Magnetic Resonance Imaging Compared to Magnetic Resonance Arthrography in Assessment of Post-Arthroscopic knee Pain

Nermeen Ali Tawfik[1], Tarek Hassan Khalil[2], Ahmed Ali Toreih[3] and Waleed Mosallam Hussein[4].

[1]Assistant lecturer of radiology, Suez Canal University, Nermeenalitawfik91@gmail.com
[2]Professor of radiology, Suez Canal University, TarekKhalil@gmail.com
[3]Assistant professor of Orthopedic surgery, Suez Canal University, A,toreih@gmail.com
[4]Lecturer of radiology, Suez Canal University, walidmosallam@yahoo.com

Abstract

Background: Arthroscopic knee surgery including partial meniscectomy, meniscal repair and anterior cruciate ligament reconstruction are the most performed surgical procedures. Magnetic Resonance arthrography is the cornerstone imaging modality in evaluating the postoperative symptomatic patients. Our prospective cross-sectional study that included 30 patients admitted to Orthopedic Department, Suez Canal University Hospital was to evaluate the diagnostic values of conventional MRI in assessing patients with post-arthroscopic knee pain with MR arthrography as standard reference in ACL reconstruction or meniscal surgeries.**Results**: In ACL group (total 21 patients), all patients had in vivo ACL grafting, the conventional MRI showed 93.3% sensitivity, 95% specificity and 94.2% accuracy in diagnosing causes of post-operative knee pain. In the meniscus surgery group (total 20 patients), six patients (30%) were treated with meniscal repair, 13 patients (65%) had meniscectomy and one patient (5%) had meniscal transplant. Conventional MRI showed 77% sensitivity, 58% specificity and 67.5% accuracy in meniscal surgeries group. MRI and MRA showed high agreement (K= 0.66) in meniscal transplant and meniscectomy less than 25%, while MRI has a low agreement (K=0.1 &0.5) with MRA in meniscal repair and meniscectomy more than 25%.**Conclusions**:MRI has high sensitivity and specificity regarding the assessment of the post-operative knee pain post ACL reconstruction, with lower sensitivity and specificity in post meniscal surgeries where MR arthrography might be necessary for detection of recurrent meniscal tear in cases of meniscal repair and partial meniscectomy more than 25%. However, when meniscus resection is minimal (less than 25%) conventional MRI is usually enough for diagnosis.

Keywords: MRI, MR arthrography, ACL, Meniscal repair, partial meniscectomy.
DOI Number: 10.48047/NQ.2022.20.20.NQ109206 **NeuroQuantology2022;20(20): 1970-1994**

Background

Arthroscopic knee surgery is one of the most performed surgical procedures. Indications for performing this procedure include surgically correctable pathologies causing functional complaints, as well as acute or persistent pain [1]. Pain is most often the major indication for surgery, however, it is also a fairly common complication of the surgical procedure [2, 3]. The most common arthroscopic repair procedures include partial meniscectomy and meniscal repair, anterior cruciate ligament reconstruction, and cartilage repair procedures [4]. Post-operative complications of anterior cruciate ligament reconstruction include either early complications due to inaccurate placement because of technical difficulties during surgery or failed ACL reconstruction because the tibial tunnel is too posteriorly placed or loss of graft fixation, graft tear or graft laxity , or late complications as anterior, posterior and lateral impingements , tunnel cysts, arthro-fibrosis and harvest site complications [5]. Post-operative meniscus surgery complications include meniscal re-tears [6]. Postoperative imaging interpretation is often complex and challenging; as such, an organized, systematic approach is essential in distinguishing between expected postoperative changes and new or pre-existing pathology [7]. Direct MR arthrography entails the intra-articular injection of 20–50 mL of a dilute gadolinium mixture into the knee joint before an MRI examination Extension of contrast agent into the meniscus substance highlights a recurrent tear or unhealed repair. Benefits of direct MR arthrography include distention of the knee joint capsule, reduced viscosity of the synovial fluid, and a high signal-to-noise ratio on T1-weighted sequences [6].

Aim & Objective

To measure the diagnostic value of Conventional MR compared to MR arthrography in diagnosis of causes of post-operative knee pain.

Methods

This prospective cross-sectional study included 30 patients with post-operative knee pain admitted to Orthopedic Department, Suez Canal University Hospital from the period April 2020 to September 2021.

Research Setting:

The study was conducted at the Radiology Department, Suez Canal University Hospital in Ismailia.

Study Population**:**

Adult patients aged more than 18 years with Post-operative knee pain admitted to Orthopedic Department, Suez Canal University Hospital.

Inclusion criteria:

1. Adult patients aged more than 18 years old.
2. Arthroscopic ACL reconstruction or repair.
3. Patients with meniscal surgery either partial meniscectomy or meniscal repair.
4. Patients with multi-ligamentous and meniscal injuries.

Exclusion criteria:

1. Adult patients aged less than18 years old.
2. Patients with MRI-incompatible metallic implants.
3. Patients with septic joints (Suspected clinically and radiologically).

Informed consent was obtained from all participating patients before performing any interventions.

Data collection:

Variables that have been obtained for each patient upon referral before undergoing the procedure:

A. History and examination:

The following points were assessed:

1. Clinical history including:

- Age
- Gender
- Type of operation
- Pain analysis (Onset, Course, Duration)
- Associated symptoms.

B. MRI scan:

Place of the study and machine:

- MRI-Unit, Suez Canal University Hospital, Diagnostic Radiology Department, Ismailia.

-The procedure was done in the radiology department using 1.5 Tesla MR scanner (Philips Medical Systems, Achieva 1.5T A-series).

Knee MRI preparation:

-The scan was scheduled.

-Any metallic objects were removed.

Knee MRI technique protocol:

Performed on 1.5T. Use 5CH knee Coil or 15CH knee Coil.

Standard knee imaging includes:

MRI of the knee in the coronal, axial, and sagittal planes on a 1.5T –T scanner

1. Sagittal & Axial fast spin-echo T2-weighted sequences.
2. Coronal fast spin-echo STIR T2-weighted sequences.
3. Sagittal & Coronal Fast spin-echo proton density sequences.
4. Sagittal Fast spin-echo proton density SPIR sequences.

Field of view of 15 cm on all images was used. Slice thickness was 3 mm with a 10 % interslice gap on all sequences except for the fast spin-echo proton density sagittal sequence, which have a 2-mm slice thickness with a 10% interslice gap.

MR Arthrography

MR arthrography was performed with approximately 25 mL of a dilute gadopentetate Di meglumine (Magnevist; BerlexLaboratories,Wayne, NJ, USA) and saline mixture (hereafter, contrast mixture), with 0.15 ml of gadopentetate dimeglumine per 20 mL of normal saline.

Blind Injection of contrast material was performed from a lateral approach into the patello-femoral joint with a 20-gauge needle. MR arthrography was performed in all patients under complete aseptic conditions after conventional MR imaging. The researcher performed the injection.

After injection of the contrast mixture into the knee joint, all patients exercised the knee by actively extending and bending the knee continuously for 5minutes while being seated before repeating imaging. After exercise, T1 & T2-weighted (750/10) fat-saturated coronal and sagittal MR images was obtained. T2-weighted (750/10) fat-saturated sagittal images was obtained before MR arthrography for comparison.

Knee MR Arthrography technique protocol:

Performed on 1.5T.Use 5CH knee Coil or 15CH knee Coil.

1. Sagittal & Axial & Coronal fast spin-echo T1 SPIR-weighted sequences.
2. Sagittal & Axial & Coronal fast spin-echo T2 SPAIR-weighted sequences.

Field of view of 15 cm on all images was used. Slice thickness was 3 mm with a 10 % interslice gap on all sequences

Image interpretation:

All MR images were reviewed retrospectively by two expert radiologists by consensus reading. Conventional MR images were reviewed by the same radiologists in a separate sitting to avoid bias.

As for meniscal retears, Conventional MR examinations were assessed for meniscal retears. MR criteria used to assess for a meniscal retear on conventional MR was abnormal meniscal signal touching an articular surface, abnormal morphology of the meniscus, or a displaced meniscal fragment. The criterion for MR arthrographic findings of a meniscal retear was abnormal communication of an intra-articular gadolinium-based contrast material into the substance of the meniscus, which is considered the gold standard for diagnosis. The two reviewers then performed consensus review of conventional MR and MR arthrogram examinations in combination for each patient. This was also done in a separate sitting from the above two reviews so as not to bias reviewers. The results were compared and sometimes a second look arthroscopic data was available, results were then interpreted to calculate sensitivity of conventional MR in detection of meniscal retears compared to MR arthrography.

As for ACL reconstruction, the images were graded for the presence or absence of anterior cruciate ligament graft tear, localized anterior arthrofibrosis, and impingement. The graft was considered intact if it could be followed from the femoral tunnel all the way through to the tibial tunnel. A torn graft was diagnosed when the graft fibers could not be identified extending from the femoral tunnel to the tibial tunnel, especially when gadolinium-based contrast material extended through a discontinuity in the graft fibers arthrography. Localized anterior arthrofibrosis was diagnosed when abnormal non-fat soft tissue is seen superior to the tibial plateau anterior to the insertion of the anterior cruciate ligament graft. Impingement was diagnosed when the anterior cruciate ligament graft contained increased signal or was enlarged and associated with either the tibial tunnel placed anterior to a line drawn along the roof of the femoral notch or the superior surface of the graft is deformed by the roof of the femoral notch then similarly , MR arthrography was done and studies were interpreted to determine the presence or absence of the anterior cruciate ligament graft findings.

Results

This cross-sectional study included 30 patients with post-operative knee pain admitted to Orthopedic Department, Suez Canal University Hospital. They were subdivided into two groups, group of ACL reconstruction & group of meniscal surgery.

ACL reconstruction group (21 patient)

Ten patients (33.3%) were treated with ACL reconstruction, and 11 patients (36.7%) had combined management.

Table 1

	N=21
Tear	
Partial	0(0%)
Complete	5(23.8%)
Abnormal orientation of the graft	
Femoral tunnel	
Anteriorly located	4(19%)
Posteriorly located	8(38.1%)
Tibial tunnel	
Anteriorly located	4(19%)
Impingement	5(23.8%)
Cyst formation	
Femoral tunnel	2(9.5%)
Tibial tunnel	2(9.5%)
Hardware failure	3(14.3%)
Arthrofibrosis	
Focal	3(14.3%)
Diffuse	4(19%)
Harvest site complications	
Hoffa fat pad impingement	2(9.5%)
Osgood-Schlatter	1(4.8%)
Ilio-tibial band friction syndrome	3(14.3%)
Bony contusions	8(38.1%)

In this table, MRI examination of ACL reconstruction group found that 5 patients (23.8%) had complete tear and no patient had partial tear. 4 patients (19%) had anteriorly located femoral tunnel as shown in **figure 7**, 8 patients (38.1%) had posteriorly located femoral tunnel and 4 patients (19%) had anteriorly located tibial tunnel. Five patients (23.8%) had impingement as shown in **figure 8**, 2 patients (9.5%) had femoral tunnel cyst, 2 patients (9.5%) had tibial tunnel cyst, 3 patients (14.3%) had hardware failure, 3 patients (14.3%) had focal Arthrofibrosis, 4 patients (19%) had diffuse Arthrofibrosis, 3 patients (14.3%) had harvest site complications, 3 patients (14.3%) had iliotibial band friction and 8 patients (38.1%) had bony contusions.

	N=21
Tear	
Partial	4(19%)
Complete	5(23.8%)
Abnormal orientation of the graft	
Femoral tunnel	
Anteriorly located	4(19%)
Posteriorly located	8(38.1%)
Tibial tunnel	
Anteriorly located	4(19%)
Impingement	5(23.8%)
Cyst formation	
Femoral tunnel	2(9.5%)
Tibial tunnel	2(9.5%)
Hardware failure	4(19%)
Arthrofibrosis	
Focal	4(19%)
Diffuse	4(19%)
Harvest site complications	
Hoffa fat pad impingement	2(9.5%)
Osgood-Schlatter	1(4.8%)
Ilio-tibial band friction syndrome	3(14.3%)
Bony contusions	8(38.1%)

Table 2

In this table, MR arthrography examination of ACL reconstruction group found that 5 patients (23.8%) had complete tear (as shown in **figure 10)** and 4 patients had partial tear (19%) (as shown in **figure 9)**. 4 patients (19%) had anteriorly located femoral tunnel, 8 patients (38.1%) had posteriorly located femoral tunnel and 4 patients (19%) had anteriorly located tibial tunnel.

eISSN 1303-5150

Five patients (23.8%) had graft impingement, 2 patients (9.5%) had femoral tunnel cyst, 2 patients (9.5%) had tibial tunnel cyst, 4 patients (19%) had hardware failure, 4 patients (19%) had focal Arthrofibrosis as shown in **figure 13**, 4 patients (19%) had diffuse Arthrofibrosis as shown in **figure 11**, 3 patients (14.3%) had harvest site complications, 3 patients (14.3%) had iliotibial band friction and 8 patients (38.1%) had bony contusions.

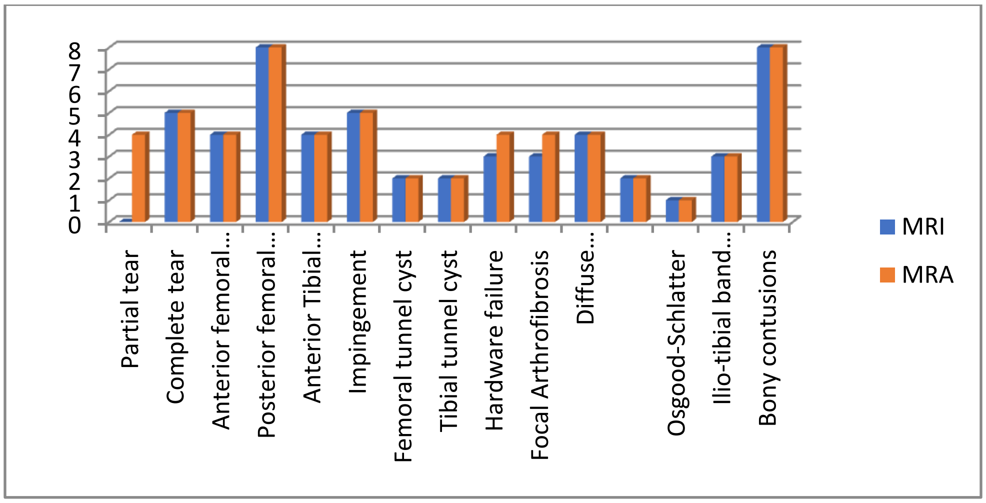

Fig. 1: MRI versus MRA findings in ACL reconstruction group (n=21).

In figure 1, MRI had the same findings of MRA except that MRA detect 4 patients with partial tear that were not detected by MRI. Also, MRA found 4 patients with hardware failure and focal Arthrofibrosis, while MRI detected only 3 patients.

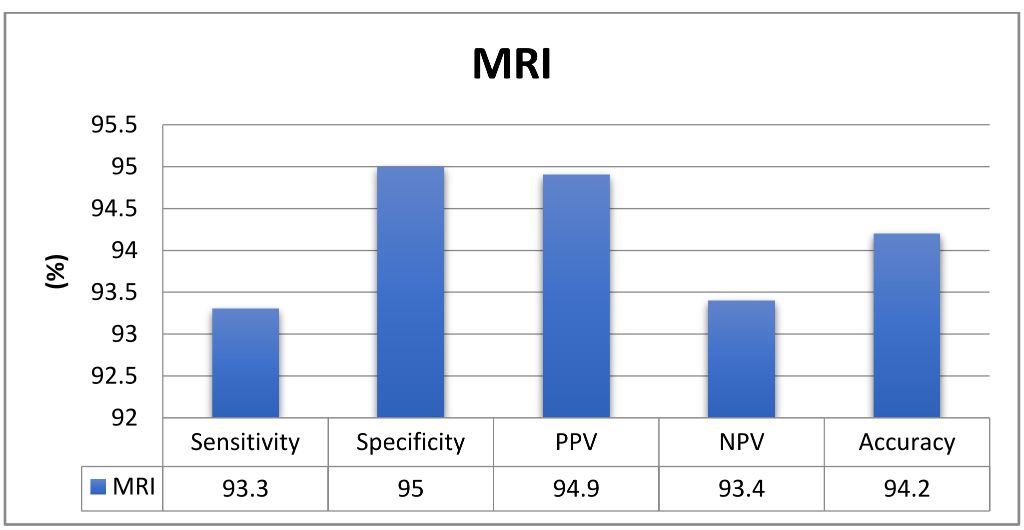

Fig. 2:-Validity of MRI in diagnosing causes of post operative knee pain in ACL reconstruction group (n=21).

In this figure, MRI had 93.3% sensitivity and 95% specificity in diagnosing cause of post-operative knee pain in ACL reconstruction group with 94.2% accuracy.

Meniscal surgery group

Six patients (30%) were treated with meniscal repair, 13 patients (36.7%) had meniscectomy and one patient (5%) had meniscal transplant.

Table 3: MRI versus MR arthrography findings of meniscal surgeries group (n=20).

	Method	Tear	Intact	P-value	Kappa
Repair (n=6)	MRI	3(50%)	3(50%)	1.00	0.143
	MRA	2(33.3%)	4(66.7%)		
Meniscectomy <25% (n=7)	MRI	5(71.4%)	2(28.6%)	0.08	0.667
	MRA	4(57.1%)	3(42.9%)		
Meniscectomy >25% (n=6)	MRI	3(50%)	3(50%)	0.242	0.500
	MRA	2(33.3%)	4(66.7%)		
Transplant (n=1)	MRI	0(0%)	1(100%)	-----	1.00
	MRA	0(0%)	1(100%)		

Data was presented as number (percentage) when it was qualitative. Abbreviations: PHMM; posterior horn medial meniscus, AHMM; anterior horn medial meniscus, PHLM; posterior horn lateral meniscus, AHLM; anterior horn lateral meniscus. Fisher exact test was used. Kappa agreement test was used.

In this table, MRI and MRA showed high agreement in meniscal transplant and meniscectomy less than 25% (k=1 and 0.667, respectively), while MRI has low agreement with MRA in meniscal repair and meniscectomy more than 25% (k=0.143 and 0.500, respectively).

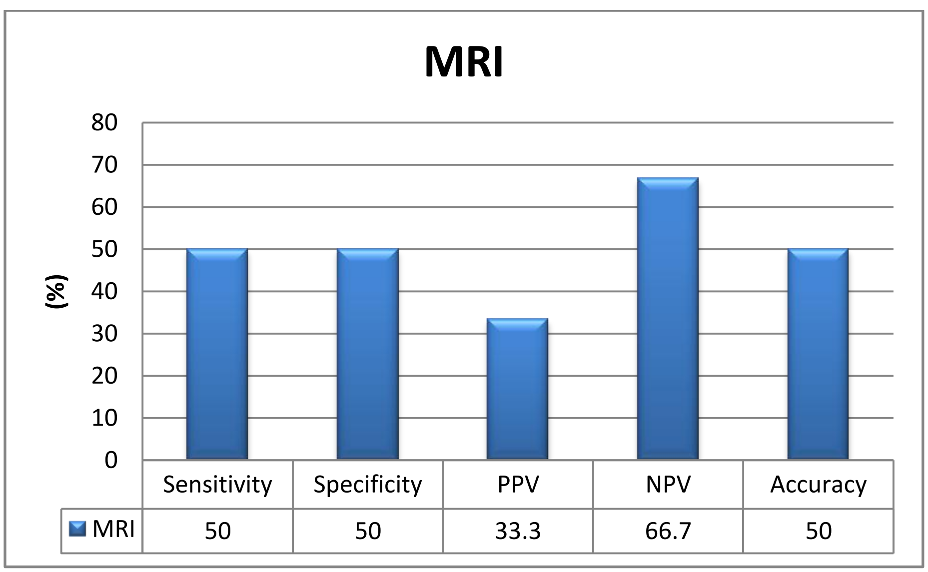

Fig. 3: Validity of MRI in diagnosing meniscal tear in meniscal repair group (n=6).

In this figure, MRI had 50% sensitivity and 50% specificity in diagnosing meniscal tear in meniscal repair group with 50% accuracy.

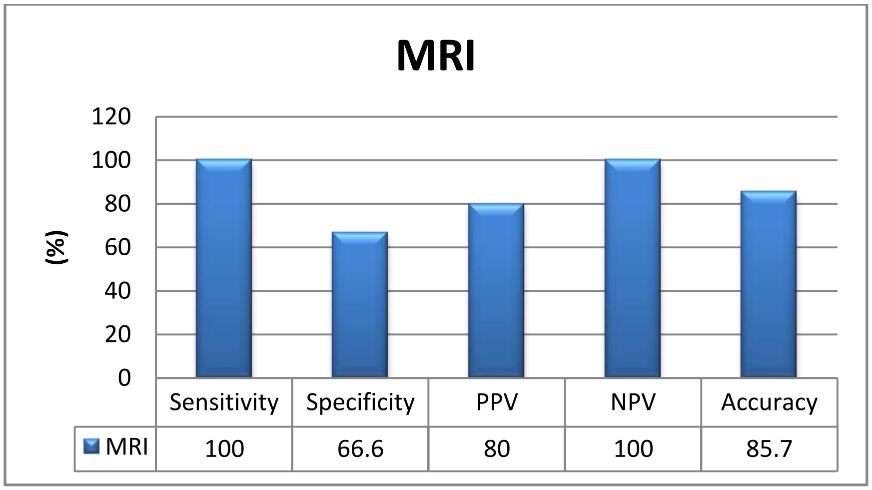

Fig. 4: Validity of MRI in diagnosing meniscal tear in menisectomy <25% group (n=7).

In this figure, MRI had 100% sensitivity and 66.6% specificity in diagnosing meniscal tear in Meniscectomy <25% group with 85.7% accuracy.

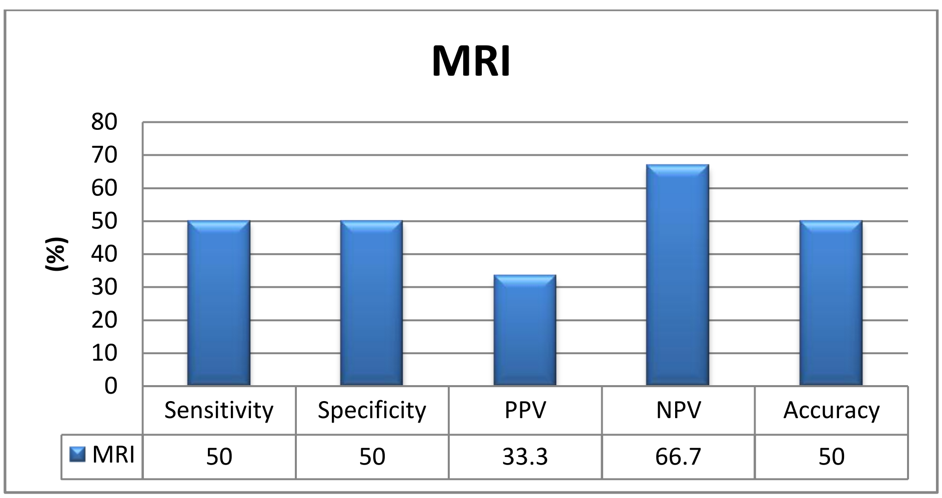

Fig. 5: Validity of MRI in diagnosing meniscal tear in menisectomy >25% group (n=6).

In this figure, MRI had 50% sensitivity and 50% specificity in diagnosing meniscal tear in Meniscectomy >25% group with 50% accuracy.

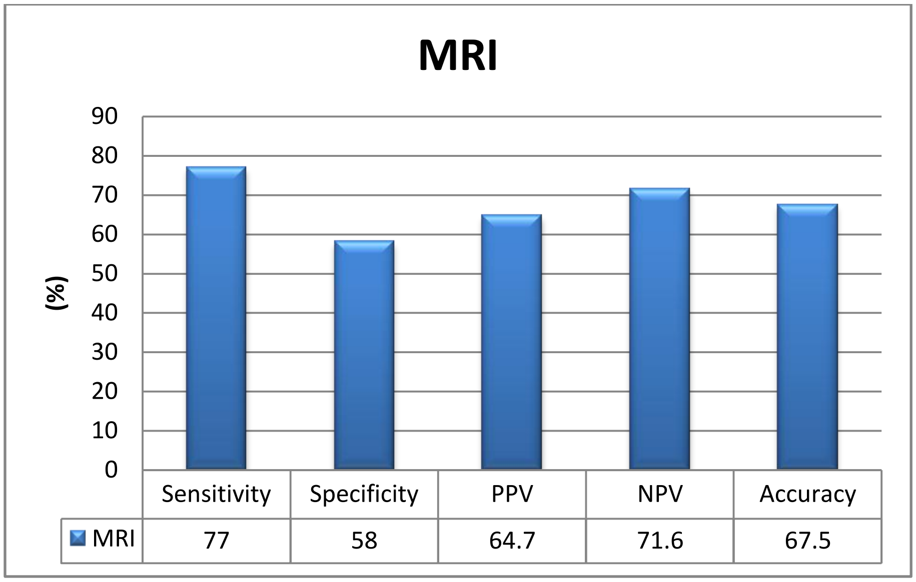

Fig. 6: Validity of MRI in diagnosing meniscal tear in all meniscal surgeries group (n=20).

In this figure, MRI had 77% sensitivity and 58% specificity in diagnosing meniscal tear in all meniscal surgeries group with 67.5% accuracy.

In this figure, MRI had 77% sensitivity and 58% specificity in diagnosing meniscal tear in all meniscal surgeries group with 67.5% accuracy.

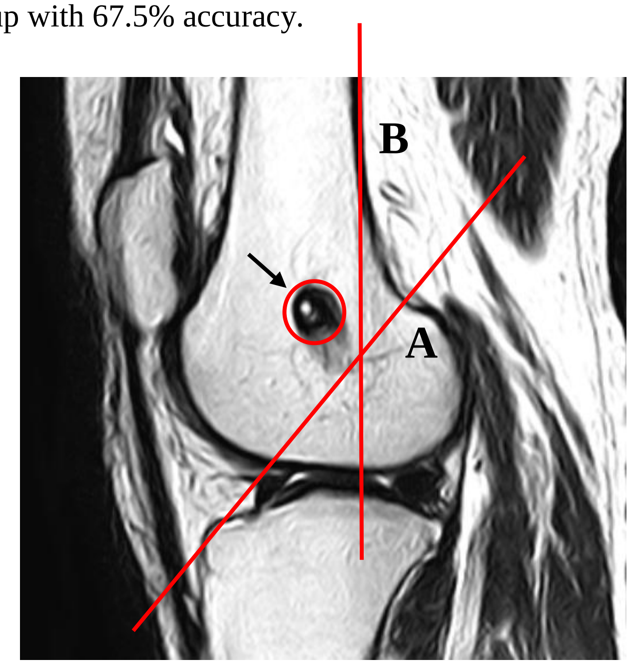

Fig. 7. Abnormally located femoral tunnel. Sagittal T2WI of extended knee showing femoral tunnel opening (arrow) abnormally placed anterior to the intersection of blumensat line (A) and posterior cortical femoral line (B).

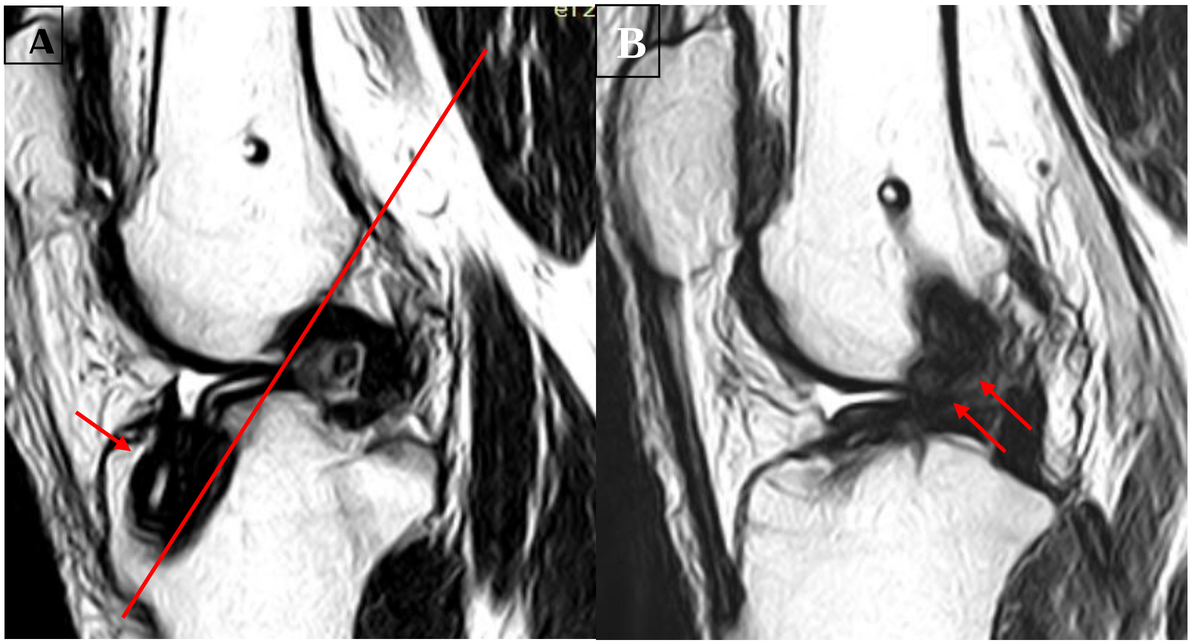

Fig. 8(A&B).Too anterior tibial tunnel & Roof impingement. Sagittal T2-weighted image showing the tibial tunnel anterior to the Blumensaat line. The graft appears posteriorly bowed (arrows) with increased signal**.**

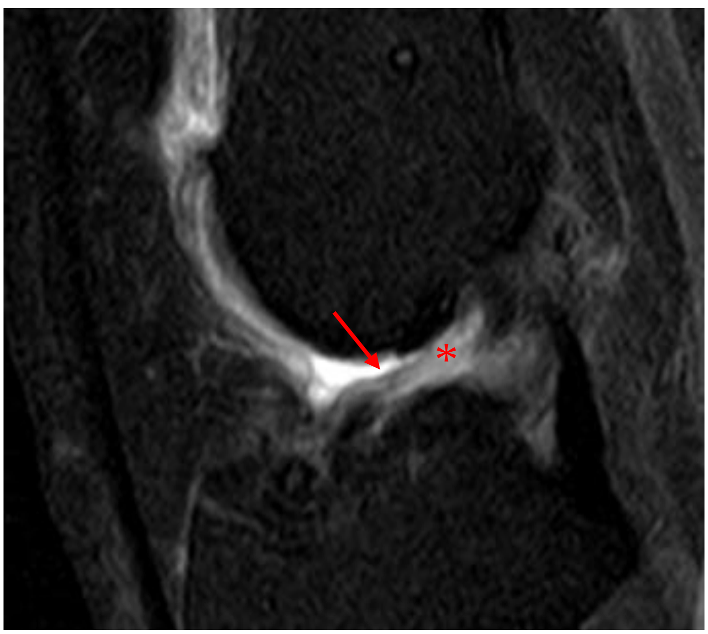

Fig. 9 Partial Graft tear. Sagittal post contrast T1-fat-suppressed images showing a partial fluid-filled graft defect (asterisks) with some fibers intact (arrows).

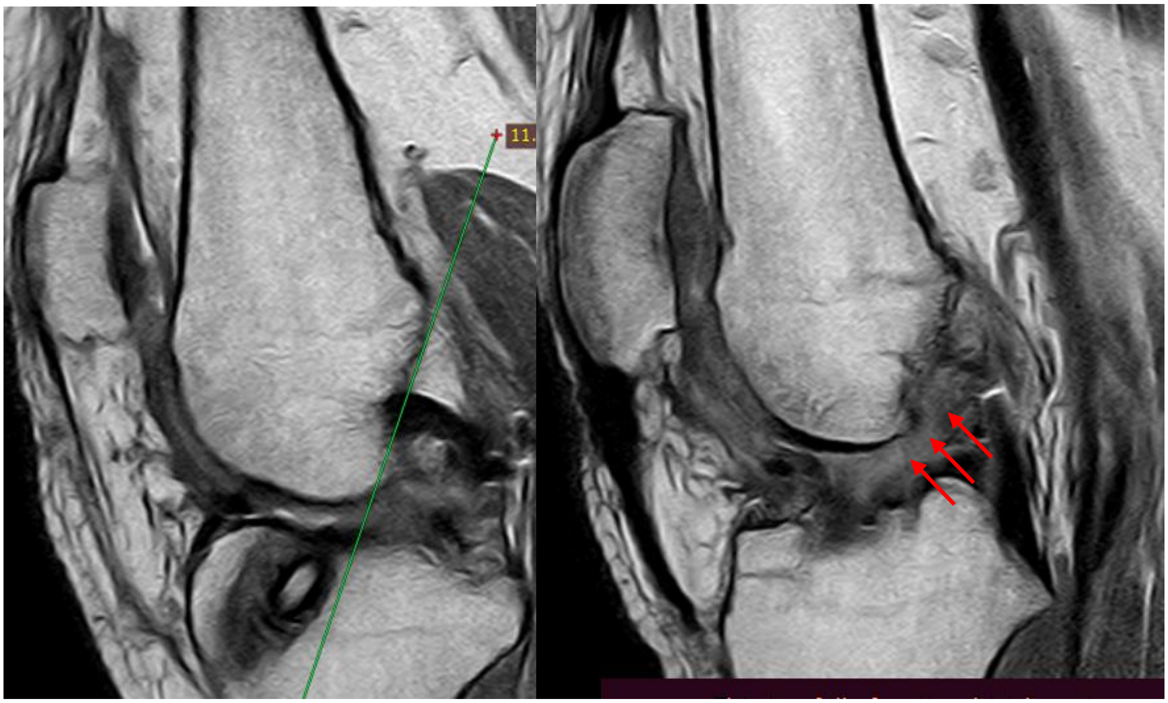

Fig. 10 (A&B).Complete graft tear & too anterior tibial tunnel. Sagittal proton density weighted image showed part of the tibial tunnel anterior to the Blumensaat line. The graft is not visualized with complete discontinuity in keeping with graft tear.

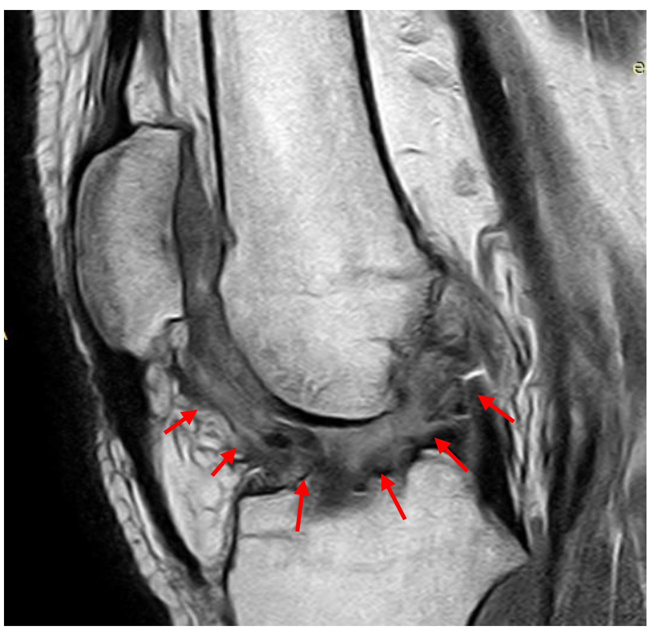

Fig.11 Diffuse joint fibrosis: Proton density weighted sagittal sections: intermediate signal intensity areas involving all, anterior and posterior compartments (arrows) and extending to the Hoffa fat pad.

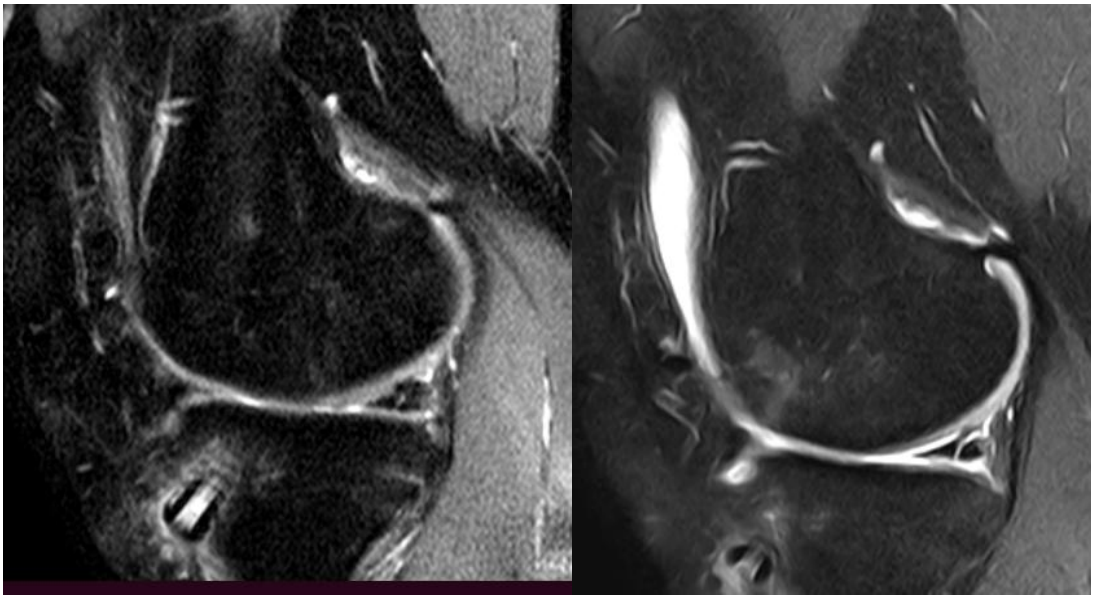

Fig. 12(A & B)Meniscal re-tear. **A)** Sagittal proton density–weighted image shows linear signal hyperintensity (arrow) ?? contacting the articular surface of medial meniscus posterior horn. **B)** Sagittal fat-suppressed image of MR arthrogram of same patient reveals contrast imbibition into posterior horn at repair site (arrow), which is diagnostic of recurrent longitudinal meniscus tear.

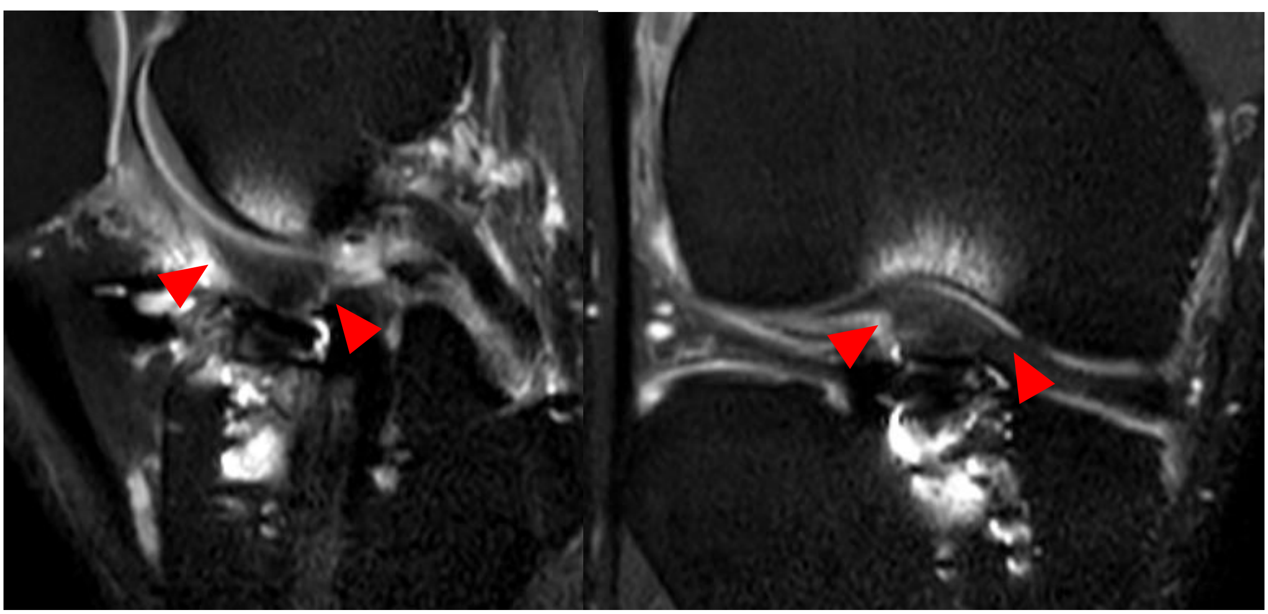

Fig. 13 (A&B).Cyclops lesion localized joint fibrosis. Sagittal & Coronal T1 fat suppressed images showed nodular hypointense structure located on the anterior aspect of the intercondylar notch (arrowheads).

Discussion

Our cross-sectional study included 30 patients with post-operative knee pain who were admitted to Orthopedic Department, Suez Canal University Hospital. Ten patients (33.3%) were treated with ACL reconstruction, 9 patients (30%) had meniscal surgeries and 11 patients (36.7%) had combined management.

We found that all patients complaining of Post operative knee pain after ACL reconstruction showed radiological findings on MRI, which concluded high sensitivity of MR in detection of causes of post ACL reconstruction knee pain.

In our study, Conventional MRI examination of ACL reconstruction group found that 5 patients (23.8%) had complete ACL graft tear. 4 patients (19%) had abnormally located femoral tunnel anteriorly, 8 patients (38.1%) had posteriorly located femoral tunnel and 4 patients (19%) had anteriorly located tibial tunnel. Five patients (23.8%) had abnormal graft signal (impingement) which was defined as such when the tibial tunnel was seen anterior to the intersection of the slope of the intercondylar roof with the proximal tibia, in these patients where the graft was seen impinged on by the roof of the inter-condylar notch as the tibial tunnel should be oriented parallel to the Blumensaat line which is a line drawn along the intercondylar roof, its distal portion should start near the tibial tuberosity, and the intra articular opening of the tunnel should be completely posterior to this line, 2 patients (9.5%) had femoral tunnel cyst, 2 patients (9.5%) had tibial tunnel cyst, 3 patients (14.3%) had hardware failure which included (interference screw or end button migration and abnormal position, breakage or non-visualization), 3 patients (14.3%) had focal Arthrofibrosis, 4 patients (19%) had diffuse Arthrofibrosis, 3 patients (14.3%) had harvest site complications which was seen as Hoffa fat pad impingement and patellar tendinopathy (Osgood Schlatter syndrome) , 3 patients (14.3%) had iliotibial band friction and 8 patients (38.1%) had bony contusions.

This showed agreement with **Farahat et al.** study that aimed to evaluate the MRI findings in symptomatic patients following ACL surgery , the study was done on 26 patients, and it showed Graft signal was found in 7 patients (27%); Complete ACL graft tear was found in 8 patients (30%), tibial tunnel cyst in 2 patients (8%), femoral tunnel cyst in 2 patients (8%) , screw failure in 4 patients (15%) and 1 case (4%) of arthrofibrosis, however it showed disagreement in 3 cases of partial tear (11.5%) which weren't detected in our study by conventional MRI study and abnormal tunnel position was found in only 6 patients (23%) compared to 57% in our study ***[8].***

Also, this is in agreement with **Ali et al.** study which aimed to assess the role of MRI in evaluation of the post-operative knee joint and assessment of the post operative complications after ACL, meniscal and cartilage surgical repair procedures. The study was done on 20 patients ranged in age from (14-50 years). They found that 20% of patients had abnormal graft signal (impingement) which was the commonest post-operative complication in this study. In some of these patients not only the tibial tunnel was mal-positioned also the femoral tunnel was also seen mal-positioned ***[17].*** It also showed that 2 patients (10%) had diffuse arthrofibrosis, 1 patient (5%) had Cyclops lesion (focal arthrofibrosis). In disagreement with our study Ali found that 1 patient (5%) had medial collateral ligament sprain and 1 patient (5%) had anterior tibial translation ***[17].***

In**Mohamed & Farid,** Aprospective study recruited 50 patients, their ages ranged between 18 and 45 years after repair of ACL, menisci and cartilage. The patients were divided into three groups, group I after ACL repair included 26 patients, group II after meniscal repair and included 16 patients, group III after cartilage repair and included 8 patients. Out of 26 patients post ACL repair, 13 patients (50%) had Intact graft, 6 patients (23%) had Graft impingement, 2 patients (8%) had complete graft tear, 1 patient (4%) had Cystic degeneration of the graft (Ganglion cyst) ***[21].***

To the best of our knowledge, there is no study done comparing MRI to MR arthrography in detecting causes of post ACL reconstruction pain, Only a single study [9] was done that aimed to determine the accuracy of MR arthrography for identification of tears of anterior cruciate ligament reconstruction grafts and for detection of localized anterior arthrofibrosis and impingement with MR arthrography used as gold standard.

In our study MR arthrography examination of ACL reconstruction group found that 5 patients (23.8%) had complete tear and 4 patients had partial tear (19%). 4 patients (19%) had anteriorly located femoral tunnel, 8 patients (38.1%) had posteriorly located femoral tunnel and 4 patients (19%) had anteriorly located tibial tunnel. Five patients (23.8%) had graft impingement, 2 patients (9.5%) had femoral tunnel cyst, 2 patients (9.5%) had tibial tunnel cyst, 4 patients (19%) had hardware failure, 4 patients (19%) had focal Arthrofibrosis, 4 patients (19%) had diffuse Arthrofibrosis, 3 patients (14.3%) had harvest site complications, 3 patients (14.3%) had iliotibial band friction and 8 patients (38.1%) had bony contusions.

In our present study, we found that detection of partial tear is better by MR arthrography, also in one case of focal arthrofibrosis & one case of hardware failure. Also, MRI had 93.3% sensitivity and 95% specificity in diagnosing causes of Post-operative knee pain in ACL reconstruction group with 94.2% accuracy in comparison with MR arthrography.

McCauley study was done on 27 patients and was revised by three reviewers, Graft tears were identified with 100% sensitivity by all three reviewers with specificities of 100%, 89%, and 94%. Localized anterior arthrofibrosis was identified with 100% sensitivity by all reviewers, with specificities of 79%, 71%, and 38%. Impingement was detected with sensitivities and specificities of 83% and 100%, 83% and 52%, and 33% and 90% by the three reviewers, respectively. Interobserver agreement was almost perfect for detection of graft tear ($\kappa = 0.83$, 0.92, and 0.83), was fair to moderate for detection of localized anterior arthrofibrosis ($\kappa = 0.50$, 0.32, and 0.22), and was slight to fair for detection of impingement ($\kappa = 0.40$, 0.08, and 0.35)**[9].**

Accordingly, this study showed MR arthrography had high sensitivity and specificity for detection of anterior cruciate ligament graft tear. These results indicate that MR arthrography can be used as an accurate technique for evaluation of anterior cruciate ligament graft integrity. This finding suggests that MR arthrography can provide high accuracy for assessment of the postoperative knee when there are persistent symptoms, new symptoms, or reinjury ***[9].***

Only one partial anterior cruciate ligament graft tear in this study was categorized as torn by all reviewers. **McCauley et al.** study did not attempt to differentiate partial from complete anterior cruciate graft tears because prior studies have shown that MRI is not accurate for

eISSN 1303-5150

differentiation of partial from complete tears when examining the native anterior cruciate ligamentwhich was unconcordant with our study.

Ng, Griffith et al found that Partial tears of the ACL are more difficult to diagnose than complete ACL tears. Partial tears were characterized by increased signal intensity and fiber laxity with increased concavity (or bowing) of the ACL, however Continuous fibers are evident which suggest the tear is not complete. The sensitivity of MRI in the diagnosis of partial tears is (40% to 75%) and specificity is (51% to 89%) ***[10].***

Another study employing 3T MRI reported a sensitivity of 77% and specificity of 97% in detecting partial tears of the ACL. They consider that if more than 50% of the ACL fibers are torn this would be considered a high grade tear, a medium grade tear is 10%-50% of fibers torn, while a low grade tear is less than 10% of fibers torn **[11].**

Another study assessing the role of postoperative MRI following arthroscopic primary ACL repair and assessing maturation of the repaired ligament concluded that postoperative MRI following arthroscopic primary ACL repair can be used to assess re-rupture of the repaired ligament with sensitivity (75%), specificity (90%), and accuracy (86%) **[12].**

Up to our knowledge, as previously mentioned no previous study was done comparing conventional MRI to MR arthrography in ACL reconstruction, we found same findings in detection of most complications except for 4 cases with partial tear, one case of hardware failure and one case of focal arthrofibrosis which were detected by MR arthrography not by conventional MRI. So we recommend to do MRI first for detection of causes of post arthroscopic knee pain after ACL reconstruction, and if partial tear is suspected MRA will be indicated.

As for meniscal injuries, in our study, we reviewed 20 patients with meniscal surgeries. they had mean age of 33.2±10.3 years ranged from 19 to 50 years old. 11 recurrent tears were found, the prevalence of recurrent meniscal tears in our study group was 55% (11/20 tears) . the study group consisted of 13 (65%) medial and 7 (35%) lateral menisci. There were 3 female patients (15%) and 17 male patients (85%). Six patients (30%) were treated with meniscal repair, 13 patients (65%) had meniscectomy, 7 cases (35%) had less than 25% of meniscus resected and 6 cases (30%) had more than 25% of meniscus resected and only one patient (5%) had meniscal transplant. So, the most common group was the partial meniscectomy less than 25%.

In **Ciliz's** study 72 postoperative menisci were evaluated. In agreement with our study, 37 recurrent meniscal tears were found. The prevalence of recurrent meniscal tears in this study group was 68% (37/72 tears). The study group consisted of 50 (69%) medial and 22 (31%) lateral menisci. In 33 patients (45%), less than 25% of the meniscus resected which was the most common group as in our study; in 21 patients (29%) , more than 25% of the meniscus; and in 18 patients (25%), meniscal repair was performed. No meniscal transplant patients ***[13].***

Also **Magee** reviewed 100 consecutive MR and MRA studies in patient who had previous knee surgery, In 61 patients (61%) more than 25% of the meniscus resected , and this was the most common population group in contrast to our study and In 23 patients (23%) , less than 25% of the meniscus resected , and in 16 patients (16%) , meniscal repair was performed ***[14]***.

In another study done by **Magee** 11 years after the previously mentioned study, reviewed 100 consecutive knee MR arthrograms in patients with prior knee surgery. Study group was different showing only partial meniscectomy patients, no surgical repair cases were included in this study, The 100 consecutive patients (68 male and 32 female patients; mean age, 37 years; age range, 13–72 years) were referred by three orthopedic surgeons. All 100 patients had previous partial meniscectomy. 96 (96%) of the patients had less than 25 % of the meniscus resected and 4 (4%) patients had greater than 25 % of the meniscus resected***[15].***

Similarly,**Kijowski**studied 148 case of partially resected menisci, 76 patients (51.3%) were found to be torn. 45 (59.2%) of the post-operative tears were in the medial meniscus and 31 (40.1%) of the post-operative tears were in the lateral meniscus and 72 (47.9 %) were found to be untorn at the second arthroscopic surgery ***[16]***.

In our study meniscus we considered torn in conventional MRI images if high T2 signal was seen contacting an articular surface.

This was in agreement with Ali et al that concluded that the findings of abnormal meniscal morphology, high-signal-intensity joint fluid extending into a cleft within the meniscal fragmentation T2-weighted images or reaching to articular surface as well as a displaced meniscal fragment are specific signs of a retorn meniscus ***[17].***

eISSN 1303-5150

And also this was in agreement with**Chapin** with who stated that using of the stricter criterion of fluid signal intensity within a linear defect in the meniscus on T2-weighted images has been shown to provide high specificity (88%– 92%) but low sensitivity (41%–69%) for tears ***[18].***

In our study we found that MRI had 50% sensitivity and 50% specificity in diagnosing meniscal tear in meniscal repair group with 50% accuracy. It showed 100% sensitivity and 66.6% specificity in diagnosing meniscal tear in Meniscectomy <25% group with 85.7% accuracy, and 50% sensitivity and 50% specificity in diagnosing meniscal tear in Meniscectomy >25% group with 50% accuracy and overall MRI had 77% sensitivity and 58% specificity in diagnosing meniscal tear in all meniscal surgeries group with 67.5% accuracy.

This agreed with **ciliz** that showed overall conventional MRI had 54% sensitivity and 75% specificity in diagnosing meniscal tear in all meniscal surgeries group with 57.7% accuracy. The accuracy of the conventional MRI studies was significantly less than that of the MR arthrography group (P value less than .05) ***[13].***

In agreement with our results, **Magee et al.** compared conventional MRI with MR arthrography in each patient and found that conventional MRI had 52% sensitivity for detection of tears in patients with resection of greater than 25% of the meniscus, while MR arthrography had 100% sensitivity. In patients with meniscal resection of less than 25%, Conventional MRI had 100% sensitivity for detection of tears, accordingly MR arthrography was not necessary. Also, no determinable cases were detected showing meniscal retear after meniscal repair (sensitivity for detection of tears in repair group was zero% compared with 50% in our study). The study showed that the overall all sensitivity and specificity of conventional MRI for detection of meniscal retears is (78 % sensitivity, 85 % specificity)***[14].***

The combined use of pre-contrast conventional MR exam with post-arthrogram, T1-weighted, fat-saturated MR imaging increased sensitivity for detection of a meniscal retear reaching (99 % sensitivity)[15].So it became a reliable method to consider it as a gold standard in our study.

Miao study reviewed 81 patients (89 menisci), with a mean age of 25.4 years (range, 15-50 years), underwent arthroscopic meniscal repair only , including 65 medial menisci and 24 lateral menisci and it found that conventional MRI have a sensitivity and specificity of approximately 60% and 90% in detecting meniscal retear after repair and these showed agreement with our study ***[19]***.

More recently, **Kijowski and colleagues** found a sensitivity and specificity of 40% and 96%, respectively, for surfacing high T2-weighted signal in the diagnosis of re-tear after partial meniscectomy ***[16].***

In our study MRI and MRA showed high agreement in meniscal transplant and meniscectomy less than 25% (k=1 and 0.343, respectively), while MRI has low agreement with MRA in meniscal repair and meniscectomy more than 25% (k=0.167 for both).

Similar to our findings **Chapin,** study found that, MR arthrography has been advocated as an alternative to conventional MR imaging in patients with greater than 25% meniscectomy.Conventional MR imaging was accurate for the diagnosis of tear in all patients with less than 25% prior meniscectomy, but MR arthrography was necessary to diagnose tear in 16 of 61 patients with prior meniscectomy of more than 25% ***[18].***

Ciliz showed higher accuracy of conventional MR in detecting recurrent tear in minimal meniscal resection reaching 85% compared to 50% in meniscal resection more than 25%. It concluded that when meniscal resection is minimal, the right diagnosis could be obtained with conventional MRI. MR arthrography is necessary for patients with meniscal resection of more than 25% and who do not have sufficient joint effusion ***[13]***.

In contrast, the study by **White and his colleagues** found no significant difference between the performance of conventional MR imaging and MR arthrography. The sensitivity, specificity, and combined accuracy of MR imaging was 86%, 67%, and 80% versus 90%, 78%, and 85%, respectively, for MR arthrography ***[20].***

In agreement with our study, an evidence-based review was done Using PubMed, and performed a search of the literature for English-language articles from January 1990 through October 2017. It included all studies that evaluated the performance of conventional MRI, direct or indirect MR arthrography, or CT arthrography using arthroscopy as the reference standard for assessing the knee after meniscus surgery. They were 2802 article, and it concluded that the

eISSN 1303-5150

diagnostic performance of postoperative imaging studies depends on the amount of meniscus resected. Conventional MRI and direct MR arthrography had equivalent accuracy (89%) when less than 25% of the meniscus has been resected. However, after removal of 25% or more of the meniscus, direct MR arthrography had superior accuracy of 89%, compared with accuracy of 65% for conventional MR also it showed that direct MR arthrography is superior to conventional MRI for detecting recurrent tear in patients after meniscus repair ***[6]***.

Conclusions

In conclusion, our findings proved that MRI has high sensitivity and specificity regarding the assessment of the post-operative knee joint also all the above-mentioned papers stressed that MRI imaging provides excellent anatomical and morphological assessment of the knee joint after surgical intervention especially in cases of ACL reconstruction, meniscal repair and resection of more than 25% of meniscal substance being time saving, non-invasive and readily available.

Recommendations

We recommend doing conventional MRI in cases presented with post operative pain after ACL reconstruction, if a partial tear is suggested either clinically or by imaging, Further MR arthrography will be then recommended.

As for meniscal surgeries, MR arthrography is necessary for detection of recurrent tear in cases of meniscal repair and partial meniscectomy more than 25%. However, when meniscus resection is minimal conventional MRI may be enough for diagnosis.

Limitations of our study included a relatively small sample size with overlap between causes of postoperative knee pain. No previous studies were done comparing the accuracy of MRI to MRA. Also, a second arthroscopic look wasn’t applicable in most cases.

List of Abbreviations

MRI……………………………………………. Magnetic Resonance Imaging.

MRA……………………………….……….Magnetic Resonance Arthrography.

ACL…………………………………….……..Anterior Cruciate Ligament.

PCL……………………………………. …. Posterior Cruciate Ligament.

AM……………………………………………. Antero-Medial.

PL………………………………………………Postero-Lateral.

IV……………………………………………. Intravenous.

MM……………………………………….…..Medial Meniscus.

LM……………………………………………Lateral Meniscus.

AH………………………………………………. Anterior Horn.

PH………………………………………………. Posterior Horn.

CT………………………………………………Computed Tomography

PD…………………………………………………Proton Density.

<u>Figure Legends</u>

Fig. 1: MRI versus MRA findings in ACL reconstruction group (n=21).

Fig. 2: Validity of MRI in diagnosing causes of post operative knee pain in ACL reconstruction group (n=21).

Fig. 3: Validity of MRI in diagnosing meniscal tear in meniscal repair group (n=6).

Fig. 4: Validity of MRI in diagnosing meniscal tear in menisectomy <25% group (n=7).

Fig. 5: Validity of MRI in diagnosing meniscal tear in menisectomy >25% group (n=6).

Fig. 6: Validity of MRI in diagnosing meniscal tear in all meniscal surgeries group (n=20).

Fig. 7. <u>Abnormally located femoral tunnel</u>. Sagittal T2WI of extended knee showing femoral tunnel opening (arrow) abnormally placed anterior to the intersection of blumensat line (A) and posterior cortical femoral line (B).

Fig.8(A&B):<u>Too anterior tibial tunnel & Roof impingement.</u> Sagittal T2-weighted image showing the tibial tunnel anterior to the Blumensaat line. The graft appears posteriorly bowed (arrows) with increased signal.

Fig. 9: <u>Partial Graft tear</u>. Sagittal post contrast T1-fat-suppressed images showing a partial fluid-filled graft defect (asterisks) with some fibers intact (arrows

Fig. 10 (A&B): Complete graft tear & too anterior tibial tunnel. Sagittal proton density weighted image showed part of the tibial tunnel anterior to the Blumensaat line. The graft is not visualized with complete discontinuity in keeping with graft tear

Fig.11: Diffuse joint fibrosis: Proton density weighted sagittal sections: intermediate signal intensity areas involving all, anterior and posterior compartments (arrows) and extending to the Hoffa fat pad.

Fig. 12(A & B) Meniscal re-tear. **A)** Sagittal proton density–weighted image shows linear signal hyperintensity (arrow) ?? contacting the articular surface of medial meniscus posterior horn. **B)** Sagittal fat-suppressed image of MR arthrogram of same patient reveals contrast imbibition into posterior horn at repair site (arrow), which is diagnostic of recurrent longitudinal meniscus tear.

Fig. 13 (A&B). Cyclops lesion localized joint fibrosis. Sagittal & Coronal T1 fat suppressed images showed nodular hypointense structure located on the anterior aspect of the intercondylar notch (arrowheads).

References

1. Krych, A.J., et al., *Does arthroscopic knee surgery work?* Arthroscopy, 2014. **30**(5): p. 544-5.
2. Reigstad, O. and C. Grimsgaard, *Complications in knee arthroscopy.* Knee Surg Sports Traumatol Arthrosc, 2006. **14**(5): p. 473-7.
3. Hoofwijk, D.M., et al., *Prevalence and Predictive Factors of Chronic Postsurgical Pain and Poor Global Recovery 1 Year After Outpatient Surgery.* Clin J Pain, 2015. **31**(12): p. 1017-25.
4. Recht, M.P. and J. Kramer, *MR imaging of the postoperative knee: a pictorial essay.* Radiographics, 2002. **22**(4): p. 765-74.
5. Meyers, A.B., et al., *Imaging of Anterior Cruciate Ligament Repair and Its Complications.* American Journal of Roentgenology, 2010. **194**(2): p. 476-484.
6. Baker, J.C., M.V. Friedman, and D.A. Rubin, *Imaging the Postoperative Knee Meniscus: An Evidence-Based Review.* AJR Am J Roentgenol, 2018. **211**(3): p. 519-527.
7. Weber, M.A. and D.G. Blankenbaker, *Postoperative Imaging of the Knee.* Semin Musculoskelet Radiol, 2018. **22**(4): p. 375-376.
8. Farahat, A.A., et al., *MRI findings in symptomatic patients following anterior cruciate ligament surgery.* The Egyptian Journal of Radiology and Nuclear Medicine, 2015. **46**(2): p. 405-411.
9. McCauley, T.R., et al., *MR Arthrography of Anterior Cruciate Ligament Reconstruction Grafts.* American Journal of Roentgenology, 2003. **181**(5): p. 1217-1223.
10. Ng, W.H., et al., *Imaging of the anterior cruciate ligament.* World J Orthop, 2011. **2**(8): p. 75-84.
11. Van Dyck, P., et al., *Three tesla magnetic resonance imaging of the anterior cruciate ligament of the knee: can we differentiate complete from partial tears?* Skeletal Radiol, 2011. **40**(6): p. 701-7.
12. van der List, J.P., D.N. Mintz, and G.S. DiFelice, *Postoperative Magnetic Resonance Imaging following Arthroscopic Primary Anterior Cruciate Ligament Repair.* Advances in orthopedics, 2019. **2019**: p. 5940195-5940195.
13. Ciliz, D., et al., *Evaluation of postoperative menisci with MR arthrography and routine conventional MRI.* Clin Imaging, 2008. **32**(3): p. 212-9.
14. Magee, T., et al., *MR arthrography of postoperative knee: for which patients is it useful?* Radiology, 2003. **229**(1): p. 159-63.
15. Magee, T., *Accuracy of 3-Tesla MR and MR arthrography in diagnosis of meniscal retear in the post-operative knee.* Skeletal Radiology, 2014. **43**: p. 1057-1064.

16. Kijowski, R., et al., *MRI characteristics of torn and untorn post-operative menisci*. Skeletal Radiol, 2017. **46**(10): p. 1353-1360.
17. Ali, M.M.A., et al., *Role of Magnetic Resonance Imaging in evaluation of postoperative knee surgery*. The Egyptian Journal of Hospital Medicine, 2018. **72**(8): p. 4973-4976.
18. Chapin, R., *Imaging of the Postoperative Meniscus*. Radiol Clin North Am, 2018. **56**(6): p. 953-964.
19. Miao, Y., et al., *Diagnostic Values of 3 Methods for Evaluating Meniscal Healing Status After Meniscal Repair: Comparison Among Second-Look Arthroscopy, Clinical Assessment, and Magnetic Resonance Imaging*. The American Journal of Sports Medicine, 2011. **39**(4): p. 735-742.
20. White, L.M., et al., *Diagnosis of recurrent meniscal tears: prospective evaluation of conventional MR imaging, indirect MR arthrography, and direct MR arthrography*. Radiology, 2002. **222**(2): p. 421-9.

21.Mohamed, A. E., A. M. Farid and M. W. AbdElwahab (2016). "The role of MRI in assessment of the post-operative knee." IOSR Journal of Dental and Medical Sciences (IOSR-JDMS) 15(1 Ver.X): 83-93.