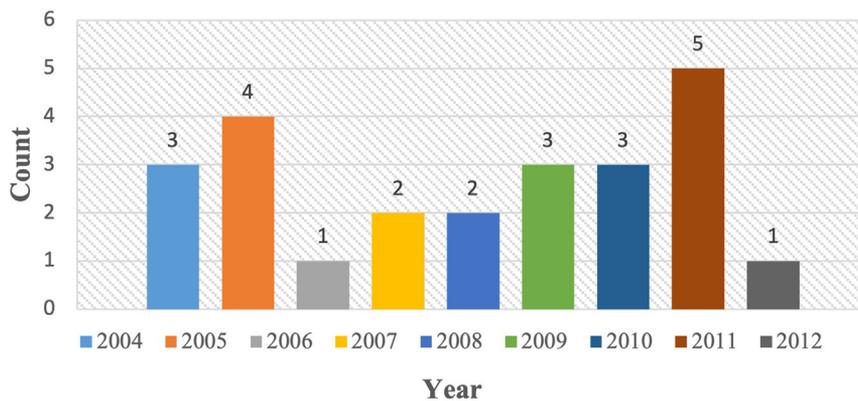


Fig 1. Incidence of surgically treated pectoralis major tears in National Football League (NFL) athletes.

Table 2. Return-to-Play Rate by Specific Position and Overall

Position	Players With Pectoralis Major Tears, n	Players Who Returned to Play, n (%)
Linebacker	8	6 (75)
Defensive guard	4	4 (100)
Offensive guard	1	1 (100)
Defensive end	2	2 (100)
Defensive back	3	1 (33)
Running back	2	2 (100)
Defensive tackle	2	2 (100)
Defensive lineman	2	2 (100)
Total	24	20 (83)

their PMM tear. All surgically repaired PMM tears were included in our calculation. Return to play was assessed for the entire cohort, as well as stratified by position (e.g., linebacker and defense vs offense). Performance analysis before and after injury was also conducted for the entire cohort, as well as stratified by offense versus defense and draft selection (round 1 or 2 vs round 3 or later). Performance scores, before and after injury, were determined based on previously published calculations for offensive and defensive players in a previous study by McGinniss et al.¹³ Appendix Figure 1 provides the calculation for the performance score described by McGinniss et al.

Data analysis was performed with the paired-samples *t* test, *P* < .05 deemed statistically significant. SPSS software (version 25; IBM, Armonk, NY) was used for statistical analysis.

Results

From our review of 80 NFL seasons from 1933 to 2013, we noted a total of 55 instances of PMM tears between 2004 and 2012. After exclusions, 24 instances unique to 24 NFL athletes were confirmed by 2 separate investigators as surgically repaired PMM tears; these athletes were included in our final study cohort. The mean cohort age at the time of injury, height, weight, and body mass index were 27.4 ± 3.5 years, 1.91 ± 0.06 m, 124.5 ± 18.09 kg, and 34.2 ± 3.88 , respectfully. Table 1 provides a complete summary of all other descriptive statistics for our study cohort. Figure 1 is a representation of the yearly incidence of PMM injuries, with the greatest number of injuries occurring in 2011. From 2004 through 2007, there was an incidence of 2.5 PMM tears per year, as compared with an incidence of 2.8 PMM tears per year between 2008 and 2012. Most players noted to have PMM tears played the linebacker position on defense (*n* = 8, 33%). Those playing on offense had the least reported injuries, and specifically, among players in the offensive guard position, only 1 player (4%) was impacted.

Table 3. Return-to-Play Period for Offensive Versus Defensive Positions

Patient No.	Position	Return to Play, d
1	Defensive	350
2	Defensive	312
3	Defensive	96
4	Defensive	308
5	Defensive	320
6	Defensive	300
7	Defensive	333
8	Offensive	284
9	Defensive	135
10	Defensive	368
11	Defensive	691
12	Defensive	329
13	Offensive	75
14	Defensive	285
15	Offensive	320
16	Defensive	333
17	Offensive	358
18	Defensive	387
19	Offensive	278
20	Defensive	178
21	Defensive	Did not return to play
22	Defensive	Did not return to play
23	Defensive	Did not return to play
24	Defensive	Did not return to play
Mean		302
SD		128

SD, standard deviation.

It should be noted that no individual player returned to play during the same season as the injury or surgical repair. Overall, 20 of the 24 players identified to have a surgically repaired PMM tear (83%) returned to play; of the players who did not return to play, all played defensive positions (2 linebackers and 2 defensive backs). A complete summary of return-to-play rates, overall and by position, is provided in Table 2. The mean return-to-play period was 302 ± 128 days for the overall cohort, with defensive players most impacted with respect to the total number of PMM tears (*n* = 19), total time away from play (4,725 days), and inability to return to play (100% of players unable to return played defensive positions). Table 3 presents these results in greater detail.

Finally, performance scores before injury and after injury were assessed. Regarding the entire group, the mean performance score was 299.26 (range, 0 to 1,301.1; median, 72.5; standard deviation, 408.6) for the cohort prior to injury and 127.94 (range, -2.4 to 724.2; median, 28.5; standard deviation, 199.3) following the return to play after surgically repaired PMM injury. This mean difference of 171.33 in performance scores was statistically significant, with *P* = .0330. Table 4 provides a complete summary of performance scores, before and after injury, of the

Table 4. Performance Analysis Before and After Pectoralis Major Injury

Population	Performance Score Before Injury	Performance Score After Injury	Difference	95% CI	P Value
Entire cohort (n = 20)	299.26	127.94	171.33	15.74 to 326.91	.033*
Defensive (n = 15)	317.79	137.28	180.51	-12.22 to 373.25	.064
Offensive (n = 5)	243.66	99.9	143.76	-248.41 to 535.93	.366
Round 1 or 2 (n = 14)	353.54	161.93	191.61	-22.55 to 405.78	.075
Round 3 or later (n = 6)	172.6	48.62	123.98	-129.63 to 377.60	.264

CI, confidence interval.

*Statistically significant ($P < .05$).

entire cohort, as well as stratified by position type (offensive and defensive) and draft selection (rounds 1 or 2 vs round 3 or later).

Discussion

Our results support findings from previous work that have reported a rising incidence of PMM tears. From 2004 through 2007, there was an incident rate of 2.5 tears per year, as compared with an incident rate of 2.8 tears per year between 2008 and 2012. Thus, an increase of 12% was seen between these 2 time frames, with the greatest number of injuries occurring in 2011 in our cohort. The return-to-play rate in our study was 83%, which is similar to that reported by Wise et al.,⁸ at 85.7%. About 79% of the cohort were athletes who played a defensive position, with the linebacker position being the position most impacted in our analysis. Our study showed similar findings to other studies that have reported linebackers and other positions on the defensive side to be more susceptible to PMM tears.⁸ When we evaluated player performance scores before and after injury, we noted statistically significant differences when we assessed the entire cohort ($P = .0330$), which is a unique finding compared with the results of Wise et al., who found no differences before versus after injury. However, in our study, no differences were appreciated once we stratified for position played (offense vs defense), as well as round drafted (round 1 or 2 vs round 3 or later). These data can be an additional reference point for orthopaedic surgeons and rehabilitation staff who work closely with professional athletes during the recovery process and can help set realistic expectations regarding return to play and performance after surgery.¹³

The staggering rise in PMM tears in the NFL has been theorized to be related to the enhanced size, speed, and strength of the modern-day athlete.⁸ The use of performance-enhancing drugs may also play an important role in PMM tears and subsequent injury.⁸ Another theory describes the recent trend of reduced numbers of mandatory practices and conditioning assignments as compared with the past.¹⁴ Therefore, our principal purpose was to evaluate the return-to-play rate after surgically treated PMM tears and compare levels of performance before and after injury. We also

looked to characterize other factors that may increase a player's propensity for PMM injury.

Limitations

The limitations of this study include the low incidence rate of PMM injury, which can influence the overall power of the study, and thus, statistically significant differences may not be discernible. However, our sample size was larger than or approximately equivalent to the sample sizes of many previously published investigations on return to play.^{9-11,13,15} A second limitation is associated with the use of a publicly available database for our cohort catchment, which leads to limited data regarding the severity of the PMM tear, exact MOI, and other concomitant injuries, as well as details regarding the operative techniques used to treat these injuries. Third, our findings may not be generalizable to other subsets of athletes who are not professional athletes (i.e., collegiate, high school, or recreational athletes) and further investigation is indicated. Finally, it is important to note that although a thorough review was conducted by the 2 investigators, there is always a risk of missed surgically treated PMM tears. However, prior studies investigating musculoskeletal injuries used a similar methodology to that used in our investigation.^{8,15,16}

Conclusions

In this study, there was an 83% return-to-play rate after surgical repair of PMM tears. Although we found a statistically significant decrease in player performance after surgery, this difference was no longer seen after players were stratified by position type and draft selection.

References

- Haley CA, Zacchilli MA. Pectoralis major injuries: Evaluation and treatment. *Clin Sports Med* 2014;33:739-756.
- Bodendorfer BM, DeFroda SF, Shu HT, Knapik DM, Yang DS, Verma NN. Incidence of pectoralis major injuries has increased 40% over the last 22 National Football League seasons. *Arthrosc Sports Med Rehabil* 2021;3:e1113-e1118.
- Brown SM, Cole WW III, Provencher MT, Mulcahey MK. Pectoralis major injuries: Presentation, diagnosis, and management. *JBJ Rev* 2021;9.

4. ElMaraghy AW, Devereaux MW. A systematic review and comprehensive classification of pectoralis major tears. *J Shoulder Elbow Surg* 2012;21:412-422.
5. Magone K, Ben-Ari E, Gyftopoulos S, Virk M. Pectoralis major tendon tear: A critical analysis review. *JBJS Rev* 2021;9.
6. Durant EJ, De Cicco FL. *Pectoralis major tear*. FL: Treasure Island, 2022.
7. Tarity TD, Garrigues GE, Ciccotti MG, et al. Pectoralis major ruptures in professional American football players. *Phys Sportsmed* 2014;42:131-135.
8. Wise PM, Ptasinski AM, Gallo RA. Pectoralis major ruptures in the National Football League: Incidence, RTP, and performance analysis. *Orthop J Sports Med* 2021;9:23259671211018707.
9. Jack RA, Evans DC, Echo A, et al. Performance and return to sport after sports hernia surgery in NFL players. *Orthop J Sports Med* 2017;5:2325967117699590.
10. Sochacki KR, Jack RA II, Nauert R, et al. Performance and return to sport after thumb ulnar collateral ligament surgery in National Football League players. *Hand (N Y)* 2019;14:487-493.
11. McHale KJ, Rozell JC, Milby AH, Carey JL, Sennett BJ. Outcomes of Lisfranc injuries in the National Football League. *Am J Sports Med* 2016;44:1810-1817.
12. Sochacki KR, Jack RA II, Hirase T, et al. Performance and return to sport after forearm fracture open reduction and internal fixation in National Football League players. *Hand (N Y)* 2018;13:682-688.
13. McGinniss A, Guinand LA, Ahmed I, Vosbikian M. Distal biceps ruptures in National Football League players: Return to play and performance analysis. *J Shoulder Elbow Surg* 2021;30:1647-1652.
14. Murray NB, Gabbett TJ, Townshend AD. Relationship between preseason training load and in-season availability in elite Australian football players. *Int J Sports Physiol Perform* 2017;12:749-755.
15. Wise PM, King JL, Stauch CM, Walley KC, Aynardi MC, Gallo RA. Outcomes of NCAA defensive football players following Achilles tendon repair. *Foot Ankle Int* 2020;41:398-402.
16. Wise PM, Gallo RA. Impact of anterior cruciate ligament reconstruction on NCAA FBS football players: Return to play and performance vary by position. *Orthop J Sports Med* 2019;7:2325967119841056.

Appendix

Player Performance Score	
	Performance Score Formula
Offensive Player	$(\text{Yards Received} \div 10) + (\text{Touchdowns Received} \times 6) + (\text{Yards Rushed} \div 10) + (\text{Touchdowns Rushed} \times 6)$
Defensive Player	$(\text{Tackles}) + (\text{Assists} \div 2) + (\text{Sacks} \times 4) + (\text{Yards Received} \div 10) + (\text{Touchdowns Received} \times 6) + (\text{Yards Rushed} \div 10) + (\text{Touchdowns Rushed} \times 6)$

Appendix Fig 1. Player performance score calculation for offensive and defensive players.