

Medial Collateral Ligament Injuries Identified at the National Football League Scouting Combine

Assessment of Epidemiological Characteristics, Imaging Findings, and Initial Career Performance

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Background: The medial collateral ligament (MCL) is one of the most commonly injured structures in the knee, especially in young athletes. The impact of MCL injury on National Football League (NFL) performance in elite collegiate athletes has not yet been described in the literature.

Purpose: We aim to (1) describe the prevalence and severity of MCL injuries in NFL Combine participants, (2) detail injury management, and (3) analyze the impact of MCL injury on NFL performance in terms of draft position, games played, games started, and snap percentage.

Study Design: Cohort study; Level of evidence, 3.

Methods: A retrospective review of all NFL Combine participants from 2009 to 2015 was performed by reviewing medical records and imaging reports from the combine to identify all players with MCL injuries. A control group was developed from the players evaluated at the combine without MCL injury. For each affected knee, the MCL injury was classified by location and severity based on results of magnetic resonance imaging (MRI). Each player's respective NFL draft position, number of NFL games played, number of NFL games started, and NFL snap percentage for the first 2 seasons in the league were collected through the use of NFL.com and Pro-Football-Focus, which are web-based, publicly accessible, comprehensive sports statistics databases.

Results: A total of 2285 players participated in the NFL Combine between 2009 and 2015. Three hundred one athletes (13.2%) were identified as having MCL injuries; 36 (12%) of the athletes with MCL injury presented with bilateral injuries, for a total of 337 MCL injuries. Additional soft tissue injury was identified on 187 of 337 (55%) MRIs. Players with a history of MCL injury were more likely to play at least 2 years in the NFL compared with those in the control group ($P = .003$). Players who had isolated MCL injury performed significantly better compared with athletes who had combined injuries with regard to draft position ($P = .034$), proportion playing at least 2 seasons in the NFL ($P = .022$), games played ($P = .014$), and games started ($P = .020$) in the first 2 years. No significant difference was found between players who underwent operative versus nonoperative management of their MCL injury.

Conclusion: A relatively high percentage of players at the NFL Combine had evidence of MCL injury (13%). A prior history of MCL tear had no negative impact on an athlete's NFL performance. Players who had isolated MCL injury performed significantly better compared with athletes who had combined injuries with regard to draft position, proportion playing 2 seasons or more in the NFL, and games played and started in the first 2 years.

Keywords: NFL; knee; sport; trauma; tear; draft

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Knee medial collateral ligament (MCL) tears are an extremely common injury in sports, including football. An investigation of the prevalence of musculoskeletal disorders at the National Football League (NFL) Combine from 1987

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to 2000 found MCL injury to be among the most common injuries.¹ The predictive value of prior MCL injury on player professional career was also analyzed during the same time period, and quarterbacks with prior MCL injury had a decreased probability of playing in the NFL ($P = .03$).² From the 2000 to 2009 NFL seasons, there were 0.155 MCL tears per team-game, more than 3-fold higher than the rate of anterior cruciate ligament tears per game (0.049).⁷ A study of high school athletes playing 20 different sports revealed that football had the highest knee injury rate (6.29 per 10,000 athlete exposures) and the MCL was the most commonly involved structure (36.1% of knee injuries).¹³ Studies on other sports have reported similar results. DeHaven and Lintner³ reported on athletes participating in football, soccer, basketball, track, and baseball at all levels and found that the MCL was the most common sprain to the knee. Further studies investigating injuries in elite soccer players reported the MCL to be the most common knee ligament injury.^{10,11} A study of professional football players found that MCL tears were the third most common of any injury type, encompassing 5% of all injuries sustained over a 7-year period.⁴ These studies also found that MCL injuries made up 9% of all severe injuries (>28 days missed time)⁴ and that the average missed time was 23 days.¹¹ While MCL tears have been reported to be the most common knee ligament injury, their effect on future athletic performance has not been well defined.

Although MCL injuries have been established as a common sports injury, with the potential for significant duration of time lost, the epidemiological characteristics and impact of MCL injury on NFL performance in elite collegiate football athletes have not yet been described in the literature. In this study, we aimed to (1) describe the prevalence and severity of MCL injuries in NFL Combine participants, (2) detail injury management, and (3) analyze the impact of MCL injury on NFL performance in terms of draft position, games played, games started, and snap percentage. Our hypotheses were that MCL injuries would be a frequent diagnosis in this cohort and that they would negatively affect players' NFL performance.

METHODS

Study Design

A retrospective review of all NFL Combine participants from 2009 to 2015 was performed following approval from

the appropriate institutional review board. Medical records and imaging reports dictated by musculoskeletal-trained radiologists were reviewed to identify all players with injuries to the MCL of their knee. Next, plain radiographs and magnetic resonance imaging (MRI) scans were independently reviewed by 2 sports fellowship-trained orthopaedic surgeons (M.T.P., J.P.B.) using the classification system from Geeslin et al.⁶ The MRIs were obtained at the time of the NFL Combine in the presence of a prior knee injury, regardless of surgical history of the knee.

The medical records were compiled at the NFL Combine, where the medical staff of each of the 32 NFL teams performed a musculoskeletal evaluation of each player. A comprehensive orthopaedic note was then dictated, and all injury data were entered into a registry available to the medical and training staff of all NFL teams. These notes were reviewed and analyzed for involved structures, severity, location, pertinent physical examination findings, and any associated pathological condition. At the NFL Combine, knee range of motion was recorded as a binary distinction: normal or abnormal.

MCL Evaluation

For each affected knee, MCL injury (Figure 1) was classified by location and severity based upon MRI results. The severity was graded into 3 separate groups: edema or chronic scarring surrounding the ligament without evidence of any tear, partial tear of the ligament, and full-thickness tear of the ligament. Tear location was delineated into proximal, midligament, or distal. Each knee was also assessed for associated injuries, including injuries to other ligamentous structures of the knee, bone bruises, Pellegrini-Stieda lesions (Figure 2), meniscal lesions, and chondral lesions.

Performance Evaluation

Player position and number of missed collegiate football games were obtained from the medical database organized during the NFL Combine. Each player's respective NFL Draft position, number of NFL games played, number of NFL games started, and NFL snap percentage for his first 2 seasons in the NFL were collected through the use of NFL.com and Pro-Football-Focus (profootballfocus.com), web-based, publicly accessible, comprehensive sports statistics databases. Snap percentage was defined as the total

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Ethical approval for this study was obtained from Partners Healthcare.



Figure 1. Medial collateral ligament (MCL) injury. Arrow points to a superficial MCL sprain of the proximal femur that has healed.



Figure 2. Pellegrini-Stieda lesion. Arrow points to calcification of the proximal medial collateral ligament consistent with a Pellegrini-Stieda lesion.

number of plays in which a player participated out of the total number of plays in which he was eligible to participate over the course of a season.

A control group was developed to evaluate whether players without MCL injuries were drafted in earlier draft rounds and had superior performance during the first 2 years of play compared with players who had MCL injuries. The control group was built from players who participated in the NFL Combine from 2009 to 2015 based on the

following set of criteria: (1) no history of MCL injury, (2) no significant missed time prior to the NFL (≤ 2 total missed games in college), and (3) no history of any surgery prior to the NFL Combine.

Statistical Analysis

The player performance metrics were compared between groups. Data were tested for normal distribution. For comparisons of normally distributed continuous variables between cohorts, an independent *t* test was used. For comparisons of nonnormally distributed continuous variables between cohorts, the Mann-Whitney *U* test was used. Comparisons of 2 categorical variables were performed by use of chi-square tests and Fisher exact tests. All *P* values were 2-tailed, and *P* values less than .05 were considered statistically significant. All statistical analyses were performed by use of The R Project for Statistical Computing (Lucent Technologies).

RESULTS

Demographics

A total of 2285 players participated in the NFL Combine between 2009 and 2015. Three hundred one athletes (13.2%) were identified as having prior or current MCL injury on MRI (Table 1). Thirty-six (12%) of the athletes with MCL injury had bilateral injuries, for a total of 337 MCL injuries. Fourteen (4.2%) MCL tears were treated surgically, while the remaining 323 (95.8%) were treated nonoperatively. MCL injury was found in all player positions with the exception of the long snapper position (Table 2). The majority of MCL injuries were sustained in the offensive (66/370; 18%) and defensive lines (71/384; 18%), while kicker/punters sustained relatively few MCL injuries (3/73; 4%). Demographic data are detailed in Table 1, and positional breakdown is displayed in Table 2.

Clinical Examination

Each of the 337 knees with a history of MCL injury underwent a physical examination. On examination, 14 (4.2%) knees had a deficit in range of motion and 37 (11.0%) showed valgus laxity at 30° of flexion, while only 1 knee demonstrated valgus laxity at 0° of flexion.

Imaging Analysis

All of the 337 knees with MRI evidence of prior or current MCL injury had MRI scans available to review. Additional soft tissue injury was identified on 187 of 337 (55%) of the scans. Prior meniscal injury was the most common additional injury identified ($n = 149$; 44%), with 92 of 149 (62%) lateral and 80 of 149 (54%) medial. Other identifiable soft tissue injuries included prior injury to the anterior cruciate ligament ($n = 10$; 3%), posterior cruciate ligament ($n = 33$; 10%), isolated fibular collateral ligament ($n = 22$; 7%), medial patellofemoral ligament ($n = 4$; 1%), and

TABLE 1
Basic Demographics of Athletes With History of Medial Collateral Ligament (MCL) at the NFL Combine

	Players With MCL Injury, n (%)	Bilateral Injury, n (%)	Isolated MCL, n (%)	Combined MCL, n (%)	Total Missed Games in College Due to Knee, Mean	Recurrences, n (%)
All athletes (N = 2285)	301 (13)	36 (12)	85 (28)	216 (72)	2.4	30 (10)
Offense (n = 1175)	147 (13)	17 (12)	35 (24)	112 (76)	2.6	15 (10)
Defense (n = 1028)	151 (15)	19 (13)	47 (31)	104 (69)	2.3	15 (10)

TABLE 2
Medial Collateral Ligament (MCL) Injury by Football Position

Position	Players at Combine, n	MCL Injury, n (%)
Quarterback	126	10 (8)
Running back	239	28 (12)
Wide receiver	308	21 (7)
Tight end	133	22 (17)
Offensive line	370	66 (18)
Defensive line	384	71 (18)
Linebacker	239	36 (15)
Defensive back	405	44 (11)
Kicker/punter	73	3 (4)
Long snapper	8	0 (0)

TABLE 3
Magnetic Resonance Imaging (MRI) Findings of Knees With Medial Collateral Ligament (MCL) Injury

	n (%)
Total number of MCL-injured knees	337
Available MRI scan	337 (100)
MRI signal	
Edema/chronic scarring surrounding MCL	259 (77)
Partial tear of MCL	70 (21)
Full tear of MCL	8 (2)
Injury location	
Proximal	294 (87)
Middle	27 (8)
Distal	15 (5)
Additional injury identified on MRI	252 (75)
Anterior cruciate ligament	10 (3)
Posterior cruciate ligament	33 (10)
Fibular collateral ligament	22 (7)
Medial patellofemoral ligament	4 (1)
Posterolateral corner	10 (3)
Meniscus	149 (44)
Lateral	92 (62)
Medial	80 (54)
Chondral	34 (10)
Available radiograph	337 (100)
Pellegrini-Stieda lesion	11 (3)

posterolateral corner (n = 10; 3%). Thirty-four chondral injuries (10%) were identified on MRI. All knees also had plain radiographs available, and 11 (3.3%) instances of a Pellegrini-Stieda lesion were identified. Details of imaging findings are described in Table 3.

Performance Analysis

All of the 2285 players who participated in the combine during the study period were included in the outcome analysis. A total of 840 met the criteria for controls and 301 athletes had evidence of MCL injury, including 85 (28%) athletes with an isolated MCL injury. The early NFL performance of these players was subsequently analyzed (Table 4). Players with MCL injury were more likely to play at least 2 years in the NFL compared with players in the control group ($P = .003$). No statistical significant difference was found between athletes with MCL injury and controls with regard to draft status, draft position, or number of games played or started in the first 2 years.

Players with isolated MCL injury performed significantly better compared with those who had combined injuries (Table 4) with regard to draft position ($P = .034$), proportion playing at least 2 seasons in the NFL ($P = .022$), games played ($P = .014$), and games started ($P = .020$) in the first 2 years. No significant difference was found in draft status for players with isolated MCL injury versus those with combined injuries. No significant difference was found between players who underwent operative versus nonoperative management of their MCL injury. Performance analysis is described in detail in Table 4.

DISCUSSION

The main findings of this study are that players with a previous history of MCL injury were more likely to play at least 2 years in the NFL than those in the control group. In addition, athletes with isolated MCL injuries performed significantly better than athletes with combined injuries with regard to draft position, proportion playing 2 seasons or more in the NFL, and games played and started in the first 2 years. In this study, 13% of the athletes included had evidence of MCL injury. Consistent with previous literature,^{8,12} only a small percentage (4.2%) of MCL injuries in this study were managed surgically.

MCL injury was found in all player positions with the exception of the long snapper position, and the majority of injuries were sustained in offensive and defensive linemen. Feeley et al⁵ found that the positions at highest risk for any injury during NFL training camp were the tight end and defensive secondary. As with the current study analysis, those authors found that punters/kickers had the lowest rate of injury.⁵

An interesting finding of our study is that players with MCL injury were more likely to play 2 years in the NFL.

TABLE 4
Impact of Medial Collateral Ligament (MCL) Injury on NFL Performance^a

	n	Drafted ^b	Draft Position ^c	2 Years in NFL ^b	Games Played First 2 Years ^c	Games Started First 2 Years ^c
Control players	840	573 (68)	163 [81, un]	476 (57)	15 [0, 27]	1 [0, 11]
Players with any MCL injury	301	203 (67)	164 [76, un]	200 (66)	16 [1, 25]	2 [0, 11]
<i>P</i> value		.829	.950	.003	.870	.531
Subgroup analysis						
Isolated MCL	85	63 (74)	135 [59, un]	65 (76)	21 [6, 27]	3 [0, 15]
Combined MCL	216	140 (65)	173 [86, un]	135 (63)	15 [0, 24]	1 [0, 9]
<i>P</i> value		.134	.034	.022	.014	.020
Nonoperative MCL	287	194 (68)	163 [75, un]	189 (66)	16 [1, 26]	2 [0, 11]
Operative MCL	14	9 (64)	180 [91, un]	11 (79)	15 [7, 20]	3 [0, 4]
<i>P</i> value		.777	.814	.398	.498	.517
MCL edema or chronic scarring	235	161 (69)	162 [75, un]	164 (70)	17 [3, 26]	2 [0, 11]
Partial or full MCL tear	66	42 (64)	186 [90, un]	36 (55)	13 [0, 24]	0 [0, 9]
<i>P</i> value		.461	.315	.027	.145	.590

^aData expressed as n (%) or median [first quartile, third quartile]. "un" indicates undrafted. NFL, National Football League.

^b*P* values correspond to Fisher exact test.

^c*P* values correspond to Mann-Whitney *U* test.

Our results may be due to confounding variables such as collegiate or combine performance, interview results, off-field issues, and team needs. In contrast, a prior investigation by Brophy and colleagues² found that quarterbacks with prior MCL injury had a decreased probability of playing in the NFL ($P = .03$).

Further soft tissue injury was identified on slightly more than half (55%) of the knee MRI scans, with meniscal injury being the most common (44%). MRI is a useful imaging study in the diagnostic workup of an acute MCL injury to evaluate the extent of medial-sided injury as well as to look for further soft tissue and bony injury. However, without the use of valgus stress radiographs,⁹ MRI cannot delineate the extent of the injury in the setting of chronic MCL tears. Valgus stress radiographs provide objective and reproducible measurements of lateral compartment gapping; these measurements provide utility for the diagnosis, management, and postoperative follow-up of patients with medial knee injuries.

In our study, we found that players with a history of an isolated MCL injury performed significantly better compared with athletes who had combined injuries. Players with isolated MCL injury had significantly better draft position, proportion playing at least 2 seasons in the NFL, and games played and games started in the first 2 years. This indicates that a history of a previous MCL tear did not affect a player's future NFL performance.

Limitations

The limitations of this study include the restraints associated with a retrospective study design. A potential for inaccuracies in reporting injuries at the NFL Combine exists, and a lack of suspicion for knee injury by the physicians diagnosing these injuries may result in a missed MCL injury. Draft position and NFL performance are highly multifactorial and are influenced by talent, experience, injury history, and many other variables. Analysis of the

present data is limited to associative interpretation rather than causal inference. Further, this study largely evaluated healed MCL tears and did not control for associated injuries, such as meniscal tears, which may confound our results. The data on MCL tears identified only current injuries and not specific surgical procedures, so those athletes who underwent surgery could be stratified into specific procedures or the effects of these interventions on their outcomes. Despite these limitations, these findings are useful to assist the counseling of future players by team physicians and to help determine optimal management of athletes with MCL injury.

CONCLUSION

A relatively high percentage of players at the NFL Combine had evidence of MCL injury (13%). A prior history of MCL tear had no negative impact on an athlete's NFL performance. Players with isolated MCL injury performed significantly better compared with athletes who had combined injuries with regard to draft position, proportion playing 2 seasons or more in the NFL, and games played and started in the first 2 years.

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