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MRI FINDINGS IN FUNCTIONALLY IMPAIRED KNEES: A PRELIMINARY REPORT

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ABSTRACT

Background: **Magnetic Resonance Imaging (MRI) is a non-invasive, non-ionizing imaging modality with excellent soft tissue resolution capable of depicting the internally deranged structures within the knee Joint (KJ) in multiple planes. The aim of this study is to highlight the role of MRI in the diagnosis of certain disease entities from various etiologies which would have been difficult to accomplish using the more available imaging modalities in our resource poor environment.**
Method: **This is a cross-sectional observational study of knee MRI. All patients presented with functional knee impairment indicated by the requesting physician. T1 and T2 weighted images, proton density weighted (PDW) and fat saturated images were acquired in the axial, sagittal and coronal planes using the flexi coil of a 1.5 Tesla Elan Vantage Toshiba MRI machine.**
Result: **Eighteen patients made up of 8 males (44.4%) and 10 females (55.6%) with functional knee impairment did knee MRI during the period of the study. They had various indications including; persistent and increasing knee pain (n = 10, 55.6%); trauma to knee (n = 5, 27.8%) and knee swelling (n=3, 16.7%). Imaging findings include neoplastic condition in 5 (27.8%), complex ligamental and menisci tears in 4 (22.2%), moderate to severe osteoarthritis in 22.2% (n = 4) and mild osteoarthritis in 3 (16.7%). Two others (11.2%) had normal knee joints.**
Conclusion: **MRI with its high soft tissue resolution is a powerful tool for assessing functionally impaired knees. Bone and joint space related injuries were the most common pathologies encountered in this study.**

INTRODUCTION

The knee joint (KJ) is the largest joint in the body. It is a synovial joint found in the mid portion of the lower limb. It consists of the hinge type tibio-femoral joint between the condyles in the distal femur and the tibia plateau and the saddle joint between the patella surface of the distal femur and the posterior surface of the patella bone. This intricate bony configuration is supported by intra and extra articular ligaments, joint cartilage, menisci, tendons, bursae, fat pads,

joint capsule and surrounding muscles which aids the KJ to play active role in weight bearing, ambulation and complex sports.[1]

A functionally impaired KJ is a joint that shows various degree of limitation in playing its role in movement and weight bearing related to routine daily activities. Pain is a major presenting symptom in functional impairment. Self-reported difficulty in accomplishing tasks, severity of pain and the psychological burden of the disability experienced by the subjects have been extensively studied using function subscales and questionaires.[2-5] Osteoarthritis accounts for majority of knee impairment in the elderly[6,7] while sports related trauma is responsible for most of the morbidity in the younger age group.[8,9].There are many grading systems for osteoarthritis. Kellgren-Lawrence system, a radiographic based classification system widely used for clinical practice and research purposes scores osteoarthritis into five grades which includes Grade 0 for normal knee joints and Grades 1-4 as mild, moderate and severe pathologies such as progressing joint space narrowing, osteophyte formation, bone sclerosis and bone end deformity.[10]

The mainstay of KJ imaging in our environment is still plain radiography, this includes weight bearing postero-anterior, non-weight bearing antero-postetior and lateral views[11]. Ultrasonography is limited to superficial knee structures while computed tomogram is used for fine bone details. Magnetic Resonance Imaging (MRI) is a non-invasive, non-ionizing imaging modality with excellent soft tissue resolution capable of depicting the internally deranged structures within the knee joint in multiple planes which includes the bony changes and the actual cause of joint space narrowing. [12] MRI findings are comparable with arthroscopic findings hence has been considered a cost effective technique than can reduce the use of arthroscopy and surgical interventions.[12] In research settings, MR imaging with its powerful tissue contrast is the imaging method of choice for detecting morphologic and compositional alterations in knee cartilage. Various imaging sequences have been developed and are considered useful as baseline findings and for monitoring the effects of therapies for osteoarthritis and cartilage injury[12]. Imaging findings can also be of medicolegal importance.[13]

The aim of this study is to highlight the role of MRI in the diagnosis of certain disease entities from various etiologies which would have been difficult to accomplish using the more available imaging modalities in our resource poor environment. There are extensive studies on knee MRI in different parts of the world but to the best of our knowledge, there is no reported knee MRI study in our region of Nigeria.

METHOD

This is a cross-sectional observational study of knee MRI over a period of 2 years (July 2021 to July 2023) in a private diagnostic center in Uyo, Akwa Ibom State. All patients presented with functional knee impairment indicated by the requesting physician. An informed consent form was diligently filled with assistance from the radiology assistant to ensure that there is no contraindication to MRI such as non-compatible ferromagnetic implants. Weight and height were measured as machine calculated body mass index (BMI), body surface area (BSA) and specific absorption rate (SAR) are prerequisites for patient safety as regards rise in tissue temperature and good quality images within appropriate scan time.[14] Patients were placed supine, feet first in neutral or slight external rotation and 5-15^0 knee flexion. T1 and T2 weighted images,

proton density weighted (PDW) and fat saturated images were acquired in the axial, sagittal and coronal planes using the flexi coil of a 1.5 Tesla Elan Vantage Toshiba MRI machine. Patients were counselled and imaging findings were explained before referral to the requesting physician. Data was analyzed with Statistical package for social sciences (SPSS) version 16.0. The assessed variables were summarized as mean, standard deviation and range.

RESULT

A total of 18 patients did knee MRI during the period of the study, they consist of 8 males (44.4%) and 10 females (55.6%), giving a male to female sex ratio of 1:1.3. The youngest was a 24-year-old female and the oldest was a 78-year-old male with a mean age of 49.7 ± 13.5 years. Most patients were within age group 40-59 years (61.1%) as shown in table 1.

Table 2 shows the laterality of the imaged knee, indication or symptom for the procedure and the referring doctor. Right knee was imaged in 50% (n = 9) of situations, left knee (n = 5, 27.8%) and both knees in 22.2% (n = 4). The indications for knee imaging were as follows; gradual onset but persistent and increasing knee pain (n = 10, 55.6%); trauma to knee with sudden onset pain (n = 5, 27.8%) and knee swelling (n=3, 16.7%). A general practitioner requested for the investigation in 44.4% (n = 8) of situations, orthopedic surgeon in 38.9%(n = 7) and a neuro-surgeon 5;6%(n = 1). On 2 (11.1%) occasions, the patients were self-referred.

The imaging findings are shown in Table 3. Bone and bony related changes were the most predominant pathology, followed by joint space and cystic changes, cartilage and muscle related pathologies in decreasing frequency. Some of the subjects had more than one lesion from the listed group.

Table 4, shows the summary of the impression made by the radiologists at the end of imaging procedure. A neoplasm was seen in 5 (27.8%) patients. Of these 5 neoplasms, 3 (60%) were suspected to be benign lesions (unencapsulated lipoma, enchondroma and synovial chondromatosis). The 2 (40%) suspected malignant lesions were parosteal osteosarcoma and a suspected myelofibrosis. Complex ligamental and menisci tears were seen in 4 patients (22.2%), moderate to severe osteoarthritis in 22.2% (n = 4) and mild osteoarthritis in 3 patients (16.7%). In the other 2, the knee joints were normal, however the following impressions were made; fracture of the proximal tibia below the condyles (5.6%) and severe lacerations of the quadriceps muscle (5.6%).

Some of the imaging findings are shown in the figures A-E below.

Table 1

Age and sex distribution of patients

Age group (years)	Male	Female	Total	Percentage (%)
20-39	-	3	3	16.7
40-59	6	5	11	61.1
>60	2	2	4	22.2
Total	8 (44.4%)	10 (55.6%)	18	100

Table 2

Frequency distribution of laterality, indication/symptom and referring doctor

Parameter	Frequency	Percentage (%)
Laterality		
Right	9	50
Left	5	27.8
Bilateral	4	22.2
Indication/symptom		
Persistent knee pain	10	55.6
Trauma	5	16.7
Knee swelling	3	27.8
Referring doctor		
General practitioner	8	44.4
Orthopedic surgeon	7	38.9
Self-referral	2	11.1
Neuro-surgeon	1	5.6

Table 3

Major MRI findings

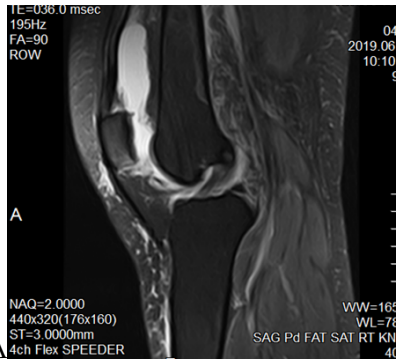
Knee part	Frequency (number of subjects seen)	Percentage (%)
Bone changes		
Osteophytes	9	50
Spiking of tibia tubercle	7	38.9
Bone edema	7	38.9
Subchondral cyst	5	27.8
Subchondral sclerosis	4	22.2
Loose bones	3	16.7
Spurs	3	16.7
Distorted alignment	2	11.1
Geodes	2	11.1
Marrow replacement	1	5.6
Tibia fracture	1	5.6
Cartilage changes		
Cartilage damage	6	33.3
Synovial chondromatosis	1	5.6
Menisci and ligament injuries		
Medial meniscus tear	6	33.3
Lateral meniscus tear	2	11.1
Anterior cruciate ligament	3	16.7
Medial collateral ligament	2	11.1
Lateral collateral ligament	1	5.6

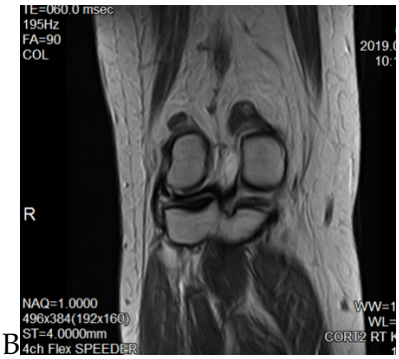
Joint space and cystic structures		
Decreased joint space	9	50
Joint effusion	7	38.9
Supra patella bursitis	2	11.1
Popliteal cyst	1	5.6
Muscle lesions		
Quadriceps tear	2	11.1
Muscle edema	2	11.1
Others		
Subcutaneous fatty tissue	1	5.6
Fabella	1	5.6

Table 4

Impression based on summary of MRI findings

Diagnosis	**Frequency**	**Percentage**
Neoplasm	5	27.8
Moderate to severe osteoarthritis	4	22.2
Complex ligamental and menisci injuries	4	22.2
Mild osteoarthritis	3	16.7
Normal knee joint	2	11.1

A 

B 

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E 

Figure A: A sagittal T2 fat saturated image of the right knee in a patient with knee pain showing fluid signal in the anterior cruciate ligament (anterior cruciate ligament injury) more marked at its attacments, bone edema at its femoral attachment and joint effusion especially in the suprapatellar region.

Figure B: A coronal T2 weighted fast spin echo image of the right knee joint showing a focal area of increased signal in the lateral femoral articular cartigae and fluid signal in the posterior aspect of the lateral meniscus in keeping with cartilage defect and meniscial tear repectively.

Figure C: Coronal T1 weighted fast spin echo image of the right knee showing genu valgus deformity, osteophytes in the medial tibial and femoral condyles, markedly reduced lateral tibiofemoral joint space, loss of the articular cartilages, fragmented subchondral bone lateral joint effusion with loose bodies.

Figure D: Coronal, fat saturated T2 weighted image of C, showing the extensive cartilage loss and subchondral bony changes in the lateral tibiofemoral joint compartment.

Figure E: Sagittal T2 weighted fast spin echo image of the right knee showing extensive areas of hypointense marrow replacement.

DISCUSSION

In carefully selected cases, MRI plays an undisputable role in the diagnosis and management of functionally impaired knees despite its cost.

In this study, 10 out of 18 representing 55.6% of the subjects were women and the predominant age group in this study was 40-49 years accounting for 61.1%. The peak age values in our study are less than the values observed in the study population of two studies done in India who studied trauma related cases but lower than an osteoarthritis (OA) based study done in Baltimore in the United States of America probably because of our mixed pathology from both traumatic and osteoarthritic subjects.[4,9,12] Creamer et al[4] reported a higher number of females with impaired knee function in their osteoarthritis based study while the trauma based study by Arumugam et al[12] had more males in their study population. Their findings show that women were more likely to report pain and associated impairment while younger men are more involved in contact-sport related trauma. Persistent knee pain was the predominant clinical indication for imaging. Pain is a major symptom in both traumatic and degenerative conditions. It is a subjective symptom and its severity may not be directly proportional to imaging findings in osteoarthritis, however studies have shown a strong correlation between severity of pain and functional impairment when assessed with WOCMAC pain scale[4]. Pain is considered to be a late finding in osteoarthritis but an early symptom in trauma. This means that the pathologic process in osteoarthritis is quite advanced at the time of imaging the knee.[15]

In terms of referring physician, only 38.9% of our subjects were made by orthopedic surgeon. Other physicians tend to image before appropriate orthopedic referral, the value of physical evaluation cannot be underscored. Some studies have reported overuse of MRI especially by general practitioners in older age group with osteoarthritis, where MRI findings are unlikely to change the diagnosis or management plan.[16] Other authors found a high yield of MRI changes requiring orthopedic referral in sports related trauma in younger ages between 18 and 45 years when imaged within 6 months of trauma.[17] In our setting with little or no insurance cover for health bills, patient compliance to pay for relatively expensive procedures are related to their purchasing power, the severity of the functional impairment experienced and their perception

of the usefulness of the procedure to improve their current status. While interacting with our subjects, we found MR Imaging for the older age group who can afford it to be a form of psychotherapy. Knowing that the sudden worsening of a long term pain is nothing sinister but just a progression of underlying disease gives a moral boost to live through the pain while planning for a more definitive solution such as knee replacement.

Bone related changes were the most predominant pathology in this study with significant overlap of findings in different age groups. Findings range from osteoarthritic changes, bone edema, cartilage defects and neoplastic causes such as marrow replacement from possible myelofibrosis. The bone edema and cartilage defects were seen in varying degrees and locations in traumatic, degenerative and neoplastic conditions. Accidental osteoarthritic changes were noted in younger subjects who were imaged for other pathologies. Studies have shown that cartilage, synovial, meniscial and subchondral bony changes occur long before radiographic evidence of bony changes while mechanical stress, age, BMI and hereditary factors determine time of presentation for osteoarthritis. Early MR Imaging has been proposed to be important in understanding knee joint pathologies.[15,18] Early imaging and appropriate surgical intervention especially in the young has shown benefits such as decreased morbidity and improved quality of life in people with knee joint diseases.[17]

Concerning injury to the menisci and ligaments, we found more medial meniscial injuries than anterior cruciate ligament (ACL) tears, more medial collateral ligament than lateral collateral ligament tears and no posterior cruciate ligament tear. The higher medial meniscial injury is in contrary to trauma based studies with more ACL injuries[9,12]but in keeping with osteoarthritis based studies.[19] Trauma, degenerative changes and normal aging process are possible causes of meniscial damage. A strong association between poorly treated meniscial injuries and development of early OA changes has been established.[19] Our study population is mixed and relatively small to deduce any substantial conclusion.

The MRI findings in the benign neoplastic lesions were quite reassuring. The extent of bony cortex, bone marrow and surrounding soft tissue involvement in the suspected malignant lesions can only be best depicted by MRI. Appropriate referrals were recommended for the best patient outcome.

Limitation

Our small sample size is a major limitation to this study. Plain radiographs are still the mainstay of knee imaging in our environment. Few MRI scanners are available and when indicated may be unaffordable for most people due to an almost non-existent health insurance.

CONCLUSION

Bone and joint space related injuries were the most common pathologies encountered in this study followed by menisci, ligament and cartilage damage. MRI with its high soft tissue resolution is a powerful tool for assessing functionally impaired knee especially in the young. The role of the knee joint in ambulation and weight bearing is important at all ages. When available and affordable, early imaging and the best multi-disciplinary based care should be provided to individuals with knee pathologies to reduce the morbidity and improve their quality of life.

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