

AIM OF THE WORK

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The aim of this study was to evaluate the role of MRI in symptomatic patients following operative management of internal knee derangement.

**PATIENTS
AND
METHODS**

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This study included 50 patients (41 males and 9 females) who were complaining after undergoing ACL reconstruction, meniscal surgery and articular cartilage repair surgery in the period between 2012 and 2014.

The patients were divided into three groups. Group I included patients who underwent ACL reconstruction surgery. Group II included patients who underwent meniscal surgery and group III included patients with articular cartilage repair procedures.

The average time interval for group I was one and half years after reconstruction. The average time interval for group II was two years after meniscal surgery and the average time interval for group III was one and half years.

Inclusion criteria

- Symptomatic patients following cruciate graft reconstructions and meniscal surgery.
- The patients included in this study were complaining of either pain, instability or knee locking especially for groups I and II.
- Evaluation of cartilage repair in group III.

Exclusion criteria

- Concomitant pathology other than degenerative osteoarthropathy.

All the studied patients were subjected to the following:

1. Full clinical history
2. Clinical examinations including Lachman, Pivot shift and McMurray tests done by the referring orthopedic.
3. **The medical ethics** were considered: the patient should be aware of the examination, patient agreement is obtained, the economic status of the patient is considered and the patient has to get benefit from the examination.
4. **Plain radiological study** including antero-posterior and lateral views was done for all patients. Informed consent was signed by all patients.
5. **High field MRI evaluation** for the 50 patients was performed with a 1.5 T dedicated system using a transmit-receive knee coil.
6. **Correlation with arthroscopic finding whenever possible.**

Technique

The patient is supine with the knee was placed in 10–15 degree external rotation (to orient the ACL with the sagittal imaging plane).

The same scanning protocol was used for all patients:

- Localizer T1-W gradient echo sequences were used.
- **Axial T1 weighted spin echo sequences** (repetition time of 600 ms, echo time of 20 ms, 18 cm field of view, 4 mm slice thickness with no interslice gap, and a 256 matrix).
- **Sagittal T1 weighted spin echo sequences** (repetition time of 600 ms, echo time of 20 ms, 18 cm field of view, 4 mm slice thickness with no interslice gap, and a 256 matrix).
- **Coronal T1 weighted spin echo sequences** (repetition time of 600 ms, echo time of 20 ms, 18 cm field of view, 4 mm slice thickness with no interslice gap, and a 256 matrix).
- **Sagittal proton density fat suppressed (PD FAT SAT) turbo-spin-echo sequences (BLADE)** were used (repetition time of 3500 ms, echo time of 48 ms, 18 cm field of view, 3.5 mm slice thickness, and a 256 matrix).
- **Coronal proton density fat suppressed (PD FAT SAT) turbo-spin-echo sequences (BLADE)** were used (repetition time of 3500 ms, echo time of 48 ms, 18 cm field of view, 3.5 mm slice thickness, and a 256 matrix).
- **Coronal oblique reconstruction** from sagittal proton density (repetition time of 1800 ms, echo time of 37 ms, 18 cm field of view, 0.90 mm slice thickness)

Post Processing & Interpretation

The source images were transferred to a dedicated workstation using Syngo Siemens Medical Solutions soft ware for post-processing. Coronal oblique reconstructions are complimentary to overcome limitations of other sequences.

RESULTS

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a. Demographic data of patients

Fifty patients were included in this study; 41 were males and 9 were females.

According to the operational procedures which have been done three different groups of studied patients have been created.

Group I included 26 patients who underwent ACL reconstruction. Their age ranged from 24 to 54 years with a mean age of 31 years.

Group II included 20 patients who underwent meniscal surgery. Their age ranged from 32 to 65 with a mean age of 49.5 years.

Group III included 4 patients who underwent cartilage repair surgery. Their age ranged from 24 to 65 with a mean age of 34 years.

The full demographic data are listed in **(Table 1)**.

Table (1): Demographic data of the studied group.

	Total cases (n = 50)		ACL (n = 26)		Meniscal (n = 20)		Cartilage (n = 4)	
	No.	%	No.	%	No.	%	No.	%
Age (years)								
<30	10	20.0	10	38.5	0	0.0	0	0.0
30 - <40	19	38.0	13	50.0	4	20.0	2	50.0
40 - <50	13	26.0	2	7.7	9	45.0	2	50.0
≥50	8	16.0	1	3.8	7	35.0	0	0.0
Min. – Max.	24.0 – 65.0		24.0 – 54.0		32.0 – 65.0		24.0 – 65.0	
Mean ± SD	39.10 ± 11.08		32.08 ± 7.06		48.40 ± 9.16		39.10 ± 11.08	
Median	34.0		31.0		49.50		34.0	
Sex								
Male	41	82.0	24	92.3	13	65.0	4	100.0
Female	9	18.0	2	7.7	7	35.0	0	0.0

b. Clinical data

The presenting complaints of patients were pain in 48 patients (96.0%) (24 patients in group I; 20 patients in group II and 4 patients in group III); instability in 11 patients (22.0%)(All in group I); locking in 5 patients (10.0%)(3 in group I, 2 in group II). (**Table 2**)

Table (2): Distribution of the three studied groups according to complaint.

	Total cases (n = 50)		ACL (n = 26)		Meniscal (n = 20)		Cartilage (n = 4)	
	No.	%	No.	%	No.	%	No.	%
Complaint								
Pain	48	96.0	24	92.3	20	100.0	4	100.0
Instability	11	22.0	11	42.3	0	0.0	0	0.0
Locking	5	10.0	3	11.5	2	10.0	0	0.0

Clinical examination revealed negative results in 20 patients (40%), positive Lachman and Pivot shift tests in 8 patients (16%), and positive Mc-Murray test in 17 patients (34%). (**Table 3**)

Table (3): Distribution of the three studied groups according to type of clinical examination test.

	Total cases (n = 50)		ACL (n = 26)		Meniscal (n = 20)		Cartilage (n = 4)	
	No.	%	No.	%	No.	%	No.	%
Type of test								
Negative	20	40.0	14	53.8	7	35.0	0	0.0
McMurray test	17	34.0	6	23.1	11	55.0	0	0.0
Lachman Test + Pivot shift	8	16.0	6	23.1	2	10.0	0	0.0
Follow up	5	10.0	0	0	0	0.0	4	100.0

c. Surgical data

Group I included 26 patients who had cruciate ligament surgery. Twenty six patients had anterior cruciate ligament surgery (100%) and no case of posterior cruciate surgery was found (0%).

Twenty five patients had reconstruction surgery (96.2%) and 1 patient had fixation of tibial attachment (3.8%). Among 25 cases of ACL reconstruction 21 patients had hamstring graft (80.8%) and 4 patients had Bone-patellar tendon-Bone graft (15.4%).

Group II included 20 patients who had meniscal surgery. Fifteen patients had partial meniscectomy (75%) and 5 patients had meniscal repair (25%).

Group III included 4 patients of cartilage repair surgery. All the patients had Mosaicplasty (100%) (**Table 4**)

Table (4): Distribution of the three studied groups according to operational procedure

	Cruciate (n = 26)				Meniscal (n = 20)		Cartilage (n = 4)	
	ACL		PCL		No.	%	No.	%
	No.	%	No.	%				
ACL reconstruction using hamstring graft	21	80.8	0	0.0	2	10.0	0	0.0
ACL reconstruction bone-patellar tendon-bone graft	4	15.4	0	0.0	0	0.0	0	0.0
Fixation of ACL attachment	1	3.8	0	0.0	0	0.0	0	0.0
PCL	0	0.0	0	0.0	0	0.0	0	0.0
Meniscal cases								
Meniscectomy	4	15.4	0	0.0	15	75.0	1	25.0
Meniscal repair	0	0.0	0	0.0	5	25.0	0	0.0
Cartilage								
Mosaicplasty	0	0.0	0	0.0	0	0.0	4	100.0

d. Radiological findings

Osteoarthritis was found in 18 cases (36%) (**Fig. 52**); four of them in ACL group (15.4%), 12 in meniscal group (60%) and 2 in cartilage group (50%). (**Table 5**)

Soft tissue calcification (**Fig. 53**) was found in one case in ACL group related to graft harvesting in bone-patellar tendon-bone graft (3.8% of total) (**Table 5**)

Table (5): Comparison between the studied groups according to X- Ray findings.

X- Ray Findings	Total cases (n = 50)		ACL (n = 26)		Meniscal (n = 20)		Cartilage (n = 4)	
	No.	%	No.	%	No.	%	No.	%
Osteoarthritis	18	36.0	4	15.4	12	60.0	2	50.0
Calcification	1	3.8	1	3.8	0	0.0	0	0.0



Figure 52: 24 year old male patient complaining of knee pain 6 months following ACL reconstruction and bilateral partial meniscectomy.

Plain x-ray showing anterior position of the tibial tunnel and degenerative osteoarthropathy of the knee joint.



Figure 53: 26 year old male patient complaining of knee pain 1.5 years following ACL reconstruction

Plain x-ray showing irregularity of the antero-inferior surface of the patella with related faint soft tissue calcification (arrow)

Tibial and femoral tunnels of ACL surgery (**Fig. 54**) were found in 25 patients of group I (96.2%); and 2 patients of group II (10%) who had previous ACL reconstruction. (**Table 6**)

Table (6): Comparison between the two studied groups according to X- Ray findings.

	Total (n = 46)		ACL (n = 26)		Meniscal (n =20)	
	No.	%	No.	%	No.	%
Tunnels of ACL reconstruction						
Negative	19	41.3	1	3.8	18	90.0
Positive	27	58.7	25	96.2	2	10.0



Figure 54: 25 year old male patient complaining of knee pain 3 years following ACL reconstruction.

Plain x-ray normal position of the tibial and femoral tunnels.

Dislodged femoral tunnel screw into the intercondylar notch (Fig. 55)



Figure 55: 38 year old male patient complaining of knee pain and locking 6 months following ACL reconstruction.

Plain x-ray showing dislodged femoral tunnel screw.

e. MRI

The MRI findings were divided into two categories; the first one included findings related to the operational procedure and the other one included findings not related to operational procedure.

Findings related to operational procedure in group I (ACL surgery)

Graft signal was found in 7 patients (4 of them were normal and 3 reflected graft impingement) (**Fig. 56**); graft tear was found in 11 patients of which 3 cases of partial tear (**Fig. 57**) and 8 cases of complete tear (**Fig. 59**); abnormal tunnel position 6 patients (**Fig. 58**); anterior tibial translation 6 patients (**Fig. 59**); tibial tunnel cyst in 2 patients (**Fig. 60**); femoral tunnel cyst 2 patients (**Fig. 61**); screw failure in 4 patients (**Fig. 62,63**) and 1 case of arthrofibrosis (**Fig. 57**). (**Table 7**)

Table (7): Distribution of the MRI- findings related to the operational procedure in ACL group.

	ACL (n = 26)	
	No.	%
Graft signal		
Normal	4	15.4
Impingement	3	11.5
Graft tear		
Partial	3	11.5
Complete	8	30.8
Anterior tibial translation	6	23.1
Abnormal tunnel position	6	23.1
Signs of bone-patellar tendon- bone graft	4	15.4
Femoral tunnel cyst	2	7.7
Tibial tunnel cyst	2	7.7
Screw failure	4	15.4
Arthrofibrosis	1	3.8

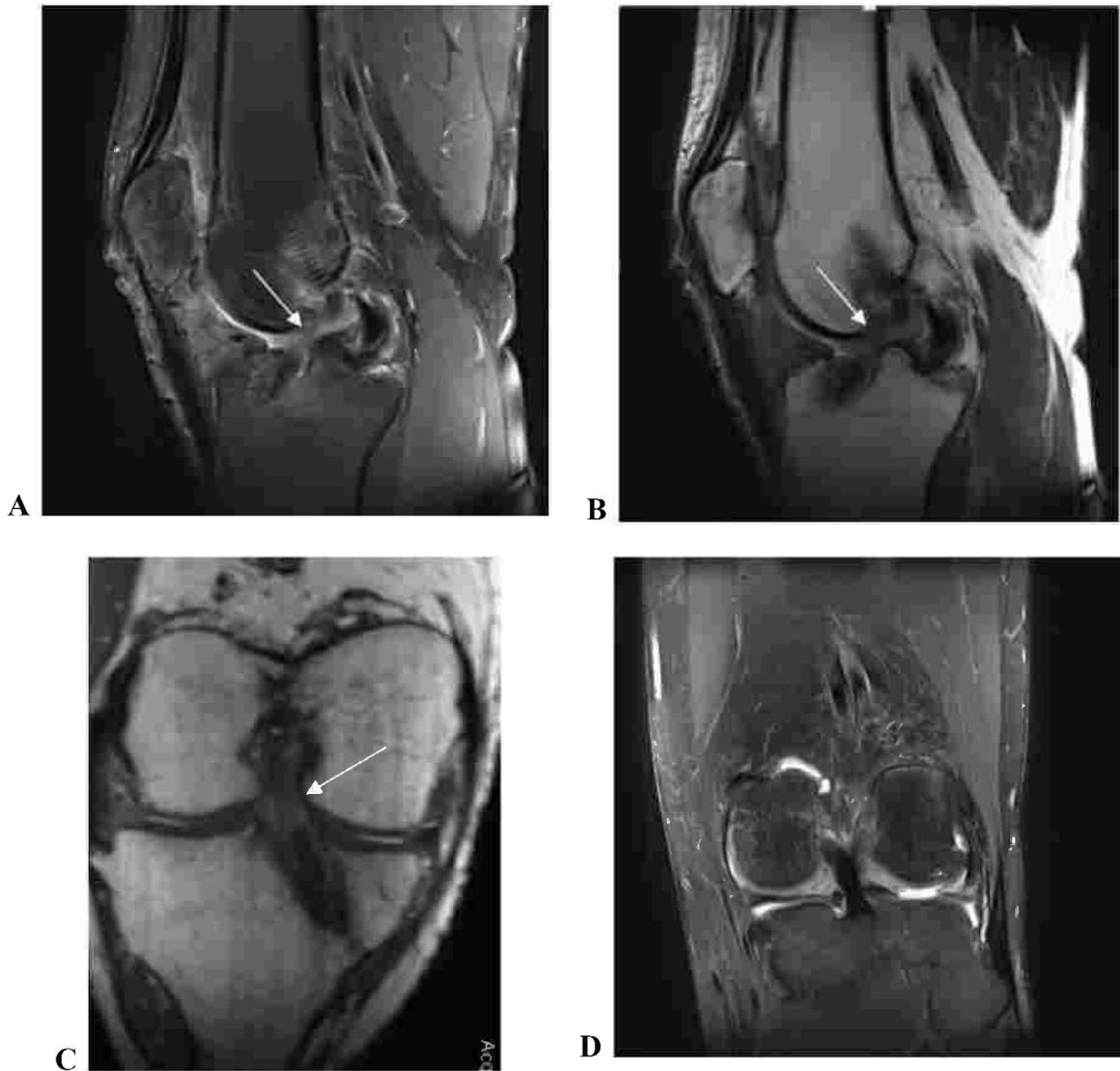


Figure 56: 25 year old male patient complaining of knee pain 1.5 years following ACL reconstruction.

A and B Mid sagittal intermediate weighted image showing kinking of the ACL reconstruction graft with intermediate high signal intensity impressive of roof impingement

C coronal oblique reformatted image confirming the presence of intermediate high signal within the graft

D patient had also cartilage defect at the lateral femoral condyle

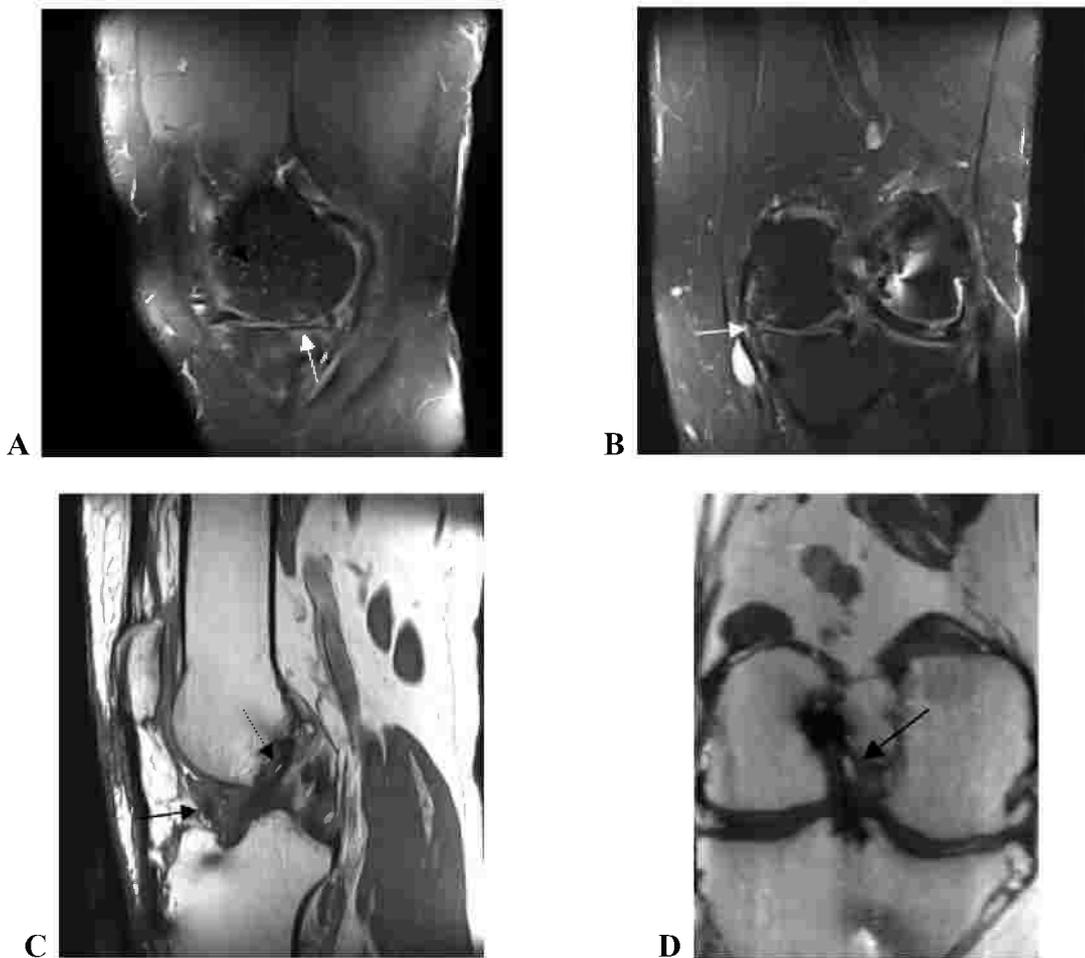


Figure 57: 31 year old male patient complaining of knee pain and limitation of movement 2 years following ACL reconstruction.

A and B sagittal and coronal intermediate weighted images showing degenerative tear of extruded medial meniscus and torn posterior horn of the lateral meniscus. (white arrows)

C sagittal PD image shows low signal intensity around the ACL graft notably anterior extending to Hoffa's pad of fat indicating arthrofibrosis (black arrow).

Noted also linear fluid signal intensity within the proximal fibers of the graft reflecting partial intra-substance tear (Dotted black arrow)

D coronal oblique reformatted image confirming partial intra-substance graft tear.

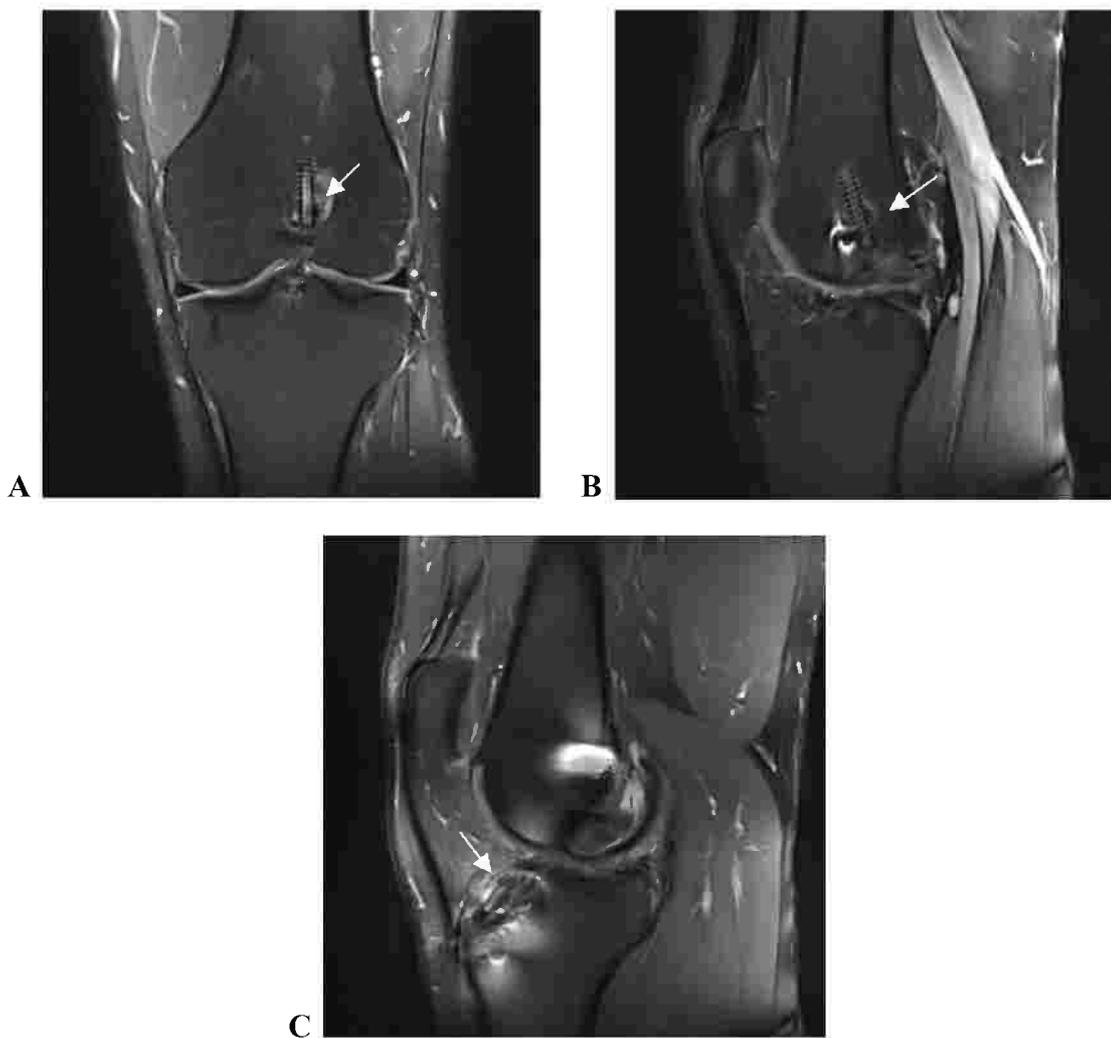


Figure 58: Different cases showing abnormal tunnel position.

A and B coronal and sagittal intermediate weighted images showing abnormal femoral tunnel position.

C Intermediate weighted sagittal images showing far anterior position of the tibial tunnel

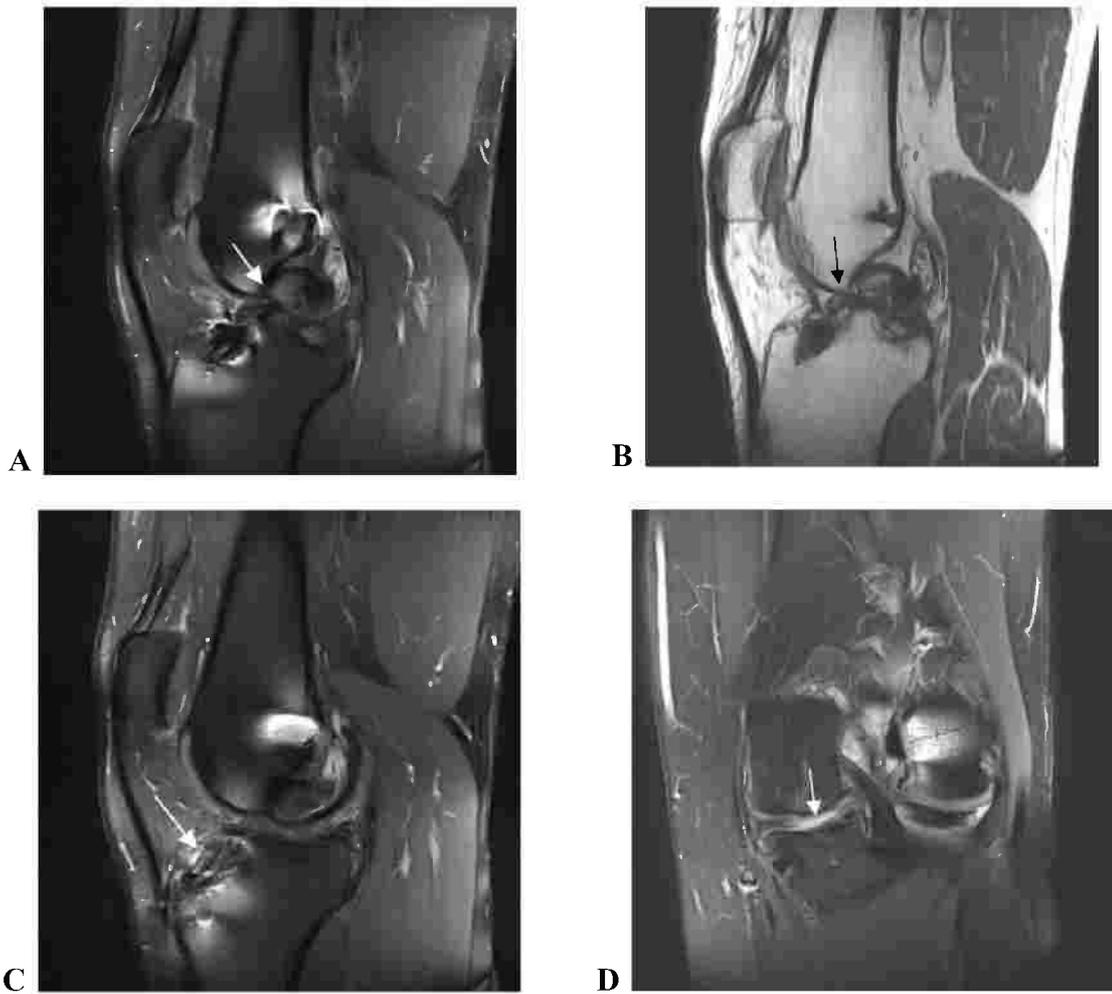


Figure 59: 24 year old male patient complaining of pain and giving way 5 years post ACL reconstruction

A and B Sagittal intermediate weighted fat suppressed and PD Shows torn ACL reconstruction graft with anterior tibial translation

C Anterior position of the tibial tunnel.

D Torn posterior horn of the medial meniscus



Figure 60: 31 year old male patient complaining of knee pain 2 years following ACL reconstruction.

A Plain x-ray showing widening of the tibial tunnel.

B and C sagittal and coronal intermediate weighted images showing tibial tunnel cyst and torn ACL graft.

D and E showing Baker's cyst and large subcortical cystic changes at the posterior aspect of the lateral femoral condyle.



Figure 61: 25 year old male patient complaining of knee pain 3 years following ACL reconstruction.

A and B sagittal intermediate and PD weighted images showing torn ACL graft.

C and D coronal intermediate weighted and sagittal PD showing femoral tunnel cyst.



Figure 62: 38 year old male patient complaining of knee pain and locking 6 months following ACL reconstruction

A and B sagittal and coronal intermediate weighted images showing dislodged femoral screw into the intercondylar fossa.

C axial PD showing dislodged screw indenting the graft

D coronal oblique reformatted image showing graft impingement

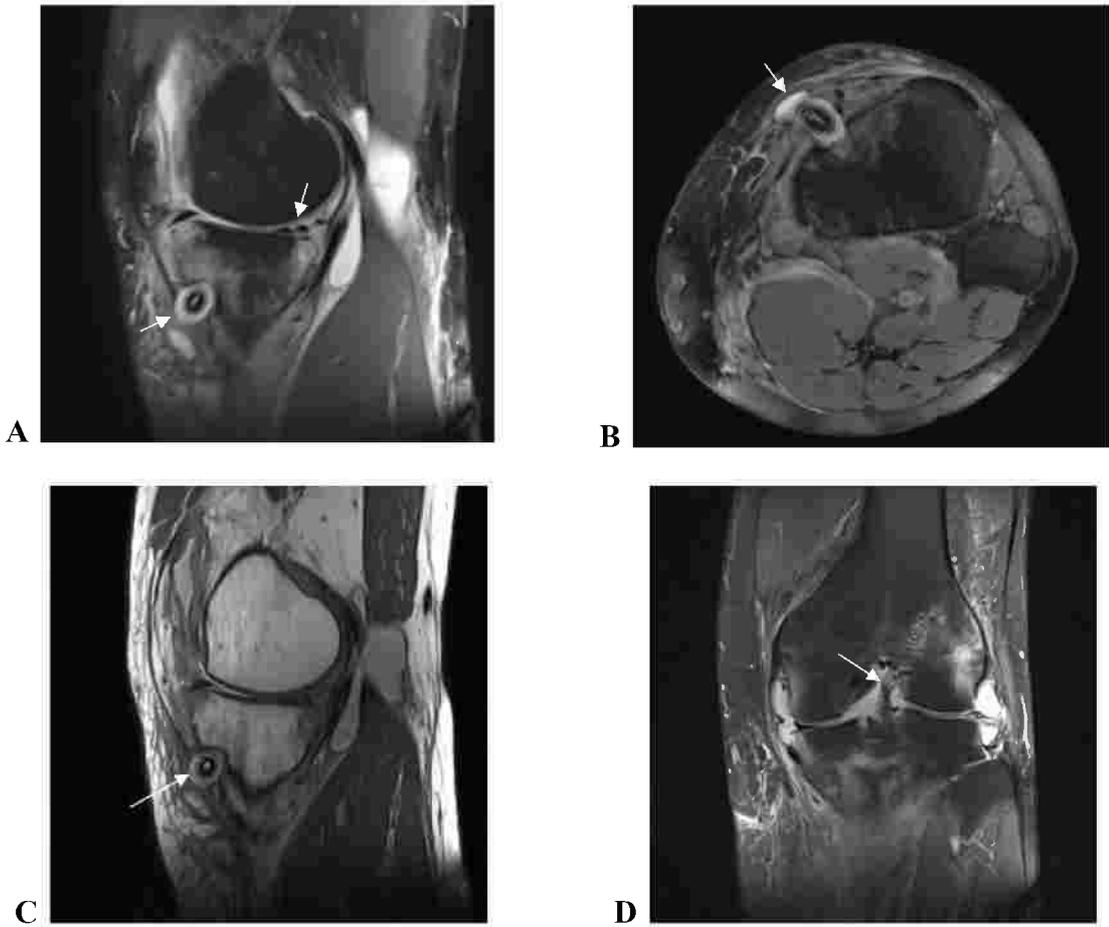


Figure 63: 31 year old male patient complaining of knee pain 2 years following ACL reconstruction.

A, B and C extruded tibial tunnel screw with related pre-tibial bursitis. Marked reduced size of the medial meniscus is also noted.

D graft impingement.

Findings related to type of procedure (Bone-patellar tendon-Bone graft) in group I (ACL surgery)

Splitting patellar tendon with irregularity of the antero-inferior surface of the patella and the tibial tuberosity as a result of graft harvesting (**Fig. 64**).

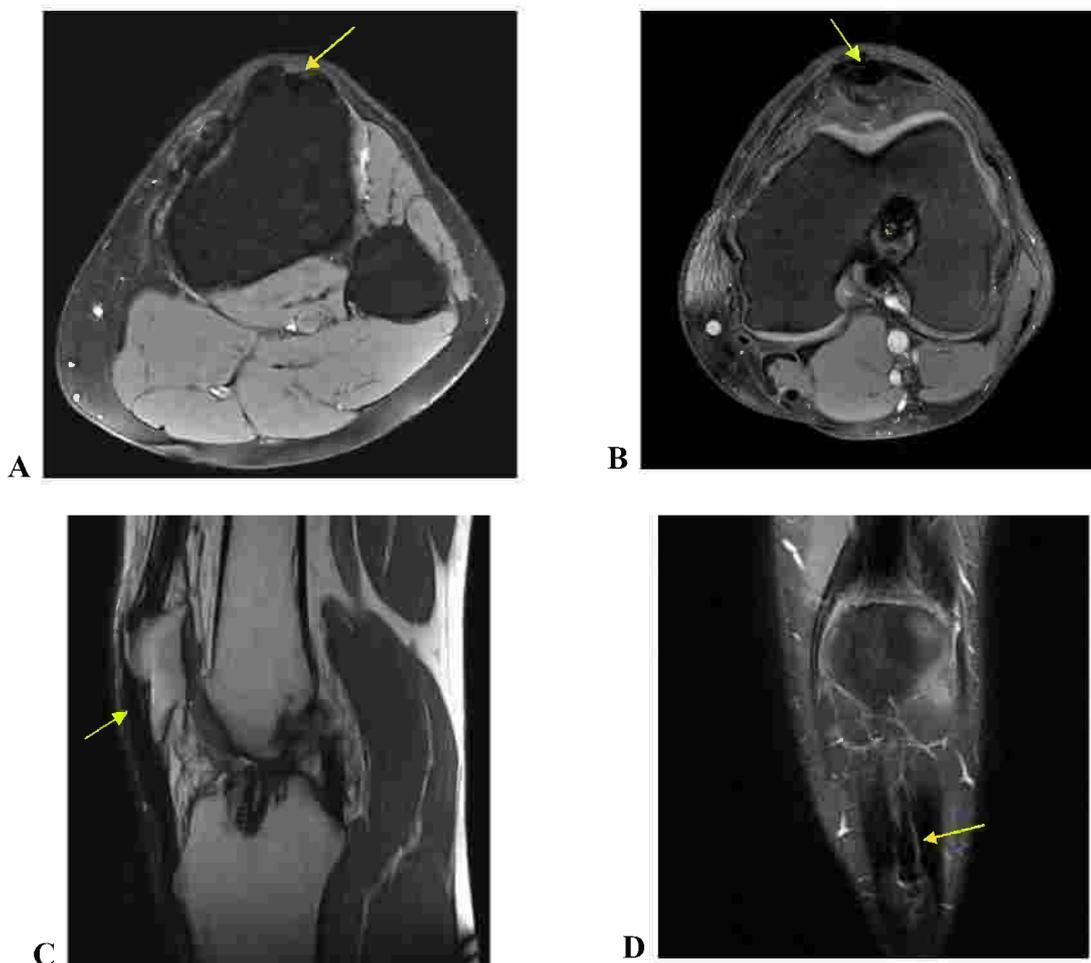


Figure 64: 28 year old male patient complaining of knee pain, locking and giving away 1 year following ACL reconstruction

A and B axial intermediate weighted at the tibial tuberosity and patellar level showing defect of patellar tendon harvesting

C and D sagittal proton density and coronal intermediate weighted showing irregularity of the antero-inferior patellar surface and splitted patellar tendon.

Findings not related to operational procedure in group I (ACL surgery)

Meniscal tear was found in 17 patients (65.4%) (**Fig. 65**); articular cartilage lesion was found in 11 patients (42.3%) (**Fig. 66**); patellar cartilage lesion in 5 patients (19.2%) (**Fig. 67**); sprained patellar retinaculum in 1 patient (3.8%) (**Fig. 68**); and 1 patient patellar tendinosis (3.8%) (**Fig. 68**). (**Table 8**)

Table (8): Distribution of the MRI- findings not related to the operational procedure in ACL group.

	ACL (n = 26)	
	No.	%
Meniscal tear	17	65.4
Articular cartilage lesion	11	42.3
Patellar cartilage lesion	5	19.2
Patellar tendinosis	1	3.8
Sprained patellar retinaculum	1	3.8



Figure 65: 33 year old male complaining of pain and giving way 2 years after ACL reconstruction

A and B Sagittal and coronal intermediate weighted fat suppressed images revealing oblique tear of the posterior horn of the medial meniscus and bone bruise of the lateral femoral condyle.

C coronal oblique reformatted imaged revealed intact graft.

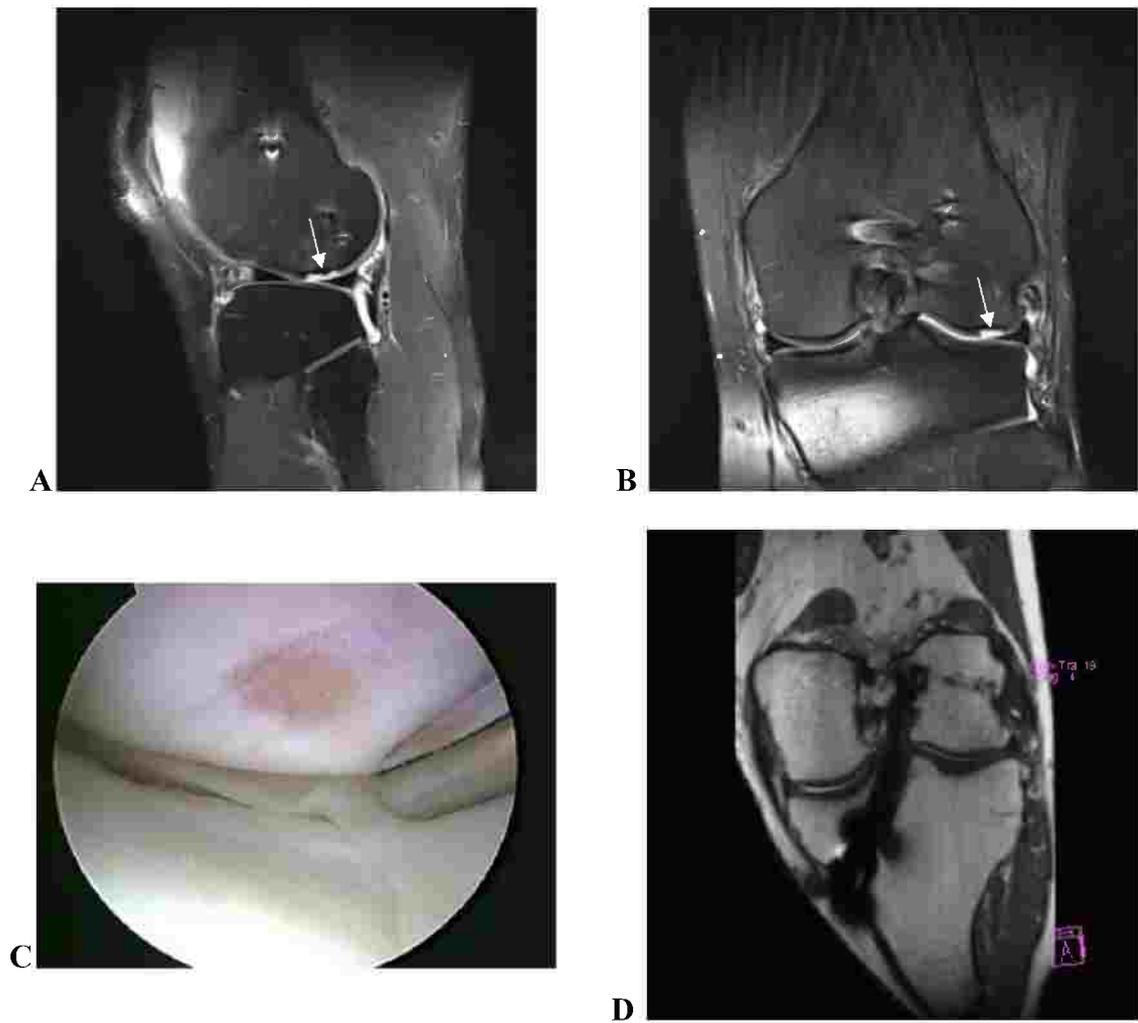


Figure 66: 31 year old male patient complaining of knee pain 1 year following ACL reconstruction.

A and B intermediate weighted sagittal and coronal images showing focal cartilage defect at the lateral femoral condyle.

C arthroscopic image showing cartilage defect.

D coronal oblique reformatted imaged revealed intact graft.

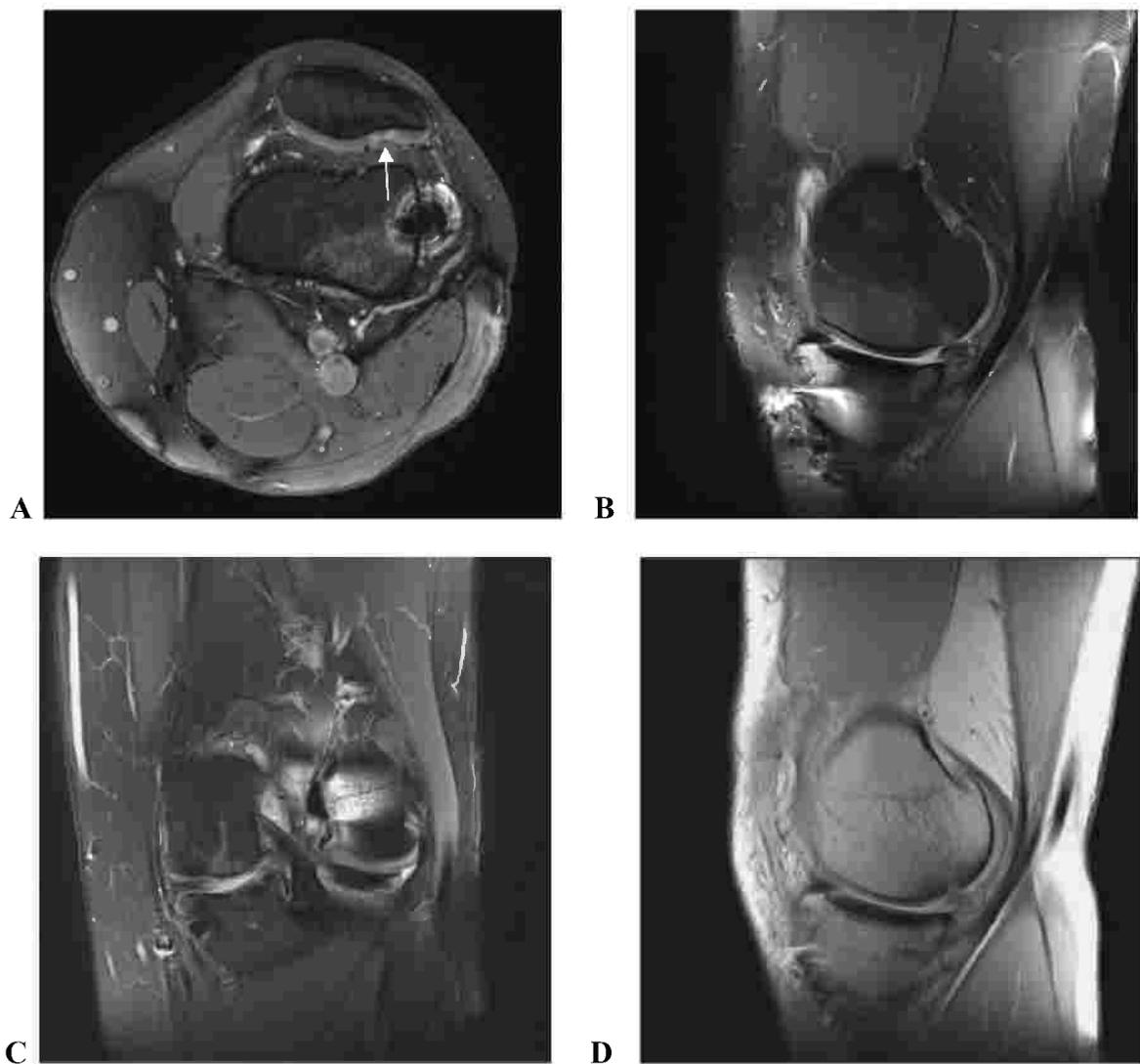


Figure 67: 24 year old male patient complaining of pain and giving way 5 years post ACL reconstruction.

A Axial intermediate weighted showing focal area of cartilage defect at the lateral patellar facet.

B, C and D sagittal, coronal intermediate weighted and sagittal PD images showing articular cartilage defect and torn posterior horn of the medial meniscus.

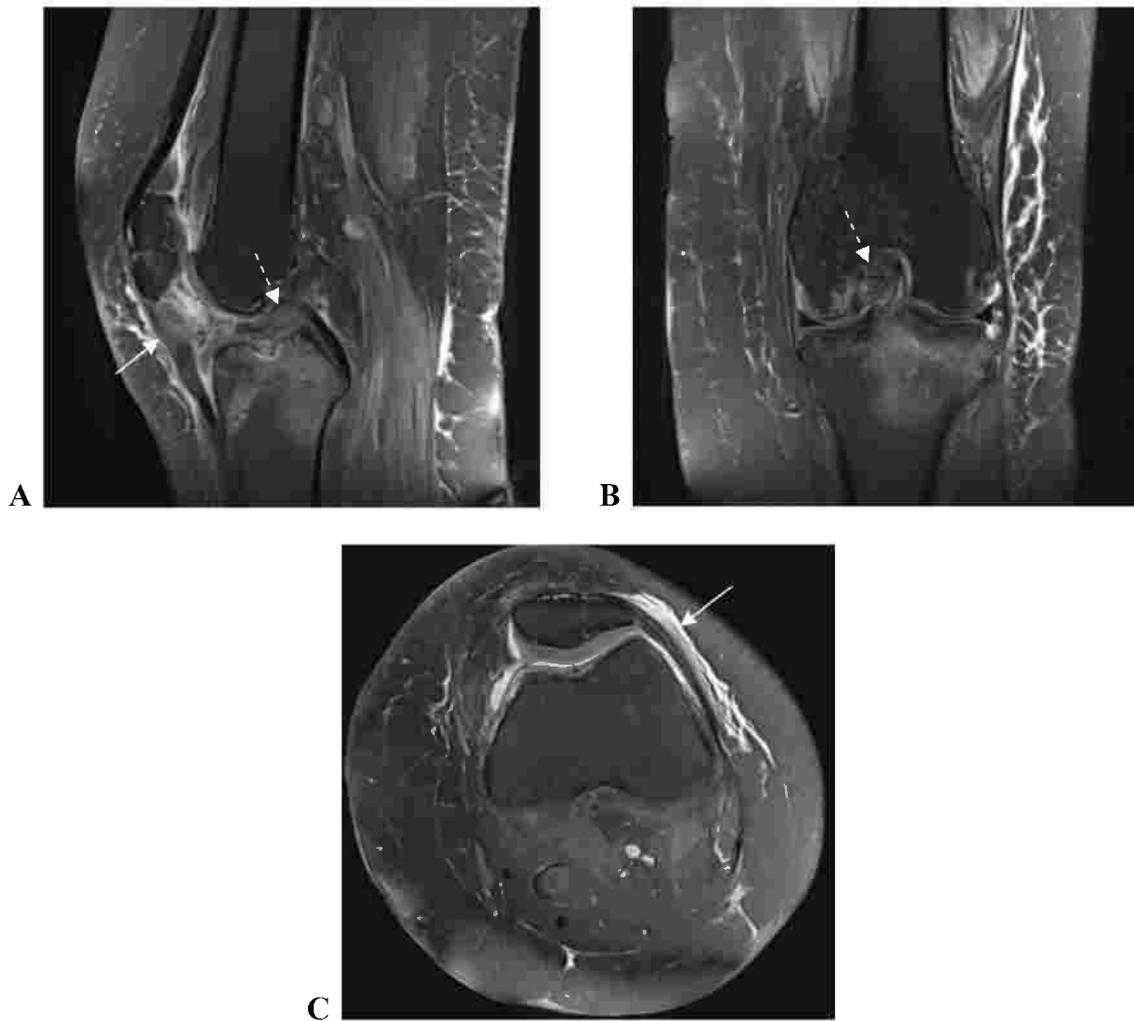


Figure 68: 29 year old female patient complaining of knee pain 6 months following fixation of avulsed ACL tibial attachment.

A and **B** sagittal and coronal intermediate weighted showing chronic sprain of ACL following tibial fixation (dashed arrow) and common patellar tendinosis (arrow).

C axial intermediate weighted image showing sprained lateral patellar retinaculum.

Findings related to operational procedure in group II (meniscal surgery)

This group included 20 patients. In 17 patients the medial meniscus was involved among which one case involved the anterior horn; two cases involved the body and 14 cases involved the posterior horn. The lateral meniscus was involved in 3 cases.

Meniscectomy was done in 15 patients (75%) and meniscal repair was done in 5 cases (25%). (Table 9)

In all the five patients who had meniscal repair surgery; the medial meniscus was involved and all showed re-tear.

Fifteen patients had partial meniscectomy three involving the lateral meniscus and 12 cases involving the medial meniscus; among which 4 patients had re-tear. (Table 10)

Among the meniscal surgery group; 9 cases showed re-torn meniscus (Fig. 69-71).

Table (9): Distribution of the studied cases according to the operational procedure in meniscal group.

	Meniscal (n = 20)	
	No.	%
Meniscectomy	15	75.0
Meniscal repair	5	25.0

Table (10): Distribution of the MRI- findings related to the operational procedure in meniscal group

	Meniscal (n = 20)	
	No.	%
Evidence of meniscectomy	11	55.0
Re-torn meniscus	9	45.0

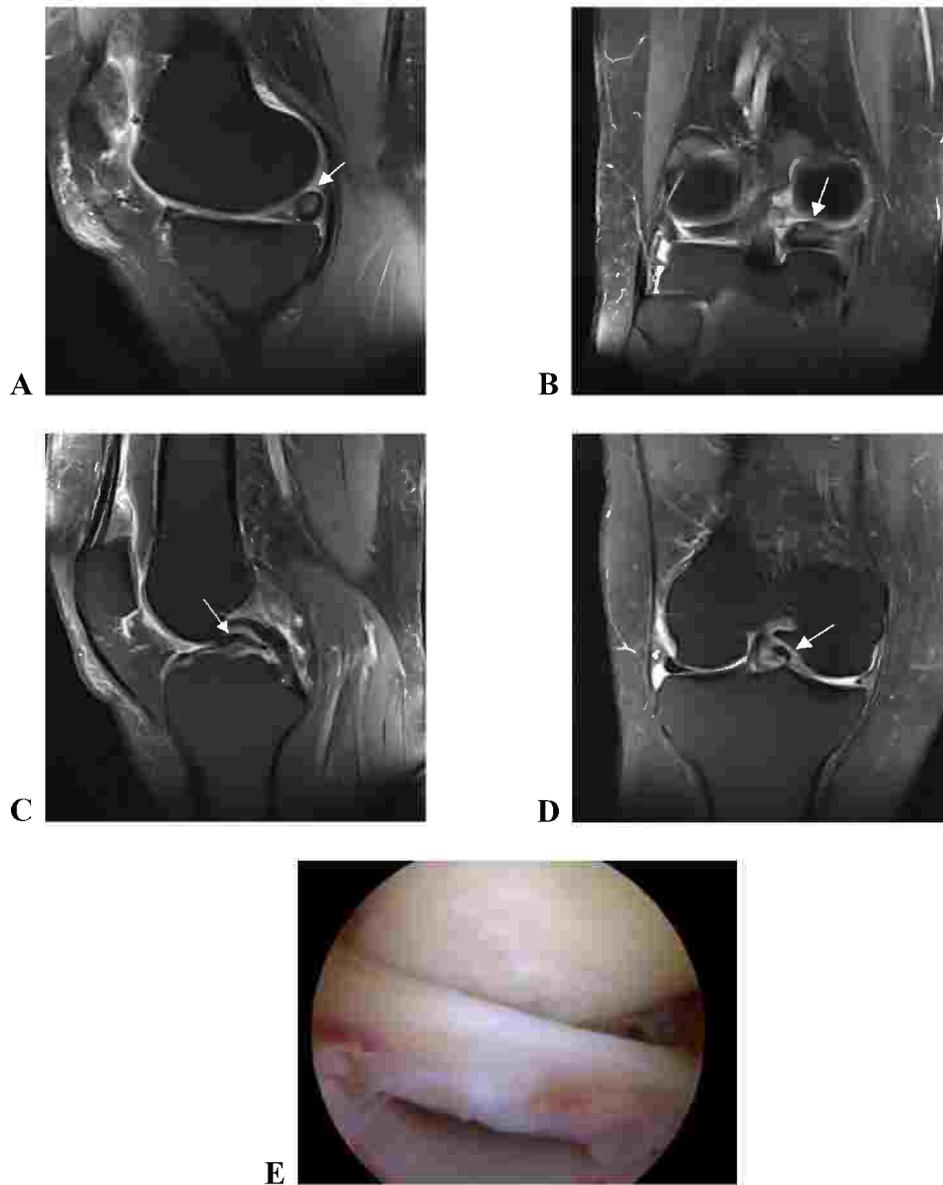


Figure 69: 64 year old male patient complaining of knee pain 2 years following partial medial meniscectomy

A and B sagittal and coronal intermediate weighted showing partial meniscectomy of the anterior horn of the medial meniscus with bucket handle tear.

C and D sagittal and coronal intermediate weighted images showing double PCL sign with displaced meniscal fragment at the intercondylar notch.

E arthroscopic image showing displaced meniscal fragment in intercondylar notch

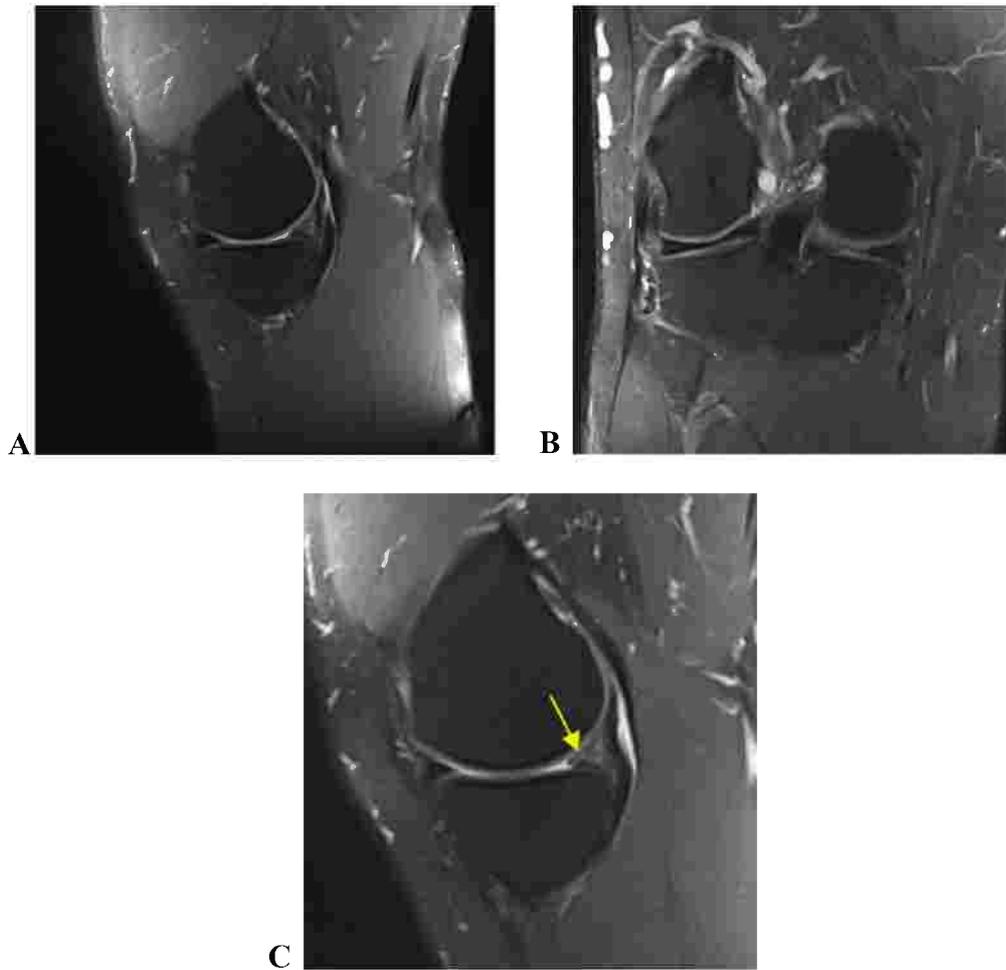


Figure 70: 45 year old male patient complaining of knee pain 1 year following partial medial meniscectomy

A and B sagittal and coronal intermediate weighted showing evidence of partial meniscectomy of the posterior horn of the medial meniscus.

C sagittal intermediate weighted image showing re-torn posterior horn of the medial meniscus.



Figure 71: 52 year old female patient complaining of knee pain 2 years following medial meniscus repair

A and B sagittal and coronal intermediate weighted showing torn posterior horn of the medial meniscus.

C and D coronal intermediate weighted images showing meniscal fragments at the superior and inferior menisco-capsular recesses (arrows)

Findings not related to operational procedure in group II (meniscal surgery)

Meniscal tear was diagnosed in 2 cases (meniscus not subject to previous surgery) (10%); 5 cases of ACL tear (25%) (Fig. 72,73); 1 case of ACL degeneration (5%) (Fig. 74); one case of ACL ganglion (5%) (Fig. 75); 11 case of articular cartilage lesion (55%) (Fig. 76); 2 cases of sprained medial collateral ligament (10%) (Fig. 77); 1 case of Hoffa's pad of fat impingement (5%) (Fig. 78); 2 cases of Baker's cyst (10%) (Fig. 79), and 1 case of patellar cartilage lesion (5%). (Table 11)

Table (11): Distribution of the studied cases according to MRI- findings not related to the operational procedure in meniscus surgery group.

	Meniscal (n = 20)	
	No.	%
Meniscal tear	2	10.0
ACL tear	5	25.0
ACL degeneration	1	5.0
ACL ganglion cyst	1	5.0
Articular cartilage lesion	11	55.0
Sprained medial collateral ligament	2	10.0
Hoffa's pad impingement	1	5.0
Baker's cyst	2	10.0
Patellar cartilage lesion	1	5.0



Figure 72: 52 year old female patient complaining of knee pain 2 years following medial meniscus repair.

A and B sagittal and axial intermediate weighted images showing partial ACL tear.

C and D sagittal and coronal intermediate weighted showed torn posterior horn of the medial meniscus.

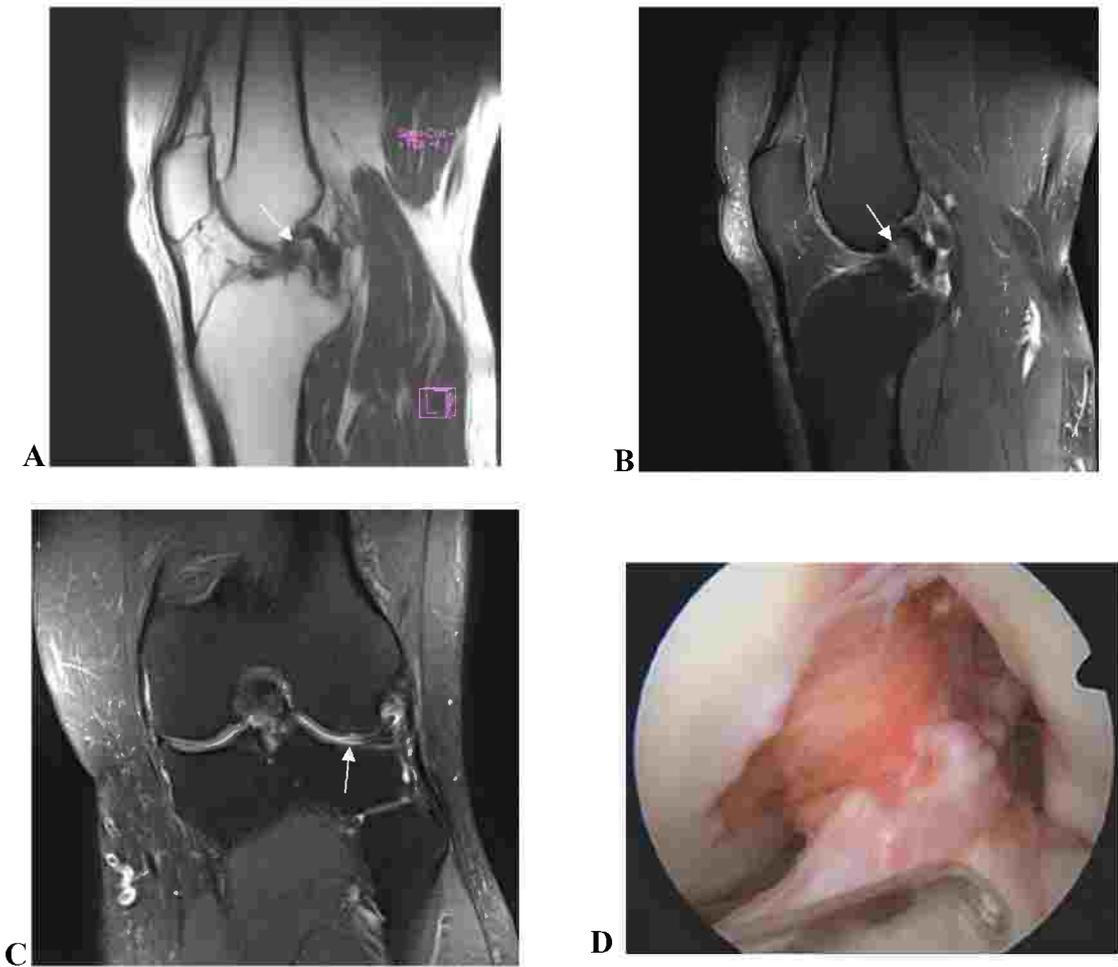


Figure 73: 50 year old male patient with partial medial meniscectomy complaining of knee pain following recent knee twisting

A, B and C sagittal proton density, sagittal and coronal intermediate weighted showing evidence of partial medial meniscectomy and focal areas of thinned out articular cartilage at the lateral femoral condyle as well as torn ACL with anterior tibial translation

D arthroscopic image showing complete ACL tear

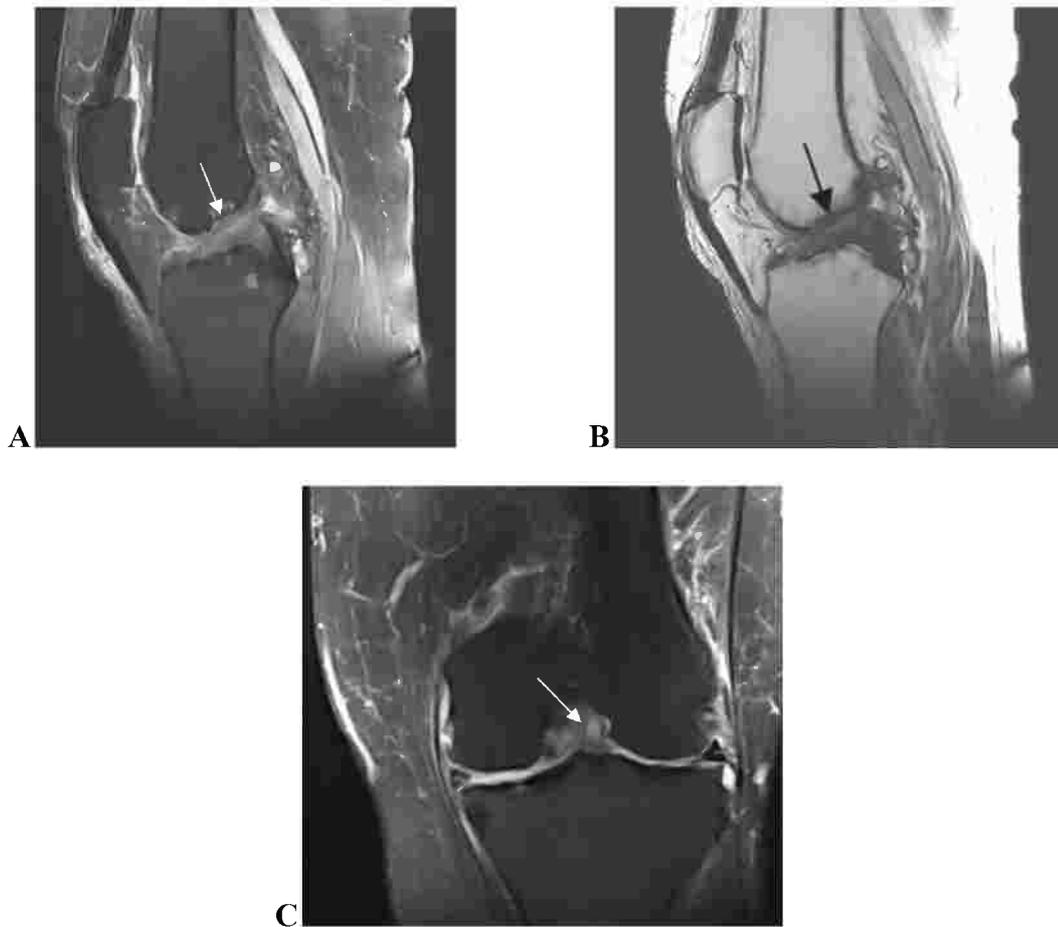


Figure 74: 65 year old male patient complaining of knee pain with previous partial medial meniscectomy long time ago.

A and B sagittal intermediate weighted and PD showing mucoid degeneration of the ACL.

C coronal intermediate weighted showing mucoid degeneration of the ACL and evidence of partial meniscectomy with re-torn medial meniscus.



Figure 75: 45 year old male patient complaining of knee pain 1 year following partial medial meniscectomy.

A and B sagittal and axial intermediate weighted images showing cyst within the fibers of the ACL representing ganglion cyst.

C and D sagittal PD and coronal oblique reformatted image confirmed intra-substance location of cyst.



Figure 76: 38 year old male patient complaining of knee pain 1 year following partial lateral meniscectomy.

A and B sagittal and coronal intermediate weighted showing focal articular cartilage defect with loose body anterior to the anterior cruciate ligament.

C arthroscopic image showing lateral femoral condyle articular cartilage defect.

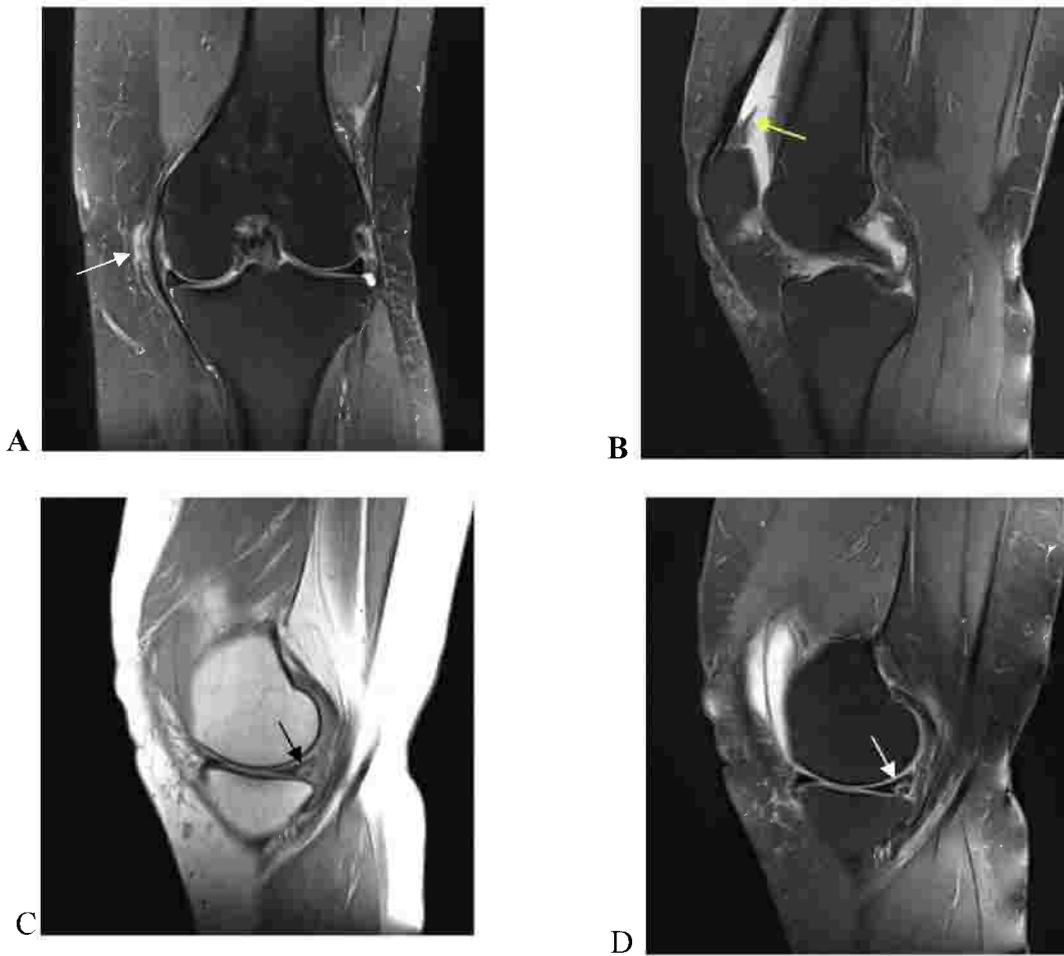


Figure 77: 45 year old female patient complaining of knee pain 1 year following medial meniscus repair.

A coronal intermediate weighted image showing sprained MCL.

B sagittal intermediate weighted image showing thickened suprapatellar plica (arrow).

C and D showing torn posterior horn of the medial meniscus.



Figure 78: 49 year old female patient with previous partial lateral meniscectomy complaining of knee pain.

A sagittal intermediate weighted showing partial meniscectomy of the anterior horn of the lateral meniscus.

B and C sagittal proton density and sagittal intermediate weighted images showing impingement of the supero-lateral Hoffa's fat of pad.

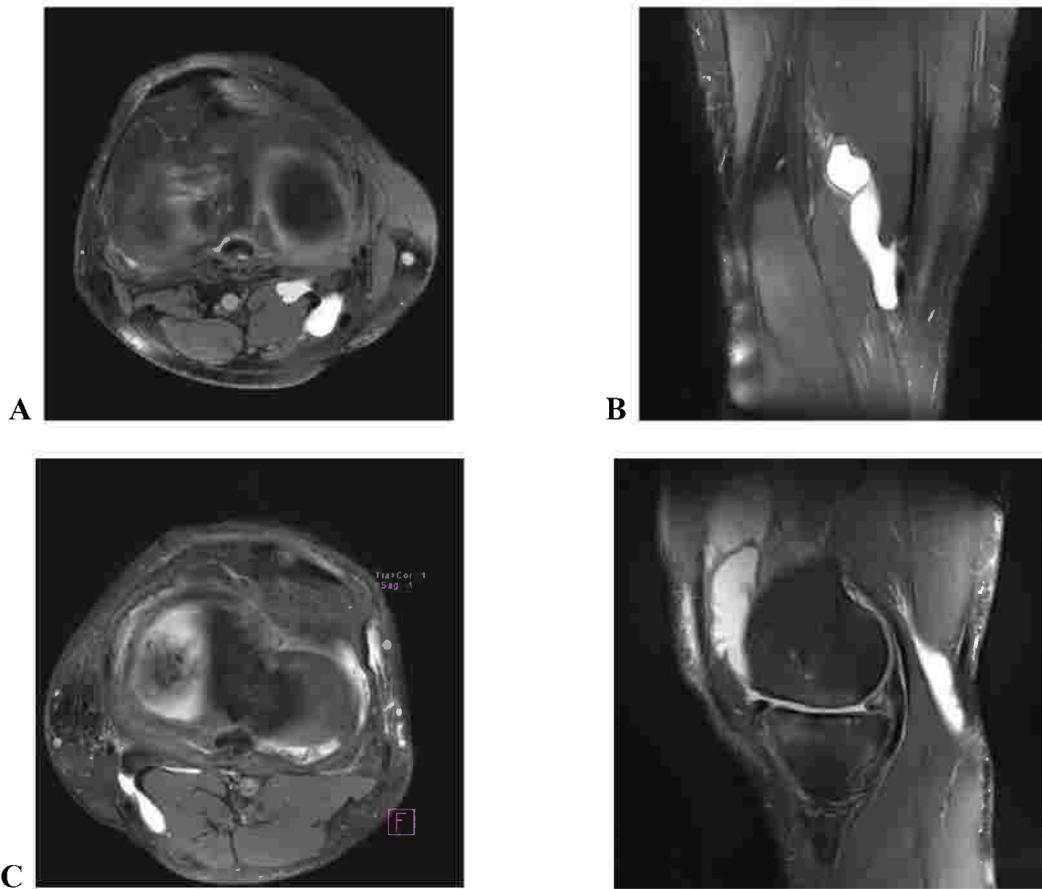


Figure 79: Different patients with incidental finding of Baker's cyst following meniscal surgery.

A and B axial and sagittal intermediate weighted images showing medium sized Baker's cyst.

C and D Another patient showing Baker's cyst.

Group III (Mosaicplasty)

In each case the following points were assessed at the site of graft

- Adequate graft filling: 4 cases (100%)
- Restoration of normal radial curve: 2 cases (50%)
- Displacement of the graft: 0 case (0%)
- Peripheral integration: 4 cases (100%)
- Graft edema: 2 cases (50%) (**Fig. 80, 81**) (**Table 12**)

Table (12): Distribution of the studied cases according to different studied parameters in cartilage group (n=4)

	No.	%
Adequate graft filling	4	100.0
Restoration of normal radial curve	2	50.0
Displacement	0	0.0
Peripheral integration	4	100.0
Graft Edema	2	50.0

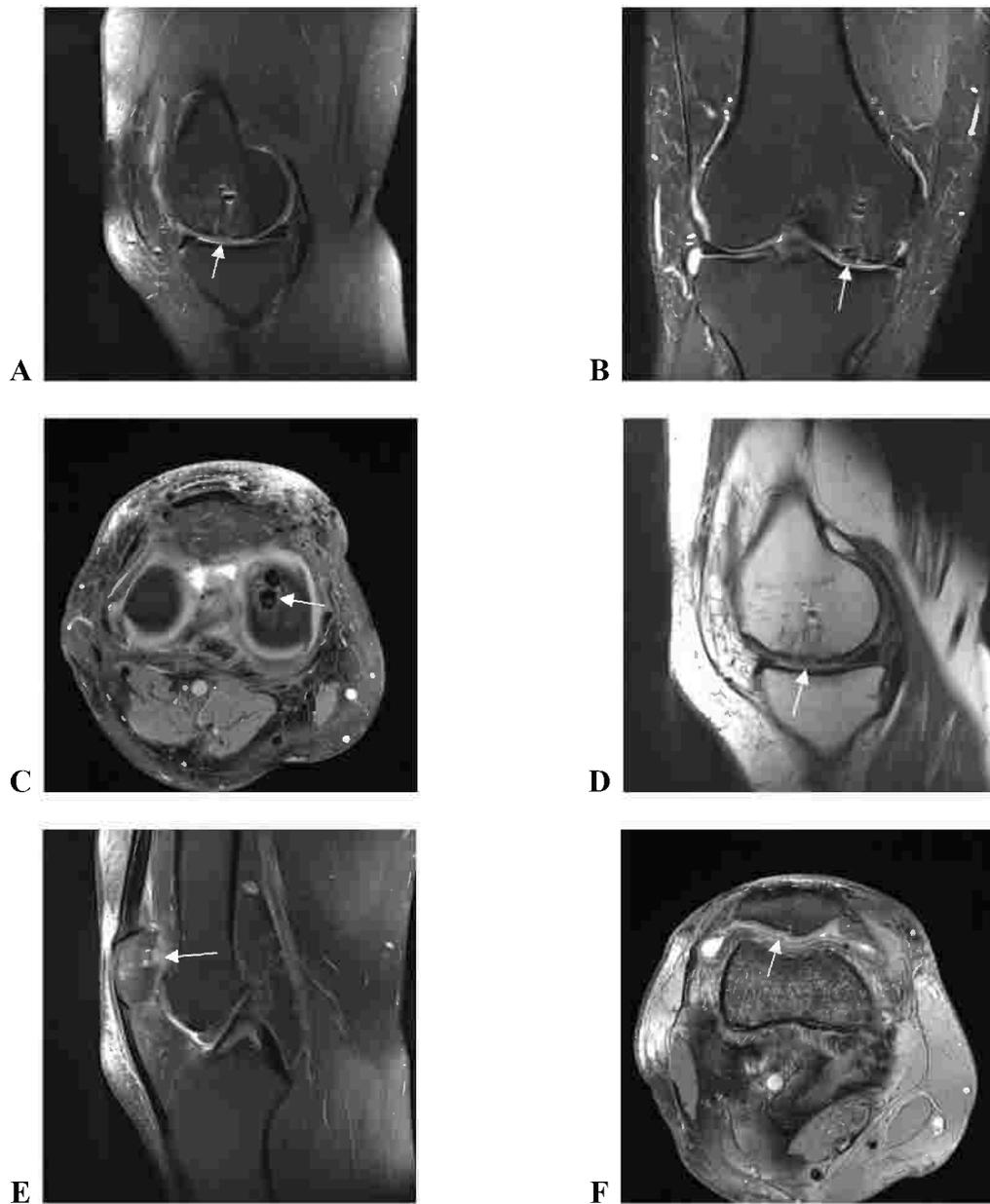


Figure 80 : 45 year old male patient complaining of pain 3 years post Mosaicplasty

A, B, C and D sagittal, coronal and axial intermediate weighted images for assessment of the graft revealed: adequate filling, restoration of normal curve, adequate peripheral graft integration with no graft edema or displacement.

E and F Sagittal and axial intermediate weighted shows cause of pain was chondromalacia patellae.



Figure 81 : 32 year old male patient complaining of pain 1 year post Mosaicplasty

A Plain x-ray showing irregularity of the articular surface of the medial femoral condyle.

B, C sagittal intermediate weighted and PD.

D coronal intermediate weighted images for assessment of the graft revealed: adequate filling, loss of normal curve, adequate peripheral graft integration with evidence of graft edema.

Assessment of the donor site for any possible complication. (Fig. 82)

Other findings: one case of meniscal tear (25%); two case of osteoarthritis (50%) and three cases of chondromalacia patellae (75%). (Table 13)

Table (13): Distribution of the studied cases according to findings not related to the operational procedure.

	No.	%
Meniscal tear	1	25.0
Osteoarthritis	2	50.0
Chondromalacia patellae	3	75.0

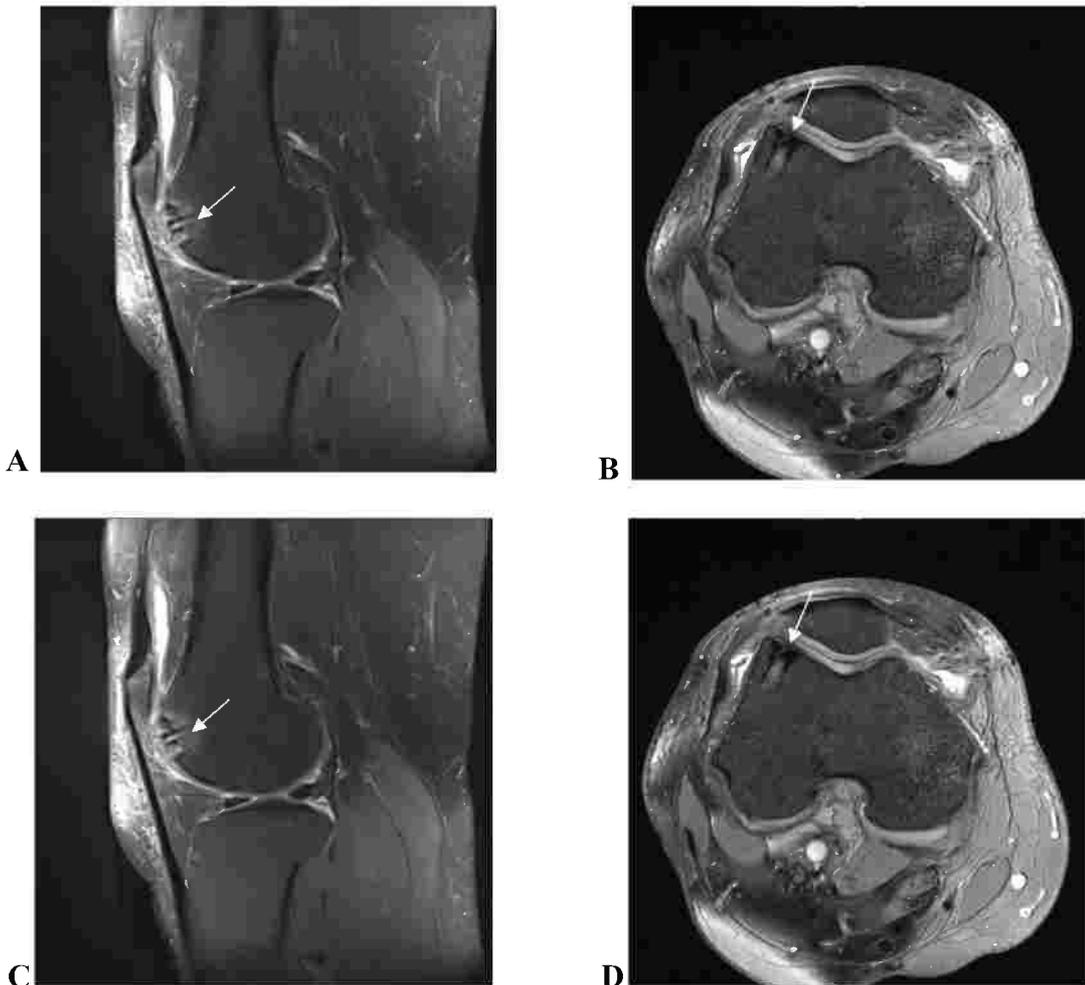


Figure 82: 45 year old male patient complaining of pain 3 years post Mosaicplasty
A, B, C and D Sagittal and axial intermediate weighted showing donor sites.