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" Distribution Of Cartilage Thickness In Knee Joint Of Osteoarthritis Patients Using 3t Mri"

Dr. Ravichandra .G.[1] Dr. Akbar Ali C M.[2] Dr.Reyan Rauf K.E.[3]

[1]*(Professor and HOD Department Of Radiodiagnosis, Yenepoya Medical College, Mangalore, Karnataka, India.)*
[2]*(Postgraduate, Department Of Radiodiagnosis, Yenepoya Medical College, Mangalore, Karnataka, India.)*
[3]*(Postgraduate, Department Of Radiodiagnosis, Yenepoya Medical College, Mangalore, Karnataka, India.)*

ABSTRACT:
BACKGROUND:
Osteoarthritis is a highly prevalent and severely debilitating chronic disease . Characteristic changes in the cartilage macromolecular matrix occur with osteoarthritis, including a decrease in proteoglycan content and disruption of the highly organized collagen fiber network . Various quantitative magnetic resonance (MR) imaging techniques have been used to identify changes in the composition and ultrastructure of articular cartilage in patients with osteoarthritis.
AIM: *To study the distribution of cartilage thickness in knee joint of osteoarthritis patients using 3T MRI and report the same.*
RESULTS:
In our study the average cartilage articular thickness of medial femoral compartment was found to be 3.2mm, in lateral femoral compartment was 2.5mm, medial tibial compartment was 2.5mm, lateral tibial compartment was 2.1mm, medial patellar compartment was 2.1mm and lateral patellar compartment was about 2.3mm. Maximum cartilage articular thickness of medial femoral compartment was found to be 3.4mm, lateral femoral compartment was 3.8mm, medial tibial compartment was 3.8mm, lateral tibial compartment 5 , medial patellar compartment was 5.2mm and lateral patellar compartment was about 5.3mm..Minimum cartilage articular thickness of medial femoral compartment was found to be 1.8mm, lateral femoral compartment was 1.9mm, medial tibial compartment was 1.8mm, lateral tibial compartment 2mm , medial patellar compartment was 2.1mm and lateral patellar compartment was about 1.8 mm.
CONCLUSION:
Cartilage is important factor in any joint disease. Indications for MRI of the cartilage include both the detection of cartilage damage and monitor treatment such as cartilage repair procedures and pharmacological therapies. Early identification of cartilage damage, either post traumatic or degenerative, is indispensable for treatment at an early stage of osteoarthritis. Both quantitative and qualitative measurements of the cartilage are needed for the follow-up of disease progression and its response to treatment.

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I. Introduction

Osteoarthritis (OA) of the knee occurs in a substantial portion of the population over the age of [1]. Yet there is limited information on the underlying causes of knee OA or reasons why the rate of disease progression varies significantly between patients.[2] Prevention and improvements in treatment for OA at the knee would benefit from a better understanding of the factors contributing to the onset and progression of the disease. The causes of degenerative changes to articular cartilage are complex and involve interrelated biological mechanical [3] and structural pathways [4]. The interrelationship or coupling of these pathways converges at an in vivo systems level in humans I.n vivo function influences the mechanical environment of articular cartilage and the mechanobiology of the tissue [5]. Thus, in vivo function is coupled to the structure and health of the joint. Patients can functionally adapt to pathological joint changes such as ligament injury or degeneration of the articular cartilage. For example, it has been observed from in vivo studies [6], that some patients with knee OA can adopt patterns of locomotion that lower the load at the knee and reduce the rate at which OA progresses. Variations in the soft tissue properties or structure[7], of the joint can influence the congruency and laxity of the joint and produce substantial variations in contact stress and joint motion that impact the mechanical environment of the cartilage. Cartilage adapts to mechanical stimuli and ultimately becomes dependent on the maintenance of that mechanical stimulus for normal tissue function. Cartilage health depends on the body's ability to maintain the equilibrium between degeneration and synthesis of cartilage constituents including collagen fibrils and proteoglycans. Chondrocytes, the cells of cartilage, retain this equilibrium by controlling enzymatic processes.[8]

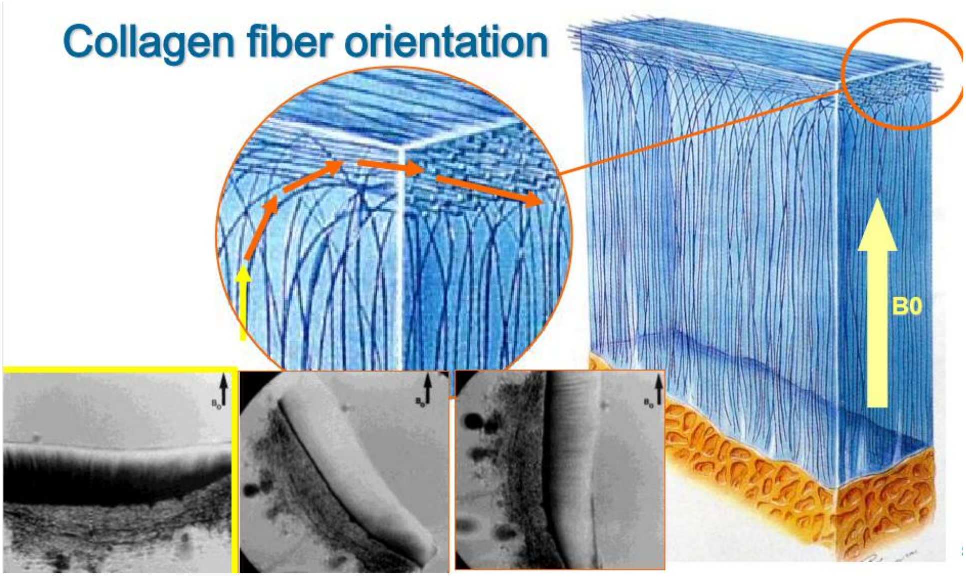


Figure 1 : collagen fibre orientation in cartilage

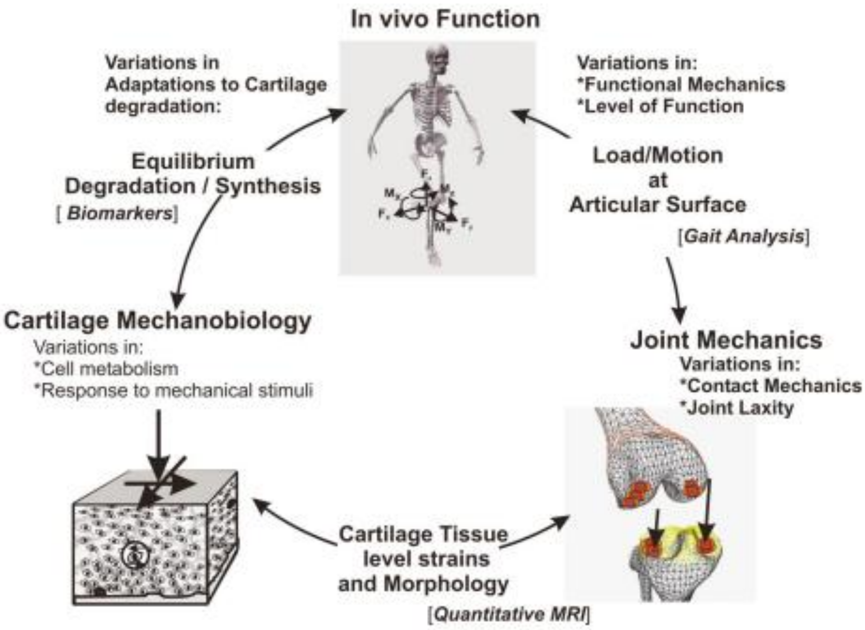


Figure 2: Pathways of Osteoarthritis (OA) of the knee

II. Material And Methods

This study will be conducted in the department of Radiodiagnosis , Yenepoya Medical College, MANGALURU , from October 2017 to September 2019,who meet the inclusion and exclusion criteria..This was a cross sectional study Cross sectional study conducted over a period of 24 months from november 2017 to october 2019.

All MR examinations were performed on a **3-Tesla MRI Scanner MRI (Signa Pioneer 3T, General Electric Healthcare)**.Routine MRI sequences along were done using with the MRI parameters .

Compartmentalization of both the knee compartments was done to allow structured assessment and prevent sampling error. The femur was divided into two sub-regions on the sagittal view - medial and lateral femoral condyle .Similarly tibia was divided into two sub-regions on the sagittal view - medial and lateral tibial condyle .Each femorotibial compartment was thus divided into 4 sub-regions for wholesome assessment of cartilage thickness and cartilage morphology. Patellar cartilage was divided into medial and lateral by the trochlear groove in the midline .Average cartilage thickness was measured in each compartment by taking five arbitrary measurements in each compartment and final single value was taken as the average of all the values in each compartment.

Source of data/Sampling method: This study was conducted in the department of Radiodiagnosis , Yenepoya Medical College, MANGALURU , from October 2017 to September 2019,who met the inclusion and exclusion criteria. .

Study Design : Cross sectional study.

Study Period : 24 Months (november 2017 - october 2019.)

STUDY DESIGN:
Cross sectional study.

Approval of the Institutional ethics committee was taken before conducting the study. The study was conducted in accordance with the ethical norms as laid down in the Declaration of Helsinki. Written consent was taken from the subjects before enrolling them for the study.

This study was carried out in the department of Radio diagnosis in Yenepoya medical college. Study was carried out over a period of 24months. Informed consent was taken.The study group consisted of 80 patients who underwent MR imaging of the knee joint. MR imaging was performed at 3.0 T by using a routine .Images from all MR examinations were reviewed first by using the routine MR protocol .Generalized estimating equation models were used to compare the sensitivity and specificity of the routine MR imaging protocol in the detection of knee joint articular cartilage.

INCLUSION CRITERIA

- All the suspected or confirmed cases of osteoarthritis referred to MRI imaging of knee joint were included in study .

EXCLUSION CRITERIA

- Patient with recent history of trauma.(last 6 months)
- Tumours around knee joint.
- Knee implants.
- Patient with history of knee joint surgery.
- Patients with claustrophobia
- Patients with Pacemaker.
- Pregnant women

Summary of MR Imaging Parameters

Parameters	Axial Proton density Fat-saturated	Coronal Proton density Fat-saturated	Coronal Fat-saturated T1	Sagittal Proton density Fat-saturated	Sagittal T2	
Fieldof vision(cm)	14.0	16	16	14	14	
Section thickness (mm)	3	3	3	3 3	3	
Spacing	1	1	1	0.5	0.5	
TE	40	40	Min full	40	35	
Flip angle	142	142	142	142	142	
Echo train length	8	8	3	8	18	
Frequency	320	320	512	320	320	
Phase	280	260	280	280	224	
NEX	4	3	2	3	1	

MR IMAGING PROTOCOL:
All MR examinations were performed on a **3-Tesla MRI Scanner MRI (Signa Pioneer 3T, General Electric Healthcare)**.Routine MRI sequences along with T2 cartilage mapping were done using with the MRI parameters as described above in the table.
Compartmentalization of both the knee compartments was done to allow structured assessment and prevent sampling error.

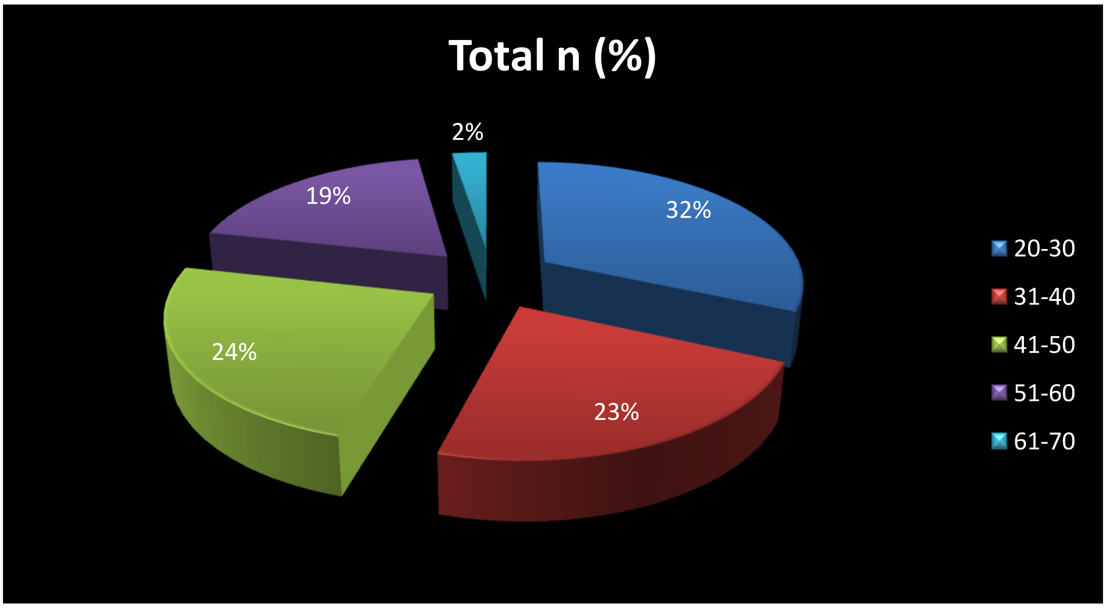
The femur was divided into two sub-regions on the sagittal view - medial and lateral femoral condyle .Similarly tibia was divided into two sub-regions on the sagittal view - medial and lateral tibial condyle .
Each femorotibial compartment was thus divided into 4 sub-regions for wholesome assessment of cartilage thickness and cartilage morphology.
Patellar cartilage was divided into medial and lateral by the trochlear groove in the midline.
Average cartilage thickness was measured in each compartment by taking five arbitrary measurements in each compartment and final single value was taken as the average of all the values in each compartment.

STATISTICAL ANALYSIS:
The data was entered and tabulated in Microsoft excel sheet. Appropriate descriptive statistical tests were used to describe the data.
Sample size (including sample size calculation and justification)
Using G*Power Software we got a sample of 80 with
Effect size d **= 0.3.**
Level of significance α = **5 %**
Power β = **80 %**

III. Results

1. Total number of patients
The total patients included in the study was 80 nos. fulfilling the inclusion criteria.
2. Age wise distribution
The mean age of the study population was 43 years,of which mean age of females was 43.8years and for males was 43.1years . Participants in age group of 20-30 years were 25(32%),31-40 years were 25(32%),20-30 years were 25(32%),20-30 years were 25(32%),20-30 years were 25(32%).

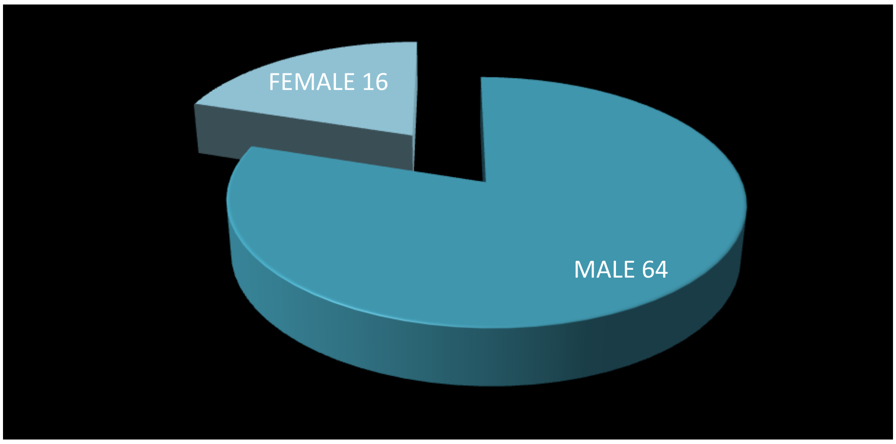
Age groups (years)	Total n (%)
20-30	25 (32)
31-40	18(23)
41-50	19(24)
51-60	15(19)
61-70	2(2)

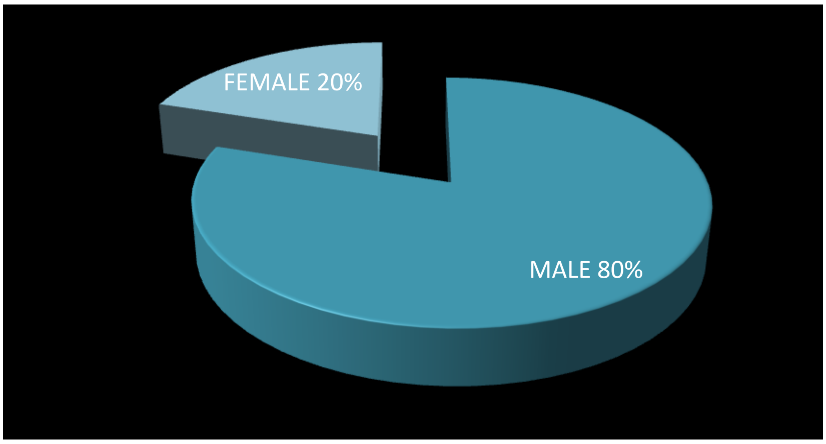


3.Gender distribution:

Among 80 subjects ,16 were females and 64 were male participants,with females being 20% of subjects and males being 80% of subjects.

TOTAL MALE	FEMALE	MALE
80	16	64

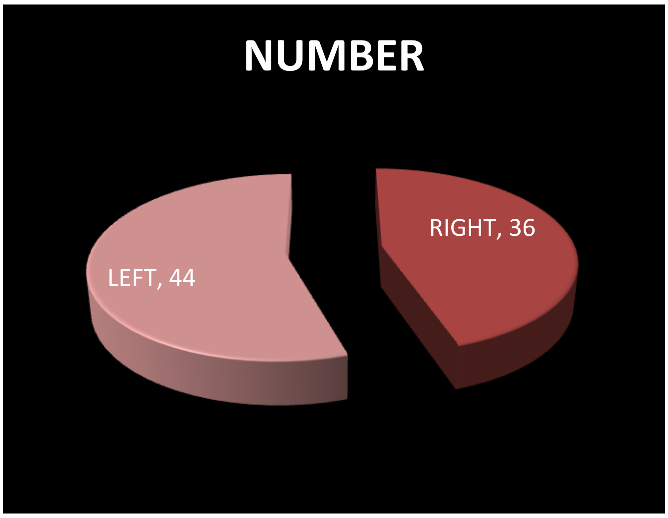


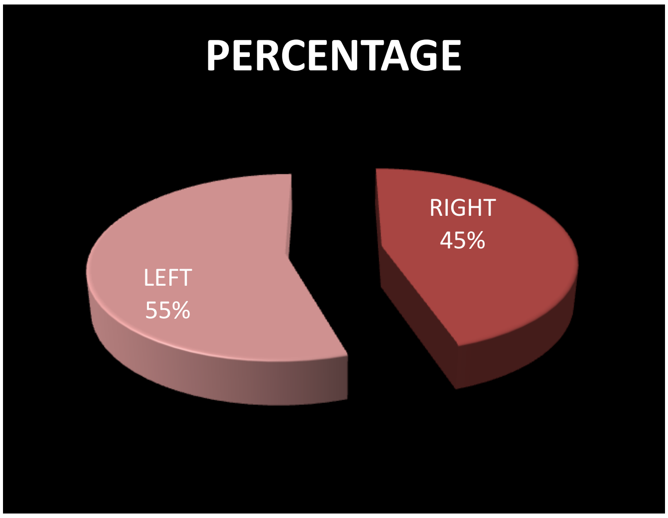


3.Side distribution:

Among 80 subjects examined ,36 were of right knee and 44 were of left knee.

RIGHT	LEFT	TOTAL
36	44	80

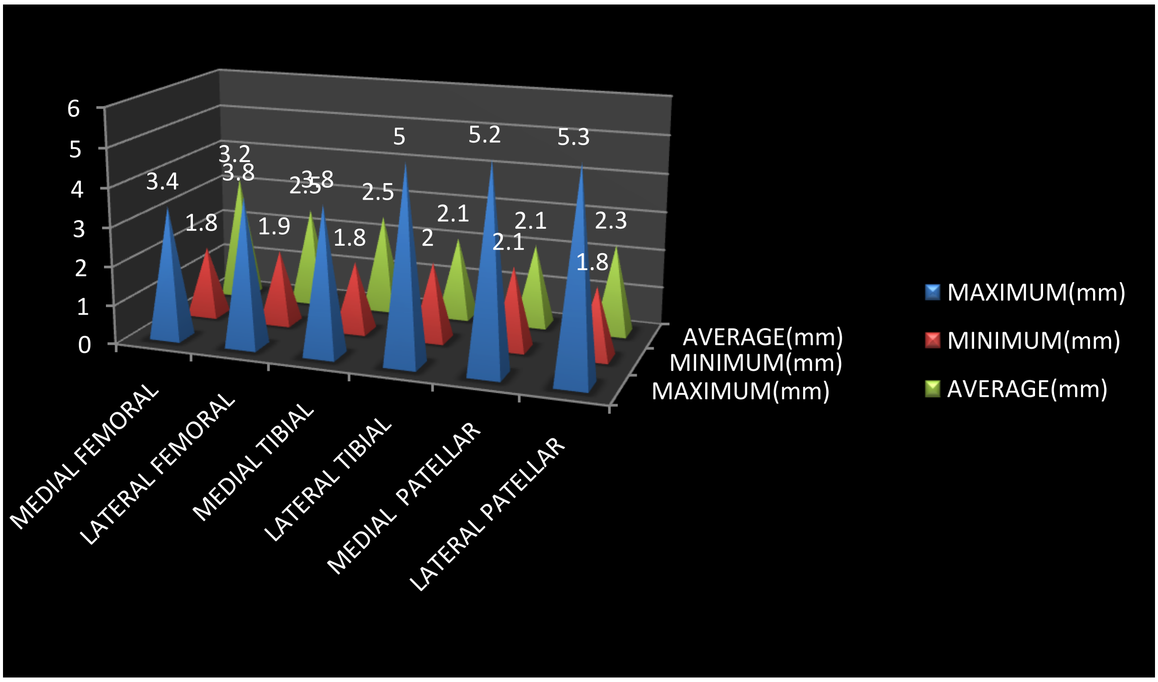




Average cartilage articular thickness of medial femoral compartment was found to be 3.2mm, in lateral femoral compartment was 2.5mm, medial tibial compartment was 2.5mm, lateral tibial compartment was 2.1mm, medial patellar compartment was 2.1mm and lateral patellar compartment was about 2.3mm Maximum cartilage articular thickness of medial femoral compartment was found to be 3.4mm, lateral femoral compartment was 3.8mm, medial tibial compartment was 3.8mm, lateral tibial compartment 5 , medial patellar compartment was 5.2mm and lateral patellar compartment was about 5.3mm. Minimum cartilage articular thickness of medial femoral compartment was found to be 1.8mm, lateral femoral compartment was 1.9mm, medial tibial compartment was 1.8mm, lateral tibial compartment 2mm , medial patellar compartment was 2.1mm and lateral patellar compartment was about 1.8 mm.

Distribution of cartilage thickness in various compartments in millimeter including average,minimum and maximum values.

COMPARTMENT	MAXIMUM(mm)	MINIMUM(mm)	AVERAGE(mm)
MEDIAL FEMORAL	3.4	1.8	3.2
LATERAL FEMORAL	3.8	1.9	2.5
MEDIAL TIBIAL	3.8	1.8	2.5
LATERAL TIBIAL	5.0	2	2.1
MEDIAL PATELLAR	5.2	2.1	2.1
LATERAL PATELLAR	5.3	1.8	2.3



IV. Discussion:

Evaluation of articular cartilage in symptomatic patients undergoing routine MR imaging of the knee joint is typically performed by using sequences that assess cartilage morphology.The main limitation of morphologic cartilage imaging sequences is their relatively low sensitivity in the detection of early cartilage degeneration.These sequences have been used extensively in osteoarthritis research studies to detect disease-and treatment related changes in articular cartilage.

In this imaging study of hyaline cartilage, the early degenerative changes in cartilage and other defects in cartilage were successfully demonstrated in our study. The majority of the patients had cartilage defects which were due to early degenerative changes in cartilage and any injury to the cartilage were clearly demonstrated in our study. In this study, we were able asses cartilage thickness that were visible on routine knee MRI protocol.

Cartilage is important factor in any joint disease. Indications for MRI of the cartilage include both the detection of cartilage damage and monitor treatment such as cartilage repair procedures and pharmacological therapies. Early identification of cartilage damage, either post traumatic or degenerative, is indispensable for treatment at an early stage of osteoarthritis. Both quantitative and qualitative measurements of the cartilage are needed for the follow-up of disease progression and its response to treatment.

Conventional MRI scan of the cartilage allows quantitative evaluation. It provides information about the shape and thickness of the cartilage and gives information about the cartilage defects. Currently used conventional MR cartilage imaging techniques such as proton density and 3D spoiled gradient echo sequences with or without fat suppression are insensitive to intra-substance alterations of cartilage composition. This is an important early marker for degenerative joint disease and suggests that qualitative assessment of cartilage is necessary.

MRI can be used as a non-invasive tool to study cartilage composition of repair tissue post cartilage repair procedures or to monitor the effect of chondroprotective therapy.

Morphologic assessment of articular cartilage by MRI specific sequences provides an excellent tissue contrast that gives detailed information of early chondral-based lesions or pathologies. An appropriate cartilage-based sequence should provide details of cartilage morphology, cartilage thickness.

Our study consists of 80 subjects in whom 64 were males and 16 females.The average age of male was 43.1 years and females was 43.8 years.

Average cartilage articular thickness of medial femoral compartment was found to be 3.2mm, in lateral femoral compartment was 2.5mm, medial tibial compartment was 2.5mm, lateral tibial compartment was 2.1mm, medial patellar compartment was 2.1mm and lateral patellar compartment was about 2.3mm Maximum cartilage articular thickness of medial femoral compartment was found to be 3.4mm, lateral femoral compartment was 3.8mm, medial tibial compartment was 3.8mm, lateral tibial compartment 5 , medial patellar compartment was 5.2mm and lateral patellar compartment was about 5.3mm.

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The p value of < 0.05 ,hence the association between the variables is found to be statistically significant.

The limitation of this study is that the cartilage findings at standard MRI knee were not confirmed with arthroscopy. While arthroscopy could be used to detect cartilage defects, it would be inadequate to assess for early or subtle intrinsic cartilage abnormalities as shown on T2 maps.Our study was a cross sectional study where, we did not have follow up of the cases.Follow up of the cases would ensue the significant impact of MRI in picking up early cartilage damage and help determine at risk cases of osteoarthritis in future.

V. Conclusion:

Cartilage is important factor in any joint disease. Indications for MRI of the cartilage include both the detection of cartilage damage and monitor treatment such as cartilage repair procedures and pharmacological therapies.

Early identification of cartilage damage, either post traumatic or degenerative, is indispensable for treatment at an early stage of osteoarthritis. Both quantitative and qualitative measurements of the cartilage are needed for the follow-up of disease progression and its response to treatment.

Conventional MRI scan of the cartilage allows quantitative evaluation. It provides information about the shape and thickness of the cartilage and gives information about the cartilage defects.

Currently used conventional MR cartilage imaging techniques such as proton density and 3D spoiled gradient echo sequences with or without fat suppression are insensitive to intra-substance alterations of cartilage composition. This is an important early marker for degenerative joint disease and suggests that qualitative assessment of cartilage is necessary.

IMAGE 1 : FULL THICKNESS CARTILAGE DEFECT IN MEDIAL FEMORAL AND TIBIAL COMPARTMENT

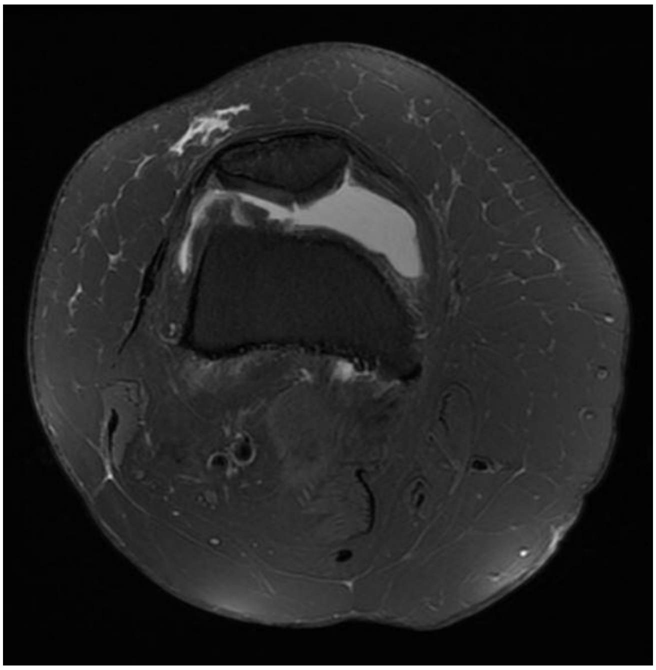

IMAGE 2 :GRADE I CHONDROMALACIA PATELLA

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