FINDINGS OF MAGNETIC RESONANCE IMAGING OF INTRA-ARTICULAR KNEE PATHOLOGY: RADIOARTHROSCOPIC CORRELATION

A RETROSPECTIVE AND PROSPECTIVE STUDY OF KNEE MRI FINDINGS AT FIVE RADIOLOGICAL IMAGING CENTRES IN NAIROBI CORRELATED WITH ARTHROSCOPY

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DEDICATION

This work is dedicated to my family: my parents Mr. and Mrs. Thiga Machira, my wife Edna and son Daniel, my sister Eva, my brothers Ram, Job and his family for their love, patience and encouragement.

They have been and continue to be my inspiration.

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MAY GOD BLESS YOU ALL

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LIST OF ABBREVIATIONS

ACL	Anterior Cruciate Ligament
AKUH	Aga Khan University Hospital - Nairobi
CECT	Contrast Enhanced CT
CM	Contrast Media
CT	Computerized Tomography
DDR	Department of Diagnostic Radiology
ETL	Echo Train Length
FN	False Negative
FOV	Field Of View
FP	False Positive
FSE	Fast Spin Echo
Gd	Gadolinium
GE	Gradient Echo
GRASS	Gradient Recalled Accusation in the Steady State Sequences
HU	Hounsfield Units
I.V	Intra Venous
KNH	Kenyatta National Hospital
LCL	Lateral collateral Ligament
MCL	Medial Collateral Ligament
MITC	Medical Imaging and Therapeutic Centre
MR	Magnetic Resonance
MRI	Magnetic Resonance Imaging
MTC	Magnetization Transfer Contrast
NECT	Non-Enhanced Computerized Tomography
NPV	Negative Predictive Value
PCL	Posterior Cruciate Ligament
PD	Proton Density
PD-fs	Proton Density – fat suppressed
PPV	Positive Predictive Value
RNI	Radionuclide Imaging
SE	Spin Echo
SNR	Signal to Noise Ratio
SPSS	Statistical Package for Social Scientists
STIR	Short Tau Inversion Recovery
T1WI	T1 Weighted Images
T2WI	T2 Weighted images
TE	Time Echo
THK	Thickness
TI	Time Interval
TN	True Negative
TP	True Positive
TR	Repetition Time
TSE	Turbo Spin Echo
UoN	University of Nairobi
WHO	World Health Organization
2D	Two Dimensional
3D	Three Dimensional

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SUMMARY

MRI and arthroscopic findings of 46 knees with varied pathologies were reviewed in a retrospective - prospective study that covered the period between January 2006 and August 2007. The Knee magnetic Resonance Imaging was carried out at five Radiological centers providing MRI services in Nairobi. These centers are: 1) Kenyatta National Hospital (KNH); 2) Medical Imaging and Therapeutic Centre-Nairobi (MITC); 3) Aga Khan University Hospital-Nairobi (AKUH); 4) MRI centre-Nairobi and 5) The Nairobi Hospital. The study was carried out in collaboration with two Orthopaedic and Trauma surgeons carrying out Knee arthroscopic surgery in Nairobi. There were 30 retrospective and 16 prospective cases collected during the duration of the study. All the 46 knees included in the study had both MRI findings and corresponding knee arthroscopic data acquired following diagnostic or therapeutic knee arthroscopic surgery. The Knee MRI images / reports done before the surgery and the arthroscopic findings of the corresponding knee formed the basis of this study.

The aim of this study was to determine the pattern of knee joint pathology as seen at five radiological imaging centres in Nairobi by MRI, the age and sex distribution and correlate these findings to the arthroscopic findings.

Males (58.7%) were more affected than females (41.3%). Majority of the patients were in the 26-50 years age group, with the right knee (67.4%) being affected more than the left (32.6%). The commonest findings encountered were meniscal tears and joint effusions constituting 78.3% and 65.2% of the cases seen respectively. Both showed a male predilection. Other pathologies seen included chondromalacia patellae, cruciate ligament tears, collateral ligament disruptions, bone bruises, patella tendinosis, synovitis and intraarticular loose bodies.

MRI showed a high sensitivity in the medial meniscus, where it was sensitive in detecting a tear in 88.9% of cases. Sensitivity for tears in the lateral meniscus was higher at 93.3%. However, specificity for a meniscal tear was lower in the medial meniscus than in the lateral meniscus (36.1% and 63.3% respectively). The sensitivity and specificity of the MRI for anterior cruciate ligament rupture (whether complete or partial) was 83.3% and 90.9% respectively. For the articular cartilage, sensitivity was 46.2% and 16.7% for femoral and tibial articular cartilage abnormalities with a specificity of 81.8% and 75.0% respectively. The sensitivity and specificity of the MRI for chondromalacia patellae was 26.7% and 81.8% respectively.

The results of this study support the use of MRI in the diagnosis of internal derangements of the knee. However, it should always be used in conjunction with a full history and clinical examination.

CHAPTER ONE

1.1 INTRODUCTION

The knee is the largest and most complex joint in the body. It is a synovial hinge joint made up of three individual joints: two condylotibial and a patellofemoral. It is composed of the articular margins of the condyles and trochlea surface of the femur, the condyles of the tibia, the patella (Figure 1), and several bursal structures encased by numerous external and internal ligaments, joined by an articular capsule (1). The Cruciate ligaments and the menisci are the main internal structures of the knee joint (Figures 2 and 3). The knee joint is prone to trauma and degenerative changes and is one of the joints associated with high morbidity especially in sports and in the elderly.

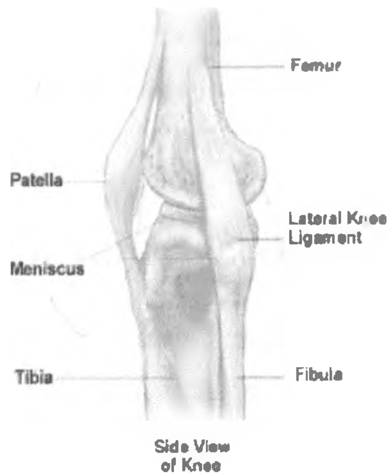


Figure 1: Schematic showing the gross anatomy of the Knee joint.

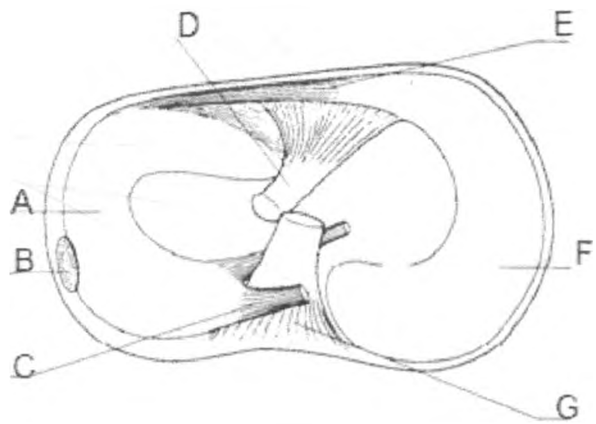


Figure 2: Schematic showing menisci and attachments of the cruciate ligaments on an axial section of Upper end of the Tibia: A=Lateral meniscus, B=Popliteus tendon, C=Anterior and Posterior meniscofemoral ligaments, D=Anterior cruciate ligament, E=Transverse ligament, F=Medial meniscus, G=Posterior cruciate ligament.

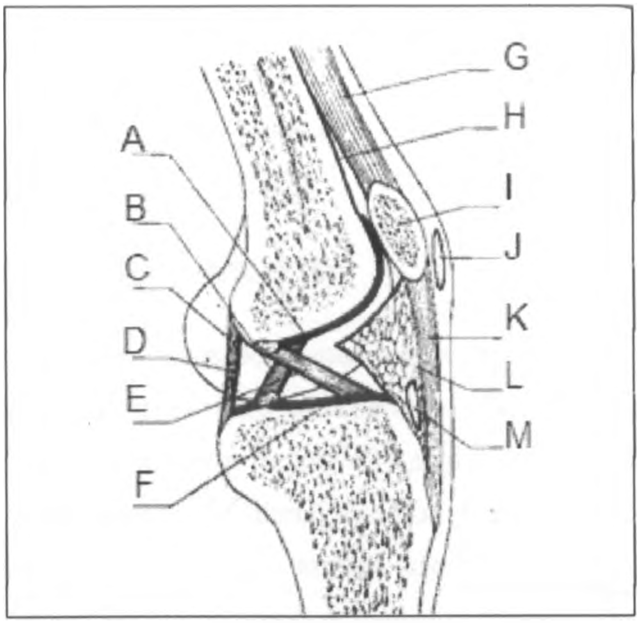


Figure 3: Schematic showing a sagittal section of the Knee joint: A=Femoral articular cartilage, B=Posterior cruciate ligament, C=Fibrous capsule, D=Synovium, E=Anterior cruciate ligament, F=Tibial articular cartilage, G=Quadriceps tendon, H=Suprapatellar bursa, I=Patella, J=Prepatellar bursa, K=Patellar tendon, L=Fat pad, M=Deep infrapatellar bursa.

1.2 IMAGING MODALITIES OF THE KNEE JOINT

MRI has established itself as the investigation of choice for the assessment of the knee and the identification of internal knee derangements. A variety of imaging modalities are however available for imaging of the knee. Therefore, both radiologists and the clinicians must be familiar with the possibilities of each imaging method and its indications as well as contraindications. In some instances a single modality is not sufficient to provide all the information that is needed, therefore all methods should be considered complementary. Below is a brief description of the various imaging modalities available for the assessment of the knee with a special emphasis on MRI.

1.2.1 RADIOGRAPHY

In most conditions, radiographic examination of the knee joint should be the first step in imaging. Radiographs of the knee in two planes are mostly sufficient to assess bony lesions, anatomical reconstruction, bone healing and callus formation and implant position. Conventional radiography is available in most clinical institutions and it is a low cost and time-sparing examination. The technique and radiographic projections of the knee depend on the clinical indications. A large variety of positioning and special projections have been published (2,3). The standard radiographic positions are anteroposterior (AP) and lateral views in supine position of the patient with the knee joint in full extension. Other views include the tunnel view which is taken in 40–50° flexion of the knee with the X-ray beam angulated to the same degree in order to visualize the intercondylar notch. The patella is investigated using an axial view of the patella. For evaluation of the joint space, radiographs in a posteroanterior (PA) view with the patient weight bearing in 45° knee flexion may be taken.

1.2.2 CONVENTIONAL ARTHROGRAPHY

The investigation and elucidation of suspected meniscal or cruciate ligament injury provides the main indication for double contrast knee arthrography (4). However, these are less well demonstrated than with MRI. Presence or rupture of a popliteal cyst or a loose body can also be readily confirmed by arthrography. A lateral injection site is the most convenient and is commonly used, however, a medial injection site can also be used. The patient lies supine and a 19-G or 21-G needle is introduced 1 cm lateral or medial to the mid-point of the patellar border. Aspiration of any synovial effusion present is done as completely as possible prior to injection of contrast medium in order to avoid dilution or bubble formation. A test injection of a small volume of contrast medium is made under fluoroscopic control to ensure the needle is correctly positioned in the joint cavity. If a satisfactory position is demonstrated, 3-5mls of positive contrast medium is injected. This is followed by 40-80.mls of air or carbon dioxide depending on the capacity of the joint. The needle is then removed and the knee manipulated to ensure even distribution of contrast medium within the joint. The patient is then placed in the prone position with a pad under the thigh of the side to be examined. For the purpose of the examination, the knee is divided into an anterior and a posterior quadrant for each of the medial and lateral compartments with the X-ray beam collimated to the compartment being examined. For better visualisation of the compartments, traction with simultaneous valgus or varus strain is applied to the knee during the examination. A variable degree of flexion may also be required to bring the tibial plateau and meniscus into profile. Four views of each quadrant are taken, rotating the leg approximately 20° between each spot view. This results into eight views per meniscus. Small meniscal tears and meniscal cysts may be better seen on delayed films as contrast may take time to adhere.

1.2.3 COMPUTED TOMOGRAPHY

Computed tomography (CT) of the knee is particularly suited to demonstrate the bony morphology, patellofemoral tracking and intraarticular fractures (5). The accurate three-dimensional localization of the bony anatomy with CT can be used to calculate the mechanical axis of long bones, rotational deformities of the leg or malrotation of a prosthesis causing complications after total knee arthroplasty (6). Evaluation of the location and bony remodelling of the tunnel after anterior cruciate ligament (ACL) reconstruction, which is important in revision cases, is possible by CT (7). With newer models of CT scanners, the single transverse sections can be reformatted to coronal and surface-rendered 3D-reconstruction producing graphic images, which improves spatial assessment of pathologies. Soft tissue pathologies, however, are less well demonstrated than with MRI.

CT arthrography may be used as an alternative to MRI in many instances. CT arthrography is a valuable alternative to MR imaging for the assessment of internal derangements of the knee. In comparison with MR imaging, it is more invasive because of the intra-articular injection of contrast material and the use of ionizing radiation. Its ability for detecting meniscal, ligamentous and cartilaginous lesions is derived from its superior spatial resolution, multiplanar capabilities, and the high-contrast resolution inherent to the intra-articular injection of contrast material (8,9). Advantages of CT arthrography include short examination time, high spatial resolution, and multiplanar capability and reduced imaging artefacts because of the presence of metallic hardware and debris, which may hinder MR imaging studies (10,11).

In CT arthrography, intra-articular injection of 15–20 mL of iodinated contrast material is performed under fluoroscopic guidance. A small volume of epinephrine (0.1 mL of a 0.1% solution) is also added to the injection to delay synovial absorption of contrast material from the joint (12,13). This is followed by active knee flexion and extension. This raises intra-articular hydrostatic pressure and helps to force the contrast material into all the recesses of the knee, including meniscal tears (14).

The presence of contrast material around the menisci enables assessment of meniscal integrity. Contrast material is normally present between the anterior horn of the lateral meniscus and the transverse meniscal ligament, or between the posterior horn of the lateral meniscus and the meniscofemoral ligaments. There should not be any contrast material between the capsule and the periphery of the medial meniscus (8). Meniscal pathology is diagnosed when contrast material is noted within the meniscal substance or when the meniscal contour is deformed.

1.2.4 ULTRASONOGRAPHY

Ultrasound in conjunction with the history and clinical examination can prove to be a simple, noninvasive, cost effective, real time, dynamic and effective modality to assess the tendons, ligaments and meniscus around the knee joint. A high frequency broadband linear transducer of at least 7.5 MHz is used. The greatest advantage of ultrasound however is for the detailed evaluation of the soft tissues within and surrounding the knee. These include ligamentous, tendinous, fibrous, fatty, synovial, and neurovascular structures. These tissues can be assessed for size, continuity, anatomic orientation, and echogenicity. Furthermore, they can be readily compared contralaterally. Evaluation of intra-articular elements such as the menisci, cruciate ligaments, and articular cartilage is limited mainly by inaccessibility, which results from the small acoustic windows obtainable in most patients.

1.2.5 RADIONUCLIDE IMAGING

Radionuclide imaging in the form of single photon emission computed tomographic (SPECT) bone scintigram also has a role in imaging knee disorders and seems to compare favourably with MRI in diagnosis of internal derangement of the knee (15,16).

Bone scintigraphy allows investigation of contralateral knee and other joints at the same time. It also provides physiological detail unlike other imaging modalities. The conventional planar scintigraphy uses ionizing radiation and gives a very high resolution but poor anatomical detail of the knee lesions. With advent of the SPECT scintigraphy and its ability to image in coronal, sagittal and transaxial planes, localization of knee lesions in overlapping structures is possible. Technically, ^{99m}Tc methyl diphosphonate is injected intravenously and a two-phase bone scan is acquired followed by SPECT scintigram. Anterior and posterior blood pool images and four static views in anterior, posterior, medial and lateral planes are obtained. SPECT scintigram is performed after securing the knees with a band keeping the legs straight. In general 360° elliptical orbit is used. Based on the type of equipment, individual departments use filters and protocols best suited to obtain optimal studies.

MRI involves no use of ionizing radiation and gives relatively good anatomical details. It has thus established itself as the investigation of choice in identifying internal knee derangements. However, bone scintigraphy and magnetic resonance imaging (MRI) are complementary in diagnosing knee lesions and where MRI is contra-indicated, bone scintigram has established itself as an alternative.

1.2.6 MAGNETIC RESONANCE IMAGING

In the developed world, MRI has become an established imaging technique of the knee joint. In order to examine soft tissue, cartilage and ligamentous structures, a large number of MRI scanning methods have been described. Images are obtained on the sagittal, coronal and axial planes. The optimal data acquisition obtains a maximum amount of information in the shortest period of time without compromising image quality. Metal implants or prostheses do not present an absolute contraindication for MRI, however, they may heat up in the magnetic field and thus constitute a high risk for patients. The following image contrast and pulse sequences are often applied:

- *T1-weighted spin echo sequences,*
- *Proton density-weighted spin echo images,*

- *T2-weighted spin echo sequences,*
- *Gradient echo sequences,*
- *Fast spin echo sequences,*
- *Fat suppression techniques (fat saturation and inversion recovery).*

There is no standard protocol and most institutions establish a routine protocol, which provides adequate visualization and answers the majority of questions. However, the choice of slice thickness, field of view, coil, and imaging matrix play an important role in determining spatial resolution. Improved spatial resolution provides the radiologist with data to present interpretation with confidence.

A typical **Knee MRI protocol** will have a three plane localizer, Axial PD, Coronal PD/T2, Sagittal PD/T2, Sagittal PD-fs and a Coronal STIR. A protocol, such as the one outlined below (Table 1), seems to address most common requests. Most MR system manufacturers now offer a dedicated knee coil, which is often a transmit-receive coil as standard. These coils use a cylindrical configuration, similar to the head coil, to provide a homogenous imaging volume, and a quadrature design that provide improved signal to noise ratio. Flexible surface coils are used as an alternative when the knee joint is too large to fit in the rigid knee coil or when the patient is unable to extend the knee, usually following trauma. Spatial resolution is necessary to image the small structures that are found in the knee and the Field of View (FOV) should be kept small ideally not exceed the length of the coil. The range of FOV in the supero-inferior length is of 160-200mm. Using a matrix of 256, allows an in-plane resolution of less than 1mm. Thin slices in the range of 3-4mm and gap of not more than 0.5mm ensure high spatial resolution. 3D acquisition using isotropic matrix is useful to provide high-resolution visualization of anatomy in any plane.

	TR msec	TE msec	TI	Matrix	NEX	ETL	FOV	THK	SAT	Time
Axial PD	*2775*	*20*		*384x224*	*2*	*16*	*16*	*3/0.4*	*S,I*	*2:46*
Coronal PD/T2	*2500*	*25/102*		*384x256*	*2*	*8*	*16*	*4/0.4*	*S,I*	*5:25*
Sagittal PD/T2	*2500*	*25/100*		*384x256*	*2*	*8*	*16*	*4/0.4*	*S,I*	*5:47*
Sagittal PD-fs	*3275*	*20*		*384x224*	*3*	*8*	*16*	*3/0.4*	*S,I Fat*	*4:41*
Coronal STIR	*4775*	*80*	*150*	*256x192*	*2*	*10*	*16*	*4/1*	*S,I*	*5:05*

Table 1: Routine Knee protocol.

Intravenous (IV) contrast may be indicated in knee joint MR imaging especially in the delineation of bone tumours, scar tissue in repeat surgery and repeat trauma. Magnetic resonance arthrography is practiced in many imaging centres for the diagnosis of meniscal tears and chondral defects. This is done by introducing a dilute solution of gadolinium in saline (1:1000) into the joint capsule. The knee is then imaged in three planes using T1W or PD weighted both fat suppressed. Indirect arthrography could be used where the synovial fluid within the joint enhances 15 minutes post IV administration of gadolinium. This occurs due to slow spread of the contrast from the synovial vascular network to the intraarticular surface of the membrane and thus into the intraarticular cavity where its concentration remains high for about 1 hour. This increases conspicuity of meniscal tears.

1.3 KNEE ANATOMY AND PATHOLOGY AS SEEN ON MRI

1.3.1 MENISCI

The Menisci are embryological remnants of the discs commonly found at condylar joints. They are fibrocartilaginous structures that allow motion in all directions, and increase stability by deepening the socket in which the femur moves. Each knee has two menisci (a lateral and a medial) that primarily follow the movement of the femoral condyles. Each of these menisci is C-shaped and has its largest dimensions in the axial plane. Each meniscus covers about two-thirds of its corresponding tibial articular surface. The lateral meniscus is smaller than the medial meniscus and has an increased curvature and thus a shorter radius (Figure 2 on page 1). For ease of diagnostic interpretation, the meniscus is divided into three parts (anterior, middle and posterior thirds). The meniscus is further subdivided radially into the inner edge, middle and peripheral regions.

The collagen bundles within each meniscus form two distinct zones. Circumferential fibres are found in the peripheral third of the meniscus, whereas the transverse collagen fibres connect the circumferential zone to the meniscal free edge. In the adult, the peripheral 10-20% of the meniscus receives a blood supply from the capillary plexus that surrounds it, but the central portion of each meniscus is relatively avascular. Because of this vascularization difference, tears may heal spontaneously, especially in young patients, and suturing of meniscal tears in this vascularized zone is an option instead of partial resection.

Menisci are triangular shaped when imaged in a plane perpendicular to the axial plane. On MR images normal menisci have low signal intensity, or even signal void. Signal intensity may be somewhat increased in the peripheral vascular zone, especially in children. The signal intensity is higher on gradient echo (GE) images than on spin echo (SE) images. In MRI the menisci are best viewed in the sagittal and coronal planes. In the sagittal plane, the normal menisci appear as homogenous low signal structure on all sequences, and have a triangular structure with an outer convex border (Figures 4 and 5).

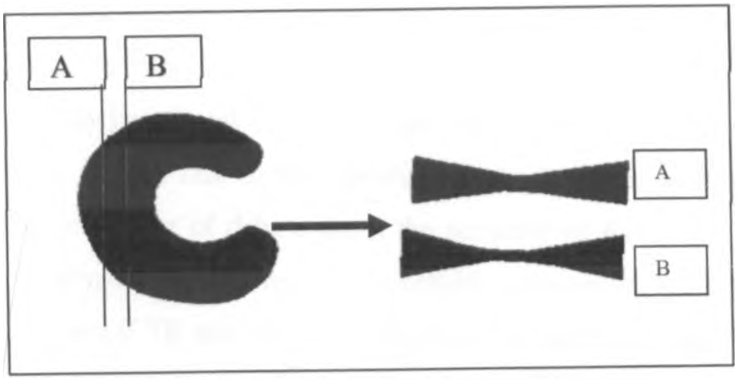


Figure 4: Schematic drawing of a normal meniscus on the left. Sagittal cuts through A and B show how consecutive sagittal MR images (A and B) should be seen through body of meniscus giving 'bow-tie' appearance.

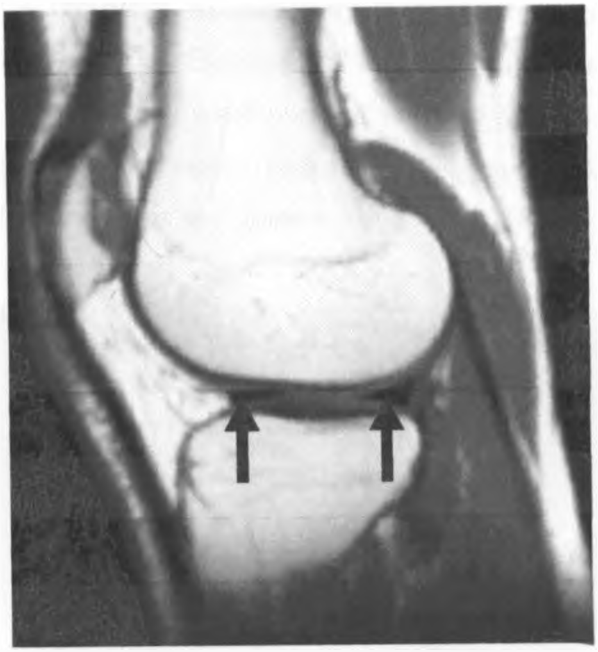


Figure 5: Sagittal T1-weighted MR image seen through body of a normal meniscus (arrows) giving 'bow-tie' appearance.

DISCOID MENISCI

There exist a large variety of abnormal meniscal shapes. Menisci may be completely or partially discoid. Typically these are found in children or adolescents, more commonly on the lateral, but also on the medial side. They have a higher incidence of tears. Discoid menisci can be diagnosed on sagittal images. More than two connecting bow ties on 3–5 mm-thick slices indicate the presence of a discoid meniscus. It is, however, easier to make this diagnosis on coronal images.

MENISCAL TEARS

Meniscal tears are best seen on short echo time (TE) sequences, such as conventional SE T1-weighted or proton-density weighted images or GE sequences. When a conventional SE sequence is used, a TR of 2000 ms or more and a TE of 20 ms is a good set of parameters. Slice thickness can be 5 mm or preferably less. Tears can also be seen on T2 STIR-weighted, or T1-weighted fat-suppressed GE images, but the risk of false positives is higher than with SE or fast SE (FSE) sequences. There has been a lot of debate about the accuracy of turbo SE (TSE) relative to SE sequences (17,18). Although conventional SE is probably superior to TSE, the latter will suffice for routine clinical imaging if TE and echo train length (ETL) are short, and if advanced sequence optimisation such as tailored radio frequency pulses (reduced blurring) is used. This means an ETL of 5 or less and a TE of maximal 20 ms.

A grading system is used to describe meniscal abnormalities (19). Grade 1 represents histological mucoid degeneration and is seen as a globular shape of abnormal signal intensity not abutting the surface (Figure 6). Grade 2 represents histologically more severe degeneration and collagen fragmentation. It is seen as a linear configuration of abnormal signal intensity not abutting an articular surface. Grade 3, histologically corresponding to a real tear, is a linear (Grade 3A) or irregularly (Grade 3B) shaped abnormal signal intensity abutting an articular margin. Some prefer to grade a severely fragmented meniscus as a grade 4.

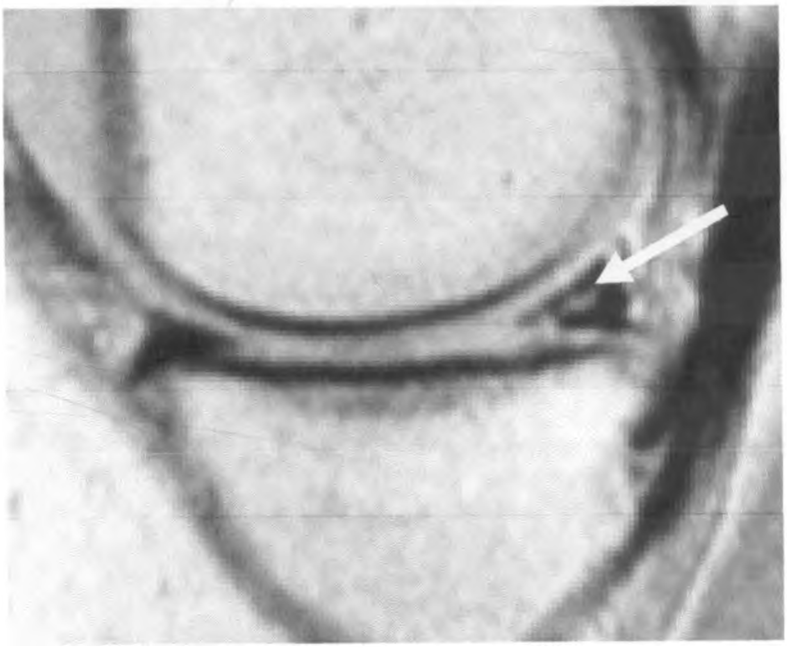


Figure 6: Sagittal T2W MRI showing a Complex (degenerative) tear (arrow) in posterior horn of medial meniscus.

There are many descriptive terms for the various types of tears. The most common and most important ones are:

a) The bucket-handle tear: This is a complete, in the axial plane-oriented vertical tear with displacement of one or two meniscal fragments. The inner segment is the handle of the bucket, which may dislocate into the intercondylar fossa (Figure 7). When the inner part of the meniscus is dislocated or when it has been removed at arthroscopy, the inner margin of the meniscus lacks the pointed shape on sagittal and coronal images. Torn meniscal fragments may rotate and dislocate anteriorly; this is the so-called flipped meniscus sign (Figure 8).

b) Radial tears: are located on the inner margin, and are difficult to detect. A subtle high-signal intensity line may be observed on sagittal images, or an irregular inner margin is seen on coronal images.

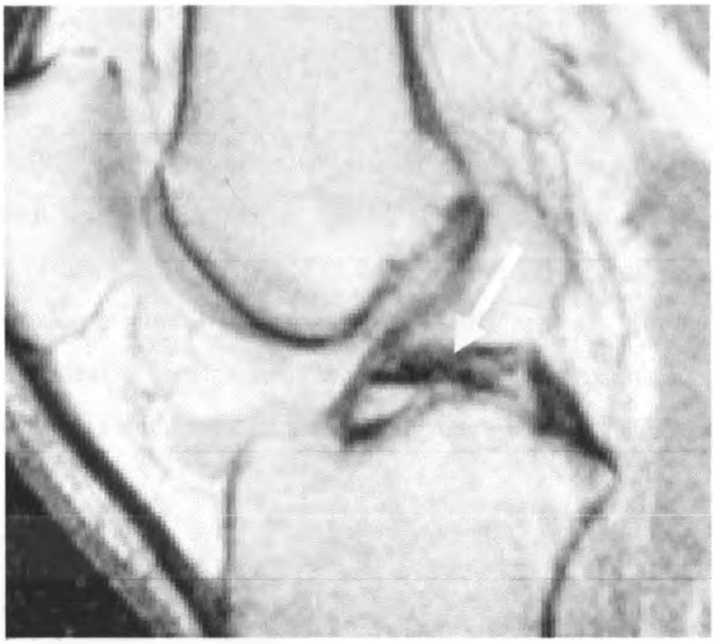


Figure 7: Sagittal T2W MRI showing a Bucket-handle tear with dislocated fragment intercondylar (arrow). The ACL is intact.

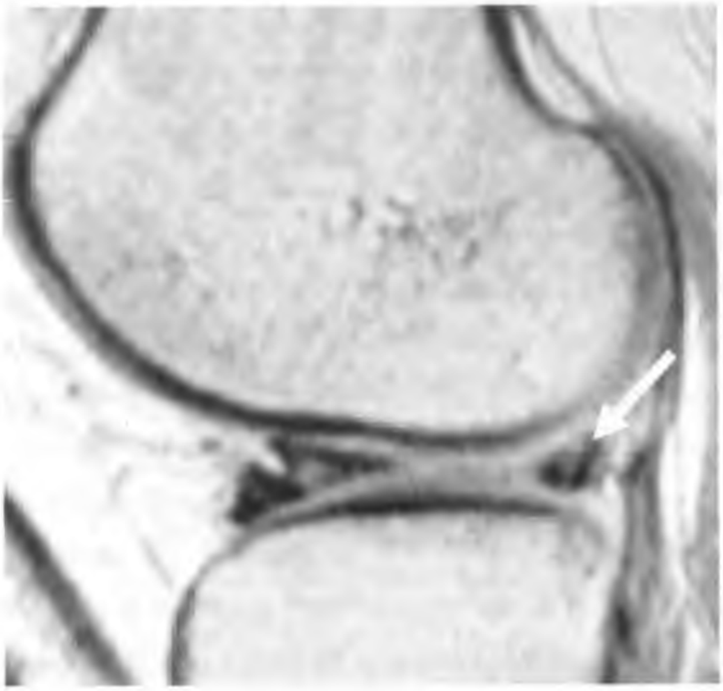


Figure 8: Sagittal T2W MRI showing a Flipped lateral meniscus: the posterior horn of the lateral meniscus is partially dislocated (arrow).

The sensitivity of MRI in the diagnosis of medial meniscal tears is reported to be 87–97%, sensitivity for lateral meniscal tears is 69–92%; specificities are 82–91% and 91–98% respectively (20-32). Thus, the performance of MRI is clinically excellent especially if one takes into account that small peripheral tears missed by MRI are not clinically relevant, and that arthroscopy is not an ideal gold standard. When the anterior cruciate ligament (ACL) is torn, accuracy for meniscal tears decreases and especially tears in the posterior lateral meniscus may be missed.

MENISCAL CYSTS

These are frequently seen in association with horizontal meniscal tears on the lateral side of the knee. The dissecting meniscal tear is contiguous with the fluid collection. The signal intensity may be lower than typical for fluid because of dehydration. MR arthrography using gadolinium improves their delineation. They are usually small, but may be large, multiloculated, and may erode bone.

1.3.2 LIGAMENTS

a) COLLATERAL LIGAMENTS - these are on each side of the joint and strengthen the capsule. The medial collateral ligament extends from the medial condylar region and attaches 4-5cm inferior to the tibial plateau and posterior to the pes anserinus insertion. Deep to this, the medial capsular ligament is composed of the meniscofemoral and meniscotibial attachments to the meniscus. The ligament represents the main restraint against valgus strain. The lateral collateral ligament (LCL) strengthens the capsule laterally, and lies somewhat posterior. LCL is made up of two layers and lies deep to the insertions of the distal iliotibial tract and biceps femoris posteriorly, and to the quadriceps retinaculum anteriorly. Deep to the LCL are the meniscofemoral and meniscotibial attachments. The intracapsular popliteus tendon passes medial to the LCL, and posterior fibres of the LCL blend with the deep capsule, which contributes to the arcuate popliteal ligament. The collateral ligaments consist of multiple layers: the deep lying meniscofemoral and meniscotibial ligaments are capsule reinforcements. Superficial to this are the tibial collateral and fibular collateral ligaments. Between the deep and more superficial layers, fat and bursa may be visualized.

Injury to the medial ligament is much more common than that to the lateral ligament. Tears and meniscocapsular separations are best evaluated in the coronal plane on T2-weighted SE, T2-weighted TSE (with fat-selective saturation) or T2 STIR-weighted GE images. Coronal images are more accurate than axial images for grading injuries of the medial and lateral collateral ligaments. MRI may show high signal intensity within and or surrounding the traumatized ligament. The ligament may be thickened in chronic injuries, or interrupted and or buckled in acute complete tears. Distraction bone bruises, located at the level of ligamentous insertions, are frequently seen in severe injury (33).

b) CRUCIATE LIGAMENTS - are intracapsular but extrasynovial. The anterior cruciate ligament (ACL) connects the posterior medial aspect of the lateral femoral condyle to the anterior tibial intercondylar region. It is composed of two functional fibre bundles: the longer anteromedial bundle tightens with knee flexion, and the shorter but bulkier posterolateral bundle which tightens with knee extension.

The posterior cruciate ligament (PCL) connects the lateral aspect of the medial femoral condyle to the posterior intercondylar fossa of the tibia, and passes medial to the ACL. In relation to the PCL two other ligaments may pass anterior (ligament of Humphrey) or more commonly posterior (Ligament of Wrisberg). In some knees, both ligaments are present.

The cruciate ligaments are, as central supporting structures, major contributors to stability. Complete ACL tears are easily diagnosed clinically by use of clinical tests like the anterior drawer test at 30° and 90°, the Lackman's test and the pivot shift test in the elderly. On MRI, some indirect signs may be used to diagnose an ACL tear. When the posterior horn of the lateral meniscus is at the level of, or even posterior to the posterior margin of the lateral tibia plateau, this indicates that the tibia is not restricted by the ACL and is allowed to move anterior relative to the meniscus and femur. The meniscus moves with the femur as one unit. The Cruciate ligaments are best visualized in the sagittal (0–10°external rotation) plane. The coronal plane offers an important second look at the cruciate ligaments.

On sagittal images the ACL is normally parallel to the intercondylar roof. On MRI there is often high signal intensity interspersed within the fibres of the ACL. The ACL consists of multiple collagen bundles that are twisted around each other like the fascicles of a rope; this organization of collagen explains the intermediate signal intensity on MR images. A second contributor to the signal is the magic-angle phenomenon. Collagen bundles that make an angle of 55° with the main field have increased signal intensity when TE is short.

The posterior cruciate ligament (PCL), a thicker and more homogeneous structure, has as a consequence lower signal intensity. Because knee MRI is performed in extension the PCL normally has a sharp bend known as the genu. The PCL is typically more uniformly hypointense than the ACL, although there may be slight increased signal intensity on short TE secondary to magic angle effect.

Acute tears are seen as loss of continuity, as an ill-defined mass, retraction of torn ends, concavity of the anterior margin or increased signal intensity within the ligament. Most tears are mid-substance tears. In proximal tears an empty notch sign may be seen. This sign describes the presence of fluid, instead of ligament, seen on coronal images at the side of origin at the inner aspect of the femoral condyle. Because haematoma and oedema resolve in time, a sub-acute or chronic tear is better defined than an acute one (34). The chronically torn ACL may be absent or may be seen in an abnormal location or orientation (Figure 9). It may for instance attach to the PCL. The PCL often becomes thickened in patients with a chronic ACL tear.

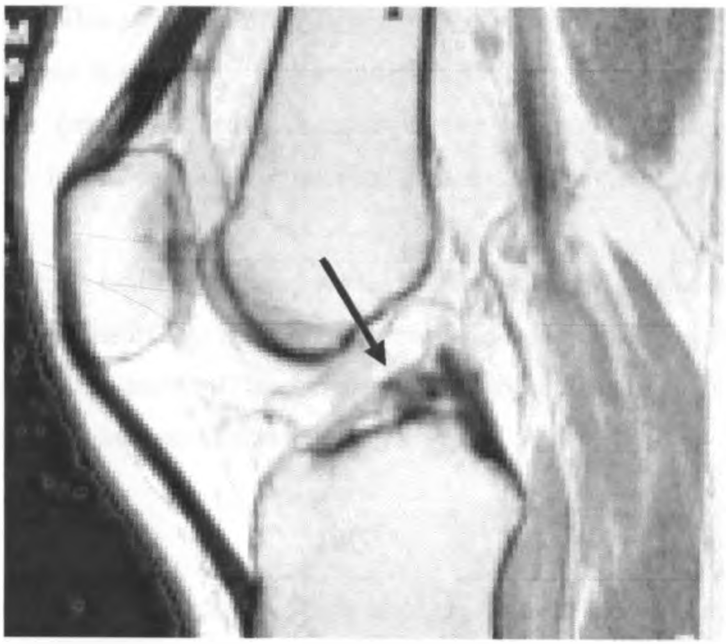


Figure 9: Sagittal T2W MRI showing a total tear of the ACL. The fibres do not attach to the femoral condyle (arrow).

The pattern of bone bruises can also hint at an anterior cruciate tear. So-called kissing contusions are seen at the posterolateral aspect of the tibial plateau and the anterolateral aspect of the lateral femoral condyle (Figure 10).

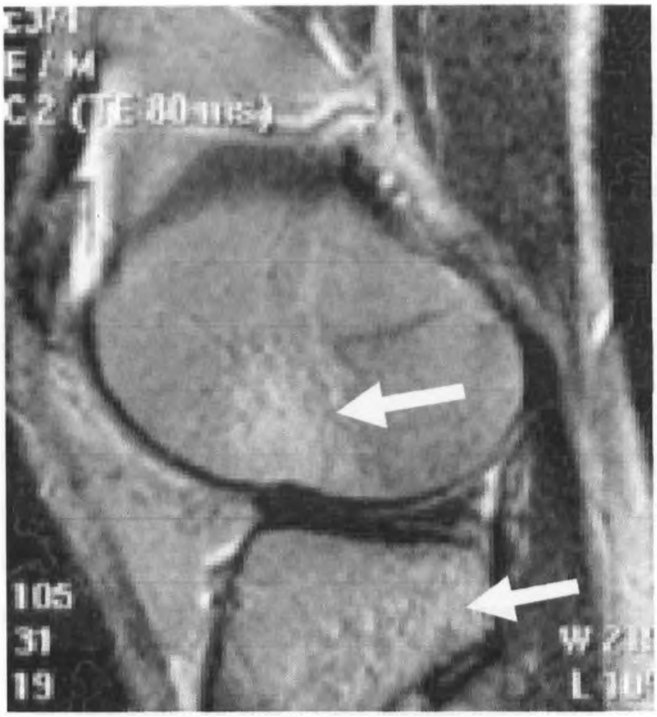


Figure 10: Sagittal PD-fs MRI showing a Bone bruise of the lateral femoral condyle and posterolateral tibial plateau (arrows), so-called kissing contusion.

Less useful in hinting at an ACL tear is the question mark sign of the PCL. It is an acute angulation of the PCL. This is not an important sign as it can also be seen with an intact ACL, especially when the knee is extended. The majority of patients with ACL tears have associated lesions: bone bruises (most frequently located in the lateral compartment), osteochondral fractures, tear of the lateral meniscus, and less frequently the medial meniscus and medial collateral band.

PCL tears are rare, but are easily diagnosed with MR. They may be missed clinically and during arthroscopy when the ACL is intact. Their management depends on the clinical findings.

Treatment of complete ACL and PCL tears depends on various factors such as level of activity, instability of the joint, and damage to other structures.

1.3.3 CARTILAGE

Cartilaginous evaluation is of clinical relevance because cartilaginous abnormalities may mimic clinical symptoms of meniscal tears, or may be the main cause of symptoms when multiple structures are deranged. Changes in treatment of inflammatory (rheumatic) diseases, disease modifying drugs in osteoarthritis and renewed interest in surgical repair such as debridement with abrasion of subchondral bone, osteotomy to modify loading characteristics, placement of artificial matrix, perichondreal grafts, chondrocyte transplantation, and osteochondral transplantation have also made diagnosis of cartilaginous disorders rapidly gain significance. In inflammatory disease MR mainly focuses on synovial disorders characterized by enhancement features, while cartilage itself is the main target in case of trauma or osteoarthritis.

Traumatic chondral defects are typically well-defined, large and (near) full thickness with subchondral osseous injury, which facilitates detection. Assessment of cartilage is important in differentiating between stable osteochondritis dissecans with intact overlying cartilage, and unstable osteochondritis dissecans with disrupted overlying cartilage. Patients with intact cartilage are preferably treated conservatively, whereas surgery is used when overlying cartilage is disrupted.

In osteoarthritis, the collagen network becomes disrupted and proteoglycan content decreases resulting in swelling representing increased water content. There is no spontaneous healing of the hyaline cartilage and ensuing repair response results in thickened fibro-cartilage or may lead to cartilage loss like fibrillation, erosions, or even cracks. These later stages of this irreversible process can be visualized under certain conditions using MRI with variable accuracy. The range of accuracies reported in literature is large and ranges from 50% to 80%. Both the joint component (cartilage loading) and the subchondral bone component play an important role in the development of osteoarthritis.

1.3.4 BONE

Bone bruise was introduced as a new radiologic diagnosis with the advent of MRI (35, 36). Bone bruises may be isolated, but are also often encountered in association with fracture of the cartilage (osteochondral fracture, osteochondritis dissecans) and or with meniscal and ligament sprains or tears. Bone bruises or radiographically occult fractures are significant MR findings because they may be career-ending injuries especially in professional athletes when not diagnosed. Patients with isolated bone bruises have decreased function and more symptoms relative to those without this pathology. Symptoms disappear and function returns with conservative management within 6 months (37). Cartilage and bone marrow is best assessed in all three planes using fat suppressed sequences and T1-Weighted images. Muscle signal is similar to other parts of the musculoskeletal system.

When properly diagnosed with MR, arthroscopy can be avoided. Contusion of the posterolateral tibial plateau is one of the commonest bruises encountered (Figure 10 on page 14) and is characteristically associated with an ACL tear. Another location associated with ACL tear is compression fracture including bone bruise at the level of the femoral notch. Bone bruises can only be excluded on short tau inversion recovery (STIR) or fat selectively suppressed T2-weighted TSE sequences, as these sequences have superior sensitivity over other sequences.

1.3.5 PATELLA

MRI is useful in the diagnosis of dislocation of the patella that may be associated with patella chondral defects. It is also useful in demonstrating degenerative changes of patella articular cartilage (Figure 11). Patella dislocation often rapidly reduces on its own and only half of the patients with patella dislocation are aware of them. Findings on MR are easily interpreted as a patella dislocation (38). A contusion characteristically occurs on the anterolateral femoral condyle (Figure 12). It results from the impaction of the patella as it either dislocates or reduces. There may be a kissing contusion on the medial side of the patella and on the anterolateral femoral condyle. In patella dislocation, the medial retinaculum (Medial patello-femoral ligament) is always injured, although it may be difficult to appreciate a frank tear. A key finding is the patella cartilage. If a piece of the cartilage is missing, an arthroscopy procedure is necessary whereas if normal, the patient is treated conservatively. The main role of the radiologist is to carefully examine the patella cartilage and to evaluate the trochlear notch, which is often hypoplastic in patients with dislocating patellae and is a predisposing factor to subsequent dislocations.

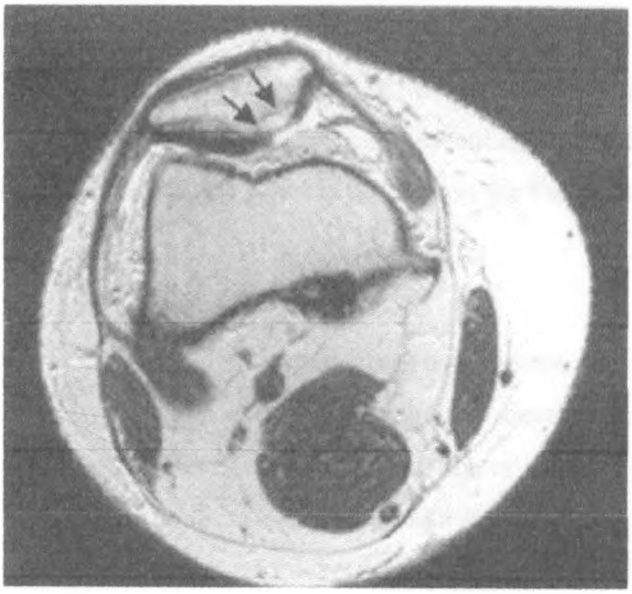
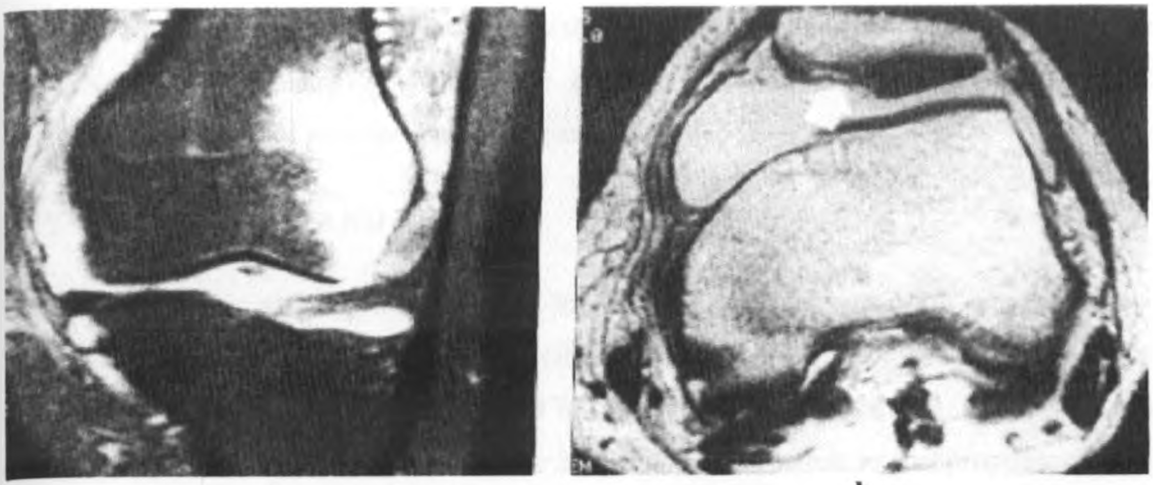


Figure 11: Axial T2W MR image showing a large chondral defect (arrows) on the apex of the patella (chondromalacia patellae).



a b

Figure 12: Patellar dislocation. a) Fast spin-echo T2W coronal MRI with fat suppression reveals large contusion in lateral femoral condyle. b) Axial T2W image shows large joint effusion with large chondral defect (arrow) on apex of patella.

1.3.6 PATELLA TENDON

Pain in the inferior patellar region in athletes may be attributed to patella tendinosis, which is often seen in MRI as thickening of the proximal patella tendon with high signal in and around it on T2-weighted images (39). Patella tendinosis is an important diagnosis that may be missed on the MRI if not actively looked for. It can be debilitating to an athlete and can require surgery to remove the focus of myxoid degeneration in the tendon. In inflammatory disease, MR arthrography mainly focuses on disorders characterized by enhancement features. There is a role for the use of contrast media (gadolinium) in the investigation for Patella tendinosis.

1.3.7 SYNOVIAL PLICAE

Embryologically, the knee is divided into compartments by superior, inferior and medial patellar plicae. The plicae are fibrous remnants of the embryological development of the knee derived from the synovial membrane (40). Half of all knees show one or more of the plicae on MRI. The range of reported medial plicae in the literature is large and ranges from 18.5% to 55% with only less than 3% being symptomatic. It may be thickened, stiff and trapped between the patella and the femur and cause pain, clicking and locking like a torn meniscus (so called Plica syndrome). Axial T2-weighted images showing joint fluid are required to visualize the medial plica. Plica syndrome is an uncommon diagnosis but an inflamed plica is easily removed at arthroscopy. The suprapatellar and infrapatellar plicae are also commonly seen on MRI but do not cause plica syndrome. However, at arthroscopy, the ligamentum mucosum (plica infrapatellaris) may be confused with the anterior cruciate ligament, which runs almost parallel with it. Occasionally, the ligamentum mucosum makes it difficult to change from one compartment to another. Ligamentum mucosum is of no importance and can be resected if necessary.

1.3.8 SYNOVIAL SPACE AND BURSAE

A synovial membrane, articular cartilage and menisci surround this space. It is variable and depends on the position of the knee. The synovial membrane of the knee bulges upward from the patella to form the suprapatellar bursa situated beneath the quadriceps tendon. Inflamed bursae may cause symptoms that mimic intraarticular abnormality and result to inappropriate therapy including surgery. Bursae around the knee will not be seen on arthroscopy and therefore MRI or physical examination must be used to identify them. Four of the important bursae are described below;

a) Popliteal bursa or Baker's cyst: An inconstant posterior pouch extends into the popliteal space in about 13% of knees. When this synovial membrane pouch is obstructed or the bursa becomes inflamed, the bursa is called a 'Baker's cyst'. It extends from the knee joint posteriorly between the tendons of the medial head of the gastrocnemius and the semimembrinosus (Figure 13 on page 19). It can contain some small amounts of fluid but greater than 5-10ml of fluid should be reported because it could be a source of symptoms. The bursae may become quite large and cause compartment syndrome, or may extend far down the leg and may rupture and cause inflammation of the surrounding musculature (mimics deep venous thrombosis clinically).

b) Prepatellar bursitis: It occurs anterior to the patella (Figure 3 on page 2) and is one of the common causes of anterior knee pain. Its cause is repetitive trauma and kneeling. On MRI, it is shown as a fluid collection superficial to the patella.

c) Pes anserinus bursa: It occurs on the anteromedial tibia just below the joint line (Figure 13 on page 19). The pes tendons are the gracilis, sartorius and the semimembrinosus. The bursa lies beneath the tendons and when inflamed, it extends proximally towards the joint (41).

d) Semimembrinosus tibial-collateral bursa: It may mimic an internal knee derangement (42). It is commonly inflamed and has a characteristic appearance hence easily picked on MRI. It occurs on the joint line and drapes over the semimembrinosus tendon like a horseshoe (Figure 13 on page 19). On coronal and sagittal images, it appears to arise at the meniscus and extending inferiorly (DDX: meniscal cyst but this has a connection to a meniscal tear).

e) Tibial-collateral ligament bursa: This bursa is uncommonly seen. It lies deep in relation to the MCL and extends vertically above and below the joint line. The bursa can be confused with a meniscocapsular separation, but unlike a traumatic separation, the fluid is well contained and cyst like rather than diffusely distributed.

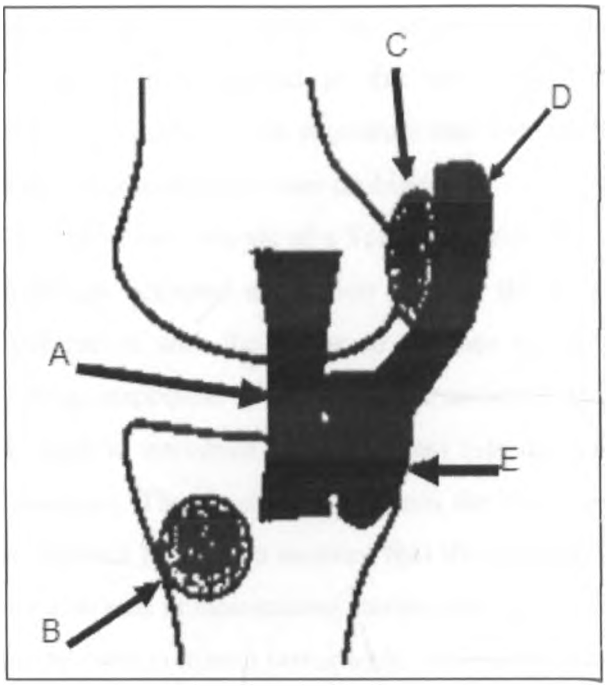


Figure 13: Schematic showing location of common bursae on the medial side of the knee (Anterior is to the left): A=Tibial collateral ligament, B=Pes Anserinus bursa, C=Baker's cyst, D=Semimembrinosus tendon, E=Semimembrinosus tibial-collateral-ligament bursa.

1.3.9 EXTENSOR MECHANISM

This is a structure that consists of the quadriceps tendon, the patella, the patellar ligament, Hoffa's fat pad, and the medial and lateral patellar retinacula. The quadriceps tendon is made up from the rectus femoris, vastus lateralis, vastus medialis and vastus intermedius.

1.4 KNEE ARTHROSCOPY

Knee arthroscopy allows an orthopaedic surgeon to diagnose and treat knee disorders by providing a clear view of the inside of the knee with small incisions, utilizing a pencil-sized instrument (Usually 4-5mm in diameter) called an arthroscope. Modern or contemporary arthroscopy of the knee was first performed in the late 1960s. With improvements on arthroscopes and higher-resolution cameras, the procedure has become highly effective for both the accurate diagnosis and proper treatment of knee problems.

Today, the arthroscope in common use consists of a Telescope with laterally attached light cable. Arthroscopes with the universally accepted angulation (30° for the standard scopes and 70° for special indications), in combination with the option to advance the tip of the scope into more distant areas of the joint, allows inspection of almost all intraarticular structures. A sheath with a sharp and a blunt trocar is used to introduce the instrument into the joint to protect the optical system from bending and breaking. The sheath also contains the irrigation port for gas or liquids. Usually the arthroscope is attached to a video monitor that the surgeon uses to see the inside of the knee. The video monitor also aids in maintaining sterility during the arthroscopic surgery.

Knee arthroscopy is one of the most common orthopaedic procedures especially in the developed countries used to diagnose and or treat many of the following problems:

a) Indications for diagnostic arthroscopy;

- Diagnostic uncertainty or uncertainty about the exact location of meniscal tears and or persistent knee pain.
- Follow-up of treatment results.

b) Indications for surgical arthroscopy grouped by structure;

- Synovium – biopsy, synovectomy, lysis of adhesions, lateral release and division of plica.
- Synovial space – lavage and removal of loose bodies.
- Intra-articular structures – menisectomy, suture of meniscus and repair of ligaments (ACL and PCL).
- Cartilage – shaving of the patella, refixing an osteochondritis dissecans fragment and chondroplasty.
- Bone – debridement and chondroplasty (mesenchymal stimulation techniques).

Portals are the key to success in arthroscopy. They define the access a surgeon will have to both view the joint and to intervene in the joint. Proper portal placement is essential to successful knee arthroscopy, as it defines the surgeon's access to the joint. Numerous approaches have been described in the literature, from the so-called "universal" antero-lateral portal to a posterior trans-septal portal. Although the various named portals are described as fixed locations, they are adjustable to address the pathology at hand while minimizing any impact on articular cartilage.

Planning for portal selection is based on the purpose of the arthroscopy. Whether diagnostic or therapeutic, the portals are planned to optimize the surgeon's access to the relevant area(s) of the knee.

Most orthopedic surgeons use a standard 3-portal technique (the antero-lateral, antero-medial, and supero-medial portals), although 2-portal technique is gaining popularity. Additional portals may be used based on the needs of the arthroscopist. These additional portals include postero-medial, supero-lateral, postero-lateral, midpatellar, posterior trans-septal and central portals. The indications for specific portals are based on the access a surgeon expects to need in a particular arthroscopy.

1.5 DIAGNOSTIC ARTHROSCOPY VERSUS MRI KNEE

MRI of the knee is increasingly becoming available as an alternative to diagnostic arthroscopy. Where MRI use in medical practice is well established, MRI has now tremendously reduced the number of diagnostic arthroscopies being performed, and it is more appropriately being used as a screening tool for therapeutic arthroscopy. Fast three-dimensional MRI allows identification of all relevant intra-articular pathologies of the knee joint within a few minutes, with high accuracy comparable to arthroscopy (43).

Where studies have been done, MRI has proven to be accurate for the diagnosis of intra- and peri-articular pathology, especially for meniscal pathology and ligamentous injuries. It is good enough, especially when using the concept of composite injury (sensitivity of 87.3% and specificity of 88.4%), to appropriately identify patients, who require arthroscopic therapy (44).

Composite injury diagnosis refers to the overall MRI assessment of the entire joint and is more important than accurate diagnosis of all specific lesions of the various anatomic structures. In playing this role MRI has diagnostic and therapeutic impact. MRI, when used in all patients with high clinical suspicion of intra-articular knee pathology instead of direct arthroscopy, can avoid 35% of arthroscopies (44).

By influencing the therapy received by a patient, MRI also has the ability to influence patient outcome and societal costs. In patients with sub-acute and chronic knee complaints and with high clinical suspicion of intra-articular knee pathology MRI of the knee can be used to select patients for arthroscopy without additional societal costs and without disadvantageous effect on patient outcome.

CHAPTER TWO

2.1 JUSTIFICATION

Locally, access to MRI services has been limited by cost and availability. KNH, the biggest teaching and referral hospital in Kenya has acquired an MRI unit in the recent past. With this, magnetic resonance imaging is bound to increasingly become more available and affordable.

Where studies have been done, Comprehensive MRI examination of the knee has been shown to give surgeons information that they cannot obtain clinically and noninvasively, and with this it has increasingly become available as an alternative to diagnostic arthrography and or arthroscopy. In addition, MRI has proven to be accurate for the diagnosis of intra- and peri-articular pathology, with sensitivity and specificity for meniscal pathology in the 80-95% range and for the cruciate ligaments injuries close to 100%.

To the best of my knowledge, no local studies had been done by anyone before this study to show the reliability of MRI in the diagnosis of intra-articular knee pathology in our setup.

2.2 RESEARCH QUESTION

What is the reliability of the MRI in predicting the possible diagnosis of intra-articular knee lesions in our set up?

2.3 OBJECTIVES

2.3.1 BROAD OBJECTIVE

The broad objective for this study was to determine the pattern of presentation of knee joint pathology as well as to find out the correlation between the radiological and arthroscopic findings of the knee in patients seen at five radiological imaging centers in Nairobi.

2.3.2 SPECIFIC OBJECTIVES – there were three specific objectives in this study:

1. To determine the age and sex distribution of the patients with these lesions.
2. To determine the spectrum of knee pathology seen by MRI scan and the anatomical distribution and frequency of these lesions in the knee.
3. To determine the correlation between the radiological diagnoses and the arthroscopic diagnoses of these lesions.

CHAPTER THREE

3.1 STUDY DESIGN

This was a descriptive retrospective-prospective study.

3.2 STUDY AREA

This descriptive retrospective-prospective study was carried out at five radiological imaging centers providing Magnetic Resonance Imaging services in collaboration with two Orthopaedic and Trauma surgeons carrying out Knee arthroscopic surgery in Nairobi. The MRI centers included in the study that carried the knee MRI examinations are: 1) Kenyatta National Hospital (KNH); 2) Medical Imaging and Diagnostic Center (MITC)-Nairobi; 3) Aga Khan University Hospital (AKUH)-Nairobi; 4) MRI center-Nairobi and 5) The Nairobi Hospital. The arthroscopic examinations / surgeries were done in The Aga Khan University Hospital (AKUH)-Nairobi, The Nairobi Hospital, The Mater Hospital and the Upper Hill Medical Center.

3.3 STUDY POPULATION

The study only included those patients who had a clinical diagnosis of intra-articular knee joint lesion(s) and had reports for both MRI and diagnostic or curative arthroscopy of the imaged knee. The patients included in this study were seen at the five study centers over a period of 20 Months (between January 2006 and August 2007). Patients who had both reports but had been seen in centers that opened during the study period were excluded from the study.

3.4 SAMPLING

3.4.1 SAMPLE SIZE DETERMINATION

Fourty six knees that met the inclusion criteria outlined below were evaluated in this study.
Prior to the start of the study, a sample size had been calculated using the following formulae:

$$n = \frac{Z^2 1 - \alpha/_2 P(1-p)}{d^2}$$

Where;

n = sample size

Z = standard error from the mean corresponding to 95%

$1 - \alpha/_2$ =2 tailed = 0.9

P = assumed accuracy of MRI=80%

d = absolute precision (5%)

Calculated sample size = 52

3.4.2 SAMPLING METHOD

Fourty six consecutive knees in Fourty six patients managed for intra-articular knee joint lesions within the specified period of time (January 2006 and August 2007) and meeting the inclusion criteria outlined below were included in the study.

3.4.3 INCLUSION CRITERIA

- Patients of all age groups were considered.
- All these patients had a clinical diagnosis of intra-articular knee joint lesion(s) and had been sent for a Knee MRI by their primary physician. All these patients only underwent the MRI that the primary physician had requested.
- All these patients underwent knee diagnostic or curative arthroscopy after the MRI examination and the recorded arthroscopy finding(s) were available. Decision for the patients to undergo the arthroscopy was made by the primary physician and was based on the findings of the MRI.

3.4.4 EXCLUSION CRITERIA

- Patient with no knee MRI report and or films and who had corresponding knee arthroscopy report.
- Patients with MRI report and or films but with no corresponding knee arthroscopy report.

3.5 MATERIALS AND PROCEDURES

3.5.1 DATA COLLECTION

- The principal researcher, with assistance from radiologists and medical records staff from the five MR imaging centers and the two knee arthroscopic surgeons, obtained the relevant records (MRI films and or MRI reports and arthroscopy reports) retrospectively as well as prospectively to cover the study period.
- Prospectively, patients who underwent knee MRI during the study period were followed up with the referring clinicians and were only included in the study after they underwent diagnostic or therapeutic arthroscopy of the imaged knee.
- Retrospectively, Information on the names and patient numbers of the study subjects was obtained from both the theatre lists and the daybooks of the institutions / Surgeons involved in the study.
- The patient's particulars including hospital number, X-ray number, age, sex, relevant clinical history and date of the MRI examination were obtained from the patients file or

MRI request form and entered into the data collection sheet (Appendix I) by the principal investigator. The MRI findings were recorded using the format outlined in the data collection sheet.

- The arthroscopy findings were similarly obtained from the patient's file by the principal investigator using the format outlined in the data collection sheet (Appendix I), and noted down only after ascertaining that the MRI report and the arthroscopy findings referred to the same knee in the same patient.

3.5.2 DATA ENTRY AND ANALYSIS

- Only the researcher filled the data collection sheets, as well as transferred the data into the computer. This ensured uniformity of data entry.
- The data was analyzed with the help of a statistician using the statistical package for social scientists (SPSS) computer software.
- The analyzed data is summarized using tables, pie charts and graphs as outlined in chapter five with reference to the specific objectives.

The accuracy, sensitivity, specificity, negative predictive value (NPV), and positive predictive value (PPV) were calculated using the following equations:

- PPV = TP/(TP + FP)
- NPV = TN/(TN + FN)
- Sensitivity = TP/(TP + FN)
- Specificity = TN/(FP + TN)
- Accuracy = (TP + TN)/(TP + TN + FP + FN).

3.6 STUDY LIMITATIONS

1. Some patients' records were incomplete, inadequate, lost or illegible hence they were excluded from the study.
2. Some patients who underwent MRI were lost to follow up.
3. Some patients who had undergone MRI delayed to undergo scheduled arthroscopy beyond the study period due to financial difficulties.
4. Patients who underwent the MRI and arthroscopy examinations were only those referred by the clinicians. This brought about selection bias.
5. Awareness of the use of MRI in management of knee pathology is not widespread among clinicians thus the desired sample size was not achieved due to a lower rate of referrals for knee MRI during the period of study.

CHAPTER FOUR

4.0 ETHICAL CONSIDERATION:

1. Before commencement of the study, requests to carry out the study were sought from the Ethical and Research Committee of KNH and the arthroscopic surgeons whose patient's data was included in this study.
2. The study did not interfere with the management of the patients in any way. The primary physician(s) decided on the MRI and the subsequent arthroscopy examinations these patients underwent. Data collection using the format outlined in the attached appendix I was only done after the patients had undergone the examinations.
3. Information obtained during the study has been treated with total confidentiality. Only patients' hospital numbers, MRI and arthroscopy findings as outlined in the data collection sheet were recorded for referral purposes and data analysis and this helped to maintain confidentiality.
4. No other examination or procedure was done on the patient apart from the one requested by the primary physician and hence, no extra financial demands were incurred by these patients.

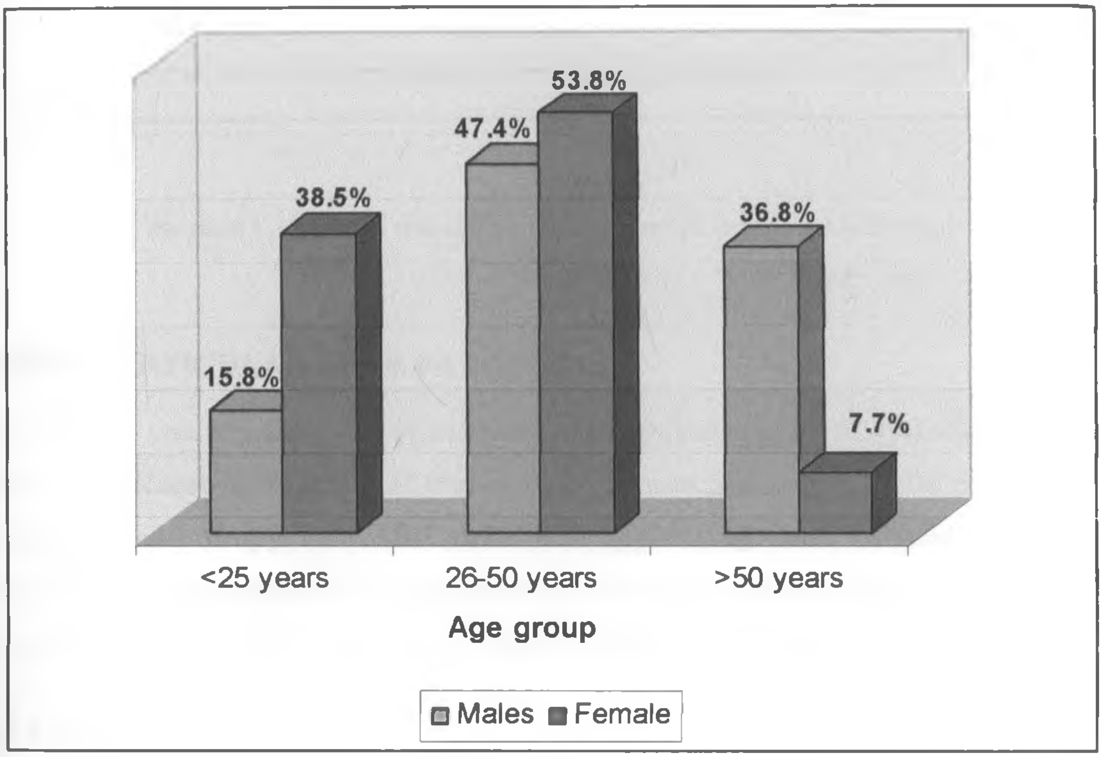
The results of this study will be for the purposes of M.Med dissertation and thereafter the respective centers and surgeons involved in the study will receive copies of the study results for future reference and to facilitate any possible improvements in patient management.

CHAPTER FIVE

5.0 STUDY RESULTS

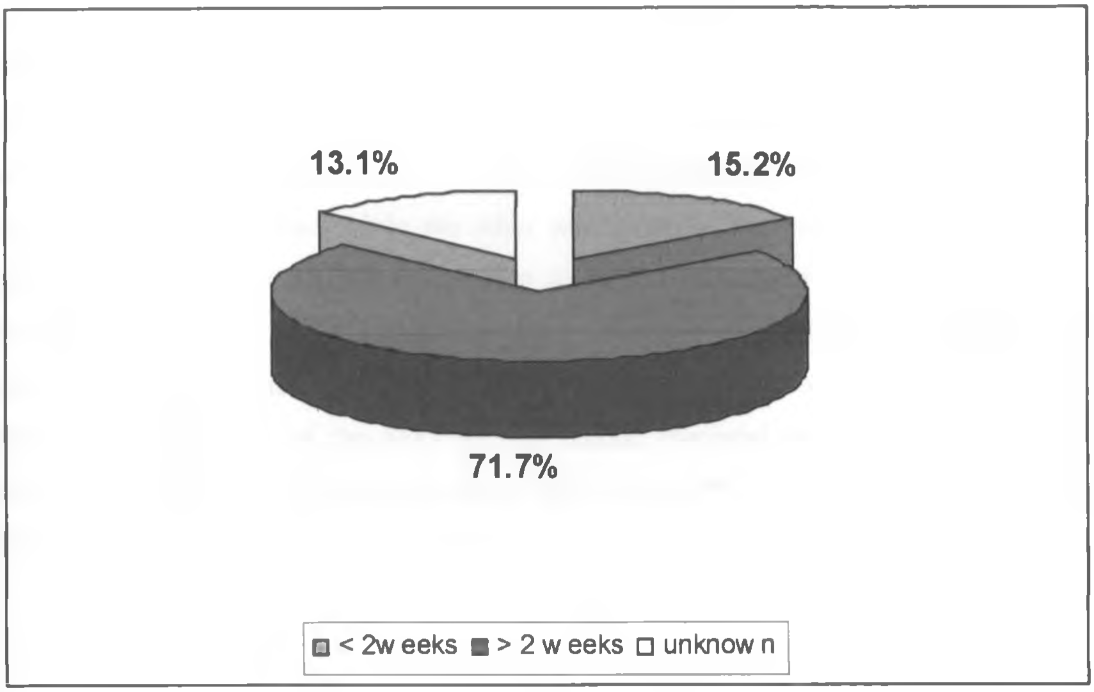
5.1 SOCIO-DEMOGRAPHIC CHARACTERISTICS

The study included 27 males (58.7%) and 19 females (41.3%). Overall, the mean and median ages were 35.64 and 35 respectively. The standard deviation was 13.75 with majority of the patients studied being in the 26-50 years age group as shown in Bar Graph 1.



Bar Graph 1: Age group and Sex distribution of the Patients with intra-articular knee joint pathology

Majority of the patients (71.7%) presented for Knee MRI and subsequent arthroscopy with two or more weeks of clinical history as shown in pie chart 1. 15.2% of the patients included in the study had clinical history of less than two weeks while in 13.1%, the duration of the clinical history was not indicated by the referring clinician.



Pie chart 1: Duration of clinical history before Knee MR imaging and Arthroscopy

5.2 INTRA-ARTICULAR KNEE PATHOLOGY

The right knee was affected in 31 of the Knees studied (constituting 67.4%) while the left was affected in 15 Knees (constituting 32.6%). All the 46 knees had complete MRI examination and all underwent arthroscopy. Both MRI and arthroscopy findings were recorded as per attached Data Collection Sheet (Appendix 1). Arthroscopy in one of the knees was however incomplete as it was abandoned during the surgery due to technical failure of the arthroscope.

5.2.1 THE MENISCI

Overall, the MRI had a higher sensitivity (88.9% for medial meniscal tear and 93.3% for lateral meniscal tear) than specificity (36.1% for medial meniscal tear and 63.3% for lateral meniscal tear).

5.2.1.1 The Medial Menisci

On MRI, 5 of the medial menisci were not seen, 13 were normal and pathology was reported in 28. Meniscal tears were reported in 16 of the menisci with pathology, degenerative meniscal change in 9, while 3 menisci were described as compressed, irregular, small and deformed. On arthroscopy, 1 meniscus was not seen, 36 were normal and pathology was reported in 9.

As shown in Table 2 below, of the 5 medial menisci not seen on MRI, 1 was confirmed absent, 1 had a longitudinal tear and 3 were normal on arthroscopy respectively. All the 13 medial menisci reported normal on MRI were confirmed to be normal on arthroscopy. The 1 Radial tear reported on MRI was confirmed a radial tear on arthroscopy. Of the 8 longitudinal tears reported on MRI, 1 was reported as a flap tear, 1 as degenerative meniscal change, 2 as radial tears and 4 as normal menisci on arthroscopy respectively. Of the 3-bucket handle tears reported on MRI, 2 were confirmed bucket handle tears while the other was a normal meniscus on arthroscopy. Medial menisci reported to have horizontal and flap tears and degenerative meniscal changes were normal on arthroscopy. 2 of the 3 medial menisci described as compressed, irregular, small and deformed on MRI were normal while 1 was a bucket handle tear on arthroscopy. Overall, the sensitivity and specificity of the MRI for the medial meniscal tears was 88.9% and 36.1% respectively, with a Positive Predictive Value (PPV) of 28.6% and a Negative Predictive Value (NPV) of 100%.

MEDIAL MENISCUS		ARTHROSCOPY FINDINGS						
MRI FINDINGS	Total	Not seen	Normal	Radial tear	Longitudinal tear	Bucket tear	Flap tear	Degenerative Change
Not seen	5	1	3	0	1	0	0	0
Normal	13	0	13	0	0	0	0	0
Radial tear	1	0	0	1	0	0	0	0
Horizontal tear	3	0	3	0	0	0	0	0
Longitudinal tear	8	0	4	2	0	0	1	1
Bucket tear	3	0	1	0	0	2	0	0
Flap tear	1	0	1	0	0	0	0	0
Degenerative change	9	0	9	0	0	0	0	0
Other lesion(s)	3	0	2	0	0	1	0	0
Total	46	1	36	3	1	3	1	1

Table 2: Medial Meniscus: MRI findings Correlated with Arthroscopy

5.2.1.2 The Lateral Menisci

On MRI, 20 Lateral menisci were normal while pathology was reported in 26. Meniscal tears were reported in 18 of the menisci with pathology, degenerative meniscal change in 5 while 3 lateral menisci were described as compressed, irregular, small and deformed. On arthroscopy, 1 lateral meniscus was not seen, 30 were normal and pathology was reported in 15.

As shown in Table 3 below, of the 20 Lateral menisci reported normal on MRI, 19 were confirmed normal while the remaining one meniscus had a longitudinal tear seen on arthroscopy. The 2 Radial tears reported on MRI were confirmed on arthroscopy. Of the 7 Lateral menisci reported on MRI to have horizontal tears, four were normal, one had a flap tear and one was reported to have a complex tear while the remaining one was reported to be small and fluffy on arthroscopy respectively. Of the 6 longitudinal tears reported on MRI, 2 were normal, 1 was reported as a complex tear, 1 as an old tear, 1 frayed and 1 to have contusion on arthroscopy respectively. Of the 3 Lateral menisci reported to have bucket handle tears on MRI, 2 were confirmed indeed to have bucket handle tears, while one was not seen on arthroscopy. Of the 5 Lateral meniscus reported to show degenerative meniscal change on MRI, only one was reported to show the degenerative meniscal change while the other 4 were reported normal on arthroscopy. A tear reported in a discoid Lateral meniscus on MRI was confirmed on arthroscopy. One lateral meniscus reported on MRI to have a reticulated tear was normal on arthroscopy. The lateral menisci described as deformed and irregular on MRI was reported to have a longitudinal tear on arthroscopy. Overall, the sensitivity and specificity of the MRI for the lateral meniscal tears was 93.3% and 63.3% respectively, with a Positive predictive Value (PPV) of 53.8% and a Negative Predictive Value (NPV) of 95%.

LATERAL MENISCUS		ARTHROSCOPY FINDINGS							
MRI FINDINGS	Total	Not seen	Normal	Radial tear	Longitudinal tear	Bucket tear	Flap tear	Degenerative Change	Other Lesion
Not seen	0	0	0	0	0	0	0	0	0
Normal	20	0	19	0	1	0	0	0	0
Radial tear	2	0	0	2	0	0	0	0	0
Horizontal tear	7	0	4	0	0	0	1	0	2
Longitudinal tear	6	0	2	0	0	0	0	0	4
Bucket tear	3	1	0	0	0	2	0	0	0
Flap tear	0	0	0	0	0	0	0	0	0
Degenerative change	5	0	4	0	0	0	0	1	0
Other lesion(s)	3	0	1	0	1	0	0	0	1
Total	46	1	30	2	2	2	1	1	7

Table 3: Lateral Meniscus: MRI findings Correlated with Arthroscopy.

5.2.2 THE CRUCIATE LIGAMENTS

5.2.2.1 The Anterior Cruciate Ligament

On MRI, 33 (71.7%) of the 46 anterior cruciate ligaments studied were reported normal, 10 (21.7%) had complete rupture, 2 (4.3%) had partial rupture and 1 (2.2%) was reported as thinning of the Ligament (Table 4). Of the 33-reported normal on MRI, 30 were confirmed normal, 1 had a complete tear, 1 had a partial tear and 1 was not seen on arthroscopy (arthroscopy was abandoned due to technical failure of the scope during surgery before it was examined). The sensitivity and specificity of the MRI for anterior cruciate ligament rupture (whether complete or partial) was 83.3% and 90.9% respectively.

Anterior Cruciate Ligament		**ARTHROSCOPY FINDINGS**				
MRI FINDINGS	Total	Not seen	Normal	Partial rupture	Complete rupture	Others
Not seen	0	0	0	0	0	0
Normal	33	1	30	1	1	0
Partial rapture	2	0	2	0	0	0
Complete rapture	10	0	0	0	9	1
Others	1	0	1	0	0	0
Total	46	1	33	1	10	1

Table 4: Anterior Cruciate Ligament: MRI findings Correlated with Arthroscopy.

5.2.2.2 The Posterior Cruciate Ligament

All the 46 (100%) Posterior Cruciate ligaments reviewed were reported normal on MRI as shown in Table 5. On arthroscopy, 44 were confirmed normal, 1 was reported bruised while 1 was not seen (arthroscopy was abandoned due to technical failure of the scope during surgery before it was examined).

Posterior Cruciate Ligament		**ARTHROSCOPY FINDINGS**		
MRI FINDINGS	Total	Not seen	Normal	Others
Normal	1	44	1	46
Total	1	44	1	46

Table 5: Posterior Cruciate Ligament: MRI findings Correlated with Arthroscopy.

5.2.3 THE COLLATERAL LIGAMENTS

5.2.3.1 The Medial Collateral Ligament

The medial collateral ligament was reported normal on MRI in 44 (95.7%) of the 46 knees reviewed in this study (Table 6). In 2 (4.3%) knees, damage to the meniscal femoral part of the ligament was seen. Of the 44-reported normal on MRI, 43 were confirmed normal while 1 was not seen on arthroscopy, a specificity of 95.5%.

Medial Collateral Ligament		ARTHROSCOPY FINDINGS	
MRI FINDINGS	Total	Not seen	Normal
Not seen	0	0	0
Normal	44	1	43
Ligament damage	2	0	2
Total	46	1	45

Table 6: Medial Collateral Ligament: MRI findings Correlated with Arthroscopy.

5.2.3.2 The Lateral Collateral Ligament

The Lateral collateral ligament was normal on MRI in 45 (97.8%) of the 46 knees reviewed. This ligament showed damage to its meniscal femoral part in one knee (2.2%) as shown in Table 7 below. Of the 45-reported normal on MRI, 44 were confirmed normal on arthroscopy while one was not seen (arthroscopy was abandoned due to technical failure of the scope during surgery before it was examined). The meniscal femoral ligament damage reported on MRI was confirmed on arthroscopy. MRI showed a specificity of 97.8% for lateral collateral ligament damage.

Lateral Collateral Ligament		ARTHROSCOPY FINDINGS	
MRI FINDINGS	Total	Not seen	Normal
Not seen	0	0	0
Normal	45	1	44
Ligament damage	1	0	1
Total	46	1	45

Table 7: Lateral Collateral Ligament: MRI findings Correlated with Arthroscopy.

5.2.4 THE PATELLA

The patella was reported normal on MRI in 37 of the 46 knees reviewed. Of those patellae reported normal on MRI, 19 were confirmed normal, 10 showed chondromalacia, 4 were reported to show degenerative changes, 1 had severe cartilage damage in its medial facet, 1 had adhesions and 1 was not seen on arthroscopy. Of the 7 patellae reported to have chondromalacia on MRI, 4 were confirmed on arthroscopy while 3 were normal. Patellae reported to have degenerative changes and contusion on MRI, were reported to have chondromalacia on arthroscopy. The sensitivity and specificity of the MRI for chondromalacia was 26.7% and 81.8% with a Positive predictive value of 57.1% and a Negative predictive value of 51.35%.

Patella		ARTHROSCOPY FINDINGS			
MRI FINDINGS	Total	Not seen	Normal	Chondromalacia	Other
Not seen	0	0	0	0	0
Normal	37	1	19	10	7
Chondromalacia	7	0	3	4	0
Others	2	0	0	1	1
Total	46	1	22	15	8

Table 8: Patella: MRI findings Correlated with Arthroscopy.

5.2.5 THE FEMORAL ARTICULAR CARTILAGE

The femoral articular surface was reported normal in 32 knees on MRI (Table 9). Of these, it was confirmed normal in 24, irregular in 4 and 3 had ulcer extending to the bone. It was not fully examined in one knee as arthroscopy was abandoned during surgery due to technical failure of the scope. Of the 11 femoral articular surfaces reported to be irregular on MRI, 7 were normal, 2 irregular and 2 had chondral flaps on arthroscopy. Femoral articular surface ulcer reported on MRI was reported as irregular surface on arthroscopy. An osteochondral defect/flap seen on MRI was confirmed on arthroscopy. Femoral articular cartilage described to have degenerative changes on MRI was reported normal on arthroscopy. The sensitivity and specificity of the MRI for femoral articular cartilage pathology was 46.2% and 75.0% with a positive predictive value of 42.3% and a negative predictive value of 75%.

Femoral Articular Cartilage		ARTHROSCOPY FINDINGS				
MRI FINDINGS	Total	Not seen	Normal	Irregular surface	Ulcer to the bone	Other
Not seen	0	0	0	0	0	0
Normal	32	1	24	4	3	0
Irregular surface	11	0	7	2	0	2
Ulcer to bone	1	0	0	1	0	0
Other Lesion(s)	2	0	1	0	0	1
Total	46	1	32	7	3	3

Table 9: Femoral articular cartilage: MRI findings Correlated with Arthroscopy.

5.2.6 THE TIBIAL ARTICULAR CARTILAGE

The tibial articular surface was reported normal in 42 knees on MRI (Table 10). It was confirmed normal in 31 knees, irregular in 8, ulcerated in one, fibrillated in one and was not fully examined in one knee as arthroscopy was abandoned during surgery due to technical failure of the scope. Of the 3 tibial articular surfaces reported to have irregular surface on MRI, in 2 it was confirmed irregular but was normal in one on arthroscopy. Tibial articular cartilage described to show degenerative changes on MRI was reported normal on arthroscopy. The sensitivity and specificity of the MRI for tibial articular cartilage pathology was 16.7% and 93.9% with a positive predictive value of 50% and a negative predictive value of 73.8%.

Tibial Articular Cartilage		**ARTHROSCOPY FINDINGS**				
MRI FINDINGS	Total	Not seen	Normal	Irregular surface	Ulcer to the bone	Other
Not seen	0	0	0	0	0	0
Normal	42	1	31	8	1	1
Irregular surface	3	0	1	2	0	0
Ulcer to bone	0	0	0	0	0	0
Other Lesion(s)	1	0	1	0	0	0
Total	46	1	33	10	1	1

Table 10: Tibial articular cartilage: MRI findings Correlated with Arthroscopy.

5.2.7 BONE LESIONS

Varied bone lesions were described on MRI in 13 (28.3%) of the 46 knees included in this study. The commonest bone lesion reported on MRI was bone bruise/edema. Bone bruise/edema was reported in the lateral femoral condyle in 5 knees, in the lateral tibial condyle in 5 knees, in the medial femoral condyle in 2 knees and in the medial tibial condyle in one knee. Other bone lesions seen on MRI included bony osteonechrosis reported in the medial tibial condyle in 2 knees and in the lateral femoral condyle in one knee. A Subchondral cyst was reported in one lateral femoral condyle. All these lesions were not seen on arthroscopy (the bones remain hidden to the arthroscope).

5.2.8 THE PATELLA TENDON

The patella tendon was normal on MRI in 43 (93.5%) of the 46 knees reviewed. Signal change signifying edema (tendinosis) was reported in two knees while partial rupture of the tendon was described in one. On arthroscopy, one of the two patella tendons reported on MRI to have edema was normal while the other was confirmed a case of patella tendinosis with a taut ligamentum pericase. The patella tendon reported to have partial rupture on MRI was normal on arthroscopy and of the 43 patella tendons reported normal on MRI, 40 were confirmed normal, one was reported hypertrophied and two were not seen (one due to generalized synovitis in the joint while in the other, arthroscopy was abandoned before the tendon was examined due to the technical failure of the scope during the surgery).

5.2.9 THE SYNOVIUM

This was normal on MRI in 45 (97.8%) of the 46 knees reviewed. Generalized synovitis was reported in one Knee on MRI and confirmed on arthroscopy. Of the 45-reported normal on MRI, generalized synovitis was seen in 3, local synovitis in 5 while white crystals were seen in one in the Synovium on arthroscopy.

5.2.10 JOINT EFFUSION

Joint effusion was described as being mild, moderate or severe. On MRI, 16 (34.8%) of the 46 knees studied had no effusion, of which 15 were confirmed with the remaining 1 being reported to have moderate effusion on arthroscopy. 11(23.9%) had mild effusion on MRI, 10 of which had no effusion while 1 was described to have moderate effusion on arthroscopy. 17 (37.0%) had moderate effusion on MRI, 16 of which had no effusion while 1 was described to have moderate effusion on arthroscopy. 2 (4.3%) had severe effusion on MRI but were reported to have none on arthroscopy (Table 11).

Joint Effusion		**ARTHROSCOPY FINDINGS**		
MRI FINDINGS	Total	No effusion	Moderate effusion	Severe effusion
No effusion	16	15	1	0
Mild effusion	11	10	1	0
Moderate effusion	17	16	1	0
Severe effusion	2	2	0	0
Total	46	43	3	0

Table 11: Joint effusion: MRI findings Correlated with Arthroscopy.

5.2.11 OTHER INTRA-ARTICULAR JOINT LESIONS SEEN

Other intraarticular knee pathologies were seen in 11 (23.9%) of the 46 knees included in this study. These included intra-articular loose bodies (seen on MRI in 2 knees), Lateral parameniscal cysts (seen in 3 knees) and small Baker's / Popliteal cysts (seen in 3 knees). Infrapatellar fat pad injury, calcification in the popliteal region and edema in the soft tissues surrounding the knee joint were described in one knee each respectively.

Other Joint Pathology		ARTHROSCOPY FINDINGS						
MRI FINDINGS	Total	Normal/not seen	Loose body	Ligamentum Mucosae	Lateral Parameniscal cyst	Erosive Chondral lesion	Intra-articular cystals	Medial Plicae
Normal	35	29	2	2	0	1	0	1
Loose body	2	0	2	0	0	0	0	0
Lateral Parameniscal cyst	3	1	0	0	2	0	0	0
Popliteal (Baker's cyst)	3	3	0	0	0	0	0	0
Soft tissue calcification	1	0	0	0	0	0	1	0
Infrapatellar fat pad injury	1	1	0	0	0	0	0	0
Soft tissue edema	1	1	0	0	0	0	0	0
Total	46	35	4	2	2	1	1	1

Table 12: Other joint pathology: MRI findings Correlated with Arthroscopy.

Of the 35 knees reported normal on MRI, Loose bodies were seen on arthroscopy in 2 while Ligamentum mucosae, erosive chondral lesion and Medial plicae were described in 2 knees, 1 knee and 1 knee respectively. Loose bodies reported in 2 knees on MRI were confirmed on arthroscopy. The lateral parameniscal cysts reported in 3 knees on MRI were associated with lateral meniscal tears and in 2 of the knees, the cysts were confirmed on arthroscopy while the lateral compartment of the third knee was not fully examined as arthroscopy was abandoned during surgery due to technical failure of the scope. Soft tissue calcification seen in 1 knee on MRI was confirmed to be intra-articular crystals on arthroscopy. Knees reported to have popliteal cyst (Baker's cyst), infrapatellar fat pad injury and soft tissue edema on MRI were all reported normal on arthroscopy.

CHAPTER SIX

6.0 DISCUSSION

The objective of this study was to determine the pattern of presentation of knee joint pathology as well as to find out the correlation between the radiological and arthroscopic findings in the knee in patients seen at five radiological imaging centers in Nairobi.

Pattern of presentation of knee joint pathology

Males (58.7%) were more affected than females (41.3%). Majority of the patients were in the 26-50 years age group, with the right knee (67.4%) being affected more than the left (32.6%).
The commonest findings encountered were meniscal tears and joint effusions constituting 78.3% and 65.2% of the cases seen respectively. Both showed a male predilection.
Other pathologies seen included chondromalacia patellae, cruciate ligament tears, collateral ligament disruptions, bone bruises, patella tendinosis, synovitis and intraarticular loose bodies.

Correlation between the radiological and arthroscopic findings

Overall, this study has highlighted a positive correlation between accuracy of MRI results and arthroscopic findings for intra-articular knee pathology (especially ACL and meniscal lesions), using arthroscopy results as a gold standard.
MRI showed a high sensitivity in the medial meniscus, where it was sensitive in detecting a tear in 88.9% of cases. Sensitivity for tears in the lateral meniscus was higher at 93.3%. However, specificity for a meniscal tear was lower in the medial meniscus than in the lateral meniscus (36.1% and 63.3% respectively). The sensitivity and specificity of the MRI for anterior cruciate ligament rupture (whether complete or partial) was 83.3% and 90.9% respectively. For the articular cartilage, sensitivity was 46.2% and 16.7% for femoral and tibial articular cartilage abnormalities with a specificity of 81.8% and 75.0% respectively. The sensitivity and specificity of the MRI for chondromalacia patellae was 26.7% and 81.8% respectively.
Use of MRI in diagnosis of intra-articular knee pathology is relatively new in our setup. Musculoskeletal MRI has a long learning curve and this may partly explain the lower specificities in diagnosis of intra-articular knee lesions seen in this study. From this, it is important to note that if MRI was to be used as the only form of pre-operative screening for these conditions, then there may well have been unnecessary arthroscopies performed.

MRI in the diagnosis of meniscal and cruciate ligament tears

The menisci are the most often damaged structures in the knee joint. The most common site for meniscal tear is the posterior horn of the medial meniscus. The a fore mentioned differences between medial and lateral meniscus (see page 7), and the predominantly medial loading in the lower extremity render the lateral meniscus less susceptible to tears. In the literature, the sensitivity of MRI in the diagnosis of medial meniscal tears is reported to be 87–97%, sensitivity for lateral meniscal tears is 69–92%; specificities are 82–91% and 91–98% respectively (20-32). Thus, the performance of MRI is clinically excellent especially if one takes into account that small peripheral tears missed by MRI are not clinically relevant, and that arthroscopy is not an ideal gold standard. When the anterior cruciate ligament (ACL) is torn, accuracy for meniscal tears decreases and especially tears in the posterior lateral meniscus may be missed.

The accuracy and sensitivity of MRI for complete cruciate tears are reported to be between 92% and 100% (21,22,23,29,45,46). It is likely that MRI is more accurate in the diagnosis of partial cruciate ligament tears than arthroscopy. On the other hand, partial tears are commonly over diagnosed. The term partial tear of the ACL remains controversial, as partial ruptures are difficult to define in equal terms by the radiologist and the orthopaedic surgeon. Therefore, a scoring system proposed by Rubin et al. (47) that distinguishes between high- and low-grade injuries and thereby discards the diagnosis of partial rupture, will probably facilitate communication with the orthopaedic surgeon.

MRI in the diagnosis of other knee pathology

The extent of cartilage abnormalities can be concealed when MRI is used as the only diagnostic tool. Arthroscopic evaluation is more useful than radiographs or MRI to grade osteoarthritis and assess surface cartilage abnormalities. MRI may miss superficial cartilage abnormalities but is more sensitive at revealing deep chondral lesions, and also helps locate subchondral lesions undetectable by arthroscopy (48). FSE sequences and especially 3D fat-suppressed GE sequence are the most commonly used cartilage sequences (49-53). This is further facilitated by the fact that magnetization transfer contrast (MTC) effects in TSE sequences result in excellent contrast between synovial fluid and cartilage. MTC decreases when collagen is disrupted leading to increased signal intensity. TSE is fast, has good signal-to-noise ratio and probably detects larger cartilaginous defects with acceptable accuracy. Small defects are not well visualized but tend to be of little clinical concern. In addition to 3D fat-suppressed GE and FSE sequences, the steady-state water excitated sequences are useful in the examination of the cartilage. The main issue in this very effective sequence is the necessity of homogeneous magnetic field.

MRI is useful to diagnose bone injuries in patients with acute knee effusions who have no ligament laxity on examination and normal findings on plain radiograph. Bone injury is the most common cause of acute effusion in this group of patients (54). An anterior–posterior measurement of 10 mm of fluid or less in the lateral aspect of the suprapatellar pouch is a reasonable threshold value for distinguishing a physiologic from pathologic amount of fluid in the knee joint (55).

Lesions in extra-articular spaces, which remain hidden at arthroscopy, are more likely to be detected with MRI. In our study, Knees reported to have popliteal cyst (Baker's cyst), infrapatellar fat pad injury and soft tissue edema on MRI were all reported normal on arthroscopy. All these lesions remain hidden to the arthroscope.

False positives and false negatives

MRI studies have higher false positive than false negative results (56). We also found this to be true when examining the combined results from meniscal lesions and ACL tears.

Radial meniscal tears are difficult to visualize on MRI; hence, they account for a large number of tears missed by MRI. However, MRI is a useful diagnostic tool in detecting radial tears of the posterior horn of the medial meniscus, which are common in elderly patients who also often have osteoarthritis that masks their symptoms. In this study, out of 6 radial tears reported on arthroscopy, only 2 (33.3%) had been described on MRI. Radial tears involve the free edge of the meniscus. Thus, the key to interpretation of this injury is the recognition of absence or blunting of the inner point of the meniscal triangle (57).

False positive MRI scans seen in the posterior horn of the medial meniscus may reflect an inability to completely visualize the area at arthroscopy, and tears that extend to the inferior surface of the meniscus may be difficult to see (58). Some false positive findings on MRI can be attributed to inadequate visualization of the meniscus at surgery and to the fact that the diagnosis of a tear can be subjective (28).

The high NPV and high specificity confirm the use of MRI as a screening tool highly predictive in avoiding unnecessary arthroscopies. The MRI examination techniques recommended in the literature at present are not able to replace arthroscopy for diagnosis of cartilage damage in the knee (59). Although MRI is being used with increasing frequency, it is unlikely to replace clinical diagnosis. It should be used in connection with clinical findings and history to provide a more complete picture. Clinical examination when combined with MRI, as earlier pointed out, provides the most accurate non-invasive source of information currently available for pathological findings in the menisci and the ACL (60).

MRI films need to be carefully examined because a meniscal tear is unlikely when MRI scans show a focus of high signal in a meniscus that does not unequivocally extend to involve the surface of the meniscus. In this study, all the ten medial and lateral menisci reported on MRI to have degenerative changes were normal on arthroscopy. Grade 1 and 2 signals (degenerative changes) are focal or linear areas of high signal confined to the substance of the meniscus with intact outer contour lines: these are not visible at arthroscopy and would be classified as a false positive result as in this study leading to unnecessary arthroscopy. Grade 1 and 2 signals (degenerative changes) are not indications for arthroscopy.

MRI is non-invasive but arthroscopy has surgical risks, with a complication rate of 2.5% in arthroscopic meniscal surgery (61). These complications include operation on wrong limb, saphenous and peroneal nerve injures, deep infections, superficial infections, vascular injuries and pulmonary embolism. Sometimes, arthroscopy reveals no abnormality or possibly minor non-pathological lesions such as plicae or chondromalacia patellae. This means that a patient could be exposed to surgical risk with no symptom benefit.

Technical aspects of MRI that may affect accuracy of diagnosis of knee pathology

It is important to note that there is no standard Knee MRI protocol and most institutions establish their own routine protocol, which provides adequate visualization and answers the majority of questions. However, the choice of slice thickness, field of view, coil, and imaging matrix play an important role in determining spatial resolution. Improved spatial resolution provides the radiologist with data to present interpretation with confidence. The bandwidth is another important factor that may affect imaging especially at high field strengths. The signal-to-noise ratio can also be improved by using a narrow receive bandwidth. One disadvantage of narrow bandwidth is the increase in chemical shift artefact and spatial misregistration, which is increased at the interfaces between cortical bone, hyaline cartilage and fibrocartilage. This effect may adversely affect diagnostic accuracy as these artefacts can simulate or obscure thinning of the cortex or overlying hyaline cartilage. Fat-suppression techniques eliminate chemical shift misregistration and so a narrow bandwidth can be used with these latter techniques.

Magnetic field strength is another important factor, which is not under the practitioner's control. Diagnostic quality in knee imaging has been researched and reported with field strengths ranging from 0.2 to 1.5T. The levels of confidence in reporting was better in high field strength than low field strength and in general, lower field strengths units must use more signal averages to provide equivalent quality as that obtained with high field strengths. This results in increased scan times. All these technical issues together with the expertise of the radiologist may contribute to differences in the reliability of the different centers. This study did not take into account some of these technical considerations as they were considered beyond the scope of the study.

CHAPTER SEVEN

7.0 CONCLUSION AND RECOMMENDATIONS

7.1 CONCLUSION

MRI is able to detect most internal derangements of the knee efficiently, for example in our study it was accurate in detecting a medial meniscal tear in 88.9% of the cases. Generally, MRI has a higher specificity (i.e. correctly identifies the absence of an internal derangement of the knee) than sensitivity (i.e. accurately identifying an internal derangement of the knee). As was shown in this study, MRI also has a higher NPV (reliability of a negative MRI result) than PPV (reliability of a positive MRI result). Thus, if a patient is given a result of a negative MRI scan, the high specificity and NPV of the scan mean that this is likely to be a true negative result.

MRI is the most appropriate screening tool prior to performing a therapeutic arthroscopy. It is preferable to diagnostic arthroscopy in most patients because it is faster and avoids surgical risks. However, MRI is not 100% accurate: if an MRI is reported as negative but the patient is still complaining of ongoing symptoms, then arthroscopy should be considered.

The results of this study support the use of MRI in the diagnosis of internal derangements of the knee. However, it should always be used in conjunction with a full history and clinical examination.

7.2 RECOMMENDATIONS

- Establishment of an imaging protocol would standardize examinations and reduce variability in results. This might involve:
    - A standard MRI protocol for knee imaging and modification where necessary.
    - Recommendations on Contrast media use in knee MR imaging for example in delineation of bone tumours, scar tissue in repeat surgery, repeat trauma and in inflammatory (non traumatic) lesions like patella tendinosis and meniscal cysts.
    - Standardization of print settings for hard copies would ease review of retrospective cases. A standardized way of interpreting the Knee MR images would also increase the accuracy of the reports.
- Availability and affordability- During the time of this study, two more centers offering MRI services opened up to the public, and with these and more opening up, MR imaging is bound to be more available but there is still serious need to make it more affordable.

- Sensitization of clinicians on the benefits of MR imaging of the knee- MRI is able to detect most internal derangements of the knee efficiently and with improvement in technology and its use in musculoskeletal imaging, there is need to keep our colleagues abreast with these developments for improved management of patients.
- Records – great difficulty was encountered in acquiring clinical data both retrospectively and prospectively. Clinicians need to be sensitized on the need to provide accurate and exhaustive information on the patients they send for imaging. This aids in interpretation of the imaging findings.
- Possible areas of future research include:
    - A study to determine the local etiological factors of specific lesions for example role of trauma as an etiological factor of the commoner pathologies would prove useful in aiding in their prevention.
    - Use of specific MRI sequences to identify pathology in each of the various tissues in and around the knee (ligaments, menisci, tendons, articular surface and bone), while keeping the investigation within acceptable times and costs.
    - Patella and articular cartilage pathologies seen proved to be diagnostic challenges radiologically. A more extensive radiologic-arthroscopic correlative study to assess pathologies of the articular cartilage would prove useful.

APPENDICES

APPENDIX 1: DATA COLLECTION FORM

Patients study No.......................................

PATIENTS DEMOCRAPHIC DATA

Age ....years
Sex ....01: M 02: F

CLINICAL HISTORY AND DIAGNOSIS

KNEE: .... 01: Right Knee 02: Left knee
CLINICAL HISTORY:
....
....

CLINICAL IMPRESSION: ....

RADIOLOGICAL EXAMINATIONS AND DIAGNOSIS

a) PLAIN RADIOGRAPHY FINDINGS / DIAGNOSIS (If available):
....
....

b) ARTHROGRAPHY FINDINGS / DIAGNOSIS (If available):
....

c) MRI FINDINGS AND DIAGNOSIS:
MRI No: .... Date MRI done: ....
MRI Centre of study: .... 01: KNH 03: MITC
02: AKUH 04: MRI Centre- Nairobi
AGE OF INJURY: .... 01: Fresh Injury (<2weeks) 02: Old Injury (>2weeks)
MRI FINDINGS AND DIAGNOSIS:

1) MENISCUS: MEDIAL.......................... LATERAL......................................

01 Not seen	04 Horizontal tear	07 Flap tear
02 Normal	05 Longitudinal tear	08 Degenerative
03 Radial tear	06 Bucket handle tear	09 Others (specify)

2) COLLATERAL LIGAMENTS: MEDIAL ....LATERAL...................................

01 Not seen	04 Meniscotibial ligament damaged
02 Normal	05 Others (specify)
03 Meniscofemoral ligament damaged	

3) CRUCIATE LIGAMENTS: ANTERIOR........ POSTERIOR................................

01 Not seen	03 Partial rupture	05 Others (specify)
02 Normal	04 Complete rupture	

4) PATELLA...

01 Not seen	03 Chondromalacia	05 Others(specify)
02 Normal	04 Subluxation	

5) PATELLA TENDON...

01 Not seen	03 Partial rupture	05 Others(specify)
02 Normal	04 Complete rupture	

6) POPLITEAL TENDON..

01 Not seen	03 Partial rupture	05 Others(specify)
02 Normal	04 Complete rupture	

7) CARTILAGE..

01 Not seen	03 Irregular surface	05 Others(specify)
02 Normal	04 Ulcer to the bone	

8) Synovia..

01 Not seen	03 Local synovitis	05 Others(specify)
02 Normal	04 General synovitis	

9) MRI DIAGNOSIS:...
....

ARTHROSCOPIC EXAMINATION AND DIAGNOSIS

Hospital No: .... Date Arthroscopy done:...............................

Hospital where arthroscopy done: ....

AGE OF INJURY: .... 01: Fresh Injury (<2weeks) 02: Old Injury (>2weeks)

ARTHROSCOPY FINDINGS AND DIAGNOSIS:

1) MENISCUS: MEDIAL.............................. LATERAL..

01 Not seen	04 Horizontal tear	07 Flap tear
02 Normal	05 Longitudinal tear	08 Degenerative
03 Radial tear	06 Bucket handle tear	09 Others (specify)

2) COLLATERAL LIGAMENTS: MEDIAL .... LATERAL...................................

01 Not seen	04 Meniscotibial ligament damaged
02 Normal	05 Others (specify)
03 Meniscofemoral ligament damaged	

3) CRUCIATE LIGAMENTS: ANTERIOR........ POSTERIOR................................

01 Not seen	03 Partial rupture	05 Others (specify)
02 Normal	04 Complete rupture	

4) PATELLA..

01 Not seen	03 Chondromalacia	05 Others(specify)
02 Normal	04 Subluxation	

5) POPLITEAL TENDON..

01 Not seen	03 Partial rupture	05 Others(specify)
02 Normal	04 Complete rupture	

6) CARTILAGE...

01 Not seen	03 Local synovitis	05 Others(specify)
02 Normal	04 General synovitis	

7) Synovia..

01 Not seen	03 Local synovitis	05Others(specify)
02 Normal	04 General synovitis	

8) Arthroscopy diagnosis

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CONCLUSION

MRI diagnosis confirmed correct on Arthroscopy
MRI diagnosis confirmed incorrect on Arthroscopy

COMMENTS:

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