Incidence of Knee Cartilage Pathology on Magnetic Resonance Imaging and Correlation to Clinical Symptoms and Orthopaedic History Among Players at the National Basketball Association Draft Combine

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Investigation performed at Northwestern University, Chicago, Illinois, USA

Background: High-level basketball athletes at the collegiate level and in the National Basketball Association (NBA) have a greater proportion of knee cartilage pathology than the nonathlete population. However, little is known as to whether identified pathology on knee magnetic resonance imaging (MRI) correlates with clinical symptoms or orthopaedic history in these players.

Purposes: (1) To evaluate knee MRI scans in a cross-sectional population of NBA Draft Combine players to establish prevalence of knee pathology, including that of articular cartilage and meniscus in professional basketball players. (2) To identify independent variables including demographic characteristics, playing history, previous knee injury, and symptoms that correlate to these MRI findings.

Study Design: Cross-sectional study; Level of evidence, 3.

Methods: Players from the NBA Draft Combine over a 2-year period voluntarily participated by undergoing bilateral knee MRI scanning and completing clinical questionnaires. MRI scans were independently and blindly evaluated by 2 radiologists for cartilage assessment (using modified Noyes score) and meniscal pathology. Associations between imaging findings and pain/function scores and orthopaedic history were evaluated.

Results: A total of 43 players (80 knees) were included. Intraclass correlation coefficients were a mean of 0.827 for agreement and 0.831 for consistency for the modified Noyes score. Cartilage pathology was identified in 48.3% of knees, with the most common locations being the patella and trochlea. Previous knee surgery was associated with lateral tibial plateau chondral pathology (odds ratio [OR], 6.58; P = .04). Reduced function scores were predictive of cartilage pathology on the lateral femoral condyle (OR, 0.55; P = .03). Increased pain scores were associated with a nonzero modified Noyes score (OR, 6.11; $P < .01$).

Conclusion: The incidence of pathology identified on knee MRI scans in players at the NBA Draft Combine without clinical symptoms was high, in line with the hypothesis. Little correlation was found between the objective imaging findings and subjective pain, function, and orthopaedic injury history. Clinicians treating high-level athletes should focus on treating clinically significant findings and be cautious about treating pathology found on imaging that may not explain or correlate with symptoms. It remains critical to study the natural history of imaging findings in these athletes to better ascertain the ultimate effect of sport and physiologic load on disease progression.

Keywords: knee; articular cartilage; meniscus; basketball; magnetic resonance imaging; professional athlete; National Basketball Association

Little is known about the effects of activity level on the incidence and progression of articular cartilage pathology of the knee. Both in vitro and in vivo studies have sought to investigate the effect of physical activity on articular cartilage, with most studies demonstrating that activity exposure does not lead to lasting deformation or

The American Journal of Sports Medicine
1–8
DOI: 10.1177/03635465251381362

deleterious effects.[10,21,22] High-level athletes with more intense training demands and levels of competition face greater loads at higher frequency than recreational athletes.[17] Higher physical activity level has been associated with a greater prevalence of focal knee abnormalities in the meniscus, cartilage, and ligaments on magnetic resonance imaging (MRI) independent of other risk factors.[27] Changes may also be specific to the loading demands by sport and competition.[3,9,11,25,26] In the National Basketball Association (NBA), 62% of injuries are to the lower extremity; knee injuries are particularly common, and certain knee injuries such as knee contusion/bone bruise and patellofemoral joint injuries are among the most physically and economically impactful injuries in terms of subsequent games missed.[1,2,6-8,18] Accordingly, many studies in these high-level basketball players consistently identify asymptomatic abnormalities in the knee, and it is possible these will later become symptomatic given the demands of sport.[14,19,24,28]

Pappas et al,[24] evaluating asymptomatic collegiate-level male and female basketball players at the beginning and end of a single season of basketball, found not only a high incidence of pathology but also a significant increase in cartilage injury score (P = .0009) and an increase in percentage with cartilage findings from 71% to 81% in the preseason to postseason. Kaplan et al[14] evaluated 40 knees in 20 asymptomatic NBA players with MRI over a 3-year period, finding a higher incidence of cartilage pathology (47.5% in total) in both load-bearing and non–load bearing surfaces relative to a nonathlete asymptomatic population. These findings are consistent with other studies in collegiate and professional basketball players.[19,28] Despite these studies demonstrating knee pathologies in asymptomatic elite-level basketball players, minimal data are available correlating such MRI findings with clinical symptoms. Furthermore, it is unclear how many of these abnormalities were preexisting or when they developed during the athlete's career.

The aims of the present study were to (1) evaluate knee MRI scans in a cross-sectional population of NBA Draft Combine players to establish prevalence of knee pathology, including that of articular cartilage, meniscus, and subchondral bone in professional basketball players, and (2) identify independent variables including demographic characteristics, play history, previous knee injury, and symptoms that correlate to these MRI findings. We hypothesized that the prevalence of pathology identified in NBA Combine athletes' knees would be high but that there would be few correlations to pain and function or to orthopaedic history.

METHODS

Study Design and Participant Recruitment

As part of the NBA & GE Healthcare Orthopedics and Sports Medicine Collaboration, members of the Collaboration's Steering Committee developed a recommended knee MRI protocol for the baseline assessment of NBA players. Participants at the NBA Draft Combine over a 2-year period (specific years omitted to preserve player anonymity) consented to voluntarily participate in this study by undergoing bilateral knee MRI using the baseline knee MRI protocol and completing clinical questionnaires. This cross-sectional design study was approved by the Northwestern University Institutional Review Board (IRB No. STU00205087) and the NBA and Players Association.

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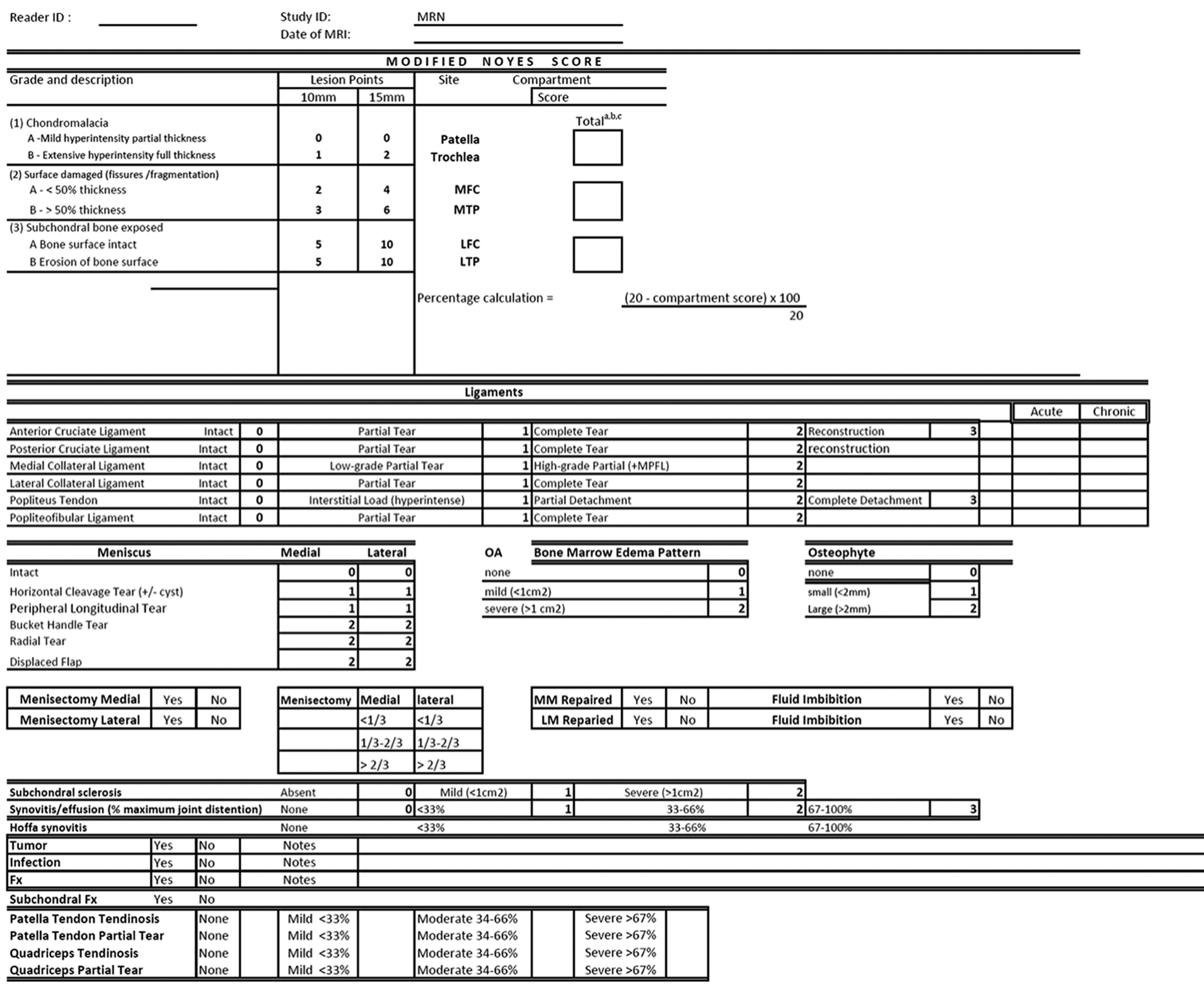
Submitted September 23, 2024; accepted August 4, 2025.

Presented as a poster at the annual meeting of the AOSSM, Nashville, Tennessee, July 2025.

One or more of the authors has declared the following potential conflict of interest or source of funding: This work is supported by the National Basketball Association & GE Healthcare Orthopedics and Sports Medicine Collaboration. S.A. has received honoraria from Encore Medical, other financial or material support from Smith & Nephew, and hospitality payments from Stryker. J.C. is a paid consultant for Arthrex, Conmed Linvatec, Ossur, RTI Surgical, Smith & Nephew, and Vericel; has received hospitality payments from Medical Device Business Services; has received support for education from Medwest Associates; and has received speaking fees from Synthes. A.B. has received IP royalties from Arthrex; is a paid consultant for Arthrex and Collagen Matrix; has received hospitality payments from DJO, Foundation Medical, GE Healthcare, and Synthes; has received speaking fees from Synthes; has received support for education from Arthrex; and receives publishing royalties or financial or material support from Slack and Springer. J.M.P. has received hospitality payments from GE Healthcare. H.G.P. has received research support from GE Healthcare, National Institutes of Health (National Institute of Arthritis and Musculoskeletal and Skin Diseases [NIAMS] and National Institute of Child Health and Human Development [NICHD]), and Seimens; has received hospitality payments from GE Healthcare and Siemens; owns stock or stock options in Imagen; and is a paid consultant for Smith & Nephew, Stryker, and UCB. B.J.C. is a paid consultant for Acumed, Aesculap/B.Braun, Arthrex, DJO, Endo Pharmaceuticals, Ossio, Regentis, and Samumed; has received research support from Aesculap/B.Braun, Arthrex, National Institutes of Health (NIAMS and NICHD), and Regentis; receives IP royalties from Arthrex and Elsevier; has received other financial and material support from Athletico, JRF Ortho, and Smith & Nephew; owns stock or stock options in Bandgrip, Ossio, and Regentis; has received support for education from Endo Pharmaceuticals; has received publishing royalties or financial or material support from *Operative Techniques in Sports Medicine;* and has received speaking fees from Terumo BCT and Vericel. AOSSM has not conducted an independent investigation on the OPD and disclaims any liability or responsibility relating thereto. Ethical approval for this study was obtained from Northwestern University (IRB No. STU00205087).



Reader ID : ______ Study ID: MRN ______
Date of MRI: ______

MODIFIED NOYES SCORE

Grade and description	Lesion Points 10mm	Lesion Points 15mm	Site	Compartment Score
(1) Chondromalacia				Total[a,b,c]
A -Mild hyperintensity partial thickness	0	0	Patella	
B - Extensive hyperintensity full thickness	1	2	Trochlea	
(2) Surface damaged (fissures /fragmentation)				
A - < 50% thickness	2	4	MFC	
B - > 50% thickness	3	6	MTP	
(3) Subchondral bone exposed				
A Bone surface intact	5	10	LFC	
B Erosion of bone surface	5	10	LTP	

Percentage calculation = (20 - compartment score) x 100 / 20

Ligaments

										Acute	Chronic
Anterior Cruciate Ligament	Intact	0	Partial Tear	1	Complete Tear	2	Reconstruction	3			
Posterior Cruciate Ligament	Intact	0	Partial Tear	1	Complete Tear	2	reconstruction				
Medial Collateral Ligament	Intact	0	Low-grade Partial Tear	1	High-grade Partial (+MPFL)	2					
Lateral Collateral Ligament	Intact	0	Partial Tear	1	Complete Tear	2					
Popliteus Tendon	Intact	0	Interstitial Load (hyperintense)	1	Partial Detachment	2	Complete Detachment	3			
Popliteofibular Ligament	Intact	0	Partial Tear	1	Complete Tear	2					

Meniscus	Medial	Lateral
Intact	0	0
Horizontal Cleavage Tear (+/- cyst)	1	1
Peripheral Longitudinal Tear	1	1
Bucket Handle Tear	2	2
Radial Tear	2	2
Displaced Flap	2	2

OA Bone Marrow Edema Pattern	
none	0
mild (<1cm2)	1
severe (>1 cm2)	2

Osteophyte	
none	0
small (<2mm)	1
Large (>2mm)	2

Menisectomy Medial	Yes	No
Menisectomy Lateral	Yes	No

Menisectomy	Medial	lateral
	<1/3	<1/3
	1/3-2/3	1/3-2/3
	> 2/3	> 2/3

MM Repaired	Yes	No	Fluid Imbibition	Yes	No
LM Repaired	Yes	No	Fluid Imbibition	Yes	No

Subchondral sclerosis	Absent	0	Mild (<1cm2)	1	Severe (>1cm2)	2		
Synovitis/effusion (% maximum joint distention)	None	0	<33%	1	33-66%	2	67-100%	3
Hoffa synovitis	None		<33%		33-66%		67-100%	

Tumor	Yes	No	Notes	
Infection	Yes	No	Notes	
Fx	Yes	No	Notes	
Subchondral Fx	Yes	No		

Patella Tendon Tendinosis	None		Mild <33%		Moderate 34-66%		Severe >67%	
Patella Tendon Partial Tear	None		Mild <33%		Moderate 34-66%		Severe >67%	
Quadriceps Tendinosis	None		Mild <33%		Moderate 34-66%		Severe >67%	
Quadriceps Partial Tear	None		Mild <33%		Moderate 34-66%		Severe >67%	

Figure 1. Standardized magnetic resonance imaging (MRI) scoring sheet for assessment of knee pathology among National Basketball Association Draft Combine participants. Fx, fracture; LFC, lateral femoral condyle; LM, lateral meniscus; LTP, lateral tibial plateau; MFC, medial femoral condyle; MM, medial meniscus; MTP, medial tibial plateau.

The investigators, the NBA, and NBA teams did not have access to which players were a part of the study or any data derived that was soley serving a purpose for the study. All data were stored in a secured, deidentified database, coded by the study's Data Coordinating Center.

Participants were administered confidential, validated questionnaires to review demographic characteristics, current medical issues and past medical history, surgical history, injury history, and playing history (Appendix 1, available in the online version of this article). For past surgical history, players were asked about prior orthopaedic issues of the knee requiring surgical intervention. For injury history, players were asked whether they had a previous or ongoing knee injury treated with nonoperative management (eg, physical therapy and intra-articular injections). They each also completed a visual analog scale (VAS) for pain and International Knee Documentation Committee (IKDC) questionnaire.

Of the 47 players who consented for the study, 3 players were excluded for not undergoing MRI and 1 player was excluded for not having baseline questionnaire data, resulting in 43 players ultimately included.

MRI Evaluation

All players underwent 1.5-T MRI, without contrast, of the bilateral knees (and 6 unilaterally) using the recommended baseline MRI protocol (Appendix 2, available online). The 6 unilateral MRI scans were excluded as they were not evaluable due to motion during image collection. Two independent radiologists (H.G.P. and J.M.P.) evaluated each MRI scan blindly using a standardized scoring sheet (Figure 1). The scoring sheet included evaluation of the ligaments, menisci, bone marrow, and tendons and use of the modified Noyes score for articular cartilage assessment. The modified Noyes score was selected due to its ability to provide nuanced evaluation of cartilage lesions and previous accuracy assessments compared with arthroscopic evaluation.[20] The modified Noyes score attributes a value

TABLE 1
Intraclass Correlation Coefficient for Modified Noyes Scoring of Intra-articular Knee Cartilage[a]

	Patella	Trochlea	MFC	MTP	LFC	LTP	Mean
Agreement	0.788	0.647	0.812	0.854	0.961	0.898	0.827
Consistency	0.791	0.663	0.815	0.856	0.962	0.898	0.831

[a]LFC, lateral femoral condyle; LTP, lateral tibial plateau; MFC, medial femoral condyle; MTP, medial tibial plateau.

from 0 to 10 to assess chondral pathology ranging from mild chondromalacia (score of 0) to complete exposure of the subchondral bone in a lesion >15 mm (score of 10) (Figure 1). Separate scores were assigned to the patella, trochlea, medial femoral condyle (MFC), medial tibial plateau (MTP), lateral femoral condyle (LFC), and lateral tibial plateau (LTP). Signs of osteoarthritis were also evaluated.

Statistical Analyses

Modified Noyes scores and MRI findings were summarized using descriptive statistics. Intraclass correlation coefficients were determined for the radiologists' evaluation of articular cartilage scoring; values <0.5 were deemed poor, values between 0.5 and 0.75 were deemed moderate, values between 0.75 and 0.9 were deemed good, and values >0.90 were deemed excellent interrater reliability.[15] Furthermore, imaging scores were correlated to VAS pain and IKDC questionnaires using multivariate linear regression analyses to determine the association between clinical symptoms and imaging findings. Predictors of absolute articular cartilage pathology (ie, a modified Noyes score >0) were determined using multivariate logistic regression analyses. All statistical analyses were performed with R (RStudio Version 2023.09.1 + 494). An a priori alpha level of .05 was used for statistical significance.

RESULTS

Player Demographic Characteristics and Player-Reported Outcome Scores

A total of 43 players (37 bilateral, 6 unilateral, for a total of 80 knees) were evaluated. The mean player height and body mass index (BMI) were 200.7 ± 8.6 cm and 24.5 ± 1.94 kg/m^2, respectively. The mean player age was 20.6 ± 1.72 years. Players reported a mean of 9.9 ± 3.0 years of highly competitive basketball competition (ie, participation with travel, Amateur Athletic Union (AAU), or other select youth, high school, or collegiate basketball programs) before the NBA Draft Combine.

The mean VAS pain score of knees was 1.3 ± 1.5 (range, 0-7). The mean IKDC function score was 8.3 ± 2.8 (range, 0-10). Pain and function scores were independent of each other, with no correlation between the 2 scores (P = .615). No associations were found between player height or BMI and the pain and function scores. Notably, no association was found between a previous orthopaedic history of knee surgery and VAS pain score (P = .836) or IKDC function score (P = .824). However, VAS pain scores were significantly correlated to an ongoing nonsurgical knee issue being treated with physical therapy or injections (β = 0.885; P = .039) and the number of years of basketball participation (β = 0.211; P = .017).

MRI Assessment of Cartilage

Between the 2 independent radiologists scoring articular cartilage using modified Noyes scoring, the intraclass correlation coefficients were a mean of 0.827 for agreement and 0.831 for consistency, signifying good to excellent interrater reliability for all evaluated anatomic regions of the knee (Table 1).

The overall prevalence of cartilage pathology was 48.3% of knees (Table 2). The most common locations of cartilage pathology were on the patella and trochlea. The most severe lesions based on modified Noyes scores were found on the MFC (4.85 ± 2.67) and LFC (3.84 ± 2.52). Focal cartilage injuries in ≥2 regions of the knee occurred in 38.6% of the sample.

Association of MRI Findings With Clinical Symptoms and Orthopaedic History

Linear regression analysis of pain and function scores versus modified Noyes scores showed no significant association between cartilage pathology and clinical symptoms (Table 3). Pain and function scores did not correlate to modified Noyes scores in any region of the knee. Logistic regression analysis revealed minimal predictivity of pathology by pain and function scores or a previous surgical history of the knee (Table 4). Reduced function scores were predictive of cartilage pathology only on the LFC (odds ratio [OR], 0.55; P = .03). Increased pain scores were predictive of nonzero total modified Noyes score (OR, 6.11; P < .01). A previous orthopaedic surgical history of the knee was predictive of cartilage pathology on the LTP (OR, 6.58; P = .04).

MRI Assessment of Meniscus

The overall incidence of current meniscal tear pathology was 10.0% (n = 8) (Table 5). An equal tear prevalence was found in the medial meniscus (n = 4; 5.0%) and the

TABLE 2
Prevalence of Cartilage Injury and Modified Noyes Scores for All Evaluated Knee Magnetic Resonance Imaging Scans[a]

	Patella	Trochlea	MFC	MTP	LFC	LTP	≥1 Region	≥2 Regions
Prevalence, %	30.0	18.8	7.5	3.8	15.9	18.2	48.3	38.6
Modified Noyes score	2.71 ± 1.84	3.13 ± 2.16	4.85 ± 2.67	2.40 ± 0.89	3.84 ± 2.52	3.25 ± 2.49	NA	NA

[a]Presence of cartilage injury defined by a modified Noyes score >0 for the associated region. "≥1 Region" column denotes knees with ≥1 region with nonzero Noyes scores. "≥2 Regions" column denotes knees with multiple regions with nonzero Noyes scores. Modified Noyes score is presented as the mean ± SD of the scores among players identified with cartilage injury in the region. LFC, lateral femoral condyle; LTP, lateral tibial plateau; MFC, medial femoral condyle; MTP, medial tibial plateau; NA, not applicable.

TABLE 3
Linear Regression Models for Association Between Pain and Function Scores and Modified Noyes Scores by Knee Region[a]

	Pain Scores		Function Scores	
	β Coefficient	*P*	β Coefficient	*P*
Patella score	–0.17	.49	0.21	.65
Trochlea score	–0.37	.15	0.11	.83
MFC score	0.17	.80	–0.79	.53
MTP score	–1.03	.51	2.90	.33
LFC score	–0.54	.38	0.25	.83
LTP score	–0.37	.42	0.96	.27

[a]LFC, lateral femoral condyle; LTP, lateral tibial plateau; MFC, medial femoral condyle; MTP, medial tibial plateau.

TABLE 4
Logistic Regression Models for Predictivity of Clinical Scores and Orthopaedic Surgical History for Cartilage Pathology by Region[a]

	Pain Scores		Function Scores		Orthopaedic Surgical History	
	Odds Ratio (CI)	*P*	Odds Ratio (CI)	*P*	Odds Ratio (CI)	*P*
Patella	0.87 (0.51-1.34)	.92	1.02 (0.81-1.36)	.75	4.19 (0.76-32.15)	.12
Trochlea	0.73 (0.35-1.23)	.31	0.94 (0.74-1.24)	.64	1.34 (0.22-7.05)	.73
MFC	0.73 (0.34-1.27)	.32	1.13 (0.88-1.38)	.99	2.16 (0.20-22.77)	.50
MTP	1.01 (0.90-1.04)	.47	0.90 (0.68-1.27)	.99	3.50 (0.25-9.10)	.36
LFC	0.92 (0.44-1.57)	.80	0.55 (0.21-0.87)	.03[b]	4.95 (0.68-40.18)	.11
LTP	0.83 (0.39-1.43)	.59	0.93 (0.73-1.27)	.56	6.58 (1.05-49.43)	.04[b]
≥1 region	6.11 (1.91-13.84)	<.01[b]	1.14 (0.90-1.51)	.28	2.74 (0.51-21.10)	.27

[a]LFC, lateral femoral condyle; LTP, lateral tibial plateau; MFC, medial femoral condyle; MTP, medial tibial plateau. CI, 95% confidence interval.
[b]*p*-value < 0.05.

lateral meniscus (n = 4; 5.0%). No players with ongoing medial meniscal tears had concomitant medial compartment cartilage defects. Players with ongoing lateral meniscal tears had a 75% (n = 3) incidence of concomitant LFC pathology and 50% (n = 2) incidence of concomitant LTP pathology. A variety of tear types were observed, including peripheral longitudinal tears (n = 4; 50% of tears), radial tears (n = 2; 25% of tears), and horizontal cleavage tears (n = 2; 25% of tears).

DISCUSSION

The main finding of the present study was that although a high prevalence of knee pathology was identified on MRI in NBA Combine athletes, little correlation was seen between objective MRI findings of chondral injury and subjective measures of clinical pain, function, or a history of orthopaedic knee problems. This cross-sectional analysis also provides a prevalence baseline upon entry into their

TABLE 5
Prevalence of Meniscal Pathology on All Evaluated Knee MRI Scans

	Medial Meniscus		Lateral Meniscus	
	Current Tear	Previous Meniscectomy	Current Tear	Previous Meniscectomy
Prevalence, % (n)	5.0 (4)	5.0 (4)	5.0 (4)	1.3 (1)

professional careers for NBA players' knee MRI findings using a standardized imaging and scoring protocol. The results support our hypotheses. Ultimately, clinicians treating NBA players should focus on discerning symptomatic knee pathology correlating with imaging to optimally treat these high-level athletes.

The highest proportion of MRI findings were related to the articular cartilage. Articular cartilage pathology was identified in 48.3% of individuals in this cohort. This is similar to the overall prevalence of 47.5% of articular cartilage pathology in 40 knees of NBA players identified by Kaplan et al[14] and 50% of articular cartilage abnormalities in 28 knees of NBA players identified by Walczak et al.[28] In the Walczak et al study, of the 14 players (28 knees) with chondral lesions, 44.4% were in the patella and 25.9% were in the trochlear groove, with each knee with a cartilage abnormality involving the patellofemoral joint.[28] The present study demonstrated a similarly higher proportion of cartilage injuries in the patellofemoral joint, with the patella (30.0% of all knees) and trochlea (18.8% of all knees) being the 2 most common locations of cartilage injury. Importantly, in the present study, the intraclass correlation coefficients for the modified Noyes score were good to excellent with 2 specialized musculoskeletal radiologists, with a mean of 0.827 for agreement and 0.831 for consistency, demonstrating the reliability of the chondral findings.

The incidence of meniscal pathology was 10.0%, less than that of articular cartilage. Tear types included peripheral longitudinal, radial, and horizontal cleavage tears. Previous NBA player studies have demonstrated a prevalence of 20%[14] and 3.6%.[28] The variability in rates of meniscal pathology may depend upon the specific samples of patients. The clinical relevance of meniscal findings on MRI remains poorly defined. Like articular cartilage lesions, meniscal tears frequently do not correlate with knee symptoms and may be asymptomatic. A study by Zanetti et al[29] comparing symptomatic and contralateral asymptomatic knees found horizontal and oblique tear patterns to be present in both symptomatic and asymptomatic knees, whereas radial, vertical, complex, and displaced meniscal tears were more likely to be symptomatic and clinically meaningful.

Unique to the current study is the correlation of imaging findings to pain and function assessments. However, despite the high incidence of pathology identified on MRI scans, we noted few correlations of pathology to other variables. The only predictive factors identified were 1) that reduced function scores were predictive of LFC cartilage pathology (OR, 0.55; P = .03), and 2) that increased pain scores were predictive of nonzero total modified Noyes scores for cartilage (OR, 6.11; $P < .01$). We noted an association between previous orthopaedic surgical history of the knee and cartilage pathology on the LTP (OR, 6.58; P = .04). Given these findings, it is possible that lateral compartment articular cartilage pathology, when present, is more likely to correlate with previous injury, surgery, or function than medial-side pathology. However, there was no association between pain scores and the region of the specifically identified articular cartilage pathology, and thus, the significance of these correlations remains unclear. Additionally, the confidence intervals for these associations are large, limiting the reliability of the associations. It is unclear why modified Noyes scores had few associations with pain and function scores. MRI-detected cartilage pathology may precede clinical symptoms. Additionally, although the modified Noyes score has been associated with arthroscopic findings with good accuracy,[20] the scoring system may not be sensitive enough to discern what may make a cartilage lesion symptomatic. Players in the NBA Draft Combine may also be less likely to report pain or symptoms because they are able to compete at a high level of sport.

Just as important are the factors that were not found to be associated with pain and functional assessments, including patellar, trochlear, MFC, MTP, and LTP chondral lesions. Studies evaluating MRI findings and their effect have been performed in other professional sports as well.[4,12,13,16,23] In Major League Baseball (MLB) players, MRI findings in asymptomatic throwing shoulders have not predicted injury/disabled list placement but did have some correlations with performance such as strikeout rates and innings pitched.[4,16] However, asymptomatic elbow MRI findings have mixed results on effect on injuries and performance in MLB throwers.[12,13] Although in the present study we did not identify previous surgery to predict cartilage lesions, Nepple et al[23] found in their study of NFL Combine Athletes that full-thickness cartilage lesions were associated with previous knee surgery and specifically meniscectomy. One reason for the discrepancy between the NFL study and the present study may be the higher number of knees (N = 704) included in the NFL study[23] relative to the 80 knees in the present study, allowing for greater detection of associations, or other factors such as type of training and loading or BMI.

The high prevalence of cartilage pathology in the absence of clinical symptoms may question the utility of using screening MRI scans in isolation for evaluation or to make decisions related to the findings that may have developed acutely or over time in elite athletes. However, using these as a frame of reference, such as obtaining pre- and postseason MRI scans to understand an athlete's new baseline, may be helpful to ascertain relevant changes. As such, some NBA teams use yearly preseason MRI as a reference to better assess in-season knee injury to determine which findings are new versus those that existed before the onset of knee symptoms. The MRI scans will also allow for an assessment of those areas most likely to limit performance during the season, including the patellar tendon and cartilage of the patellofemoral joint. It remains important to correlate the history, mechanism of injury, subjective complaints, and objective findings to determine the relevance of MRI findings and their effect on treatment decision-making. What is less known is the long-term consequence of these imaging-based abnormalities and whether they would ultimately become consequential for patients either during league play or after their career ends.

Limitations

Several limitations exist in this study. The study is cross-sectional, and longitudinal follow-up is important to understand how cartilage injury may affect future symptoms, development of osteoarthritis, and career length and performance. Data precision and reliability are limited by the small sample size of the study. The study population was specific to the NBA Draft Combine over a 2-year period, and results may not apply broadly to other athletes of different levels and sports. Combine players may not be representative of NBA rostered players, especially those with greater number of years of professional basketball experience. The NBA Draft Combine attendees are more likely to be relatively healthier players who can participate in the Combine activities. Additionally, those participating in the study did so on a voluntary basis and may have been more likely to want or need an MRI scan and may have had less of a barrier to participating in the study. Responses to survey questions are subject to the athletes, who may underreport pain or functional limitations during the NBA Draft Combine. The volume and duration of collegiate participation in basketball activities that may place them at risk for cartilage injury vary as well. Although we noted the prevalence of pathology identified on knee MRI, it is not possible to determine whether these pathologies were the result of activity level, years of play, previous injury,[5] or other patient history factors. The NBA Draft Combine is held annually before the NBA draft and typically after players' collegiate season, and MRI scans may reflect states of variable workload that may depend on their level of collegiate training and participation with NBA clubs during the predraft period, which may influence imaging findings.[26] Furthermore, in the evaluation of chondral defects, additional anatomic factors such as lower extremity alignment are important to consider, and these data were not available for analysis. Finally, although the modified Noyes score is a validated measure for assessing knee cartilage defects, it is not frequently used in clinical practice and may limit the clinical interpretability of our findings.

CONCLUSION

The incidence of pathology identified on knee MRI scans in players at the NBA Draft Combine without clinical symptoms was high. Little association was found between the objective imaging findings and subjective pain, function, and orthopaedic injury history. Clinicians treating high-level athletes should focus on treating clinically significant findings and be cautious about treating pathology found on imaging that may not explain or be associated with symptoms. It remains critical to study the natural history of imaging findings in these athletes to better ascertain the ultimate effect of sport and physiologic load on disease progression.

ACKNOWLEDGMENTS

The authors acknowledge Kim Amrami, Garry E. Gold, and Thomas M. Link for their contributions to study design and execution.

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REFERENCES

1. Agel J, Olson DE, Dick R, Arendt EA, Marshall SW, Sikka RS. Descriptive epidemiology of collegiate women's basketball injuries: National Collegiate Athletic Association Injury Surveillance System, 1988-1989 through 2003-2004. *J Athl Train*. 2007;42(2):202-210.
2. Allahabadi S, Su F, Lansdown DA. Systematic review of orthopaedic and sports medicine injuries and treatment outcomes in Women's National Basketball Association and National Basketball Association players. *Orthop J Sports Med*. 2021;9(2):232596712098207.
3. Angioi M, Maffulli GD, McCormack M, Morrissey D, Chan O, Maffulli N. Early signs of osteoarthritis in professional ballet dancers: a preliminary study. *Clin J Sport Med*. 2014;24(5):435-437.
4. Beletsky A, Okoroha KR, Cabarcas B, et al. Magnetic resonance imaging findings of the asymptomatic shoulder may impact performance, not future injury list placement in Major League Baseball pitchers. *Arthrosc Sports Med Rehabil*. 2022;4(2):e487-e493.
5. Davidson EJ, Figgie C, Nguyen J, et al. Chondral injury associated with ACL injury: assessing progressive chondral degeneration with morphologic and quantitative MRI techniques. *Sports Health*. 2024;16(5):722-734.
6. Deitch JR, Starkey C, Walters SL, Moseley JB. Injury risk in professional basketball players: a comparison of Women's National Basketball Association and National Basketball Association athletes. *Am J Sports Med*. 2006;34(7):1077-1083.
7. Dick R, Hertel J, Agel J, Grossman J, Marshall SW. Descriptive epidemiology of collegiate men's basketball injuries: National Collegiate Athletic Association Injury Surveillance System, 1988-1989 through 2003-2004. *J Athl Train*. 2007;42(2):194-201.

8. Drakos MC, Domb B, Starkey C, Callahan L, Allen AA. Injury in the National Basketball Association: a 17-year overview. *Sports Health*. 2010;2(4):284-290.
9. Driban JB, Hootman JM, Sitler MR, Harris KP, Cattano NM. Is participation in certain sports associated with knee osteoarthritis? A systematic review. *J Athl Train*. 2017;52(6):497-506.
10. Eckstein F, Hudelmaier M, Putz R. The effects of exercise on human articular cartilage. *J Anat*. 2006;208(4):491-512.
11. Gao KT, Pedoia V, Young KA, et al. Multiparametric MRI characterization of knee articular cartilage and subchondral bone shape in collegiate basketball players. *J Orthop Res*. 2021;39(7):1512-1522.
12. Garcia GH, Gowd AK, Cabarcas BC, et al. Magnetic resonance imaging findings of the asymptomatic elbow predict injuries and surgery in Major League Baseball pitchers. *Orthop J Sports Med*. 2019;7(1):2325967118818413.
13. Gutierrez NM, Granville C, Kaplan L, Baraga M, Jose J. Elbow MRI findings do not correlate with future placement on the disabled list in asymptomatic professional baseball pitchers. *Sports Health*. 2017;9(3):222-229.
14. Kaplan LD, Schurhoff MR, Selesnick H, Thorpe M, Uribe JW. Magnetic resonance imaging of the knee in asymptomatic professional basketball players. *Arthroscopy*. 2005;21(5):557-561.
15. Koo TK, Li MY. A guideline of selecting and reporting intraclass correlation coefficients for reliability research. *J Chiropr Med*. 2016;15(2):155-163.
16. Lesniak BP, Baraga MG, Jose J, Smith MK, Cunningham S, Kaplan LD. Glenohumeral findings on magnetic resonance imaging correlate with innings pitched in asymptomatic pitchers. *Am J Sports Med*. 2013;41(9):2022-2027.
17. Load, overload, and recovery in the athlete: select issues for the team physician—a consensus statement. *Curr Sports Med Rep*. 2019;18(4):141-148.
18. Mack CD, Herzog MM, Maak TG, et al. Epidemiology of injuries among National Basketball Association players: 2013-2014 through 2018-2019. *Sports Health*. 2025;17(3):585-593.
19. Major NM, Helms CA. MR imaging of the knee: findings in asymptomatic collegiate basketball players. *Am J Roentgenol*. 2002;179(3):641-644.
20. Milewski MD, Smitaman E, Moukaddam H, et al. Comparison of 3D vs. 2D fast spin echo imaging for evaluation of articular cartilage in the knee on a 3T system scientific research. *Eur J Radiol*. 2012;81(7):1637-1643.
21. Multanen J, Nieminen MT, Häkkinen A, et al. Effects of high-impact training on bone and articular cartilage: 12-month randomized controlled quantitative MRI study. *J Bone Miner Res*. 2014;29(1):192-201.
22. Musumeci G, Castrogiovanni P, Trovato FM, et al. Physical activity ameliorates cartilage degeneration in a rat model of aging: a study on lubricin expression. *Scand J Med Sci Sports*. 2015;25(2):e222-230.
23. Nepple JJ, Wright RW, Matava MJ, Brophy RH. Full-thickness knee articular cartilage defects in National Football League Combine athletes undergoing magnetic resonance imaging: prevalence, location, and association with previous surgery. *Arthroscopy*. 2012;28(6):798-806.
24. Pappas GP, Vogelsong MA, Staroswiecki E, Gold GE, Safran MR. Magnetic resonance imaging of asymptomatic knees in collegiate basketball players: the effect of one season of play. *Clin J Sport Med*. 2016;26(6):483-489.
25. Peers SC, Maerz T, Baker EA, et al. T1ρ magnetic resonance imaging for detection of early cartilage changes in knees of asymptomatic collegiate female impact and nonimpact athletes. *Clin J Sport Med*. 2014;24(3):218-225.
26. Rubin EB, Mazzoli V, Black MS, et al. Effects of the competitive season and off-season on knee articular cartilage in collegiate basketball players using quantitative MRI: a multicenter study. *J Magn Reson Imaging*. 2021;54(3):840-851.
27. Stehling C, Lane NE, Nevitt MC, Lynch J, McCulloch CE, Link TM. Subjects with higher physical activity levels have more severe focal knee lesions diagnosed with 3T MRI: analysis of a non-symptomatic cohort of the Osteoarthritis Initiative. *Osteoarthritis Cartilage*. 2010;18(6):776-786.
28. Walczak B, McCulloch P, Kang R, Zelazny A, Tedeschi F, Cole B. Abnormal findings on knee magnetic resonance imaging in asymptomatic NBA players. *J Knee Surg*. 2010;21(1):27-33.
29. Zanetti M, Pfirrmann CWA, Schmid MR, Romero J, Seifert B, Hodler J. Patients with suspected meniscal tears: prevalence of abnormalities seen on MRI of 100 symptomatic and 100 contralateral asymptomatic knees. *Am J Roentgenol*. 2003;181(3):635-641.