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Knee Pain: Ligaments and Meniscus Tear Abnormalities among Various Patient Age Groups and Meniscus Gap

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Abstract: **-**Knee pain is a common complaint affecting people of all age groups. To choose an effective treatment, we evaluate the extent of the Ligaments and meniscus tear abnormalities among various patient age groups and the meniscus gap. This was an observational prospective study of 100 patients aged 18 to 65 years, who complained of knee pain and were assessed by an MRI scan. In this study, 100 patients were included, of which 58 were males and 42 were females. The mean age of the patients was 35.7 years. Our study found that joint effusion is associated with ACL tears; some patients had bone contusions, and the femur was more commonly involved. The longitudinal tear was the commonest type of meniscal tear. Baker's cyst was the most common cyst lesion found and in the present study, we evaluate the meniscal height on the normal and abnormal medial, lateral meniscus on a coronal plane was statistically significant. The knee MRI technique and sequences correctly identify the ligament tear with the exact position and soft tissue. Considering the usual meniscus size may help you differentiate between a discoid and a small meniscus. This might be vital to managing surgeries on the knee joint.

Keywords*:* Magnetic Resonance Image, Anterior cruciate ligament, Posterior cruciate ligament, Medial collateral ligament, Lateral collateral ligament

1. Introduction

The knee, which is the primary weight-bearing joint, gives the body flexibility and stability during physical exercise as well as equilibrium when standing [1]. The knee joint is crucial in the human body with a complex movement differentiated by including ligamentous and meniscal components. The knee joint is primarily responsible for the stability and activity of the human body. Knee discomfort may affect anyone at any age [2]. Magnetic resonance imaging is a widely used imaging technique for assessing patients with knee symptoms, which has virtually superseded diagnostic arthroscopy in this context [3]. The gold standard in imaging research is magnetic resonance imaging. In terms of analyzing the internal architecture of the knee, MRI provides several benefits over other types of imaging, one of which is the ability to modify contrast to show off various tissue types. Knee joint discomfort may have a traumatic origin or a non-traumatic cause, such as an infection or

inflammation. Sometimes failing to find the precise lesion causing discomfort prevents patients from receiving the best care possible. MRI can show a particular type and the quantity of both bone and soft tissue abnormalities [2]. The technique is unmatched in its ability to diagnose non-osseous knee structural derangement and is particularly suitable for high-resolution examination of the musculoskeletal (MSK) system, including muscle, tendon, ligament, and hidden bone injuries [4,5]. Preoperative MRI may reduce the need for needless surgical arthroscopies and help prepare for the operation [6,7]. Additionally, the flexibility of MR imaging in the evaluation of meniscal tears has been shown using 3D volume approaches. It may be used to compress pictures of meniscal tears in both orthogonal and non-orthogonal planes. Differentiating bone marrow, ligaments, tendons, muscle tissue, synovium, cysts, and cartilage components is possible with MR imaging, which also has superior soft tissue discrimination [8,9]. Our study aimed to assess the use of knee MRI in the diagnosis of ligaments, meniscal tears, cysts, and other knee diseases.

2. Methods

Study area

The study was carried out at the Parul Sevashram Hospital, Vadodara. It is an approximately 750 bedded tertiary medical facility located in Waghodia, Gujarat.

Study designs and search strategy:

A prospective observational study was carried out in the Radiology Department between June 2022 to May 2023. Clinical and Pathological data were retrieved from the MR Console room and double-recorded into the MRI record book. The study was approved by the Institute ethical committee of Human Research (PU-IECHR) with approval number PUIECHR/PIMSR/00/081734/5303.

Patient Selection:

For all the cases of Knee in Parul Sevashram Hospital from July 2022 to May 2023 we reviewed in detail the records of the Patient case file which was used to confirm information from other data sources. The 100 patients examined ranged in age from 18 to 65 and came with a variety of knee joint issues, with 58 males and 42 female patients.

Inclusion Criteria

Patient with clinical symptoms of knee Pain for confirmation of the diagnosis

Exclusion Criteri

Patients not included who are not fitted in MR Imaging, post-operative cases, and Patients with knee joint fractures or dislocations were also eliminated as illustrated in Fig 1.

Imaging protocols:

A variety of individuals with a painful knee as their presenting symptom was evaluated using GE Signa HDxt 1.5 T NNMR01 High Gradient MRI scanner knee coil is used for examination. The MRI procedure included the following sequences: T1W, T2W, and PD in the axial, sagittal, and coronal planes. T2 fat spin-echo proton density-weighted images with fat suppression were often used to evaluate fluid and articular cartilage and identify areas of marrow hyperemia, across the axial, sagittal, and coronal planes.

Data Analysis

Statistical analysis was performed using M S Excel and Statistical Package for the Social Science Software, (SPSS) version 26.0. Normal and Abnormal Meniscus Height was measured using the Z test. A Statistical p-value <0.05 was considered statistically significant.

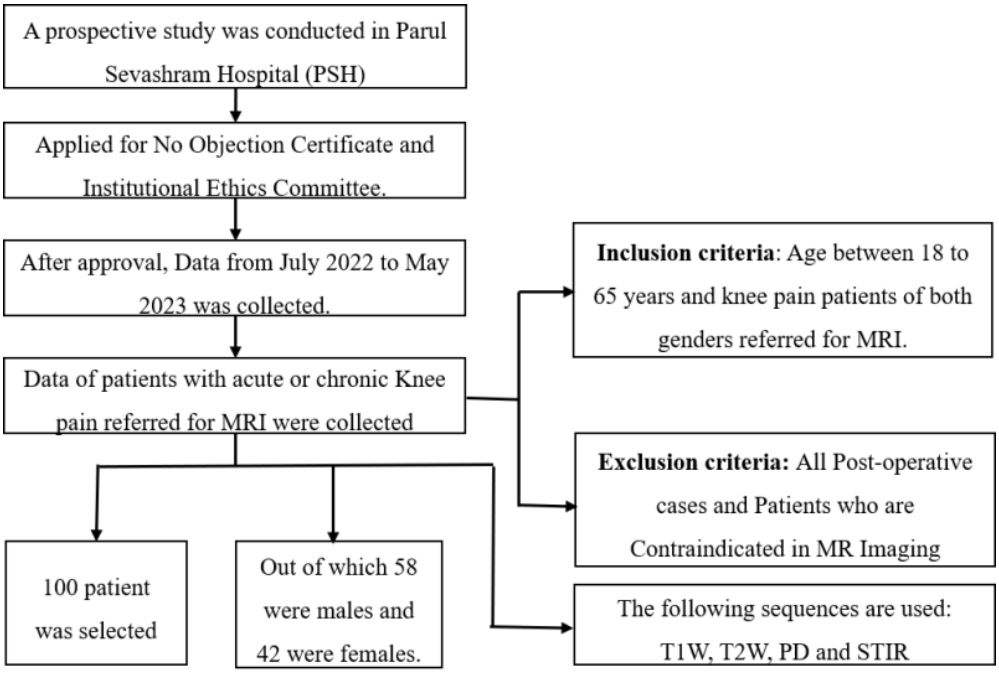


Fig 1: Study of flow chart

3. Results

The 100 participants who had acute or chronic knee pain at the time of the presentation age ranged from 15 to 65 years and they were divided into 5 age groups. 58 patients (58%) were males and 42 patients (42%) were females the mean age is 35.7 years, the majority of patients were between the ages of 26 and 35, so more people were affected in the younger age group i.e., 15-35 years represented in Table 1.

Table 1: Demonstration of patients according to age group and gender

Age group	Male	Female
15-25	15	11
26-35	21	7
36-45	10	11
46-55	6	8
56-65	6	5
Total	58	42

Males are more prone to knee pain rather than females. Males tend to be physically active and move about more than females do. As a result, they are more susceptible to developing more knee deterioration as shown in graphical representation in Fig 2.

Fig 2: Graphical Demonstration of patients according to their age group

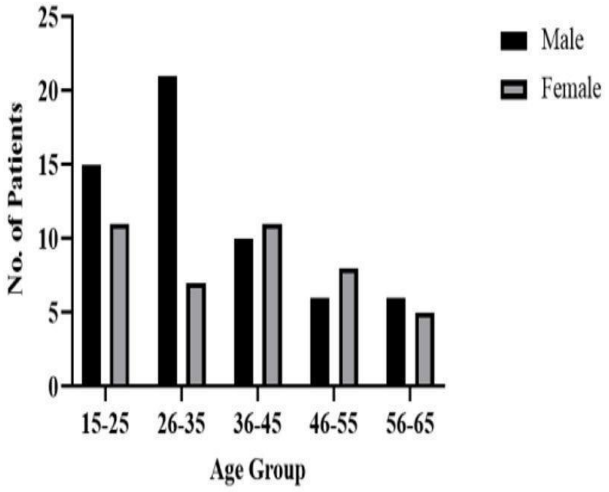


Table 2: Distribution of Patient according to gender and Knee examined

Gender	Right Knee		Left Knee	
	Normal Knee	Problematic Knee	Normal Knee	Problematic Knee
Male	5	24	8	21
Female	13	10	9	10
Total	18	34	17	31

Including both the knee out of 100 individuals, 65 individuals had problems with the knee joint and 35 patients had normal knee joint as illustrate in Table 2.

Table 3: Description of MRI finding on the basis of ACL and PCL involvement in both the genders

Findings	ACL		PCL	
	Male	Female	Male	Female
Partial Tear	16	9	4	1
Complete Tear	17	1	1	0

Anterior cruciate ligament (ACL) abnormalities were present in 43 patients including male and female patients, 33 of whom were males and 10 were females, who reported ACL injuries. Most ACL injuries occur in the young age group between 15-35 years and are reported to have more ACL tears than older people, according to the data in Table 3.

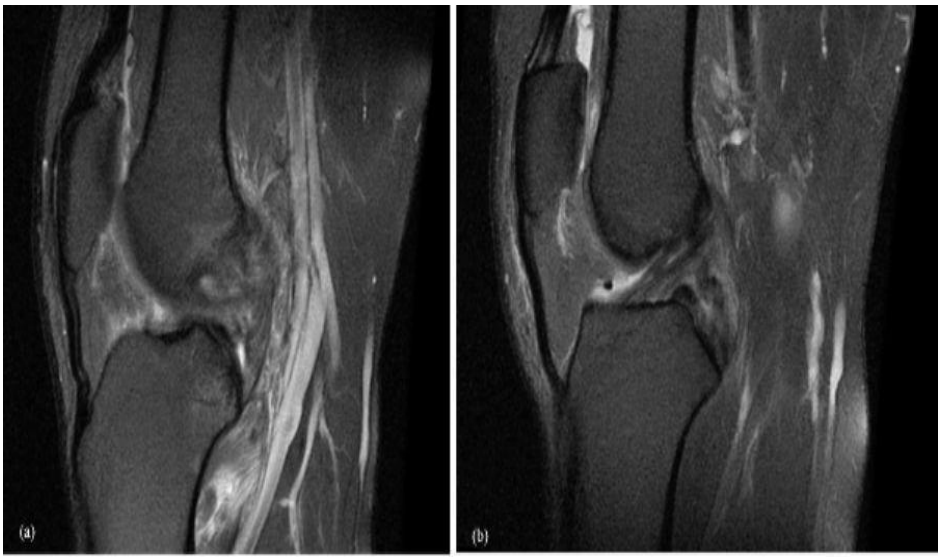


Fig 3: Sagittal PD+FS image shows ACL complete tear, Sagittal PD+FS image shows PCL complete tear

The ACL ligament is most frequently torn in a partial (most encountered ligament injury) or a complete tear (torn apart into two separate pieces) especially in athletes who play sports that involve quick starts, sports, and pivots. Posterior cruciate ligament (PCL) abnormalities were present only in 6 patients as depicted in the table. Although as indicated in Table 3, males are more affected than females, in comparison to the ACL, the PCL is less injured.

Table 4: Description of MRI finding on the basis of Collateral Ligaments

Findings	Medial collateral ligament	Lateral collateral ligament
Grade I	8	2
Grade II	3	1
Grade III	1	1

There are 16 patients had abnormal collateral ligaments on average injuries to the medial and lateral collateral ligaments 11 patients with only Medial collateral ligament (MCL) tears, out of them 9 patients were males and 2 were females and 3 patients with Lateral collateral ligament (LCL) tears, 2 were males and only one was female, as well as 2 males who had rips in both ligaments, all had evidence to grade I, grade II, and grade III injuries as summarized in Table 4. A most typical knee ligamentous injury is a ruptured MCL than the LCL.

Table 5: Involvement ofTear with the Meniscal Body

Findings	Medial Meniscus	Lateral Meniscus
Anterior horn	4	4
Posterior horn	17	3
Anterior horn with body	3	1
Posterior horn with body	14	3

Involvement of medial as well as lateral meniscus was also seen satisfactorily on MRI. The distribution of findings of the meniscus involvement is summarized in Table 5. The overall medial meniscus was more commonly involved rather than the lateral meniscus. The posterior horn was more involved and is associated with the body of both the menisci and either with the posterior horn.

Table 6: Distribution of meniscal tear in Medial and Lateral Meniscus

Findings	Medial Meniscus	Lateral Meniscus
Grade I	2	1
Grade II	5	0
Grade IIa	3	2
Grade III	4	1
Longitudinal tear	8	2
Vertical tear	4	1
Root tear	2	0
Complex tear	2	1
Oblique tear	6	2
Bucket handle tear	2	1

Depending on the anatomy of the injury, there are numerous types of meniscal tears. Only the medial meniscus was injured in 31 individuals, out of them 22 patients were males and 9 were females. In 3 of the patients, 2 were males and one was female, only the lateral meniscus was affected, and 7 individuals, 5 were males and 2 were females, exhibited damage to both the medial and lateral sides of the meniscus. Reportedly indicates data research that meniscus tears are more prevalent among individuals between the ages of 26 to 45. In analysis, as seen in Table 6 the longitudinal tears were found to be the most common meniscal tear.

Table 7: Distribution of patients according to knee pathology

Findings	Male	Female	Total
Joint effusion	33	12	45
ACL	33	10	43
PCL	5	1	6
MCL	11	2	13
LCL	4	1	5
Medial menisci	28	11	39
Lateral menisci	8	3	11
Oedema	19	7	26
Bakers' cyst	1	2	3
Parameniscal cysts	1	0	1
Ganglion cyst	1	0	1

Osteoarthritis	5	2	7
Bone contusion	7	1	8
Quadriceps tendinopathy	5	0	5
Synovitis	1	0	1
Sarcoma (Osteo, Soft tissue)	0	2	2
Hoffa's fat pad	2	0	2
Osteochondromas	0	1	1
Other	12	5	17

The current study stated that joint effusion is the most common pathology in both genders followed by ACL and medial meniscus. We found there are 4 types of joint effusion Gross, mild, minimal, and moderate joint effusion. According to a study, mild joint effusion affects more people who have acute knee pain. There were 16 patients with bone marrow oedema, 4 patients with subchondral marrow oedema, 2 patients with subcutaneous oedema, one with quadriceps fat pad oedema, one with areas of marrow oedema, mild interstitial oedema, and bone marrow oedema is noticed more commonly as demonstrated in Table 7.

A multiloculated baker's cyst was seen in the popliteal fossa which is fluid-filled, expanding lesions covered in the synovium that spreads into the posteromedial joint region in the medial section of the popliteal fossa, between the medial head of the gastrocnemius and the semimembranosus tendon (Fig 4 (a)).

In our MRI results one patient was diagnosed with a ganglion cyst located along the dorsal aspect of the posterior cruciate ligament as shown in Fig 4 (b). Parameniscal cysts on the medial side are slightly more common than those on the lateral side as shown in Fig 4 (c).

Those 7 people were diagnosed with OA, of whom 4 had mild to moderate alteration, 2 had degenerative OA, and one had moderate to severe abnormalities. 4 individuals had involvement in the medial compartment, one had a presence in the lateral compartment, one had involvement in both bilateral compartments, and one had inclusion in the patellofemoral compartment.

Oseteophytic and bone contusion changes seen in patellofemoral from mild to severe involvement in the medial and lateral compartment, the lateral femoral condyle was more frequently affected than its medial compartment. There was a total of 5 reported cases of quadriceps tendinopathy, all of which were males. None of the cases in females were reported.

There were 2 incidences of sarcoma among females. One of them the individual had a soft tissue sarcoma, and another had a malignant bone lesion such as osteosarcoma or metastatic tibial involvement as shown in Fig 5. A single case of multiple small sessile Osteochondromas is noted from the distal femur and proximal tibia.

There have been 2 cases of Hoffa's fat pad. In the end, there were 17 cases of various diseases including a complete substance tear of a medial patellofemoral ligament, a complete tear of a lateral patella-tibial ligament, a partial tear of the medial patellar retinaculum, grade 4 chondromalacia patellae, mild lateral subluxation of patella, diffuse thinning of patellar cartilage, minimal supra patellar effusion, high suspicion of bone infarcts, the strain of popliteus muscle, mild reduction in patellofemoral joint space, lateral dislocation of patella, patella Alta, depression and Mucoid cyst. The degenerative condition known as Mucoid degeneration is rare and affects the ACL.

Fig 4: (a) Sagittal T2 and Axial T2 show a baker's cyst lesion in the medial aspect of the popliteal fossa (b) Right sagittal PD+FS and Axial T2 image showing well-defined ganglion cyst on T2 and STIR (c)Left Coronal PD and Axial PD+FS showing parameniscal cyst seen arising from the poster medial adjacent to the medial meniscus

Fig 5: (a) Coronal PD and Axial T2 image showing a lobulated soft tissue lesion sarcoma in the skin and subcutaneous plane along the medial aspect of the knee joint (b) Coronal T1 image and Axial T2 image showing osteosarcoma extension of solid soft tissue

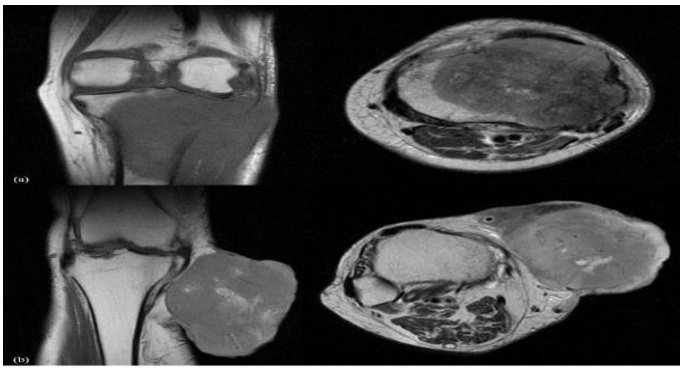


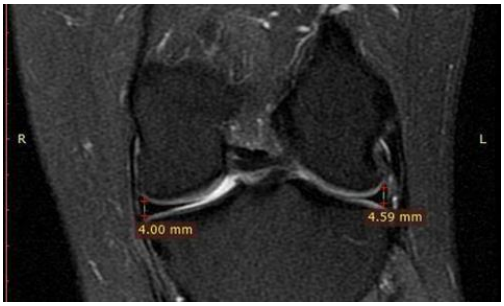
Table 8: Distribution of Normal and abnormal menisci Height in the observed patients

Parameters	Normal Menisci		Abnormal Menisci		P value	Z value
	Mean	SD	Mean	SD		

Height of the Medial menisci (mm)	4.70	1.17	4.65	1.85	0.03*	1.95
Height of the Lateral menisci (mm)	4.76	1.41	3.5	2.10	0.002*	1.95

**Significant*

The height of the medial meniscus and lateral meniscus of both the normal menisci and abnormal menisci are summarized in Table 8. The coronal height of the normal medial meniscus and lateral meniscus were statistically significant in the study of the associations of the meniscus characteristics (Z=1.95)



.Fig 7: Measurement of the meniscus on coronal image

The statistically significant outcomes are as follows: On the coronal section, as shown in Fig 7, there was no high difference in the height of the medial meniscus and lateral meniscus in normal menisci.

4. Discussion

The current study was an observational MRI analysis for several types of knee joint discomfort causes. We found that the particular population's mean stage was 35.7 years, and males comprised the majority of those who participated. The outcomes of our research are consistent with persons of Yadav et al., (2013) who reported a mean age of 36.70 years and a majority of male participants in their study [10]. A male majority was also noted in a study conducted by certain writers [11,12]. MR imaging was performed on 100 individuals out of them 65 patients had knee injuries. In the current study, knee injuries occurred more often in younger people aged 15 to 35 years. Similar results were seen in their study, where the mean age was between 24 and 36 years [13].

Some of the population reported that their MRI results were normal. Patients may be included in this who are not only suffering from serious knee injuries but additionally suffer from painful knees. In the study we conducted, ACL tears and joint effusions have been identified to be the two most frequently occurring soft tissue abnormalities. The most frequent soft tissue anomaly identified in the published literature was meniscal tears, followed by joint effusions [14,15].

The most frequent disease affecting the ACL was a tear, with the majority becoming painful in character. The PCL immersion pathology found in our investigation can be compared to that found by Singh J et al., (2004) [11]. In comparison to the ACL, the PCL is usually not injured, because it is bigger, thicker, and even more durable than the ACL, the PCL can also sustain damage, but it happens more rarely. Overextending the knee (hyperextension) is the most frequently observed way to damage the PCL. These injuries may develop as a result of both sports-related injuries and automobile accidents.

The MCL is more raptured than the LCL. Frequently have injuries to their MCL, and many of these milder injuries likely go undetected. Injuries to the LCL of the knee, which are uncommon on their own, typically happen in conjunction with other ligamentous or meniscal injuries, a posterolateral corner injury, or both. There are categories for grading collateral ligament injuries: Grade 1 is a minor sprain that heals without instability.

Grade 2 is a significant sprain or partial tear that damages the ligament, raising the possibility of further injuries. Grade 3 is a complete tear that leads to active joint instability.

Similar to some studies in the literature, the medial meniscus was found to have somewhat more tears than the lateral meniscus, according to an MRI [16,17]. The primary cause of meniscus tears in athletes is upper-leg twisting or turning while the foot is firmly planted and the knee is flexed. The medial meniscus can become fractured and torn in older people as an outcome of attractional variations (which classically happen at the posterior horn of the meniscus). Meniscal tears, which most frequently affect the posterior horns, were the most frequent soft tissue abnormalities discovered in our study. The findings are results that had been previously reported [11,18]. In our analysis, longitudinal tears were discovered to be the most common kind of meniscal tear, in opposition to the earlier findings by Babu S et al., (2021) that vertical tears were the most common meniscal type [19]. One of the patients had bucket-handle tears in the lateral meniscus, and 2 of the individuals had bucket-handle tears in the medial meniscus. According to published research, the medial meniscus is the location of the majority of bucket-handle tears. When viewed axially, the separated inner fragment looks like the hand of a bucket, and the remaining large peripheral portion looks like the bucket. Bucket handle tears are typically found in young adults with a locking history.

Oedema results from an imbalance in the forces that hold fluids in the tissues and vasculature. Homeostasis between these forces maintains fluids in a stable condition between tissues and the vasculature (starling equation). Standing or sitting in one place for an extended period frequently results in oedema [20].

The baker’s cyst was the most frequent cystic lesion affecting the knee joint. Sohail K et al., (2015) earlier published a study with similar findings [21]. In this research, ganglion cysts have been found in one patient. The posterior portion of the cruciate ligament may have been subjected to mechanical stress as the result of knee motion, which is the suggested cause of PCL ganglion cysts.

Some patients had OA. A study participant's patella-femoral arthritis is shown in this MR image. A significant cause of morbidity, especially in the elderly, OA of the knee is a highly prevalent condition. The most prevalent joint condition in older people is knee OA, which is highly widespread. It is predicted to affect people over 45 years in the general population. In comparison to the lateral compartment, the medial femorotibial joint compartment is more frequently affected and more severe.

Bone contusions are present in 80% of patients with an ACL rupture, most frequently in the femur condyles or the tibia plateau. The tibia was more frequently involved in contusions than the femur to findings in the literature, but according to our result, the femur was more frequently involved in contusions than the tibia [22]. The lateral femoral condyle was more frequently affected than its medial compartment. Our findings are consistent with the earlier findings by literature [14,22]. A direct impact on the bone, traction from avulsion trauma, or load on a subchondral surface are the three leading causes of bone contusions.

Quadriceps tendinopathy is a condition where the quadriceps muscle inserts at the proximal pole of the patella. It is more common in males than females and is caused by chronic overuse and overload [23]. Synovitis is a rare condition that can be caused by excessive use of the joint, but can also be caused by inflammatory arthritis.

Soft tissue sarcomas are malignant tumors that originate in mesenchymal and primitive neuroectodermal tissues. Osteosarcomas are cancerous tumors that originate from the bone. Elderly people may suffer from secondary osteosarcoma due to Paget disease's malignant degeneration, significant bone infarctions, post-radiotherapy for other illnesses, osteochondroma, and osteoblastoma [24]. Osteochondromas can be hereditary multiple exostoses or developed due to prior trauma to the growth plate, and MRI can be beneficial for better evaluation. MRI can be beneficial because osteochondromas become cancers and commonly changes into chondrosarcoma [25].

In the present study of normal meniscus patients, the average height of the medial meniscus was 4.70 mm, and the average height of the lateral meniscus was 4.76 mm. According to the literature, menisci are described as having a median height of 3 and 5 mm and the posterior horn of the normal medial meniscus measures the most

(11.7 mm), followed by the anterior horn (8.8 mm), mid-body (9.70 mm), and posterior horn (8.37 mm) of the normal lateral meniscus [26,27]. The coronal plane provided the most accurate measurement of the height of the meniscus [28]. Knee pain is a prevalent problem affecting people of all ages, and the knee is one of the joints that is injured the most commonly. It is acknowledged that MRI is the method that is best for imaging the knee to identify the disease and direct patient care and treatment.

5. Conclusion:

The present study suggests that MRI imaging can be used as a gold standard method for knee investigation due to its effectiveness in the assessment of knee pathologies. 35% of patients had knee pain with normal MRI, patients are recommended for MRIs even though they may not be required, and the study found that only desirable physical examinations and clinical evaluations can reliably diagnose patients. It also increases their financial burden. MRI knee protocol provides accurate and complete identification of both soft tissue and the complex structure for the analysis of any associated injuries to the ACL, PCL, collateral ligaments, menisci, osteochondral structures, and cysts. Identifying the difference between a discoid meniscus and a little meniscus may be possible by being aware of the typical meniscus size. To manage surgical procedures in the knee joint, this may be crucial.

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