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Original article

A Comparison of Arthroscopic and Magnetic Resonant Imaging Findings in Diagnosis of Posterior Medial Meniscus Root Tear

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Abstract:

Background: Meniscal root tears (MRTs) are defined as radial tears within 1 cm of the meniscus insertion, or avulsions at the insertion of the meniscus. This study aimed to assess accuracy and role of MRI in diagnosis of Posterior Medial Meniscus Root Tear in comparison with arthroscopic findings. **Methods:** This cross-sectional observational study included 30 patients with suspected posterior root tear of medial meniscus who were admitted to Benha University Hospital. All patients were subjected to complete history taking, local examination and special tests as McMurray test, Radiological assessment including MRI Technique and Arthroscopic assessment. **Results:** Arthroscopic intervention with partial menisectomy was done for 2 cases of type1 injury and meniscial repair was done for 22 patients of all other types. So, we found one False positive and one False negative case. According to Validity of MRI in diagnosis of PMMRT, MRI showed 96.15% Sensitivity, 75.00% Specificity and 77.12% Accuracy in diagnosis of PMMRT. **Conclusion:** MRI is a valid non-invasive technique in diagnosis of PMMRT and useful in detecting and classifying PMMRT which is helpful for orthopedic surgeons to manage PMMRL tears in clinical practice.

Keywords: Arthroscopic, Magnetic Resonance Imaging, Diagnosis, Posterior Medial Meniscus Root Tear.

Introduction

Meniscal root tears (MRTs) are defined as radial tears within 1 cm of the meniscus insertion, or avulsions at the insertion of the meniscus. This injury leads to failure of the meniscus to convert axial loads into transverse hoop stresses. The changes in joint loading led to accelerated cartilage degeneration, with changes comparable to those seen following a total meniscectomy (1).

Extrusion of the medial meniscus has been observed in both partial and total meniscal root tears, with extrusion >3 mm being associated with increased cartilage degeneration and osteophyte formation (2).

Meniscal root tears may be acute or chronic. The etiology of posterior medial meniscus root tears is often degenerative, as seen in middle-aged women, but it can also be seen in an acute setting in association with multiple ligament knee injuries. Up to one-fifth of medial meniscal tears are found in the posterior root (3).

Root tears are not always evident at physical examination or from magnetic resonance imaging (MRI), so all diagnostic measures should be used in order to effectively assess this pathology. It is important to identify risk factors such as varus alignment and a high BMI, which can predispose to medial meniscus root tears; therefore, a thorough physical examination should be performed (4).

Presenting symptoms are posterior knee pain; an essential—but not always present—clinical diagnostic tool is the presence of a popping sound during light activities such as doing housework, going upstairs/downstairs, rising from a chair, and squatting (3).

MRI should be incorporated in the diagnostic workup of meniscal root tears to supplement patient history and physical examination findings. Previous studies have suggested that MRI is 93% sensitive, 100% specific, and has a positive predictive value of 100% for detection of meniscal root tears. However, an accurate diagnosis of a root tear using MRI is highly dependent on the quality of the image and the skill of the radiologist (5).

There was an arthroscopic classification by Bin and co-workers which developed a classification based on extrusion of the medial meniscus on MRI and finding of the torn site displacement. They were divided into 3 types; type A: non-displaced, type B: overlapped (the torn tissue overlapped on each other), and type C: widely displaced. They found that the widely displaced group had a 4° greater varus deformity, and higher rates of meniscus extrusion, grade III or IV chondral wear in the medial femoral condyle and medial compartment

osteoarthritis than did the nondisplaced or overlapped group (6).

Therefore, this study aimed to assess accuracy and role of MRI in diagnosis of Posterior Medial Meniscus Root Tear in comparison with arthroscopic findings.

Patients and methods

This cross-sectional observational study included 30 patients with suspected posterior root tear of medial meniscus who were admitted to Benha University Hospital. The study was done at Benha University Hospital from January 2022 to January 2023. Informed consent was obtained from all participants included.

Inclusion Criteria were patients of both sexes with an age range from 18 to 65 years old.

Exclusion Criteria were patient less than 18 years and more than 55 years, concomitant tears of the lateral meniscus, mucoid degeneration of anterior cruciate ligaments, a cyclops lesions and arthrosis.

All patients were subjected to Complete history taking (Onset, course, duration and relation of the disease to stress was documented, History of trauma regarding site and type, History of any systemic diseases e.g., liver diseases, diabetes mellitus hyperlipidemia or hypertension, History of drug intake, previous hospital admission and family history of a similar condition). General clinical examination including assessment of vital signs. Local examination and special tests as McMurray test.

The McMurray test, also known as the McMurray circumduction test, is used to evaluate individuals for tears in the meniscus of the knee. A tear in the meniscus may cause a pedunculated tag of the meniscus which may become jammed between the joint surfaces.

Akmese Sign is applied during clinical examination. With the patient lying supine, the lower extremity to be examined is brought into a figure-of-4 position. This allows the knee to have a slight varus position (or at least ensure that there is no valgus force on the knee) causing the medial collateral ligament and medial capsule to release.

Then, protecting external rotation of the hip and flexion, the medial joint line is palpated for pain/sensitivity while knee flexion is lowered to 10°C to 20°C (near extension). Next, while taking the knee into hyperflexion (110°-130°), the medial joint line is palpated again for pain/sensitivity. Patients with severe tenderness in angles near extension and minimal or no tenderness in hyperflexion were considered to have a positive Akmese sign.

Radiological assessment

MR Imaging Technique: MR imaging was performed with a 1.5-T scanner

(Intera Achieva; Philips Medical Systems, Best, The Netherlands) and a knee coil. Fast spin echo pulse sequences were used to obtain modified proton density-weighted images (TR/TE, 4,000/36) in sagittal, coronal, and axial planes as well as sagittal fat suppression T2-weighted images (TR/TE, 2,293/60). MR imaging parameters were follows field of view, 16 cm; excitations 1; matrix size 512 448; section thickness, 3.5 mm for sagittal and axial images and 3 mm for coronal images; no interslice gap.

MR Imaging Analysis: MR images were retrospectively reviewed by one musculoskeletal radiologist without knowledge of preoperative MR imaging results. We evaluated the meniscal root tear configuration of the medial meniscal posterior horn on MR imaging and compared it with arthroscopic findings. We calculated the sensitivity, specificity, and diagnostic accuracy of each configuration in the medial meniscal posterior horn root tear. MR imaging and arthroscopic criteria used for the diagnosis of a medial meniscal root tear required a tear within 5mm of the tibial attachment site of the posterior horn of the medial meniscus. Previously described MR imaging and arthroscopic criteria for meniscal tears were utilized and tear configurations were evaluated and classified into 1 of 5 configurations (7).

Four important sings in MRI images were observed and reported for their diagnostic value in detecting and classifying PMMRT (Furumatsu et al., 2017) as following: A ghost (or white meniscus) sign that shows a disappearance of the MM posterior root/horn on some slices of sagittal MR images can diagnose the MMPRT. A cleft/truncation sign (vertical linear defect) on coronal MR images in MMPRT diagnosis. A “giraffe neck sign” was determined by a lateral view of giraffe neck-like shape of the MM posterior segment on coronal MR images between 3 and 9 mm away from the posterior margin of the MM**. A radial tear sign** (radial linear defect) with complete discontinuity of the posterior root ligament and fluid gap on axial MR images

Arthroscopic assessment: Systematic arthroscopic evaluations were performed using 30° arthroscopes with/without ACL reconstruction. First, standard anterolateral portals were used for routine evaluation; then, the posteromedial and posterolateral compartments of the knee were visualized through the intercondylar notch using 30° arthroscopes The type and location of meniscal tears were assessed by probing. After systematic evaluations, the meniscus tears were treated (repair or meniscectomy) with or without ACL reconstruction. Data of the type and location of meniscal tears were collected

from arthroscopic surgical report form referring to arthroscopic images.

The tear gap, which is the distance between the torn meniscus and the midportion of the corresponding edge of the root attachment, was measured using a probe scale at 10° of knee flexion and valgus stress. Root tears were classified into 5 types according to the presence of a complete tear and the measured value of the tear gap: type 1, incomplete root tear; type 2, complete root tear with no gap or overlapped; type 3, complete root tear with gap measuring 1-3 mm; type 4, complete root tear with gap measuring 4-6 mm; and type 5, complete root tear with gap measuring ≥7 mm (7).

Statistical analysis:

The collected data was tabulated and analyzed by suitable statistical methods using the statistical package for social science (SPSS) (V.20, IBM Inc., Chicago, IL, USA). Categorial data was expressed as number and percentage. Continuous data was expressed as mean and standard deviation (SD). Suitable tests of significance were used. A two tailed P value < 0.05 was considered statistically significant.

Research ethics committee: Ms.48.10.2021

Results

General characteristic, clinical properties and Chronicity of knee lesions of the studied cases were presented in Table 1.

According to Incidence of PMMRT by MRI, 3 (10%) patents were diagnosed to have partial tear while 23 (76.67%) patents had complete tear and no tear was found in 4 patients who had other lesions and prepared for arthroscopic surgery. According to MRI signs which are signs of PMMRT, 25 (83.33%) patients showed cleft sign, ghost sign represented in 23 (76.67%), 24 (80%) patents were found to have giraffe neck sign in their MRI images and 17 (56.67%) showed radial tear sign. According to Associated lesions reported by MRI, 4 (13.33%) patents had anterior cruciate ligament tear, one (3.33%) had posterior cruciate ligament tear, 10 (33.33%) patients had Anterior cruciate ligament degeneration, 3 (10%) patients had Posterior cruciate ligament degeneration, 14 (46.67%) patients had subchondral bone marrow edema, 11 (36.67%) patients had Insertional PMMRL osseous changes, 13 (43.33%) patients had Regional synovitis, 24 (46.67%) patients had Osteoarthritis and 2 (6.67%) patients had Insufficiency fracture Table 2

According to Root tear classification According to MRI Type 1 PMMRT was found in 3 (10%) patients while the most

frequent type was simple complete tear (type 2) which was found in 16 (53.33%) patients and type 3 was found in two patients and four patients had type 4 PMMRT and only one patient had type 5 PMMRT. 4 patients had no PMMRT. According to Root tear classification According to Arthroscopic diagnosis, one patient from the 4 patients who were diagnosed by MRI to have no PMMRT, diagnosed to have partial PMMRT (type 1) by Arthroscopy and another patient who was diagnosed to have complete tear (type 2) by MRI showed no tear by Arthroscopy while all other MRI findings matched with Arthroscopy Table 3.

Arthroscopic intervention with partial menisectomy was done for 2 cases of type1 injury and meniscial repair was done for 22 patients of all other types Table 4.

So, we found one False positive and one False negative case. According to Validity of MRI in diagnosis of PMMRT, MRI showed 96.15% Sensitivity, 75.00% Specificity and 77.12% Accuracy in diagnosis of PMMRT Table 5.

Table 1: General characteristic, clinical properties and Chronicity of knee lesions of the studied cases (N=30).

Age (years)	Range		27 – 61 years
	Mean ±SD		49.27 ±8.1
Age group	<50 years		12 (40%)
	≥50 years		18 (60%)
Gender	Males n (%)		8 (26.67)
	Females n (%)		22 (73.33)
BMI	Range		23.1 - 41.6
	Mean ±SD		31.9 ±4.8
Clinical properties of patients	history of osteoarthritis		24 (80%)
	a history of trauma		11 (36.67%)
	Symptoms	Popping sensation& pain	23 (76.67%)
		Pain without popping	9 (30%)
	Akmese sign		20 (66.67%)
	Symptom onset (months)		6.12 ±4.31
	The mean time between MRI and arthroscopic surgery **(days)**		13.54 ±7.68
Chronicity of knee lesions	Acute **(< 1 month)**		9 (30%)
	Sub-acute **(1-3 months)**		3 (10%)
	Chronic **(> 3 months)**		18 (60%)

Table 2: MRI Findings and associated lesions reported by MRI of the studied cases (N=30).

MRI Findings	**Incidence of PMMRT**	partial tear	3 (10%)
		complete tear	23 (76.67%)
		No root tear (By MRI)	4 (13.33%)
	Associated signs	cleft sign	25 (83.33%)
		ghost sign	23 (76.67%)
		girafe neck sign	24 (80%)
		radial tear sign	17 (56.67%)
Associated lesions reported by MRI	anterior cruciate ligament **tear**		4 (13.33%)
	posterior cruciate ligament **tear**		1 (3.33%)
	Anterior cruciate ligament degeneration		10 (33.33%)
	Posterior cruciate ligament degeneration		3 (10%)
	subchondral bone marrow edema		14 (46.67%)
	Insertional PMMRL osseous changes		11 (36.67%)
	Regional synovitis		13 (43.33%)
	Osteoarthritis		14 (46.67%)
	Insufficiency fracture		2 (6.67%)

Table 3: Root tear classification According to MRI and Root tear classification According to Arthroscopic diagnosis of the studied cases (N=30).

Root tear classification According to MRI	**Type 1**	3 (10%)
	Type 2	16 (53.33%)
	Type 3	2 (6.67%)
	Type 4	4 (13.3%)
	Type 5	1 (3.33%)
	Total patients with PMMRT	26 (86.67%)
No PMMRT		4 (13.33%)
Root tear classification According to Arthroscopic diagnosis	**Type 1**	4 (13.33%)
	Type 2	15 (50%)
	Type 3	2 (6.67%)
	Type 4	4 (13.3%)
	Type 5	1 (3.33%)
	Total patients with PMMRT	26 (86.67%)
No PMMRT		4 (13.33%)

Table 4: Type of arthroscopic intervention for treatment of the studied cases (N=30).

Type of arthroscopic intervention for treatment	Meniscus Repair	22 (73.33%)
	Partial Meniscectomy	2 (6.67%)
	Meniscectomy	2 (6.67%)

Table 5: Validity of MRI in diagnosis of PMMRT.

MRI Validity test	True positive	25
	True negative	3
	False positive	1
	False negative	1
	Positive Likelihood Ratio	3.85
	Negative Likelihood Ratio	0.05
	Positive Predictive Value	29.94%
	Negative Predictive Value	99.43%
	Sensitivity	96.15%
	Specificity	75.00%
	Accuracy	77.12%

Cases:

Case 1: Male patient aged 51 years; suffered from pain and popping sensation. MRI: complete root detachment (type2). ARTHROSCOPY: confirmed MRI diagnosed as medial meniscus root tear Figure 1.

Case 2: Female patient aged 45 years suffered from continuous pain which increased during walking, MRI: complete root tear (type 2), ARTHROSCOPY: confirmed MRI diagnosed as medial meniscus root tear Figure 2.

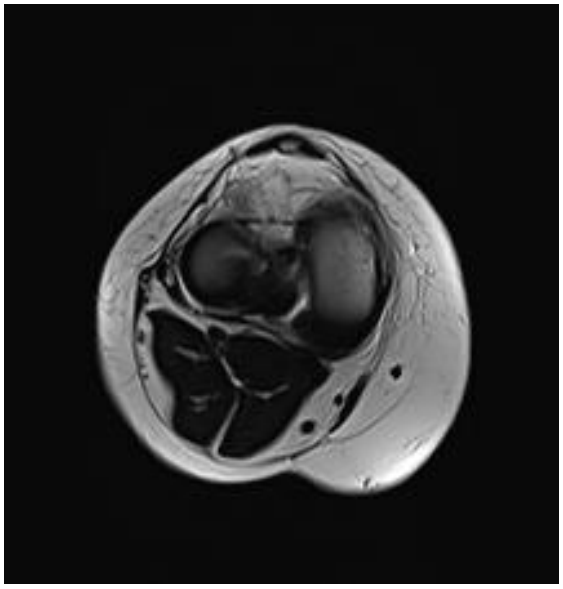

Figure 1: Male patient aged 51 years; suffered from pain and popping sensation. MRI: complete root detachment (type2). ARTHROSCOPY: confirmed MRI diagnosed as medial meniscus root tear.

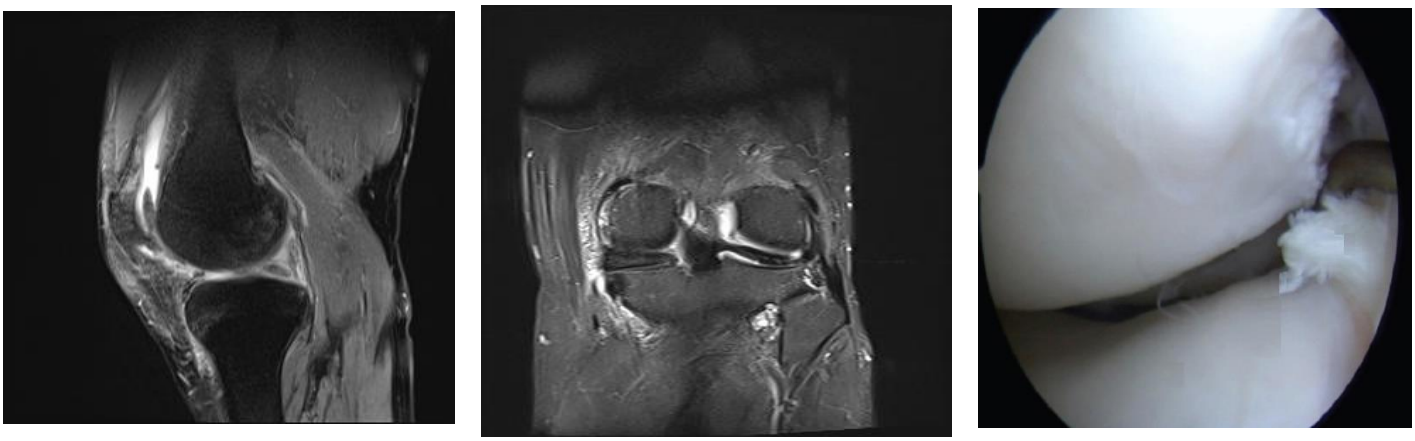

Figure 2: Female patient aged 45 years suffered from continuous pain which increased during walking, MRI: complete root tear (type 2), ARTHROSCOPY: confirmed MRI diagnosed as medial meniscus root tear.

Discussion

Several recent reports have suggested that PMMRL tears are relatively common, particularly in the middle-aged or elderly population, and may be a cause of medial tibiofemoral osteoarthritis of the knee, which is the most common source of total knee arthroplasty. MRI is the primary diagnostic tool for PMMRL tears and has been regarded as both reliable and accurate for detection (2, 8).

Tears of the PMMRL continue to receive increasing attention in the literature, largely due to wide recognition of the

importance of this structure. Nevertheless, detailed information on the PMMRL in terms of frequency, types, and associated factors is not well established. This study aimed to address these unclear issues related to the PMMRL lesion (9).

In a former study (10), PMMRL lesions, including degeneration and tearing, were frequent findings. Among 419 consecutive knees undergoing MRI for knee symptoms, we found root ligament lesions in 28.6%, including tears in 14.3%.

Previous studies have shown wide variability in prevalence of PMMRL tears, ranging from 0.4 to 29.5%. It is likely that the variability in PMMRL tear prevalence is a result of a combination of factors, including different patient populations; differences in diagnostic methods (imaging vs arthroscopy); and differences in definition, including location and inclusion of partial tears (11).

Most studies have used binary classification systems for meniscal root tears: normal or tearing and, most frequently, either a radial tear or avulsion at the insertion of the meniscus (12).

However, besides those types, our assessments have revealed that PMMRL tears can be further classified into additional subtypes, such as longitudinal cleavage tear. We believe that longitudinal cleavage tears of the PMMRL may result from direct extension of preceding PHMM tears into the adjacent root ligament (13).

Possibly, this is because the PMMRL is the stiffest meniscal attachment among all of the root ligaments and thus would be uniquely predisposed to injury at the junction with the PHMM during activities (10).

Moreover, the junction between the posterior horn and the root ligament may be structurally weaker because of the differences in morphology and collagen distribution between the fibrocartilagenous meniscus, root ligament, and enthesis (14).

Additionally, PMMRLs are exposed to more stressful conditions in both tensile and compressive loads, whereas the anterior root ligaments are mostly exposed only to tensile loads. We believe that a detailed description of PMMRL pathology would be helpful for orthopedic surgeons to manage PMMRL tears in clinical practice. Conventionally, PMMRL tears have been treated by meniscectomy (15).

However, because recent biomechanical studies have revealed significant changes in contact pressure and knee joint kinematics due to PMMRL tears, several techniques for meniscal root repair to restore joint biomechanics to near normal conditions have been developed (16).

Conclusion

MRI is a valid non-invasive technique in diagnosis of PMMRT and useful in detecting and classifying PMMRT which is helpful for orthopedic surgeons to manage PMMRL tears in clinical practice.

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