Research Square

Preprints are preliminary reports that have not undergone peer review.
They should not be considered conclusive, used to inform clinical practice,
or referenced by the media as validated information.

Medial Meniscus Posterior Root Notch Angle and Lateral Tibial Plateau Morphology Are Associated with Medial Meniscus Posterior Root Tears

Aoran Sun
Beijing Tsinghua Chang Gung Hospital
Pengfei Fu
Beijing Tsinghua Chang Gung Hospital
Zihao Wang
Beijing Tsinghua Chang Gung Hospital
Congyong Ye
Beijing Tsinghua Chang Gung Hospital
Hao Liu
Beijing Tsinghua Chang Gung Hospital
Ligong Fu
Beijing Tsinghua Chang Gung Hospital
Lianxu Chen
bjchenlx69@163.com

Beijing Tsinghua Chang Gung Hospital

Research Article

Keywords:

Posted Date: November 6th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-11386656/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License.
Read Full License

Additional Declarations: No competing interests reported.

Abstract

Purpose

This study aimed to identify the associations of MMPRNA, tibial lateral anteroposterior dimension (TLAPD), and aspect ratio of the lateral tibial plateau (ARLTP) with MMPRT.

Methods

This retrospective case-control study included 95 patients with complete MMPRT and 95 matched controls with knee pain but no pathological meniscal changes on MRI. MRI measurements included the MMPRNA, tibial mediolateral dimension (TMLD), tibial medial anteroposterior dimension (TMAPD), and TLAPD. The aspect ratio of the medial tibial plateau (ARMTP) and ARLTP were calculated. Measurements were compared between the experimental and control groups. Receiver operating characteristic (ROC) curve analysis was used to determine the area under the curve (AUC), maximum Youden index, sensitivity, specificity, and optimal cutoff values for variables showing significant differences.

Results

No significant differences in demographic characteristics, Kellgren-Lawrence (K-L) grade, TMLD, TMAPD, and ARMTP were observed between the two groups ($P > 0.05$). The MMPRNA was significantly smaller in the MMPRT group than in the control group(MMPRT group mean: 125.9°±22.6°; control group mean: 138.9°±16.1°; $P < .001$), as was the TLAPD (MMPRT group mean: 39.5 ± 3.9 mm; control group mean: 42.4 ± 3.8 mm; $P < .001$). In contrast, the ARLTP was significantly greater in the MMPRT group (MMPRT group mean: 1.8 ± 0.2; control group mean: 1.7 ± 0.1; $P < .001$). ROC analysis identified an optimal MMPRNA cutoff of 144.66°, with a sensitivity of 81.1%, a specificity of 46.3%, and an AUC of 0.67. The optimal ARLTP cutoff was 1.76, yielding a sensitivity of 56.8%, a specificity of 85.3%, and an AUC of 0.73. For TLAPD, the optimal cutoff was 39.21 mm, with a sensitivity of 45.3%, a specificity of 85.3%, and an AUC of 0.70.

Conclusions

Smaller MMPRNA and TLAPD, as well as larger ARLTP, are closely associated with the MMPRT.

INTRODUCTION

The meniscus is a critical component of the knee joint, playing a key role in load distribution and stress absorption by increasing the contact area of the tibiofemoral joint and converting axial loads into hoop stresses[5, 7, 13].Anatomically, the meniscus can be divided into five parts: the anterior root, anterior

horn, body, posterior horn, and posterior root[8]. Among these, the meniscus posterior root bears the majority of the knee joint load, including axial compressive and shear forces[19]. Medial meniscus posterior root tears (MMPRT) refer to bony avulsions, soft tissue avulsions, or radial tears within 9 mm of the medial meniscus posterior root (MMPR) attachment site, accounting for approximately 10% to 21% of all meniscus tears [13, 14, 17, 18]. MMPRT leads to disruption of the integrity and loss of tension of the medial meniscus, resulting in complete loss of load-transmitting capacity. The biomechanical consequences are similar to those of total meniscectomy, ultimately leading to articular cartilage damage and osteoarthritis of the knee[1, 2, 9]. Therefore, early accurate diagnosis and timely appropriate management of MMPRT can delay knee joint degeneration and improve knee joint function.

Risk factors for MMPRT are multifactorial. Previous studies have shown that age, sex, body mass index (BMI), Kellgren-Lawrence (K-L) grade, mechanical axis angle, and activity level can all influence the occurrence of MMPRT[10]. However, these risk factors do not adequately explain why MMPRT is more likely to occur during knee flexion or squatting. Prior studies have identified abnormal knee anatomical morphology as a risk factor for MMPRT; specifically, anatomical variations such as an increased posterior tibial slope, a narrowed femoral intercondylar notch, and a shallow medial tibial plateau concavity are significantly associated with the development of MMPRT [20, 3, 15]. These anatomical factors directly affect the stress load borne by the medial meniscus posterior root by altering the mechanical environment of the tibiofemoral joint. Anatomical studies of the knee have demonstrated that the medial meniscus posterior root straddles the inflection point of the articular cartilage of the medial tibial plateau[4, 11], which we have termed the medial meniscus posterior root notch angle (MMPRNA). We hypothesize that a sharper inflection point would correspondingly increase the stress exerted on the posterior root, thereby elevating the risk of MMPRT. Furthermore, kinematic studies have shown that during knee flexion, the tibia undergoes internal rotation and the lateral femoral condyle moves posteriorly, disengaging from the tibial plateau and losing normal contact with the tibia[6, 16]. We propose that a smaller tibial lateral anteroposterior dimension (TLAPD) and a larger aspect ratio of lateral tibial plateau (ARLTP) would cause the lateral femoral condyle to disengage from the tibial plateau earlier, resulting in greater load borne by the medial tibiofemoral compartment and consequently increasing the risk of MMPRT.

This study aimed to investigate the relationship between MMPRNA, TLAPD, ARLTP and MMPRT, explore novel anatomic risk factors for MMPRT, and provide evidence to support its prevention and early diagnosis.

MATERIALS AND METHODS

Study Design

This study was approved by the Ethics Committee of Beijing Tsinghua Changgung Hospital (approval number: 25237-4-01). We retrospectively reviewed patients who presented to the Department of Joint Surgery at Beijing Tsinghua Changgung Hospital between January 2019 and December 2024. A total of

435 patients with medial meniscus posterior root tears were identified. Ultimately, 95 patients with MMPRT who met the inclusion and exclusion criteria were enrolled as the experimental group.Inclusion criteria: (1)patients with medial knee pain; (2)positive tenderness in the posteromedial joint space; (3)positive McMurray sign; (4)complete tear of the medial meniscus posterior root confirmed by arthroscopy; (5)Kellgren-Lawrence (K-L) grade < 3. Exclusion criteria were as follows: (1)acute violent injury causing MMPRT; (2)definite knee ligament injury on MRI; (3)concomitant rheumatoid arthritis or other bone diseases; (4)previous knee surgery; (5)knee deformity; (6)incomplete or poor-quality MRI data; (7)K-L grade ≥ 3. Based on the demographic characteristics and the degree of knee degeneration in the experimental group, 95 matched patients who presented to our outpatient clinic during the same period with knee pain and had no pathological meniscus changes on MRI were enrolled as the control group at a 1:1 ratio (Fig. 1).

Measurement Methods

Age, sex, body mass index (BMI), and laterality were collected for all patients. The K-L grade was determined on radiographs to assess the degree of knee degeneration. Anatomical parameters of the knee were measured on MRI, including MMPRNA,tibial mediolateral dimension (TMLD), tibial medial anteroposterior dimension (TMAPD) and TLAPD. Aspect ratio of medial tibial plateau (ARMTP) and ARLTP were subsequently calculated. All imaging parameters were independently measured by two orthopedic surgeons using a picture archiving and communication system (GE Medical System Information Technologies). For quantitative variables, the mean values of the two observers' measurements were used for statistical analysis. For qualitative variables, concordant results between the two observers were adopted; in cases of disagreement, a third senior physician made the final determination, and that determination was used as the definitive result.

On coronal T2-weighted fat-suppressed MRI of the knee, the plane in which the complete posterior root of the medial meniscus was visible was selected, and the angle between the tangent to the medial tibial plateau and the tangent to the medial tibial plateau slope was measured as MMPRNA (Fig. 2).

Using the measurement method described by Dejin Yang et al.[21], on axial T2-weighted fat-suppressed MRI of the knee, the tibial plateau plane without meniscus coverage was selected, and the maximum mediolateral distance of the tibial plateau was measured as TMLD. A perpendicular line was drawn through the point at 25% of the mediolateral width of the tibial plateau from the medial edge, and the anteroposterior distance of the tibial plateau along this line was measured as TMAPD. Similarly, a perpendicular line was drawn through the point at 25% of the mediolateral width from the lateral edge, and the anteroposterior distance of the tibial plateau along this line was measured as TLAPD (Fig. 3). ARMTP (TMLD/TMAPD) and ARLTP (TMLD/TLAPD) were then calculated.

Knee joint imaging was performed using a Philips Ingenia 3.0T MRI scanner. The scanning protocol included three-dimensional fast spin-echo proton density-weighted imaging, T1-weighted turbo spin-echo imaging, and T2-weighted fat-suppressed imaging. The acquisition parameters were as follows: TR = 1100 ms, TE = 86 ms, slice thickness = 0.7 mm, slice gap = -0.3 mm, matrix size = 228×229, FOV = 16

cm×16 cm, acquired voxel size = 0.70 mm×0.70 mm×0.70 mm, and reconstructed voxel size = 0.40 mm×0.40 mm×0.40 mm. Fat suppression was achieved using spectral attenuated inversion recovery. After acquisition, sagittal, coronal, and axial images with a slice thickness of 4 mm were reconstructed. An 8-channel dedicated knee phased-array coil was used, and the total scan time was approximately 5 minutes. All MRI data were stored in DICOM format for subsequent analysis.

All patients were positioned supine, feet first. The examined side was placed close to the magnet center, with the body shifted toward the contralateral side. The knee was flexed 10–15° to allow adequate visualization of the anterior cruciate ligament. The space within the coil was filled with triangular pads and sponge cushions to prevent internal and external rotation of the knee and to minimize motion artifacts. The scanning center was set at the inferior border of the patella, and a dedicated knee coil was used.

Statistical Analysis

Statistical analyses were performed using SPSS 27.0 software and R software version 4.3.3. Continuous variables are presented as mean ± SD, and between-group comparisons were conducted using the independent samples t-test or the Wilcoxon signed-rank test. The Shapiro - Wilk test was used to assess the normality of continuous variables. Categorical variables are expressed as n (%) and were compared using the chi-square test or Fisher's exact test. Receiver operating characteristic (ROC) curve analysis was performed to determine the area under the curve (AUC), maximum Youden index, sensitivity, specificity, and optimal cutoff values for variables showing significant differences. P value < 0.05 was considered statistically significant.

To assess interobserver agreement, intraclass correlation coefficient (ICC) were calculated using a two-way mixed-effects model with an absolute agreement definition for each variable. ICC values < 0.8 were considered poor, 0.8 to 0.9 good, and > 0.9 excellent. The mean ICC was 0.98 (95% CI: 0.98–0.99) for MMPRNA, 0.92 (95% CI: 0.90–0.94) for TLAPD, 0.89 (95% CI: 0.85–0.92) for TMAPD, and 0.96 (95% CI: 0.94–0.97) for TMLD. These high ICC values indicate strong interobserver agreement and high measurement reliability.

RESULTS

As shown in Table 1, no statistically significant differences were observed between the two groups in age, BMI, sex, affected side, or K-L grade (P > 0.05), indicating that the demographic characteristics and the severity of knee degeneration were well balanced and comparable between groups.

Anatomical parameters differed between the MMPRT and control groups. No statistically significant differences were found in TMLD, TMAPD, or ARMTP between the two groups (P > 0.05). The MMPRNA was significantly smaller in the MMPRT group than in the control group (MMPRT group mean: 125.9° ±22.6°; control group mean: 138.9°±16.1°; P < .001). TLAPD was also significantly smaller in the MMPRT group (MMPRT group mean: 39.5 ± 3.9 mm; control group mean: 42.4 ± 3.8 mm; P < .001). In contrast,

ARLTP was significantly greater in the MMPRT group than in the control group (MMPRT group mean: 1.8 ± 0.2; control group mean: 1.7 ± 0.1; P < .001) (Table 2). These findings indicate that MMPRNA, ARLTP, and TLAPD differ significantly between patients with MMPRT and controls, and that these parameters are closely associated with the occurrence of MMPRT, representing independent risk factors for this condition.

Table 1
Comparison of demographic characteristics and degree of knee degeneration between the MMPRT group and the control group

categories		**MMPRT(n = 95)**	**Control(n = 95)**	***P***
Age(years)	63.2 ± 6.7	62.2 ± 7.2	0.319	
BMI(kg/m^2)	27.7 ± 4.2	26.6 ± 2.7	0.446	
Sex, n(%)			0.217	
Male	17 (17.89)	24 (25.26)		
Female	78 (82.11)	71 (74.74)		
Side, n(%)			0.383	
Right	42 (44.21)	48 (50.53)		
Left	53 (55.79)	47 (49.47)		
K-L grade, n (%)			1.000	
0	1 (1.05)	1 (1.05)		
1	44 (46.32)	45 (47.37)		
2	50 (52.63)	49 (51.58)		

*Statistically significant (*P* < 0.05).Abbreviations: BMI, body mass index; K-L, Kellgren-Lawrence.

Table 2
Comparison of radiographic factors between the MMPRT group and the control group

categories	MMPRT(n = 95)	Control(n = 95)	*P*
MMPRNA(°)	125.9 ± 22.6	138.9 ± 16.1	< 0.001
TMLD(mm)	70.4 ± 4.9	70.8 ± 5.9	0.638
TMAPD(mm)	46.6 ± 3.5	47.0 ± 3.6	0.391
TLAPD(mm)	39.5 ± 3.9	42.4 ± 3.8	< 0.001
ARMTP	1.5 ± 0.1	1.5 ± 0.1	0.598
ARLTP	1.8 ± 0.2	1.7 ± 0.1	< 0.001

*Statistically significant ($P < 0.05$).Abbreviations: MMPRNA, medial meniscus posterior root notch angle; TMLD, tibial mediolateral dimension; TMAPD, tibial medial anteroposterior dimension; TLAPD, tibial lateral anteroposterior dimension; ARMTP, aspect ratio of medial tibial Plateau; ARLTP, aspect ratio of lateral tibial plateau.

Based on ROC analysis, the optimal cutoff value for MMPRNA was 144.66°, with a sensitivity of 81.1%, a specificity of 46.3%, a maximum Youden index of 0.27, and an AUC of 0.67 (95% CI: 0.59–0.74). A smaller MMPRNA was associated with a higher risk of MMPRT (Fig. 4-a). The optimal cutoff value for ARLTP was 1.76, with a sensitivity of 56.8%, a specificity of 85.3%, a maximum Youden index of 0.42, and an AUC of 0.73 (95% CI: 0.66–0.80). A larger ARLTP was associated with a higher risk of MMPRT (Fig. 4-b). The optimal cutoff value for TLAPD was 39.21 mm, with a sensitivity of 45.3%, a specificity of 85.3%, a maximum Youden index of 0.31, and an AUC of 0.70 (95% CI: 0.62–0.77). A smaller TLAPD was associated with a higher risk of MMPRT (Fig. 4-c).

DISCUSSION

This study found that smaller MMPRNA and TLAPD, along with larger ARLTP, were closely associated with MMPRT and represent risk factors for this condition. Measurement of MMPRNA, TLAPD, and ARLTP may help identify patients at higher risk for MMPRT. The optimal cutoff value for MMPRNA was 144.66°, with a sensitivity of 81.1% and a specificity of 46.3%. The high sensitivity suggests that MMPRNA may serve as an initial screening indicator for MMPRT; however, its relatively low specificity limits its utility as a standalone diagnostic tool. The optimal cutoff value for ARLTP was 1.76, with a sensitivity of 56.8% and a specificity of 85.3%. The high specificity indicates that ARLTP offers a distinct advantage in the clinical confirmation of MMPRT and is suitable for scenarios requiring high diagnostic certainty. The optimal cutoff value for TLAPD was 39.21 mm, with a sensitivity of 45.3% and a specificity of 85.3%. Similar to ARLTP, TLAPD also demonstrated high specificity, suggesting that it likewise has considerable clinical value in confirming MMPRT. The combined application of ARLTP, TLAPD, and MMPRNA may

improve the efficiency of imaging-based identification of MMPRT, thereby providing an anatomical basis for the prevention and early clinical diagnosis of this condition.

This study is the first to define and measure MMPRNA. Given the absence of literature examining the relationship between MMPRNA and MMPRT, we reviewed the anatomy of the medial tibial plateau. Johannsen et al. described the medial meniscus posterior root attachment as located approximately 9.6 mm posterior to the apex of the intercondylar eminence, 0.7 mm lateral to the inflection point of the articular cartilage of the medial tibial plateau, and anteromedial to the tibial attachment of the posterior cruciate ligament[12].Previous anatomical studies have demonstrated that the MMPRT crosses over the inflection point of the articular cartilage of the medial tibial plateau. We termed the angle formed by the MMPRT as it is compressed against this inflection point the MMPRNA, and hypothesized that the magnitude of this angle may influence stress distribution within the MMPRT. From a biomechanical perspective, the anatomical significance of a smaller MMPRNA lies in the following: the inflection point of the medial tibial plateau articular cartilage is relatively sharp, and the MMPRT forms a smaller angle as it crosses this inflection point, analogous to a rope passing over a sharp edge. When the meniscus is subjected to circumferential stress, stress becomes highly concentrated at this inflection point, resulting in localized high stress on the posterior root fibers. According to the principle of stress concentration, the sharper the corner, the more pronounced the stress concentration effect. Chronic repetitive stress concentration may lead to microdamage accumulation and degenerative changes in the posterior root fibers, ultimately progressing to complete tear.

This study is the first to identify a larger ARLTP and a smaller TLAPD as independent risk factors for MMPRT. ARLTP is defined as the ratio of TMLD to TLAPD, reflecting the morphological characteristics of the lateral tibial plateau—a larger ratio, or a smaller TLAPD, indicates a relatively flatter lateral tibial plateau. No previous studies have investigated the association between ARLTP or TLAPD and MMPRT. To interpret this finding, we reviewed the literature on knee joint kinematics. Hai-Nan Chen et al. demonstrated that during knee flexion, the tibia undergoes approximately 11° of internal rotation relative to the femur, during which the medial femoral condyle exhibits minimal anteroposterior translation, whereas the lateral femoral condyle slides posteriorly to a greater extent on the tibial plateau[6].S. Nakagawa et al. found that during active knee flexion from 90° to 133°, the mean posterior translation of the lateral femoral condyle was 13 ± 6 mm, while that of the medial femoral condyle was 2 ± 2 mm, with a mean tibial internal rotation of 15 ± 9° occurring about an axis through the medial femoral condyle. During full passive knee flexion to 162°, the lateral femoral condyle moved posteriorly beyond the posterior edge of the lateral tibial plateau, disengaging from the tibial plateau and losing normal contact with the tibia[16].Based on the aforementioned findings from our knee kinematic study, we propose that when the ARLTP is large—that is, when the TLAPD is small—the lateral femoral condyle is more likely to prematurely disengage from contact with the tibial plateau during knee flexion, thereby interrupting or diminishing the load transmission pathway to the lateral compartment. According to the mechanical principles of load sharing, a reduction in lateral load transmission necessarily results in greater compressive and rotational loads being borne by the medial femorotibial joint. The MMPR, as a critical stabilizing structure and load-transmitting unit of the medial compartment, experiences substantially

increased circumferential stress under this loading pattern, thereby elevating the risk of tearing. This hypothesis is consistent with the clinical observation that MMPR tears predominantly occur during activities such as squatting and knee flexion, and is also in agreement with the finding that MMPR tears are more prevalent in varus-aligned knees. Furthermore, an increased ARLTP or a decreased TLAPD may also be associated with alterations in rotational stability of the knee. A relatively flatter lateral plateau may alter the trajectory of the lateral femoral condyle during flexion–rotation movements, leading to a shift in the rotational center of the femorotibial joint and subjecting the medial meniscus posterior root to greater shear forces.

This study has several limitations. First, as a single-center retrospective case–control study, the sample source was relatively homogeneous, which may have introduced selection bias. Because all data were obtained from a single medical institution, the generalizability of the findings is limited. Second, the study population consisted exclusively of Chinese patients, and ethnic and anatomical differences may exist. Knee anatomical parameters can vary significantly across different ethnic populations; therefore, caution is warranted when extrapolating our conclusions to other populations. Third, anatomical parameters were measured on static MRI, which cannot reflect biomechanical changes of the knee under dynamic loading conditions. Fourth, external validation was not performed.

CONCLUSION

This study identified that a smaller MMPRNA, a larger TLAPD, and a larger ARLTP are closely associated with the MMPRT. MMPRNA demonstrated high sensitivity and may serve as a preliminary screening indicator, whereas ARLTP and TLAPD exhibited high specificity, facilitating clinical diagnosis. The combined use of these anatomical parameters may function as imaging-based warning indicators for MMPRT, providing an anatomical basis for the prevention and early diagnosis of MMPRT.

Abbreviations

MMPRT, medial meniscus posterior root tear; MRI,magnetic resonance imaging;BMI, body mass index ; K-L , Kellgren-Lawrence ; ROC, receiver operating characteristic ; AUC,area under the curve; MMPRNA, medial meniscus posterior root notch angle ; TMLD, tibial mediolateral dimension ; TMAPD, tibial medial anteroposterior dimension ; TLAPD, tibial lateral anteroposterior dimension ; ARMTP, aspect ratio of medial tibial plateau ; ARLTP ,aspect ratio of lateral tibial plateau

Declarations

Data availability statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

Funding statement: The authors did not receive support from any organization for the submitted work.

Conflict of interest disclosure: The authors declare no conflicts of interest.

Patient consent statement (if applicable):Not Applicable.

Permission to reproduce material from other sources (if applicable): Not Applicable.

Authors' contributions: Aoran Sun and Pengfei Fu are contributed equally to this work.Aoran Sun designed the study. Aoran Sun and Pengfei Fu have contributed to data collection and interpretation. All authors contributed to the analysis and interpretation of data and critically reviewed the manuscript. All authors approved the final version of the manuscript and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Ethics Approval and Consent to Participate: Ethics approval was obtained from the Ethics Committee of Beijing Tsinghua Changgung Hospital (Ethics Approval Reference No. 25237-4-01,Date of registration: 2025-03-07) and was conducted in accordance with the Declaration of Helsinki. We confirmed that all methods were carried out in accordance with relevant guidelines and regulations. The requirement for informed consent was waived by the Institutional Review Board due to the retrospective nature of the study.

For clinical trials (if applicable)**:** Not Applicable.

Consent for publication (if applicable)**:** Not Applicable.

References

1. Adams JG, McAlindon T, Dimasi M, Carey J, Eustace S. Contribution of meniscal extrusion and cartilage loss to joint space narrowing in osteoarthritis. Clin Radiol. 1999;54(8):502–6.
2. Allaire R, Muriuki M, Gilbertson L, Harner CD. Biomechanical consequences of a tear of the posterior root of the medial meniscus. Similar to total meniscectomy. J Bone Joint Surg Am. 2008;90(9):1922–31.
3. Altinayak H, Karatekin YS. Increased Medial Femoral Condyle Angle and Narrow Intercondylar Notch Are Associated With Medial Meniscus Posterior Root Tear. Arthroscopy: J Arthroscopic Relat Surg. 2023;39(10):2154–63.
4. Banovetz MT, Roethke LC, Rodriguez AN, LaPrade RF. Meniscal Root Tears: A Decade of Research on their Relevant Anatomy, Biomechanics, Diagnosis, and Treatment. Arch Bone Jt Surg. 2022;10(5):366–80.
5. Bhatia S, LaPrade CM, Ellman MB, LaPrade RF. Meniscal Root Tears: Significance, Diagnosis, and Treatment. Am J Sports Med. 2014;42(12):3016–30.
6. Chen H-N, Yang K, Dong Q-R, Wang Y. Assessment of tibial rotation and meniscal movement using kinematic magnetic resonance imaging. J Orthop Surg Res. 2014;9(1):65.
7. Chung JY, Song HK, Jung MK, Oh HT, Kim JH, Yoon J-S, Min B-H. Larger medial femoral to tibial condylar dimension may trigger posterior root tear of medial meniscus. Knee Surg Sports Traumatol

Arthrosc. 2016;24(5):1448–54.
8. Fox MG. MR imaging of the meniscus: review, current trends, and clinical implications. Radiol Clin North Am. 2007;45(6):1033–53. vii.
9. Harner CD, Mauro CS, Lesniak BP, Romanowski JR. (2009) Biomechanical consequences of a tear of the posterior root of the medial meniscus. Surgical technique. J Bone Joint Surg Am 91 Suppl 2:257–70.
10. Hwang B-Y, Kim S-J, Lee S-W, Lee H-E, Lee C-K, Hunter DJ, Jung K-A. Risk factors for medial meniscus posterior root tear. Am J Sports Med. 2012;40(7):1606–10.
11. Johannsen AM, Civitarese DM, Padalecki JR, Goldsmith MT, Wijdicks CA, LaPrade RF. Qualitative and Quantitative Anatomic Analysis of the Posterior Root Attachments of the Medial and Lateral Menisci. Am J Sports Med. 2012;40(10):2342–7.
12. Johannsen AM, Civitarese DM, Padalecki JR, Goldsmith MT, Wijdicks CA, LaPrade RF. Qualitative and quantitative anatomic analysis of the posterior root attachments of the medial and lateral menisci. Am J Sports Med. 2012;40(10):2342–7.
13. Koenig JH, Ranawat AS, Umans HR, Difelice GS. Meniscal root tears: diagnosis and treatment. Arthroscopy. 2009;25(9):1025–32.
14. LaPrade CM, James EW, Cram TR, Feagin JA, Engebretsen L, LaPrade RF. Meniscal root tears: a classification system based on tear morphology. Am J Sports Med. 2015;43(2):363–9.
15. Moon H-S, Choi C-H, Jung M, Lee D-Y, Eum K-S, Kim S-H. Medial Meniscal Posterior Horn Tears Are Associated With Increased Posterior Tibial Slope: A Case-Control Study. Am J Sports Med. 2020;48(7):1702–10.
16. Nakagawa S, Kadoya Y, Todo S, Kobayashi A, Sakamoto H, Freeman MA, Yamano Y. Tibiofemoral movement 3: full flexion in the living knee studied by MRI. J Bone Joint Surg Br. 2000;82(8):1199–200.
17. Park DY, Min B-H, Choi BH, Kim YJ, Kim M, Suh-Kim H, Kim JH. The Degeneration of Meniscus Roots Is Accompanied by Fibrocartilage Formation, Which May Precede Meniscus Root Tears in Osteoarthritic Knees. Am J Sports Med. 2015;43(12):3034–44.
18. Parsaoran Butarbutar JC, Riantho A, Fidiasrianto K, Ivander G. Meniscus Medial Posterior Root Tear Management. Orthop J Sports Med. 2024;12(10suppl3):2325967124S00381.
19. Walker PS, Arno S, Bell C, Salvadore G, Borukhov I, Oh C. Function of the medial meniscus in force transmission and stability. J Biomech. 2015;48(8):1383–8.
20. Wang J, Peng K, Gu J, Gao S. A larger radius of the medial femoral posterior condyle is a risk factor for medial meniscus posterior root tears. BMC Musculoskelet Disord. 2024;25(1):616.
21. Yang D, Wu X-D, Zhou Y, Yin X, Huang Y, Shao H, Tang H. Correlation between tibial valgus deformity and aspect ratio of resected tibial surface in female Chinese patients undergoing total knee arthroplasty. Front Surg. 2022;9:1079981.

Figures

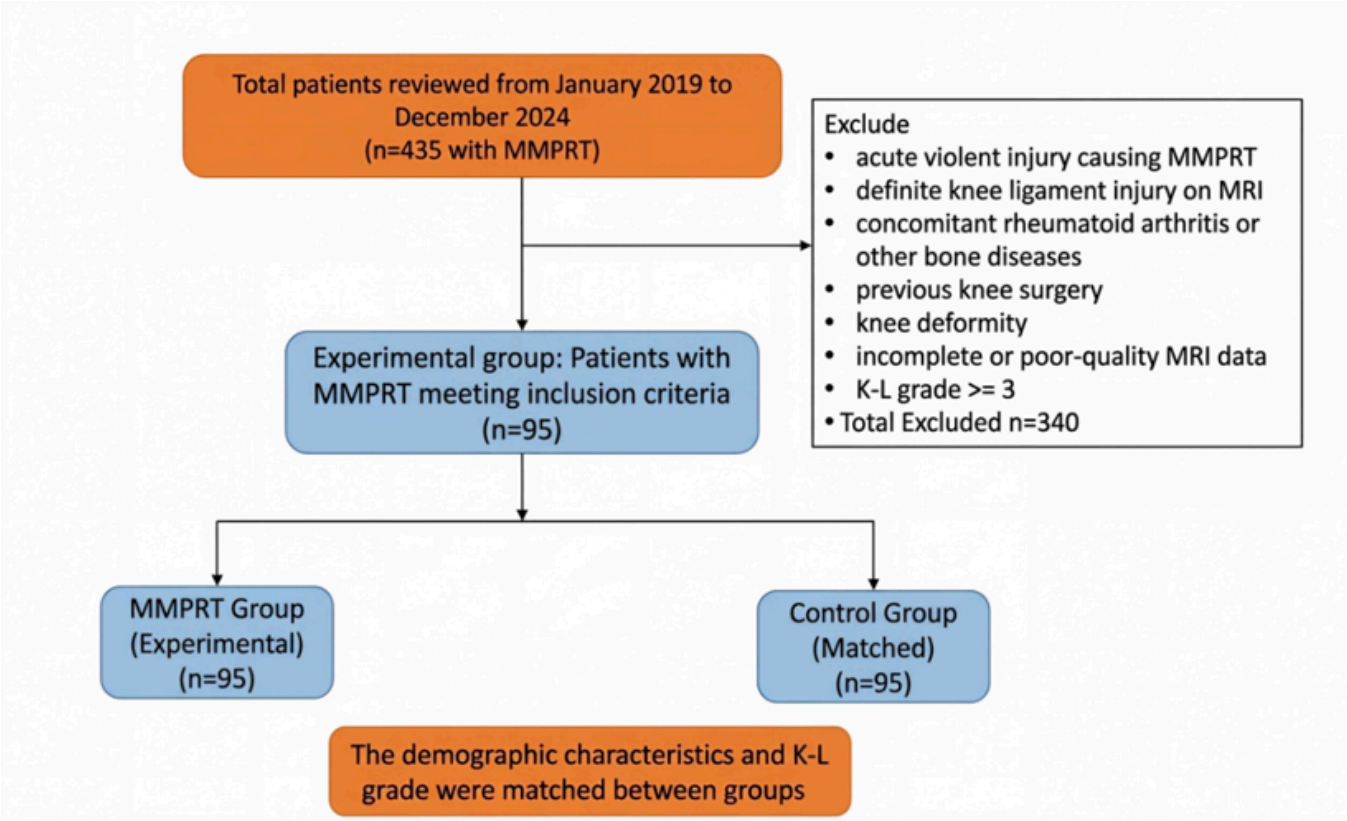


Figure 1

Flow diagram of patient inclusion. MMPRNA, medial meniscus posterior root notch angle; MMPRT, medial meniscus posterior root tear; MRI, magnetic resonance imaging; K-L, Kellgren-Lawrence.



Figure 2

Measurement of MMPRNA. MMPRNA,medial meniscus posterior root notch angle.

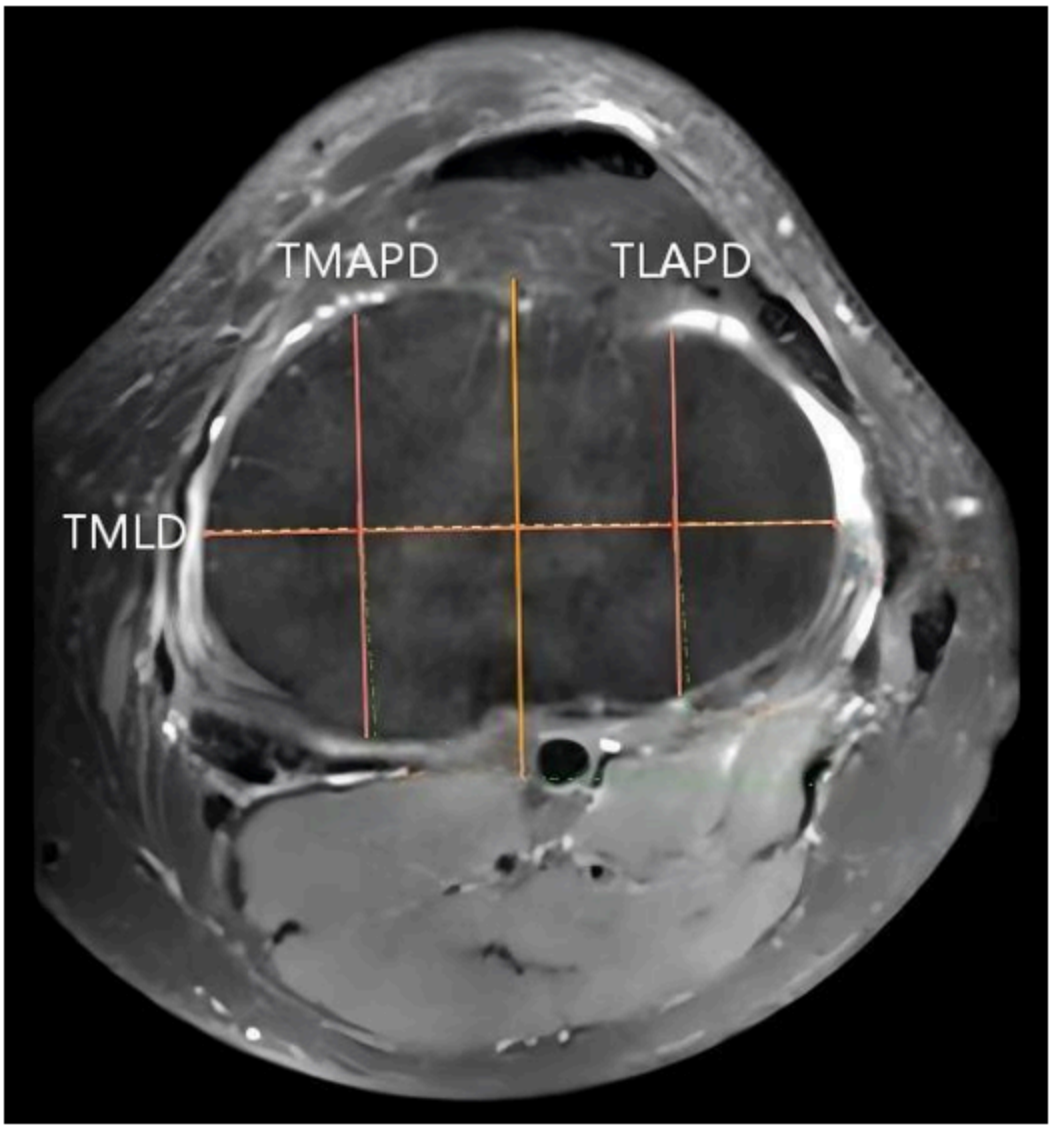


Figure 3

On axial knee MRI, select a meniscus-free tibial level. TMLD is the maximum mediolateral tibial plateau width. TMAPD and TLAPD are the anteroposterior distances measured along perpendiculars at 25% of the mediolateral width from the medial and lateral edges, respectively. TMLD,tibial mediolateral dimension;TMAPD,tibial medial anteroposterior dimensions; TLAPD,tibial lateral anteroposterior dimensions.

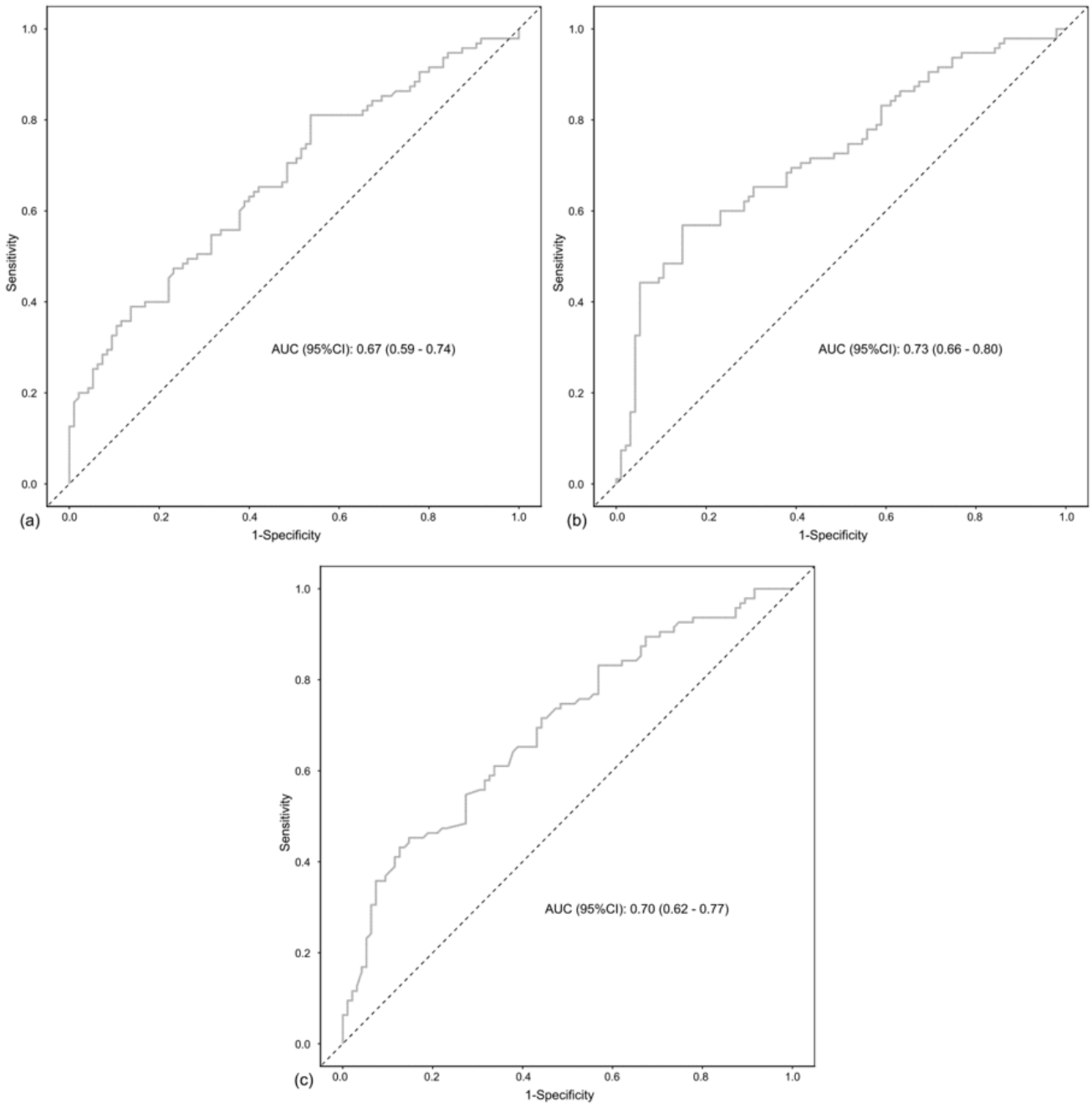


Figure 4

Receiver operating characteristic curve of MMPRNA(a)、ARLTP(b) and TLAPD(c). AUC, area under the curve. MMPRNA, medial meniscus posterior root notch angle. ARLTP, aspect ratio of lateral tibial plateau. TLAPD, tibial lateral anteroposterior dimensions.