MRI EVALUATION OF PAINFUL KNEE JOINT- THE CORRELATION OF MULTIPLE COEXISTING PATHOLOGIES, AGE AND SEX

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ABSTRACT

BACKGROUND

1. To evaluate the incidence and coexistence of multiple knee joint pathologies causing painful knee and their correlation to age and sex. 2. To evaluate the Magnetic Resonance Imaging (MRI) features in various knee pathologies and to identify the common lesions.

MATERIALS AND METHODS

A retrospective study was performed using the clinical data of patients presenting with painful knee joint which were evaluated with MRI. Data from 200 patients examined between September 2015 and August 2016 were included into this study. The data was analysed statistically to evaluate the correlation between the MR pathological findings to age and sex of the patients.

RESULTS

The patient's age ranged between 8 and 75 years (mean: 36 years). Anterior cruciate ligament (ACL) tear was the commonest finding (60%) followed by bursitis (55%), meniscal degeneration (54.6%) and meniscal tear (52%). Primary signs of ACL tear were hyperintensity, discontinuity and nonvisualisation. Secondary signs like Posterior cruciate ligament (PCL) buckling, PCL index of greater than 0.5, uncovered Lateral meniscus (LM) and bone contusion assisted in diagnosis in indeterminate cases. Mid substance was the commonest site of ACL tear (64%). PCL tear accounted for only a small percentage (7%). Medial Meniscus (MM) tear (35%) was commoner than LM tear (17%). The posterior horn of meniscus was the commonest site of injury (86.5%). Age was significantly correlated with meniscal degeneration and tear, Medial collateral ligament (MCL) degeneration, parameniscal cyst, and chondromalacia patellae. A significant correlation between male gender and ACL injury was noted. Meniscal injury was significantly correlated with bursitis, as well with MCL injury. Bone bruise was significantly correlated with ACL injury, MCL injury and Lateral collateral ligament (LCL) injury.

CONCLUSIONS

MRI findings of certain pathologies in a painful knee can coexist and significantly correlate with each other, age and sex of the patient.

KEYWORDS

Magnetic Resonance Imaging, Coexisting Pathologies, Painful Knee, Anterior Cruciate Ligament, Meniscal Tears.

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BACKGROUND

The numbers of patients with complain of painful knee joint are quite significant, therefore MRI of the knee is of great value to understand and diagnose the various pathologies causing them. Though Arthroscopy is considered "the gold standard" for the diagnosis of such lesions, it is an invasive procedure; thus associated with all the potential complications of a surgical procedure. MRI has gained in popularity as a diagnostic tool for musculoskeletal disorders in recent times. MRI provides a non-invasive, non operator dependent, cost effective means to diagnose knee pathologies. MRI gives sufficient information in taking decisions for conservative treatment and avoids unnecessary arthroscopy.[1]

MRI is the most commonly used imaging modality in the evaluation of the knee joint, with high degree of accuracy in the detection of meniscal and ACL injury.[2-5] However coexistence of more than one knee pathology decreases the rate of accuracy of MRI.[6-8] Therefore we undertook a retrospective study of MRI findings of the patients of painful knee to evaluate the incidence and coexistence of various

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knee joint pathologies, their correlation to each other, age and sex of the patients. We also assessed the diagnostic usefulness of MRI in such patients and identify the common lesions.

MATERIALS AND METHODS

The data from a total of 200 patients (123 males, 77 females) who presented with painful knee joint, were evaluated with MRI using a 1.5 Tesla MR unit GE, Sigma HDXT (Twin) MRI machine with a superconducting magnet using a QD extremity coil, between September 2015 and August 2016 in a tertiary care center. The cases were referred from Orthopaedic OPD. The ages of the patients ranged between 8 to 75 years (mean=36 years). The pathological findings on the MRI examinations like injuries of the menisci, medial collateral ligament (MCL), lateral collateral ligament (LCL), anterior cruciate ligament (ACL) and posterior cruciate ligaments (PCL), as well as parameniscal cyst, Baker cyst, Chondromalacia patellae (CP), bone bruise, bursitis, and tumor were evaluated in all patients.

Patients were placed in supine position with the knee in a closely coupled extremity coil and the knee was externally rotated by 15-20°, for better visualization of ACL on sagittal images.[9] For better accuracy in assessment of the patellofemoral compartment and patellar alignment, the knee was flexed slightly 5-10°.[10] Pulse sequences used were SE, FSE, GRE, PDFS and STIR in three standard imaging planes namely coronal, sagittal and axial. Slice thickness of 4 mm, FOV of 17cm x 17cm and 192 x 160 matrixes were used. On axial acquisition the patellofemoral joint was used as an initial localizer for subsequent sagittal and coronal planes. The collateral ligaments and body of the menisci were evaluated in coronal plane and cruciate ligaments, menisci and synovial anatomy were assessed in sagittal plane.

A statistical analysis was performed to examine the relationship between the pathological findings and patient's age and sex using GraphPad Software (QuickCalcs). A P value <0.05 was regarded as significant.

RESULTS

The total number of cases and types of knee joint pathologies are shown in Table 1.

Meniscal or Ligament Pathologies				
	Grade- I Degeneration[a]	**Grade- II Degeneration[b]**	**Tear[c]**	**Total**
MM anterior horn	36	50	4	90
MM posterior horn	16	98	66	180
LM anterior horn	20	76	14	110
LM posterior horn	24	115	26	165
ACL	12	4	120	136
MCL	15	22	50	62
LCL	5	7	45	57
PCL	0	0	14	14
Other Pathologies				
Bursitis				110
Bone-bruise				70
Baker cyst				60
Chondromalacia patellae				30
Osteochondral lesion				24
Meniscal & Parameniscal cyst				18
Synovial plica				15
Arthritis				12
Ganglion cyst				8
Synovial pathology				6
Tumor				4

Table 1. The Total Number of Cases and Types of Knee Joint Pathologies

([a] Grade I degeneration of the meniscus :- one or several punctate signal intensities not contiguous with articular surface; Grade I degeneration of the MCL/LCL:- subcutaneous edema; [b]Grade II degeneration of the meniscus :- a linear intra-meniscal signal intensity without articular surface extension; Grade II degeneration of the MCL/LCL :- morphologic disruption or internal high signal intensity and/or fluid in the MCL/LCL bursa; [c]Meniscal tear :- signal intensity extended to at least one articular surface; MCL/LCL tear :- discontinuity of the ligament).

Ligament and Meniscal Tears	**No. of Cases**	**Percentage**	**Total No. of Cases (n=200)**
ACL	120	60%	
Menisci	104	52%	
MCL	50	25%	
LCL	45	22.5%	
PCL	14	7%	

Table 2. The Percentage of Ligament and Meniscal Tears

ACL Tear	Female	Male	Total
		n (%)	
Normal	50 (25 %)	30 (15%)	80 (40%)
Partial tear [a]	12 (6%)	26 (13%)	38 (19%)
Complete tear [b]	15 (7.5%)	67 (33.5%)	82 (41%)
Correlation of ACL tear and gender	P-	P+	

Table 3. The Incidence of ACL Injury and Sex Distribution

(n = number of cases; % = percentage of total; a = Partial tear of the ACL: intra-ligamentous signal intensity without discontinuity of ligament; b = ACL tear: discontinuity of the ligament; P+ = significant correlation (P=0.0001); P- = insignificant correlation)

In our study group 150 cases presented with history of trauma and 50 cases without trauma. Among the ligament and meniscal pathologies, the common conditions encountered were ACL tears (60%) followed by meniscal degeneration (54.6%), meniscal tears (52%) and MCL tears (25%) (Table 1 and Table 2). Out of the 120 ACL tears, 70 (58.33%) had acute complete tears, 38 (31.66%) had acute partial tears, and 12 (10%) had chronic tears. Hyperintensity in the ligament was noted in 70 cases (Figure 1), discontinuity in 32 cases and nonvisualisation of ACL in 18 cases (Figure 2). Secondary signs such as PCL buckling (Fig. A, B), PCL index of >0.5, anterior tibial subluxation (Figure 4: A, B) and uncovered LM (Figure 5) were noted. Mid substance was the commonest location of ACL tear (64%). There was a significant correlation between male gender and ACL injury (P=0.0001) (Table 3).

Figure 1. Sagittal PDWI-ACL Tear- Hyperintensity of ACL

Figure 2. Sagittal PDWI-ACL Tear- non Visualization of ACL in Intercondylar Notch

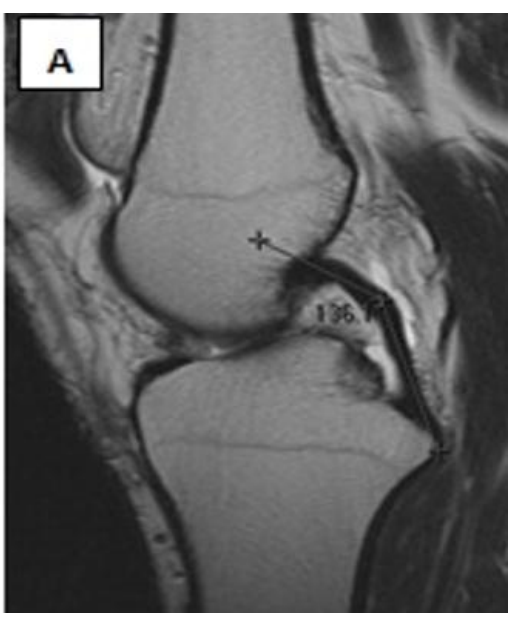

Figure 3A. Sagittal PDWI- Secondary Sign of ACL Tear- A. Normal PCL Angle (n >110˚)

Figure 3B. PCL Buckling/Decreased PCL Angle

Figure 4A. Sagittal T2WI- Secondary sign of ACL tear – A: No Anterior Tibial Subluxation

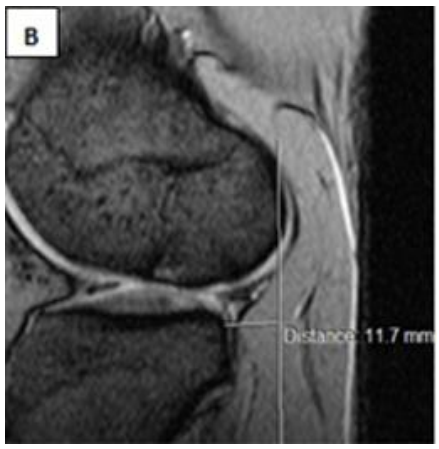

Figure 4B. Anterior tibial Subluxation

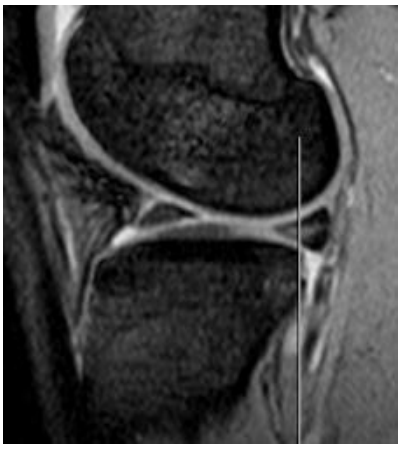

Figure 5. Sagittal PDWI- Secondary Sign of ACL Tear – Posteriorly Displaced Horn of LM (Uncovered Meniscal Sign)

PCL tears accounted for only a small percentage of cases (7%). Discontinuity of PCL in mid-substance was seen in 8 cases, hyperintensity in 4 cases and avulsion was noted in 2 cases.

	Meniscal Pathologies (n=200)			
Location	**Normal**	**Grade- I Degeneration[a]**	**Grade –II Degeneration[b]**	**Tear[c]**
MM anterior horn	110 (55%)	36 (18%)	50 (25%)	4 (2%)
MM posterior horn	20 (10%)	16 (8%)	98 (49%)	66 (33%)
LM anterior horn	94 (47%)	20 (10%)	76(38%)	10 (5%)
LM posterior horn	35 (17.5%)	24 (12%)	117 (58.5%)	24 (12%)

Table 4. The percentage of meniscal pathologies

(n = number of cases; % = percentage of total)

The commonest meniscal pathology was meniscal degeneration (54.6%) and type II degeneration accounting for (42.6%). MM tear was commoner than LM tear accounting for 67.3% cases. Bucket handle tear of MM was clearly evident on sagittal images as absent bow tie sign, double PCL sign and displaced meniscal fragment in intercondylar notch on coronal images (Figure 6: A, B, C). The posterior horn was the commonest site of involvement, accounting for 86.5%. Out of the 104 meniscal tears, 57 (54.8%) were horizontal tears, 35 (33.65%) longitudinal tears (Figure 7: A, B) and 10 (9.61%) bucket handle tears.

MCL tears are commoner than LCL tears, accounting for 25% of total cases. Among the MCL pathologies 15 cases (7.5%) had Grade I degeneration, 22 (11%) Grade II degeneration and 50 (25%) had tears.

Figure 6A. Sagittal PDWI Shows 'Absent Bow tie Sign' the Donor Site (Arrow) of BHT

Figure 6B. Sagittal Image - Double PCL Sign, Meniscal Fragment (Arrow) Anterior to Normal PCL (Arrowhead) and Paralleling its Course

Figure 6C. Coronal Image Shows Dark Meniscal Fragment (Arrow) Displaced into Intercondylar Notch

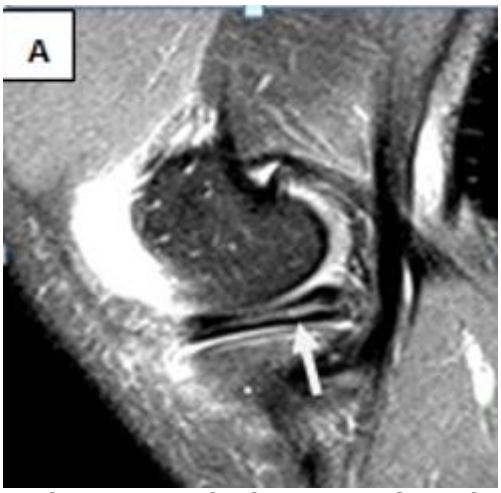

Figure 7A. Sagittal PDWI- Horizontal Tear of Lateral Meniscus

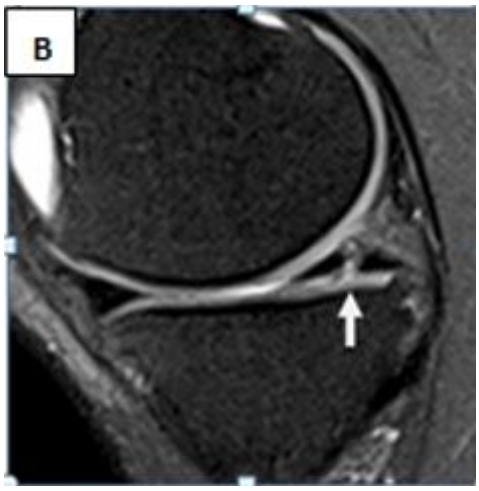

Figure 7B. Sagittal PDWI- Longitudinal Tear of Medial Meniscus

MCL tears are commoner than LCL tears, accounting for 25% of total cases. Among the MCL pathologies 15 cases (7.5%) had Grade I degeneration, 22 (11%) Grade II degeneration and 50 (25%) had tears.

O'Donoghue's Unhappy Triad	No of Cases	Percentage	Total No. of Traumatic Cases
ACL, MM, MCL injuries	23	15.33 %	(n=150)
ACL, LM, MCL injuries	8	5.33 %	

Table 6. Incidence of Combined Meniscal and Ligament Injuries

Secondary Changes	No. of Cases	Percentage	Total no. of Traumatic Cases
Bursitis	110	73.33%	(n=150)
Joint effusion	82	54.66 %	
Bone bruise	70	46.66 %	
Chondromalacia patellae	24	16 %	
Cystic lesions*	18	12%	

Table 7. Secondary Changes Associated with Traumatic Cases

*Cystic lesions: meniscal cysts (n=10), parameniscal cysts (n=6), ganglion cyst (n=2).

Out of the 150 traumatic cases, O'Donoghue's classic unhappy triad (ACL, MM, MCL injuries) was common, accounting for 15.33%. It was observed that bursitis was the commonest associated secondary finding, accounting for 73.33% followed by joint effusion 54.66% and bone contusion 46.66% of traumatic cases.

Other Knee Pathologies	Sex n (%)		Total
	Male	Female	
Bursitis	70 (35%)	40 (20%)	110 (55%)
Joint effusion	52 (26%)	30 (15%)	82 (41 %)
Bone bruise	22 (11%)	48 (24%)	70 (35 %)
Baker cyst	38 (19%)	22 (11%)	60 (30%)
Chondromalacia patellae	20 (10%)	10 (5%)	30 (15 %)
Cystic lesions	12 (6%)	6 (3%)	18 (9 %)
Synovial pathology	4 (2%)	2 (1%)	6 (3%)

Table 8. The Incidence of other Knee Pathologies and their Sex Distribution

(n= number of cases (n=200); %= percentage of total)

We observed that male gender was significantly correlated with bursitis, joint effusion, Baker cyst and chondromalacia patellae. The meniscal cyst and ganglion cyst with their relation to the meniscus and ligament respectively, were well demonstrated on T2WI (Figure 8 and Figure 9). Pathologies such as Baker cyst, synovial plicae and chondromalacia patellae were also clearly demonstrated on MR images (Figure 10: A, B, C, D).

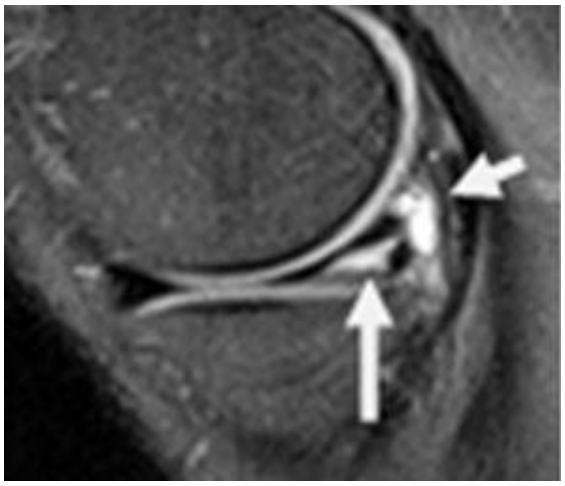

Figure 8. Sagittal PDWI- Meniscal Cyst Communicated with Horizontal Tear of Lateral Meniscus

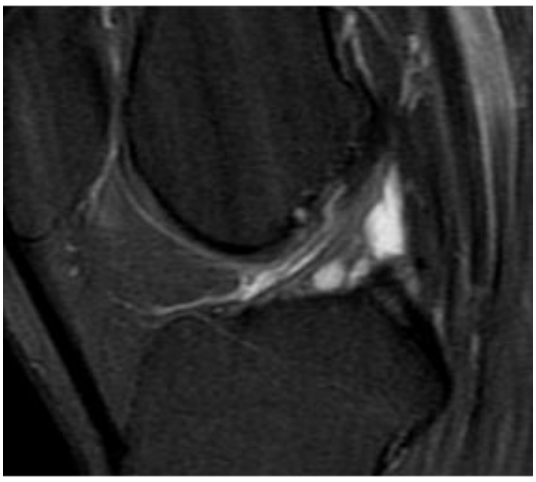

Figure 9. Sagittal PDWI- ACL Ganglion Cysts

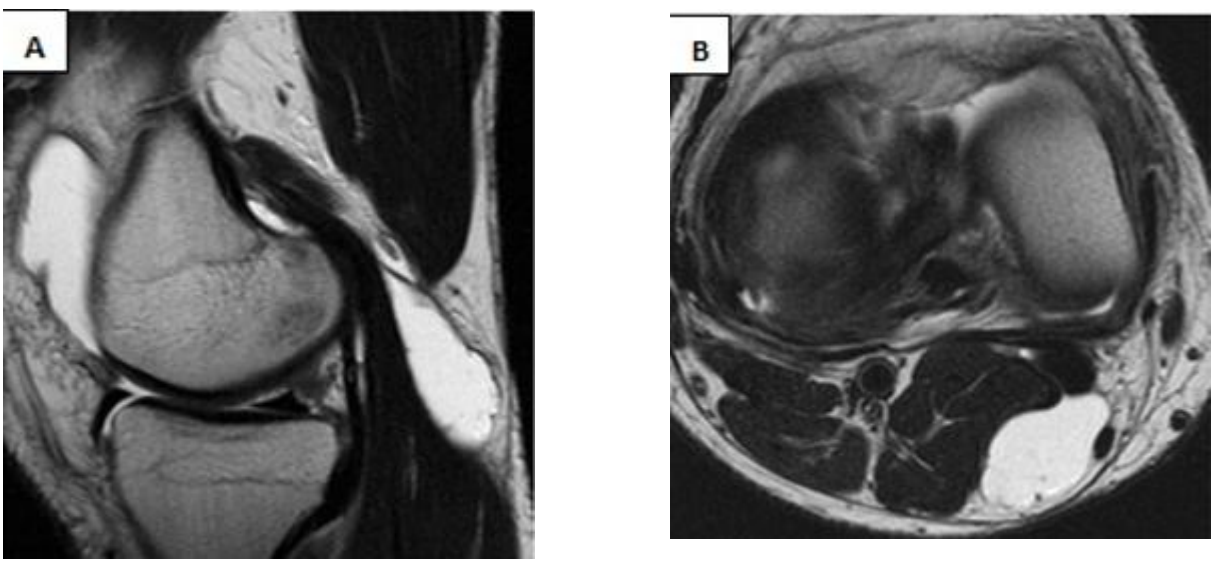

Figure 10. Sagittal and axial T2WI (A and B) - Baker Cyst-hyperintense Cystic Lesion, Clearly Showing Relation with Muscle and Joint

Figure 10C. Sagittal PDFS –suprapatellar Plica

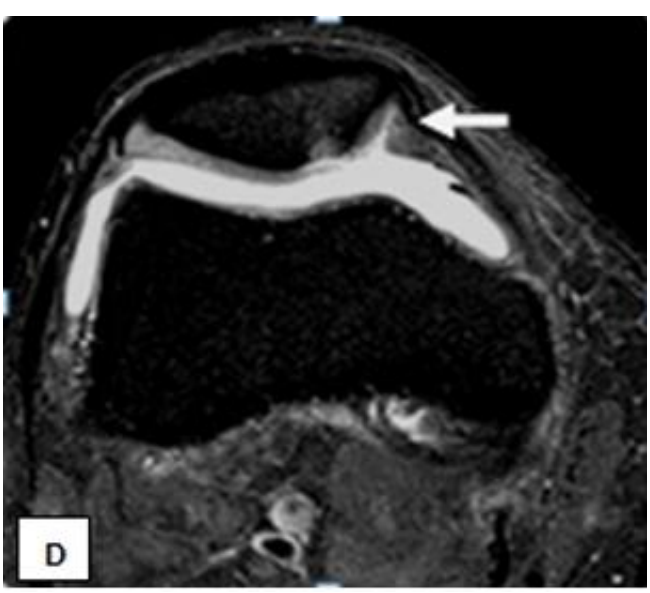

Figure 10D. Axial GRE – chondromalacia Patellae – irregularity and Fissuring of the Articular Surface of Patella

Age Group in Years	Knee Pathologies							
	Meniscal		ACL Tear	MCL		Baker Cyst	CP*	Parameniscal /Meniscal Cyst
	Deg*	Tear		Deg*	Tear			
0-10	0	3	2	0	2	1	0	0
11-20	10	7	10	2	3	2	0	0
21-30	20	10	50	3	4	6	1	2
31-40	55	35	22	4	7	5	2	2
41-50	190	22	16	8	8	10	5	7
51-60	65	12	12	15	18	24	14	4
61-70	97	15	8	5	8	12	8	3
P Value	0.0459	0.0105	0.0283	0.0303	0.0125	0.0280	0.0453	0.0316

Table 9. Correlation of Knee Pathologies and Age

(Deg*: Degeneration; CP*: Chondromalacia patellae).

Knee Pathologies	Bone Bruise		Bursitis		CP*		Baker cyst	
	With	Without	With	Without	With	Without	With	Without
ACL injury	78	42	50	70	72	48	52	68
MCL injury	32	18	33	17	23	27	23	27
LCL injury	30	15	20	25	18	27	25	20
Meniscal injury	44	60	65	39	46	58	58	46

Table 10. Correlation of Combined Knee Pathologies

CP*= Chondromalacia patellae.

Age was significantly correlated with meniscus degeneration and tear (P=0.046 & P=0.010), MCL degeneration (P=0.030), parameniscal cyst (P=0.031), and chondromalacia patellae (P=0.045). ACL injury was common in younger age group 21-30 years (P=0.028). Bursitis was significantly correlated with MCL injury (P=0.023), as well as meniscal injury (P=0.010). Bone bruise was significantly correlated with ACL injury (P=0.001), MCL injury (P=0.047), LCL injury (P=0.025). ACL injury was significantly correlated with Chondromalacia patellae (P=0.028).

DISCUSSION

MR imaging has brought revolution in field of knee imaging. Many studies have been done comparing MR imaging with arthroscopic findings which have corroborated the role of MR imaging in the clinical arena. MRI has been recognized as the main imaging tool for evaluation of suspected internal derangements of knee joint.[11] In contrast to conventional and CT arthrography, multiplanar MR has advantage in complete evaluation of the joint capsule, cruciate and collateral ligaments and menisci.

In our study we found that positioning knee with 5-10° of flexion and 15-20° of external rotation was optimal. Acute lesions were seen as high signal intensity in T2WI with great degree of accuracy which correlated with study by Mink et al.[3] In our study ACL tear was the commonest pathology which correlated with study by Sonnin et al.[12] Mid substance was the commonest site of ACL tear which was concordance with study by Berquist et al.[9] The features of ACL tear like hyperintensity in the ACL, discontinuity and non-visualisation were similar with study by Gentili et al.[13] In indeterminate cases of ACL tear, diagnosis was made using the secondary signs such as PCL buckling, anterior tibial displacement, uncovered meniscus sign and bone contusions. ACL tears in which MR examinations were performed within 6 weeks of injury were considered as acute and after 6 weeks as chronic as mentioned by Vahey et al.[14] PCL tear accounted for only a small percentage of cases (7%) which was correlated with study by Sonnin et al.[12]

The commonest meniscal pathologies observed were meniscal degeneration, Grade II degeneration accounting for the most (42.6%) which correlated with study by Serhat Avcu et al.[15] MRI features of Grade I degeneration (one or several punctate signal intensities not contiguous with an articular surface), Grade II degeneration of the meniscus (linear intra-meniscal signal intensity without articular surface extension) and meniscal tear (hyperintensity extended to the articular surface) are shown in (Figure 11: A, B, C). The degeneration of menisci demonstrated high signal intensity due to imbibed synovial fluid as explained by Stoller et al.[16] The MM tears were commoner than LM tears in our study which corresponded with study by La Prade and colleagues.[17] and study by Shetty DS et al.[18] We found that T2* weighted GRE images clearly depicted the meniscal tears than FSE images, as supported by Rubin et al.[19]

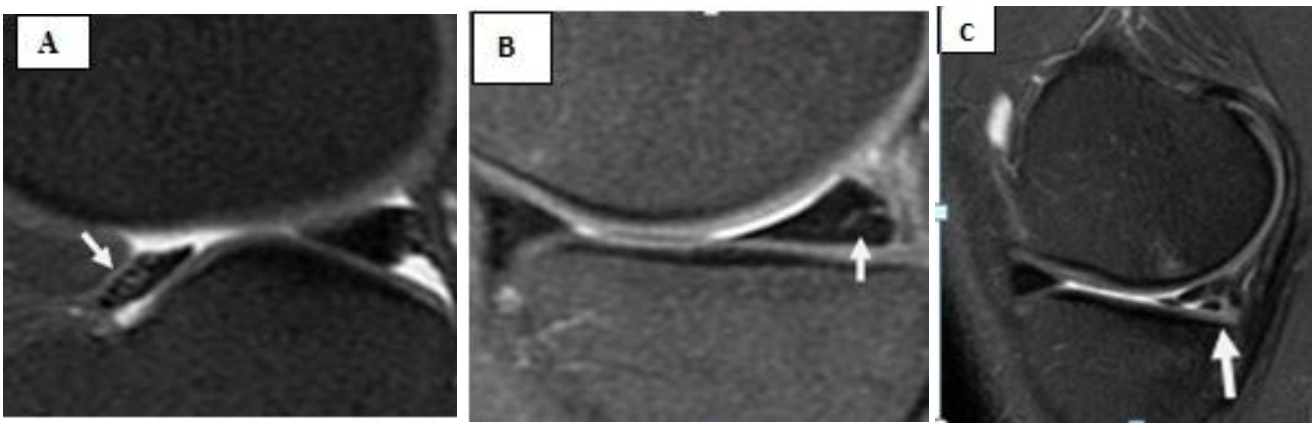

Figure 11. Sagittal PDWI-A-Grade I Meniscal Degeneration; B-Grade II Meniscal Degeneration; C-Meniscal Tear

In our study Baker cyst, meniscal cyst and ganglion cyst were the common cystic lesions. Meniscal cyst were intrameniscal, parameniscal and synovial. Parameniscal cysts often communicated with the horizontal tear of meniscus similar to study by Burk et al.[20]

Simultaneous injuries to several supporting structures were relatively common in the knee Duncan et al.[21] Coexistence of meniscal tears with ligament injuries greatly affected the management protocol and prognosis.[6] When an ACL tear was detected on the MRI, special attention was paid to the posterior horn of the LM to detect any subtle peripheral tear.[22] In our study the O'Donoghue's medial unhappy triad was commonly seen among combined meniscal and ligamentous injuries, accounting for 15.33%. In our study it was observed that meniscal injury was significantly correlated with bursitis (P<.01), as well as MCL injury (P<.05), while no significant correlation was observed with ACL tear. In concordance with Miller et al.[23] no association was found between Baker cyst and ACL or MCL injury in our study.

Age was significantly correlated to meniscal degeneration and tear, MCL degeneration, parameniscal cyst, and chondromalacia patellae. ACL injury was common in younger age group. There was a significant correlation between male gender and ACL injury. Meniscal injury was significantly correlated with bursitis, as well as MCL injury. Bone bruise was significantly correlated with ACL injury, MCL injury and LCL injury. Chondromalacia patellae were significantly correlated with ACL injury. These correlations of simultaneous injuries in our study were in concordance with study by Serhat Avcu et al.[15]

CONCLUSION

MRI is the investigation of choice in the evaluation of internal joint structures of the knee. The diagnostic accuracy of MRI, for composite knee injuries is reliable enough, despites its variability in relation to different individual structures of the knee. Thus it helps in selecting the patients judiciously for arthroscopic interventions. It has the added benefit as a noninvasive investigation in planning of management protocol of such patients. We conclude that certain knee pathologies are significantly correlated with each other, and the age and sex of the patient. Therefore one should always remember that various knee pathologies can coexist in a painful traumatic knee.

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