Meniscectomy and Resultant Articular Cartilage Lesions of the Knee Among Prospective National Football League Players

An Imaging and Performance Analysis

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Background: The effect of prior meniscectomy and the resulting reduction in meniscal tissue on a potential National Football League (NFL) player's articular cartilage status and performance remain poorly elucidated.

Purpose/Hypothesis: (1) To determine the epidemiology, imaging characteristics, and associated articular cartilage pathology of the knee among players with a previous meniscectomy who were participating in the NFL Combine and (2) to evaluate the effect of these injuries on performance as compared with matched controls. The hypothesis was that players with less meniscal tissue would have worse cartilage status and inferior performance metrics in their first 2 NFL seasons.

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

Methods: All athletes with a history of a meniscectomy and magnetic resonance imaging scan of the knee who participated in the NFL Combine (2009-2015) were identified. Medical records and imaging were analyzed, and surgical history, games missed in college, position played, and draft position were documented. The conditions of the meniscus and cartilage were graded with modified ISAKOS scores (International Society of Arthroscopy, Knee Surgery and Orthopaedic Sports Medicine) and ICRS scores (International Cartilage Repair Society), respectively. Players with a previous meniscectomy of at least 10% of total medial or lateral meniscal volume excised (ISAKOS meniscus grade $\leq$8) and matched controls without a significant pre-Combine injury were similarly evaluated and compared by position of play through analysis of draft position, number of games played and started, and how many eligible plays they participated in (snap percentage) within the first 2 NFL seasons.

Results: Of the 2285 players who participated in the NFL Combine (2009-2015), 287 players (322 knees) had a prior meniscectomy (206 lateral, 81 medial). Among these players, 247 (85%) had a total of 249 chondral lesions, most commonly on the lateral femoral condyle (111 lesions, 45%). There was a significant inverse correlation found between the ISAKOS medial and lateral meniscus grade and the corresponding compartment chondral lesion grade (P = .001). A poorer meniscus score was also associated with worse chondral pathology, especially in the lateral compartment. After controlling for position of play, the injury-free control group had a significantly greater number of total games played and games started and higher snap percentage versus those with a prior meniscectomy of at least 10% volume (ISAKOS meniscus grade $\leq$8). Players with severe chondral lesions (ICRS grade 4) in the medial and lateral compartments had significantly worse performance metrics when compared with matched controls.

Conclusion: Previous meniscectomy of at least 10% of total medial or lateral meniscus volume in prospective NFL players was significantly correlated with larger and more severe chondral lesions. Chondral and meniscal defects of the knee were found to result in a significant decrease in objective performance measures during a player's initial NFL career versus matched controls. Given these findings, players with a prior meniscectomy with evidence of chondral damage should be evaluated carefully for their overall functional levels; however, additional work is needed to fully clarify the effect of prior knee meniscal surgery on overall NFL performance.

Keywords: NFL Combine; meniscus tears; cartilage; knee; contact athlete; performance

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Healthy meniscal and chondral tissue is important for optimal function of the knee, especially in high-level contact athletes such as National Football League (NFL)

players.[9,12,15] Meniscal tears and meniscectomies have been reported to result in a greater likelihood of the development of subsequent articular cartilage lesions,[7,10,11,14,20] likely resulting from altered knee joint biomechanics. Although the precise incidence and demographics of articular cartilage lesions are unknown, full-thickness defects have been reported to be more common in athletes and active patients in comparison with the general population.[8,18] Specifically, meniscal tears have been demonstrated to accelerate the development of knee osteoarthritis in contact athletes. Smith et al[16] performed a review of college football athletes from 2005 to 2009 and reported that a prior anterior cruciate ligament reconstruction or meniscectomy was significantly associated with knee osteoarthritis. Similarly, meniscectomy was found to be a strong risk factor for focal cartilage defects.[13]

However, the incidence and extent of previous meniscectomies and how this affects a potential NFL player's articular cartilage status and performance remain poorly elucidated. Therefore, the purposes of this study were (1) to determine the epidemiology, imaging characteristics, and associated cartilage pathology of the knee among players with a previous meniscectomy who were participating in the NFL Combine and (2) to evaluate the effect of these injuries on NFL performance metrics as compared with matched controls. The hypothesis was that players with less meniscal tissue would have worse cartilage status and a poorer performance in the first 2 NFL seasons.

METHODS

Study Design

Our institution's Institutional Review Board (protocol 2015P002224/MGH) and the NFL Physician Society Research Committee approved this study. A retrospective review of all players who participated in the NFL Combine between 2009 and 2015 and who had a history of meniscal surgery was completed to identify those players who previously underwent a meniscectomy. This was done via an iterative process analyzing each player's existing medical records, surgical history, presence of surgical knee incisions, and review of prior operative reports. At the NFL Combine, the medical staff of each of the 32 NFL teams performed a musculoskeletal evaluation of each player, and a comprehensive orthopaedic note was dictated following examination of the athlete. All injury data were collected through review of the injury data registry available to the medical and training staff of all NFL teams after the completion of the NFL Combine. These notes were reviewed and analyzed for involved structures, residual injury, and associated soft tissue and bony pathology of the knee. Additionally, magnetic resonance imaging (MRI) was performed at the NFL Combine in the presence of a prior knee surgery.

Inclusion criteria were any prospective NFL player with a previous meniscectomy who was examined at the NFL Combine between 2009 and 2015 and who was concurrently evaluated with MRI of the surgical knee. Exclusion criteria included any player with no evidence of meniscectomy on MRI or players with a previous meniscectomy with concomitant ligamentous injury as confirmed on physical examination and imaging. Meniscal root tears were excluded from the analysis. Additionally, players who did not have an MRI scan available to review were excluded.

The control group was composed of players who participated in the NFL Combine from 2009 to 2015 and based on the following criteria: (1) no prior knee injury, (2) no significant missed time before the NFL ($\leq$2 total missed games in college), (3) no history of knee surgery before the NFL Combine, and (4) drafted in the NFL Draft following the NFL Combine. For both groups—players with a previous meniscectomy and players in the control group—the number of games missed during collegiate play, position of play, and draft position were collected. Undrafted players in the study group were given a draft round of 8 with a draft number of 254 to assign them a numerical value.

Imaging Evaluation

Meniscus. MRI imaging was reviewed to assess for meniscal injury as well as any associated injuries. Coronal, axial, and sagittal T1- and T2-weighted MRI cuts were used to identify the degree of meniscal tissue excised during the index meniscectomy. Classification of meniscal volume was performed with a modified International Society of Arthroscopy, Knee Surgery and Orthopaedic Sports Medicine (ISAKOS) classification[1,19] (Figure 1). The modified ISAKOS score was based on a 0 to 9 scale. Each anatomic region of the meniscus was graded on a scale of 0 to 3. The scores for each anatomic region of the meniscus were then summed. A score of 9 indicated that no meniscus volume had been excised, while a score of 1 indicated that

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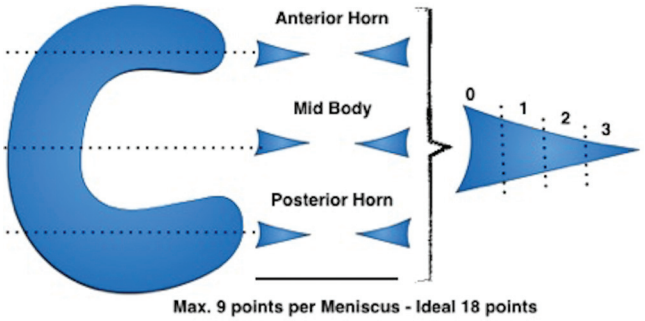

Figure 1. Schematic representation of the modified International Society of Arthroscopy, Knee Surgery and Orthopaedic Sports Medicine classification for remnant meniscal tissue.

90% of meniscus volume had been previously resected (Figures 1 and 2).

Cartilage. To evaluate chondral lesions, imaging was analyzed to determine the location, depth, and size of the defect. Chondral lesion location was grouped into medial compartment (medial femoral condyle, medial tibial plateau) and lateral compartment (lateral femoral condyle and lateral tibial plateau) for statistical analyses. The International Cartilage Repair Society (ICRS) classification was utilized to describe chondral lesions, which were grouped into 3 categories: no lesion, shallow chondral damage, ICRS grades 1-3; full-thickness chondral defect, ICRS grade 4 (Figure 3).

Performance Outcomes

To analyze performance during their initial NFL careers, players participating in the NFL Combine from 2009 to 2015 with a meniscal injury were compared with matched controls. Controls were matched by position of play to all players with a history of a previous meniscectomy. All players were organized according to the following positions of play: offensive lineman, quarterback, running back, wide receiver, tight end, defensive lineman, linebacker, and defensive back. Athletes were evaluated by analysis of draft position, number of games played and started, and snap percentage (defined as the total number of plays in which a player participated out of the total number of plays for which the player was eligible to participate over the course of a season) during the first 2 NFL seasons. The number of games played and started during the first 2 seasons of play was obtained from STATS.com, while the snap percentage for each of the first 2 seasons of play was collected with profootballfocus.com.

Statistical Analysis

The primary aims of this analysis were (1) to evaluate if the amount of excised meniscus correlated with the severity of chondral damage and (2) to identify if there was a relationship between amount of meniscus excised and player performance in the first 2 seasons of play and to compare the performance of these players with healthy matched controls. To evaluate the effect of meniscal excision on performance, players with at least 10% excision (ISAKOS score $\leq$8) of either the lateral or medial meniscus were grouped. A more detailed analysis of meniscal pathology was not performed owing to the insufficient injury volume at each position. These players were then evaluated to determine if the degree of meniscal excision correlated with performance. Following correlation analysis, these players' performance during the first 2 seasons of NFL play was compared with the performance of the control group. To evaluate for correlation, Spearman's rho tests were used and significance defined as $P < .05$. To compare the performance of players with prior meniscectomy with that of the control group, a Mann-Whitney U test was utilized. Similarly, to compare the performance of players who underwent prior meniscectomy in conjunction with an ICRS grade 4 cartilage lesion with that of control players, a Mann-Whitney U test was used. Inter- and intrarater agreement was assessed with 50 randomly selected player MRI scans by 3 investigators (J.C., J.A.G., G.F.L.). MRI measurements were used with a 2-way random effects model to calculate the intraclass correlation coefficient (ICC). The ICC values were interpreted as follows: ICC $<$ 0.40, poor agreement; 0.40 $\leq$ ICC $\leq$ 0.75, fair to good agreement; ICC $>$ 0.75, excellent agreement. For all measurements, ICC was $>$0.86. All statistical analyses were performed with SPSS Statistics (v 24.0; IBM).

Figure 2. Left knee magnetic resonance imaging (T1) demonstrating a previously excised medial meniscus with extrusion of the remnant tissue (assigned 1 of 3) in this cut of the body of the meniscus.

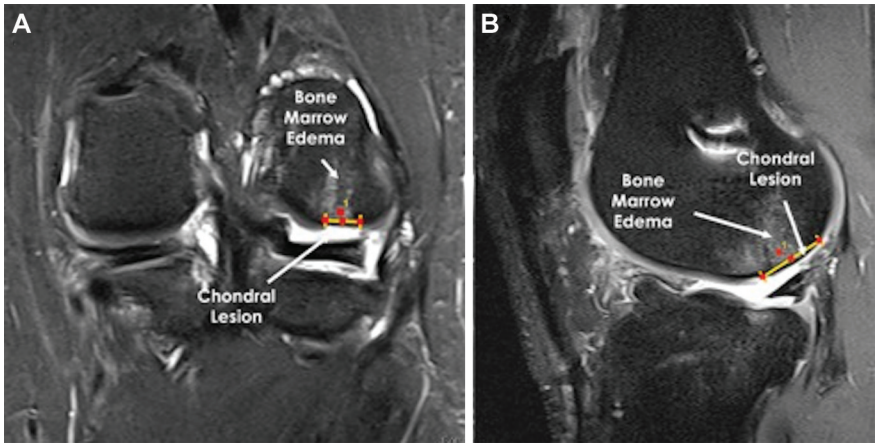

Figure 3. (A) Coronal and (B) sagittal magnetic resonance imaging (T2) demonstrating a full-thickness chondral defect (International Cartilage Repair Society grade 4) in a right knee. The chondral defects are measured through use of the in-system imaging software. Of note, bone marrow edema can be observed in the lateral femoral condyle.

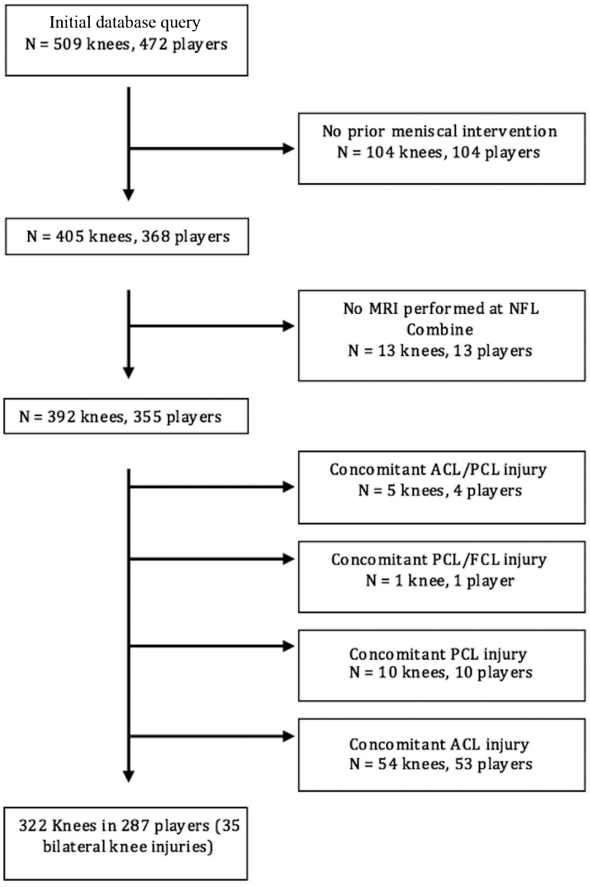

Figure 4. Flowchart demonstrating distribution of patients included and excluded in the final performance analysis. For players who had bilateral knee meniscectomies (n = 35), the knee with the greatest amount of meniscus resected was used in the analysis. ACL, anterior cruciate ligament; FCL, fibular collateral ligament; MRI, magnetic resonance imaging; NFL, National Football League; PCL, posterior cruciate ligament.

RESULTS

Patient Demographics

Initial review of the 2285 players who participated in the NFL Combine between 2009 and 2015 yielded 472 eligible players (509 knees) with a meniscal injury. A total of 185 players (187 knees) were removed from the final analysis, owing to a lack of a prior meniscal procedure, insufficient imaging, or concomitant ligamentous injury, producing a study population of 287 players (322 knees) with prior meniscectomy (81 medial meniscectomies, 206 lateral meniscectomies). A flowchart of patient selection is shown in Figure 4. Of the 287 included players, 247 (85%) had a total of 249 chondral lesions, most commonly located on the lateral femoral condyle (111 lesions, 45%). The prior meniscectomy group had a mean draft round pick of 2.3, with a mean overall draft pick number of 113.5.

The control group, made up of 300 players who fulfilled the criteria as described, included 40 offensive linemen, 33 quarterbacks, 40 running backs, 40 wide receivers, 27 tight ends, 40 defensive linemen, 40 linebackers, and 40 defensive backs. These players demonstrated a mean draft round of 3.8 with a mean overall draft pick number of 113.4. A total of 682 of 2285 (29.8%) athletes were excluded from the control group, given that they missed >2 games during their college careers as a result of injury. There was no significant difference between the control group and prior meniscectomy group with respect to mean overall draft pick number (P = .714).

Amount of Meniscus Excised and Cartilage Status

Players with lateral meniscus ISAKOS grades of 0 to 6 had a significantly greater number of lateral compartment full-thickness chondral lesions when compared with players with lateral meniscus ISAKOS grades of 7 to 9 (P = .016). Additionally, a significantly greater number of full-thickness lesions >1 cm^2 were identified in players with lateral meniscus ISAKOS grades of 0 to 6 (P = .030). The

TABLE 1
Player Demographic Data and Concomitant Injury Details: Meniscus Pathology[a]

Location (Prior Meniscectomy; n = 287)	Distribution of Associated Chondral ICRS score in Compartment	
	With Prior Meniscectomy	Without Prior Meniscectomy
Medial meniscus (n = 81)		
ISAKOS scores 0-3 (n = 5)		
Grades 1-3	MFC: 0	LFC: 0
Grade 4	MFC: 3	LFC: 0
Grades 1-3	MTP: 0	LTP: 0
Grade 4	MTP: 3	LTP: 1
ISAKOS scores 4-6 (n = 10)		
Grades 1-3	MFC: 2	LFC: 1
Grade 4	MFC: 8	LFC: 1
Grades 1-3	MTP: 2	LTP: 1
Grade 4	MTP: 5	LTP: 0
ISAKOS scores 7 and 8 (n = 66)		
Grades 1-3	MFC: 25	LFC: 7
Grade 4	MFC: 4	LFC: 4
Grades 1-3	MTP: 12	LTP: 4
Grade 4	MTP: 3	LTP: 3
Lateral meniscus (n = 206)		
ISAKOS scores 0-3 (n = 10)		
Grades 1-3	LFC: 0	MFC: 0
Grade 4	LFC: 5	MFC: 0
Grades 1-3	LTP: 3	MTP: 0
Grade 4	LTP: 7	MTP: 0
ISAKOS scores 4-6 (n = 76)		
Grades 1-3	LFC: 24	MFC: 11
Grade 4	LFC: 20	MFC: 3
Grades 1-3	LTP: 13	MTP: 6
Grade 4	LTP: 17	MTP: 0
ISAKOS scores 7 and 8 (n = 120)		
Grades 1-3	LFC: 27	MFC: 11
Grade 4	LFC: 28	MFC: 7
Grades 1-3	LTP: 24	MTP: 8
Grade 4	LTP: 7	MTP: 1

[a]The modified ISAKOS score was based on a 0-9 scale: a score of 9 indicates a presence of all meniscal tissue, while a score of 0 indicates complete excision of all meniscal tissue. Grades listed are ICRS grades. ISAKOS, International Society of Arthroscopy, Knee Surgery and Orthopaedic Sports Medicine; LFC, lateral femoral condyle; LTP, lateral tibial plateau; MFC, medial femoral condyle; MTP, medial tibial plateau.

distribution of meniscal and chondral lesions by location with the modified ISAKOS and ICRS scores for the 287 players' knees with a confirmed prior meniscectomy is summarized in Tables 1 and 2.

Correlation Analysis Between Remaining Meniscal Tissue and Chondral Damage

A significant negative correlation was found between the amount of medial and lateral meniscus remaining at the time of evaluation and the severity of medial and lateral chondral lesions (inverse relationship between the amount of meniscus remaining and the severity of chondral lesions). Detailed correlation analysis of the relationship between amount of medial and lateral meniscus excised and chondral damage is reported in Table 3. Nonsignificant Spearman correlation coefficients were found between (1) the amount of meniscal excision and chondral damage and (2) all performance metrics.

TABLE 2
Player Demographic Data and Concomitant Injury Details: Chondral Pathology in Compartment of Previous Meniscectomy

Location	Chondral Lesions (n = 249)		ICRS Score[a]	
	No.	Mean Size, cm^2	Grades 1-3	Grade 4
Medial femoral condyle	42	1.49	27	15
Medial tibial plateau	25	0.891	14	11
Lateral femoral condyle	111	1.29	51	60
Lateral tibial plateau	71	0.891	40	31

[a]The International Cartilage Repair Society (ICRS) classification was utilized to describe chondral lesions, which were grouped into 3 categories: no lesion, shallow chondral damage (grades 1-3) and full-thickness chondral defect (grade 4).

TABLE 3
Spearman Correlation Coefficient Between Amount of Meniscus Remaining After Meniscectomy and Chondral Defect Grade and Size by Intra-articular Location

Location: Chondral Grade/Size	Rho[a]	*P* Value
Medial femoral condyle		
Grade	–0.283	<.001[b]
Size	–0.130	.021[b]
Medial tibial plateau		
Grade	–0.323	<.001[b]
Size	–0.050	.377
Lateral femoral condyle		
Grade	–0.521	<.001[b]
Size	–0.297	<.001[b]
Lateral tibial plateau		
Grade	–0.470	<.001[b]
Size	–0.211	<.001[b]

[a]A larger absolute value of the Spearman correlation coefficient (rho) indicates a stronger correlation; negative values indicate an inverse relationship between the 2 factors being analyzed. Values are based on the amount of meniscus remaining in the corresponding compartment per modified International Society of Arthroscopy, Knee Surgery and Orthopaedic Sports Medicine score (0-9).
[b]Indicates significance ($P < .05$).

Prior Meniscectomy Cohort Performance Versus Control Group Performance

Running backs, wide receivers, offensive linemen, defensive linemen, and linebackers who had at least 10% of

TABLE 4
Comparison of Performance Metrics of Quarterbacks, Running Backs, Wide Receivers, Tight Ends, and Defensive Backs With and Without Prior Meniscectomy[a]

	Season 1		Season 2		Snap Percentage	
	Games Played	Games Started	Games Played	Games Started	Season 1	Season 2
Quarterbacks						
With prior meniscectomy (n = 14)	3.9	3.4	4.8	2.4	19.9	40.6
Without prior meniscectomy (n = 33)	5.9	4.2	8.5	7.3	37.3	23.1
P value	.182	.511	.003[b]	.001[b]	.109	.075
Running backs						
With prior meniscectomy (n = 35)	6.6	1.3	6.4	2.1	17.1	19.3
Without prior meniscectomy (n = 40)	11.5	2.9	11.1	3.6	25.6	27.1
P value	<.001[b]	.050[b]	<.001[b]	.170	.050[b]	.148
Wide receivers						
With prior meniscectomy (n = 32)	9.1	2.0	8.7	3.7	26.6	50.0
Without prior meniscectomy (n = 40)	13.3	4.6	13.3	8.2	47.5	58.5
P value	.002[b]	.020[b]	.001[b]	.001[b]	<.001[b]	.667
Tight ends						
With prior meniscectomy (n = 20)	7.7	1.8	9.8	3.7	22.5	37.9
Without prior meniscectomy (n = 27)	11.6	4.4	12.8	5.5	32.4	69.2
P value	.042[b]	.025[b]	.137	.232	.135	.383
Defensive backs						
With prior meniscectomy (n = 46)	7.8	2.9	5.2	2.9	29.7	28.4
Without prior meniscectomy (n = 40)	13.5	7.4	12.8	7.2	60.3	60.0
P value	<.001[b]	<.001[b]	<.001[b]	.002[b]	<.001[b]	<.001[b]

[a]All variables, including games played, games started, and snap percentage, are presented as mean values.
[b]Denotes statistical significance, $P < .05$.

the meniscus (medial or lateral) resected before the combine had significantly worse performance metrics when compared with uninjured controls. Players with ICRS grade 1 to 3 medial compartment lesions who underwent prior medial meniscectomy were found to have significantly worse ($P < .001$) scores in all performance metrics except for season 1 snap percentage ($P = .465$). Similarly, players with ICRS grade 1 to 3 lateral compartment lesions who underwent prior lateral meniscectomy were found to have significantly worse ($P < .001$) scores in all performance metrics as compared with uninjured controls. Detailed comparison and performance metrics are reported for skill players in Table 4 and for linemen and linebackers in Table 5.

Medial Compartment Chondral Defects Effect on Performance

Given the significant correlation found between amount of medial meniscus excised and degree of medial chondral damage (Table 3), the players with at least 10% of their medial meniscus excised during a prior meniscectomy (n = 81) were further analyzed. Of these players, those with an ICRS grade 4 lesion of either the medial tibial plateau or medial femoral condyle were grouped and compared with the control athletes. Players with a prior medial meniscectomy who also had medial compartment ICRS grade 4 lesions performed worse in their first 2 seasons of play when compared with patients with a previous meniscectomy with no grade 4 chondral lesions.

Lateral Compartment Chondral Defect Effect on Performance

Given the significant correlation found between the amount of lateral meniscus excised and the degree of lateral compartment chondral damage (Table 3), players with prior lateral meniscectomy (n = 206) were divided by ICRS grade corresponding to the lateral compartments. Patients with ICRS grade 4 lesions in either the lateral tibial plateau or lateral femoral compartment were grouped and compared with the control group. In general, players with a prior lateral meniscectomy who also had lateral compartment ICRS grade 4 lesions performed worse in their first 2 seasons of play.

DISCUSSION

The most important finding of this study was that there was an inverse relationship between the amount of meniscus remaining and the presence/severity of chondral lesions in prospective NFL players with a previous medial and/or lateral meniscectomy. Additionally, players with prior meniscectomy performed significantly worse in their first 2 seasons of NFL play as compared with matched controls in the majority of positions. Specifically, players with a meniscectomy involving at least 10% of the meniscus resulted in significantly fewer total games played and started and a significantly lower snap percentage during the first 2 seasons of play as compared by position of play

TABLE 5
Comparison of Performance Metrics Between Linemen and Linebackers With and Without Prior Meniscectomy[a]

	Season 1		Season 2		Snap Percentage	
	Games Played	Games Started	Games Played	Games Started	Season 1	Season 2
Offensive linemen						
With prior meniscectomy (n = 62)	6.4	3.6	6.7	4.6	30.7	36.9
Without prior meniscectomy (n = 40)	10.0	7.3	11.6	8.9	54.5	63.9
P value	.006[b]	.007[b]	<.001[b]	.002[b]	.004[b]	.002[b]
Defensive linemen						
With prior meniscectomy (n = 48)	6.9	1.7	7.5	3.7	20.8	28.8
Without prior meniscectomy (n = 40)	14.1	5.1	13.7	8.2	41.8	51.2
P value	<.001[b]	<.001[b]	<.001[b]	.002[b]	<.001[b]	<.001[b]
Linebackers						
With prior meniscectomy (n = 30)	8.8	4.9	7.0	3.6	27.1	28.3
Without prior meniscectomy (n = 40)	13.7	6.9	13.8	8.8	45.9	47.8
P value	<.001[b]	.195	<.001[b]	<.001[b]	.013[b]	.023[b]

[a]All variables, including games played, games started, and snap percentage, are presented as mean values.
[b]Denotes statistical significance, $P \leq .05$

with matched controls. Moreover, the presence and grade of lateral femoral condyle and tibial plateau articular cartilage chondromalacia significantly affected games started and played and snap percentage. In addition, medial compartment chondral lesions (medial tibial plateau and medial femoral condyle) led to significantly fewer total games played and games started and a lower snap percentage for the majority of positions.

Meniscal and chondral injuries have been reported to be common in high-level football players. With regard to meniscal injuries, >12% of the NFL Combine participants between 1987 and 2000 demonstrated a meniscal tear.[3,13] Aune et al[2] reported a high rate of return to sport among active NFL players who underwent a lateral meniscectomy. However, this study simply reported return to play (defined as playing at least 1 game after meniscectomy) and did not assess any long-term effects, such as the effects on performance, career length, or development of chondral lesions and osteoarthritis. Brophy et al[4] examined the effects of anterior cruciate ligament reconstruction and meniscectomy and reported that a history of meniscectomy, but not anterior cruciate ligament reconstruction, significantly shortened the average length of an NFL career. This conclusion stands to reason, as meniscectomy has been demonstrated to alter joint loading and biomechanics, with increased joint pressure and instability. The increased joint pressure is detrimental to cartilage health and leads to osteoarthritis on a long-term basis.[1]

In this study, based on 287 patients with a meniscectomy, 247 (77%) had chondral lesions, most commonly on the lateral femoral condyle (127 lesions, 40%). Likewise, Brophy et al[6] identified 118 cases of articular cartilage injuries in NFL players from 1992 to 2006. Similar to the findings of the present study, the authors reported that injuries were more likely to occur in games rather than practice, with half the injuries seen in linemen. Moreover, most of these articular cartilage injuries involved the femoral condyles.[6] Full-thickness cartilage defects of the knee have been shown to have a high prevalence in this population. Nepple et al[13] reported that 17.3% of participants at the NFL Combine from 2005 to 2009 who underwent knee MRI had radiographic evidence of full-thickness cartilage loss. The authors found that these cartilage defects were associated with a history of prior meniscectomy. There are few reports regarding return to play after surgical treatment of knee cartilage lesions. Scillia et al[15] examined NFL players who were treated with chondroplasty and found that of 52 players, 36 (67%) were able to return to play at the NFL level. The authors concluded that the surgical procedure of microfracture was associated with a decreased chance of return to play.[15] Steadman et al[17] documented that 19 of 25 (76%) NFL players ultimately returned to play after microfracture and that those who did had an average career length of 4.6 years. Taken with the findings of the present study, it is evident that chondral injuries have the ability to shorten NFL careers; however, there is a lack of a consensus for the optimal treatment of these lesions.

In general, injuries have been shown to have a negative effect on the performance and longevity of NFL careers, regardless of injury location or severity or position of play.[4,5] The data from this study further demonstrate the negative effects that meniscal and chondral lesions have on an NFL player's performance and longevity. Specifically, this study points to the direct relationship between the amount of meniscus excised and the resulting chondral damage. Our findings further confirm the relationship between the condition of the meniscus and the presence/severity of chondral lesions of the knee via grading of players' MRI scans with comprehensive scoring systems. Aside from this, our results also demonstrate poorer performance during the initial seasons of NFL careers with a worse condition of the meniscus and cartilage of the ipsilateral knee across most compartments. Given the high-contact nature of the sport and regular exposure of high loads, it is possible that resection of the meniscus leads to an expedited

onset of osteoarthritis, resulting partially from chondral lesions across various compartments.

We acknowledge some limitations of this study, including the restraints associated with the retrospective nature of the study design and potential inaccuracy in the reporting of injuries at the NFL Combine. Furthermore, the imaging available for review (MRI) was not performed at the time of injury but rather obtained at the Combine. The evaluated time span (ie, the first 2 seasons of NFL play) may be insufficient to truly demonstrate the subjective and objective effects of meniscal and chondral pathology, as osteoarthritis and joint degeneration are progressive. We also acknowledge the effect of multiple variables, outside the condition of the player's menisci and knee cartilage, which factor into the objective measurements utilized to compare our patient and control groups. Furthermore, this study does not differentiate between surgeons and surgical technique, nor was rehabilitation protocol information available for analysis. Despite these limitations, these findings may be used to assist team physicians to counsel future players and determine optimal management of chondral or meniscal injuries in contact athletes. Future studies should further investigate the effects of these injuries on career length and thoroughly analyze the effect of these injuries in specific positions of play.

CONCLUSION

Previous meniscectomy of at least 10% of total medial or lateral meniscus volume in prospective NFL players was significantly correlated with larger and more severe chondral lesions. Chondral defects at the medial and lateral tibial plateau and femoral condyle were found to result in a significant decrease in objective performance measures during players' initial NFL careers versus those of matched controls. Given these findings, players with a prior meniscectomy with evidence of chondral damage should be evaluated carefully for their overall functional levels.

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