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Beyond the Surface: T2 Mapping of Knee Cartilage in Early Osteoarthritis

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Abstract

Background: Osteoarthritis (OA) of the knee poses a significant burden on global healthcare systems due to its prevalence and associated morbidity. Early detection and intervention are crucial for managing the progression of this degenerative joint disease. T2 mapping, a magnetic resonance imaging (MRI) technique, has emerged as a promising tool for assessing the biochemical composition and structural integrity of articular cartilage. A comprehensive review of literature establishes the rationale for employing T2 mapping in the context of OA pathophysiology.
Objectives: This study aims to investigate the utility of T2 mapping in evaluating early-stage knee OA by comparing T2 values in patients with early OA changes and no OA.
Methods: This study was conducted following approval from the institute's regulatory and ethics committees in 60 patients referred from the orthopedics department with clinical symptoms of osteoarthritis (OA) and those without clinical or radiological evidence of OA. Study was done on a 1.5 Tesla MRI scanner with a 8 -channel knee coil. T2 color maps were generated using default software settings and measured in 12 regions manually. Cartilage thickness analysis across knee compartments was done in axial, sagittal and coronal PDFS images.
Results &Discussion: IBM SPSS Statistics version 29.0 was used for data analysis. Statistical analysis using the unpaired t-test revealed a statistically significant increase in average T2 values (P = 0.0005) in early OA patients compared to controls without OA. Cartilage thickness analysis across knee compartments showed no significant differences between OA patients and controls without OA. These findings underscore MR T2 mapping's potential to detect early cartilage matrix degeneration in OA, despite similar cartilage thickness between groups.
Conclusion: The findings from this study contribute to enhancing our understanding of the early biochemical changes in knee cartilage

associated with OA progression. In conclusion, this thesis advocates for the integration of T2 mapping into clinical practice as a valuable adjunct to conventional imaging techniques for diagnosing and managing early osteoarthritis of the knee.

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Introduction:-

Osteoarthritis imposes a substantial burden on individuals in India, often leading to disability, highlighting the urgent need for medical intervention. It ranks as the most common musculoskeletal disorder nationally and represents a significant joint ailment, affecting approximately 22-30% of individuals in India (1)Various factors contribute to the development of osteoarthritis, including age, gender (particularly female), obesity, repetitive physical activity, occupational hazards like prolonged knee bending, familial predisposition, prior joint injuries, and insufficient vitamin D levels. Additionally, lifestyle factors such as stress, poor posture, infectious illnesses, and conditions like diabetes can exacerbate the condition(1).

Beyond symptom management, it is imperative to address and mitigate the risk factors associated with osteoarthritis through preventive strategies. Early stages of cartilage deterioration involve molecular alterations in collagen, shifts in water content, and proteoglycan loss. Hence, the potentiality to non-invasively recognize changes in the concentration of proteoglycan and integrity of collagen before visible morphological changes is crucial for early cartilage injury detection.MRI due to its ability to detect tissue differences is superior for detecting cartilage morphological alterations. However, conventional MRI fails to detect physiological and biochemical cartilage changes preceding morphological alterations.

Conventional MRI techniques commonly used include 2D or multi-slice T1-weighted, proton density (PD)-weighted, and T2-weighted imaging, with or without fat suppression(2). Recent advancements in imaging technology, such as improved gradients, radiofrequency coils, and fast or turbo spin-echo techniques like water-only excitation, have been adopted. While SPGR and GRE techniques have delivered high-quality images with resolutions as fine as 0.3×0.6×1.5mm, 3D-SPGR is currently regarded as the standard for morphological cartilage imaging (3). These methods have the disadvantages of lack of reliable contrast between cartilage and fluid and long imaging times. Therefore, newer techniques have emerged for morphologic imaging of cartilage, some of which include dual-echo steady-state (DESS) imaging, driven equilibrium Fourier transform (DEFT) imaging, balanced steady-state free precession (SSFP) imaging with fat suppression and its variants, such as fluctuating equilibrium MRI (FEMR), linear combination (LC) SSFP, IDEAL SSFP, phase sensitive SSFP, and vastly interpolated projection reconstruction (VIPR) imaging (4). However, these techniques are still limited in their ability to depict physiology and biochemistry of cartilage, although allowing time for application of other sequences to explore cartilage physiology .

Compositional MR imaging assessment focuses on the molecular status of artilage , particularly its collagen and glycosaminoglycan content ,providing valuable insights into the disease processes underlying osteoarthritis. They have provided valuable insights into the early and potentially reversible pathological changes in articular cartilage ,offering a potential avenue for mitigating the long term consequences of osteoarthritis .Various techniques such as T2 mapping ,delayed gadolinium –enhanced MR imaging of cartilage ,T1 ρ imaging ,sodium imaging and diffusion weighted imaging can be utilized to evaluate the collagen structure and proteoglycan levels within the matrix of knee cartilage (4).These methods can be utilized individually or in combination ,across various magnetic field strengths , to enhance the characterization of articular cartilages in both clinical and research settings. This study aims to investigate the utility of T2 mapping in evaluating early-stage knee OA by comparing T2 values in patients with early OA changes and no OA.

Materials and Methods:-

After obtaining approval from institute regulatory committee and ethics committee,the study was done in department of radiodiagnosis, KMCT Medical College , Mukkam, Kozhikode. Patients referred from the orthopedics department with clinical symptoms of osteoarthritis (OA), diagnosed clinically, as well as patients without clinical or radiological evidence of OA who were referred for MRI knee with an interest in cartilage mapping, were included in this study

from January 2023 to June 2024. Patients were screened using predefined inclusion/exclusion criteria. Relevant data for each patient were recorded after reviewing their case sheets and previous medical records. The final study population consisted of 60 patients, including 35 patients with clinical evidence of OA but no radiological evidence, and 25 patients without clinical or radiological evidence of OA who served as controls.

All MR T2mapping studies were performed in a 1.5 Tesla MRI scanner (Signa HDxt) using a 8 channel knee coil. To avoid T2 variations by physical activity, loading of the knee temperature and diurnal alteration, all individuals had a resting time about 30 min .The sequences specified in the protocol are as follows: sagittal T2, PDFS,coronal T1,coronal PDFS and STIR axial PDFS,T2 and axial, coronal and sagittal T2 mapping sequence. The T2 mapping total acquisition time was 15 min. T2 mapping sequence was acquired from the inferior aspect of the femoro tibial cartilage up to patellar cartilage superiorly.A T2 colored map was created using the default software settings and functions.The default parameters of T2 intensity are 25-75 ms. The color scale ranges from red to blue colors in which green or blue color corresponds to high T2 values on the color coded scale on at least 2 consecutive slices. The MR images were transferred to the workstation for the offline quantification of T2values. The average T2values were calculated by manually created elliptical ROI which is inspected on the sequences. ROI were created considering margin of 0.5 to 1mm from bone surface to prevent inclusion of subchondral bone.

Image post processing and analysis: The knee joint was divided into five compartments for MRI analysis
· Patella
· Medial femoral condyle
· Lateral femoral condyle
· Medial tibia
· Lateral tibia

This division allowed for focused assessment of each anatomical region affected by OA.

Measurement and Quantification:
1. T2 Values:
Quantified offline to assess cartilage integrity and degeneration. T2 values reflect the biochemical composition of cartilage and can detect subtle changes indicative of early OA. For measuring T2 values ,four sagittal slices spanning the femorotibial joint was selected ,with the two central slices in the medial and lateral femorotibial compartments chosen for analysis. Regions of interest (ROIs) were manually delineated on these four sagittal slices to encompass the entire area of femoral and tibial cartilage beween the meniscal bases. These areas were further categorized into anterior (cartilage under the anterior meniscal horn) ,central (cartilage not covered by either meniscal horn) ,and posterior zones (cartilage under posterior meniscal horn) .This resulted in a total of 6 distinct ROIs per slice in the representative cartilage T2 map(5). Great care was taken to ensure that ROIs avoided including subchondral bone or joint fluid ,and that they were consistently placed in the exact same positions across all examinations. To determine the mean T2 value for each specific cartilage area ,the mean T2 values of respective ROI s were aggregated and calculated ,taking into account the size of the ROIs. This method ensured a comprehensive and standardized assessment of cartilage T2 values across different regions of interest within the FTJ.

2. Cartilage Thickness:
Measured in each compartment to provide additional objective for metrics of cartilage health. Articular cartilage thickness was assessed using high resolution, proton density weighted fast-spin-echo sequences .Measurements were conducted perpendicular to the bone/cartilage interface ,spanning from the subchondral bone to the outer surface of the articular cartilage. Various axial, coronal and sagittal cuts were utilized for quantification. The axial image through the thickest part of the patellar cartilage was chosen. For coronal cuts ,a plane bisecting the femur on the axial images was identified and Cahill zones 1through 5 were marked. Three sagittal cuts included through the median ridge of the patella on the axial image ,another through the center of the medial femoral condyle on the coronal image .Sagittal slices of the medial and lateral femoral condyles were delineated into Cahill zones A,B and C34.At the patella measurements were taken at the midpoint of the medial and lateral facets on axial slices and at the median ridge on sagittal MRI .At the medial femoral condyle ,measurements were taken at five locations on coronal and sagittal images .The midpoint of the medial condyle, Cahill zones 1(MID1) ,2(MID2) ,B (MIDB) and C(MIDC).Similarly at the lateral femoral condyle ,measurements were taken at the midpoint of the lateral condyle and at Cahill zones 4(MID 4) ,5 (MID 5),B (MID B) and C(MIDC).The lateral trochlear cartilage thickness was measured at the midpoints of Cahill zone A (MID A).On the tibia measurements were made at the midpoint of the medial tibial plateau and the lateral tibial plateau on the coronal images (5).

Statistical analysis

For data analysis, IBM SPSS Statistics software version 29.0 utilized. Descriptive statistics such as frequency analysis and percentage analysis were employed to summarize categorical variables, while mean and standard deviation were used to describe continuous variables. This approach provides a clear overview of the data distribution and central tendency measures .To assess significant differences between independent groups, particularly in terms of T2 values or cartilage thickness ,the unpaired t -test was employed. This statistical test allows for the comparison of means between two groups and helps determine whether observed differences are statistically significant.

34 year old male presented with complaints of right knee pain ,predominantly in the medial aspect without any previous history of trauma or surgeries. X ray AP ,lateral knee showed KL score grade1

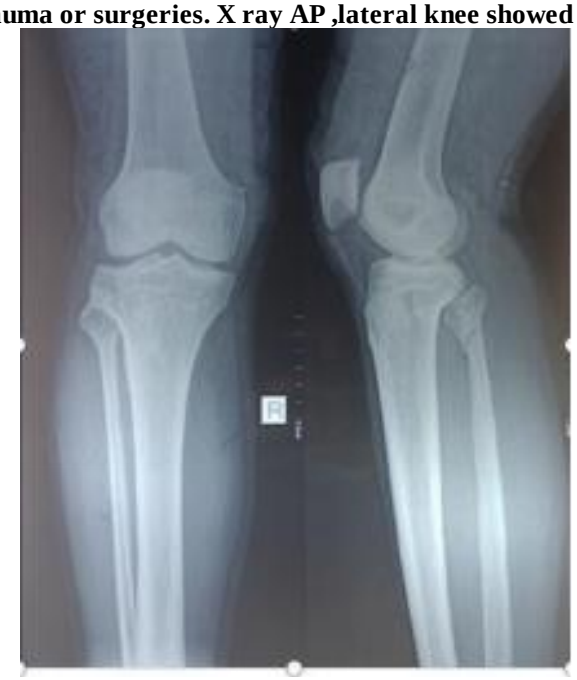

Fig1:-X rayright knee:AP and lateral view.

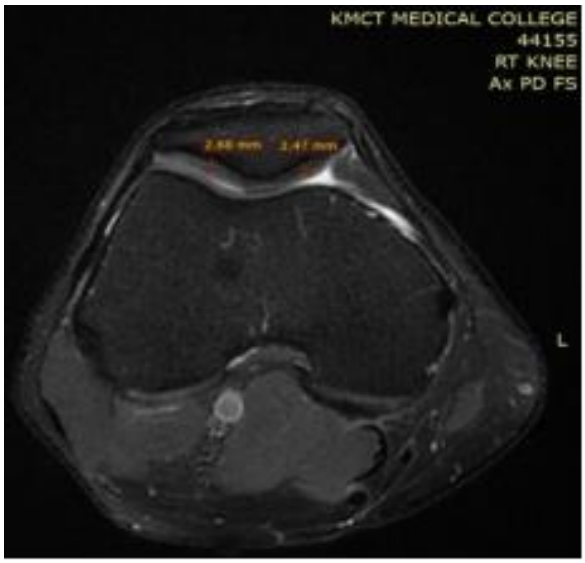

Fig2:-AxialPDFSwithmeasurementofretropatellarcartilagethickness.

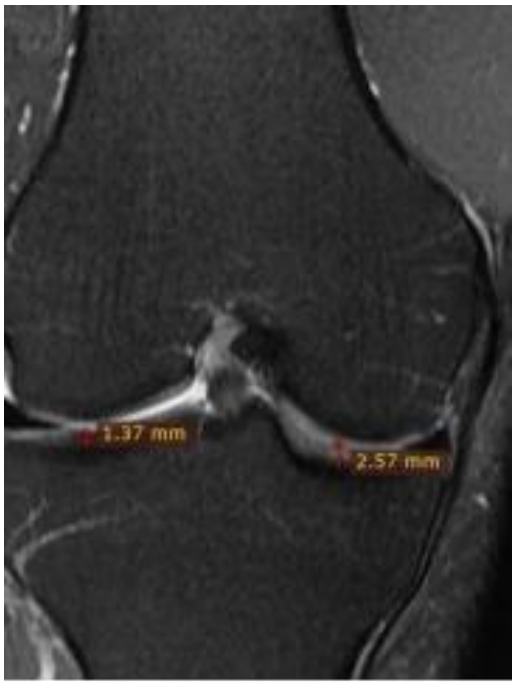

Fig 3:-Coronal PDFS showing measurement of tibial articularcartilage thickness in medial and lateral aspect.

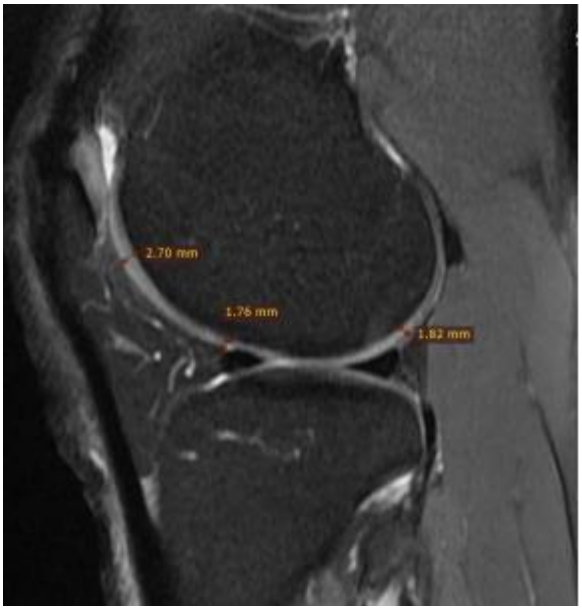

Fig4:-SagPDFSimageshowingarticularcartilagemeasurementinCahilzones MID A,MID B and MID C of lateral femoral condyle.

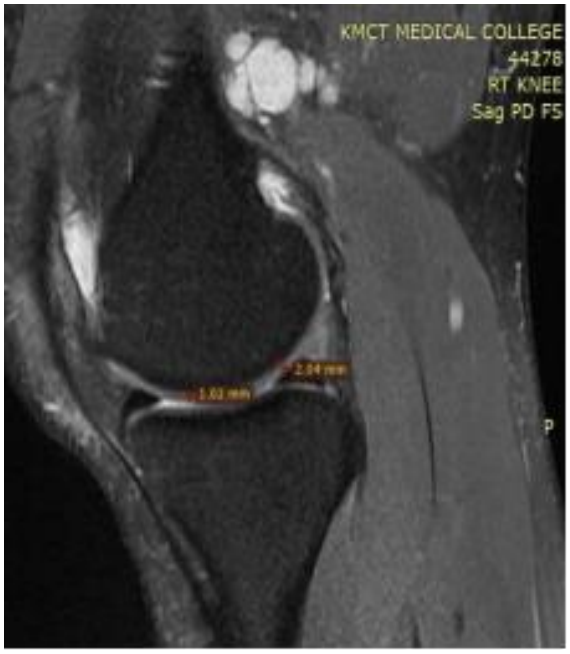

Fig 5:- Sag PDFSimage showing articular cartilagemeasurement in Cahil zones MID B and MID C of medial femoral condyle.

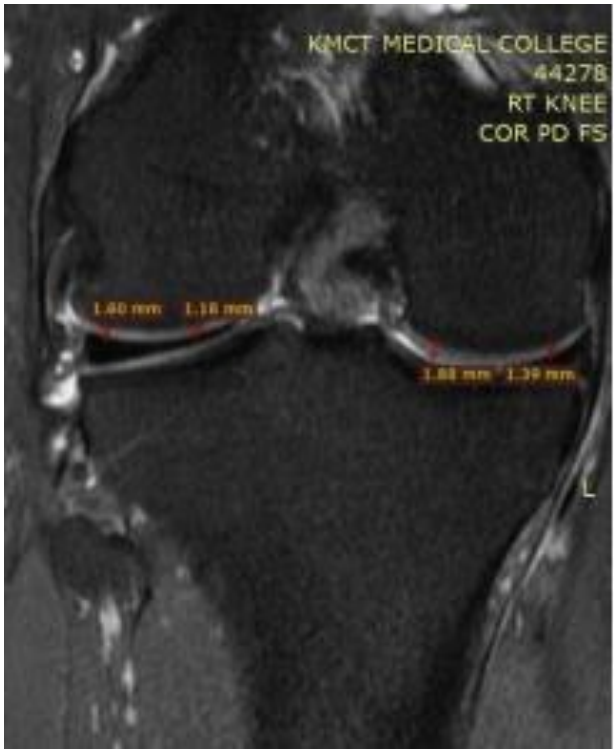

Fig6:-CoronalPDFSshowingmeasurementofarticularcartilagemeasurementin Cahil zones MID 1,2 ,3 and 4 .

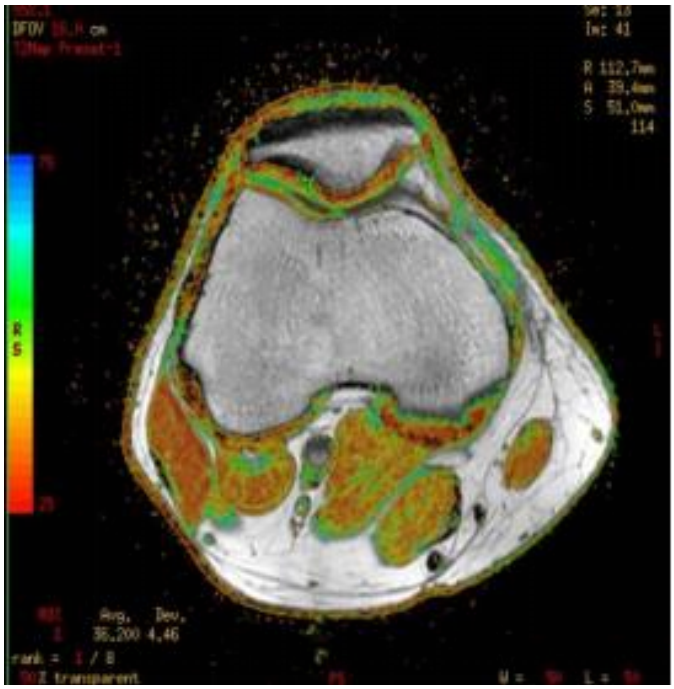

Fig7:-AxialT2map.

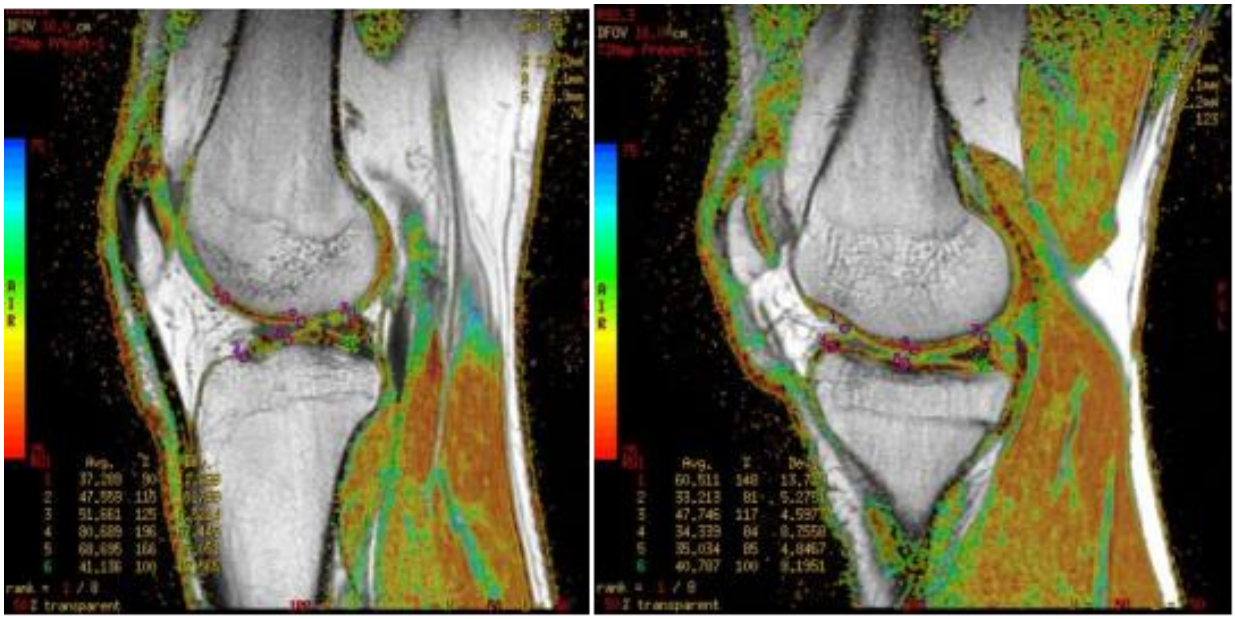

Fig8:-SagT2map inlateralandmedialfemoralcartilage.

Results:-

A total of 60 patients participated in the study ,out of which 35 had symptoms suggestiveofosteoarthritis.Amongthesamples50%werefemales (30individuals) and 50 % males (30 individuals).

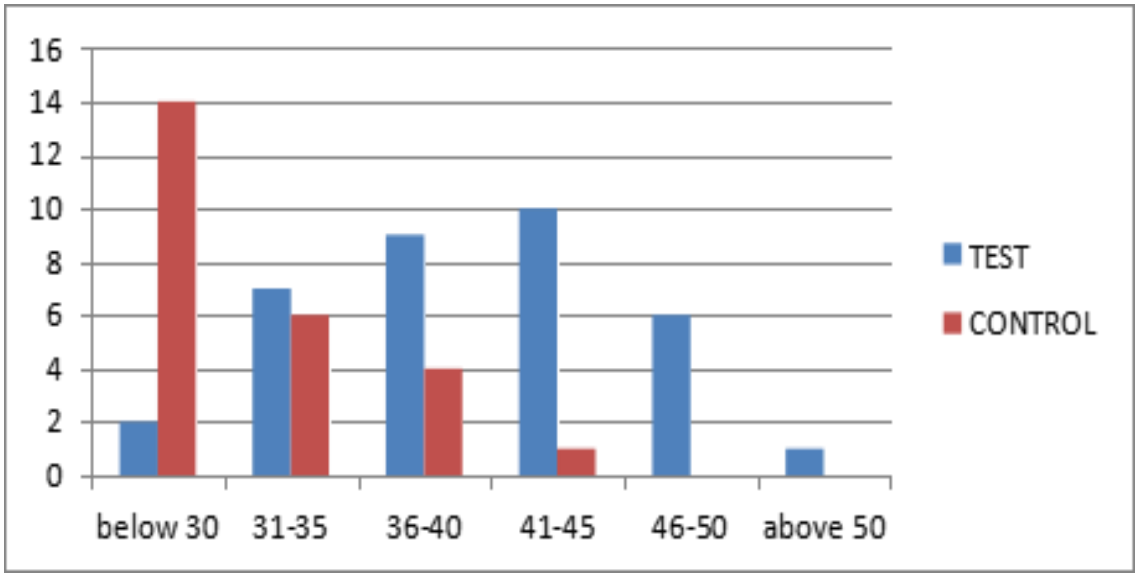

Fig9:-Bardiagramdepictingtherangeofagedistributionamong thestudy population.

In the controls group, the mean age was 28years with a standard deviation of 14.6.Highest number of the controls were below 30 years i.e 14 individuals. There were no controls above 45years.

In the tests, the mean age was 40 years with a standard deviation of 8.1. The highest number of tests were within the age range of 41-45 years and onlyone individual was above 50 years (aged 51).

ComparisonofT2valuesbetweentests andcontrolsofstudypopulation

T2valuesobtainedineachcompartments:themedial,lateralcondyles of femur , lateraland medialtibial plateaus , and the patella (P).

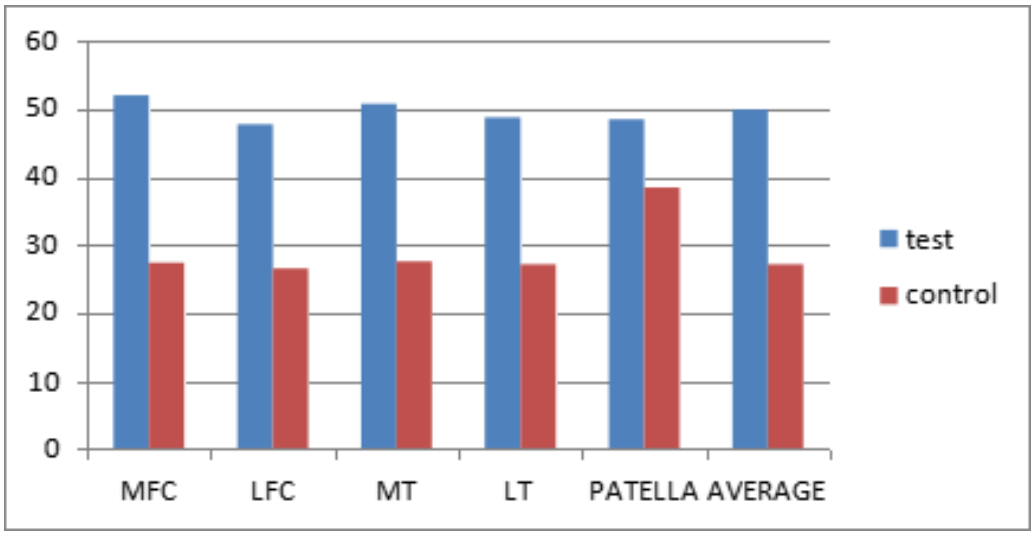

Fig 10:- Bar diagram depicting comparison of T2 values among tests and controls of thestudygroupinfivecompartmentsandaverageT2 value. MFCindicates T2 value in medial femoral cartilage, LFC- T2

value in lateral femoral cartilage, MT- T2 value in medial tibial cartilage, LT- T2value in lateral tibial cartilage and PATELLA-T2 value in retropatellar cartilage.

In the controls, highest T2 value was observed in the retropatellarcartilage , 38.5 ms with standard deviation of 4.9.ThelowestT2 value was observed in thelateral femoral cartilage 26.6 ms with standard deviation of 2.7.The mean T2 values in the medialfemoral,medialandlateraltibiawere27.4+/-2.7ms,27.6+/-2.1msand

27.2+/- 2.6msrespectively. Theaverage T2 valuewas 27.2+/-1.5 ms.
Inthetests ,average T2valuewas 49.9+/-2.3ms .Thehighest T2valuewas observed in the medial femoral cartilage52 +/- 4.6 ms while thelowestT2 value was observed in the lateral femoral cartilage47.8 ms +/- 2.7.The mean T2 values inthe retropatellar ,medial and lateral tibial cartilage were 48.5 +/- 4.0ms, 50.8+/ 5.6ms and 48.8+/- 3.1ms respectively.

Comparisonof cartilagethicknessbetweenthetestandthecontrolgroup.

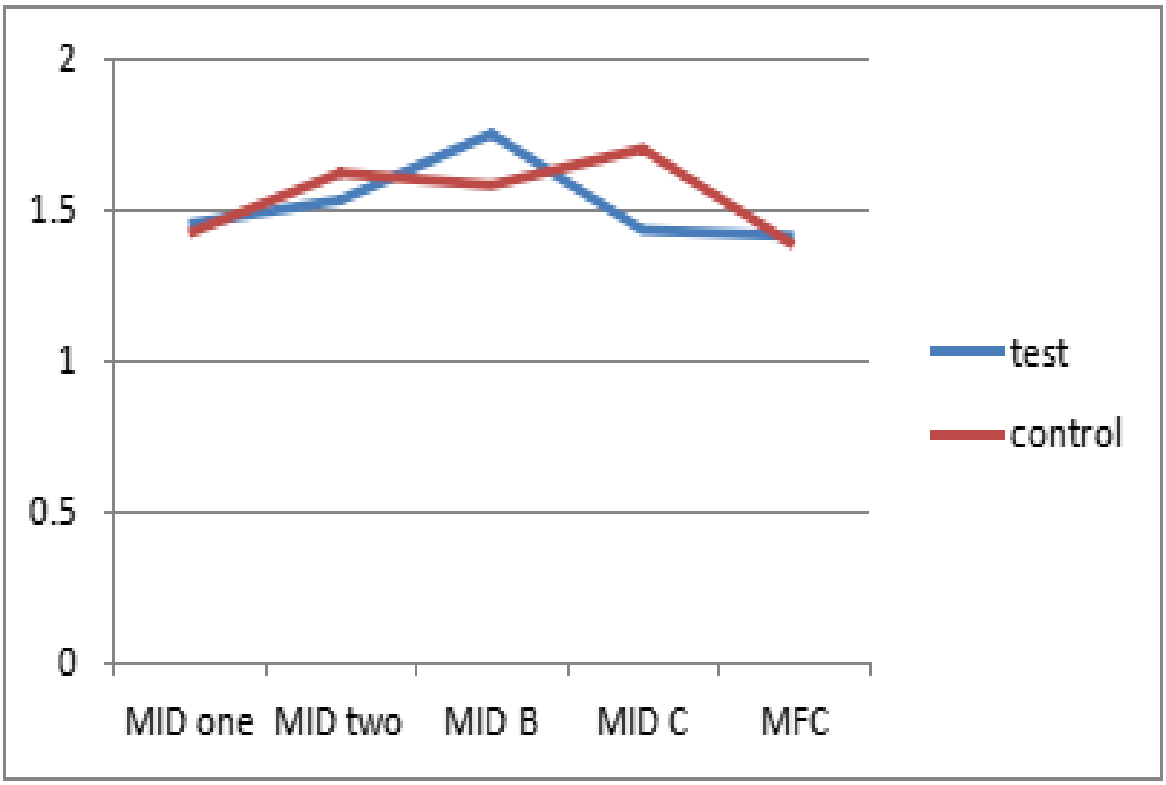

Fig 11:- Line diagram showing cartilage thickness in various Cahil zones of medial femoral cartilage.

In controls, the maximum cartilage thickness (1.70 +/- 0.24 mm) was observedin Cahil zone MIDCof medial femoral cartilage while lowest value (1.3+/-0.12 mm) wasobservedinCahilzoneMFC. ThecartilagethicknessinMID1,MID2andMIDB were 1.42+/-0.17, 1.6+/-0.37 and 1.58+/-0.30 mmrespectively.

In tests , the maximum cartilage thickness (1.7+/- 0.48 mm) was observedin Cahil zoneMIDBofmedialfemoralcartilagewhilelowestthickness(1.41+/-0.18mm)was observedin Cahil zoneMFC.

The cartilage thickness in MID1,MID2 and MIDC were 1.45+/-0.28, 1.53+/-0.40 and 1.43+/-0.39 mmrespectively.

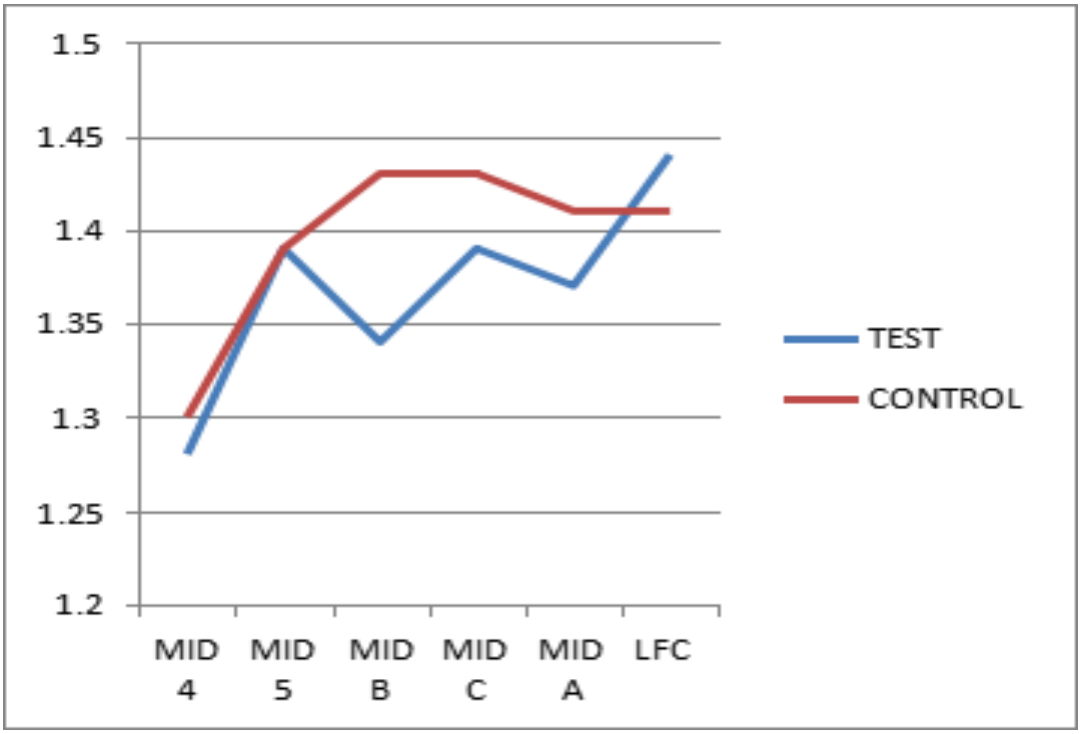

Fig 12:-Line diagram showing cartilage thickness in various Cahil zones oflateral femoral cartilage.

In controls, the maximum cartilage thickness (1.43 +/- 0.17 mm) was observedin Cahil zone MIDBoflateralfemoral cartilage while lowest thickness (1.3+/-0.13mm)was observedin Cahil zoneMID4.The cartilage thickness in MID5,MIDCand LFC were 1.39+/-0.19, 1.43+/-0.18 and 1.41+/- 0.16 mmrespectively.

In tests , the maximum cartilage thickness (1.44+/- 0.18 mm) was observedin Cahil zoneLFC of lateralfemoral cartilage while lowest thickness (1.28+/-0.15 mm) was observedin Cahil zoneMID4.The cartilage thickness in MID5 ,MIDB and MIDC were 1.39+/-0.15, 1.34+/-0.41 and 1.39+/-0.12 mmrespectively.

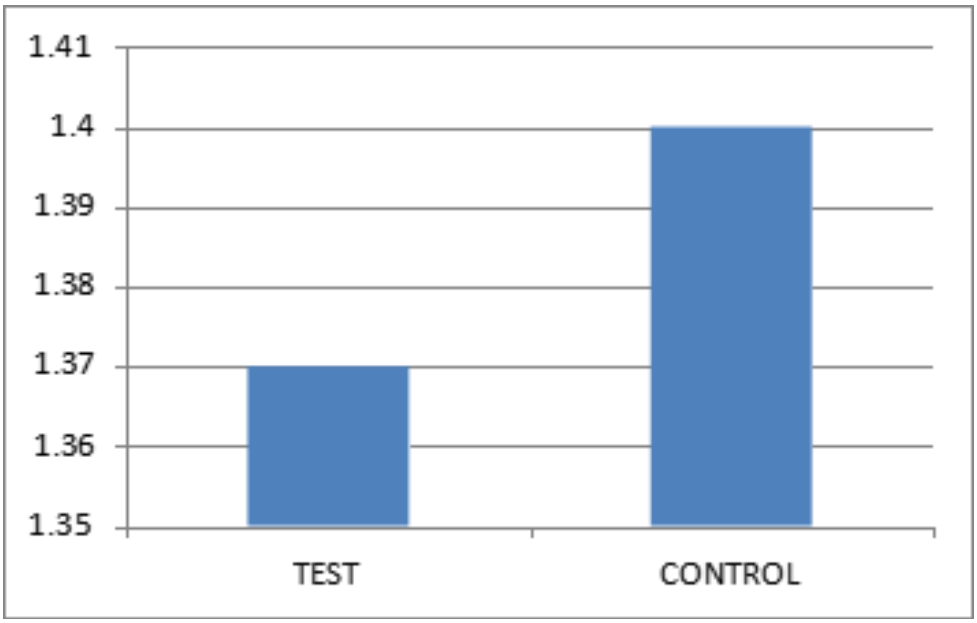

Fig13:-Bardiagramdepictthecomparisonofcartilagethicknessamongbothstudy groups in medial tibial plateau. Themeancartilagethickness(measuredatmidpointofmedialtibial plateau)intest and controls were 1.37+/-0.13 and 1.40+/- 0.20mm respectively.

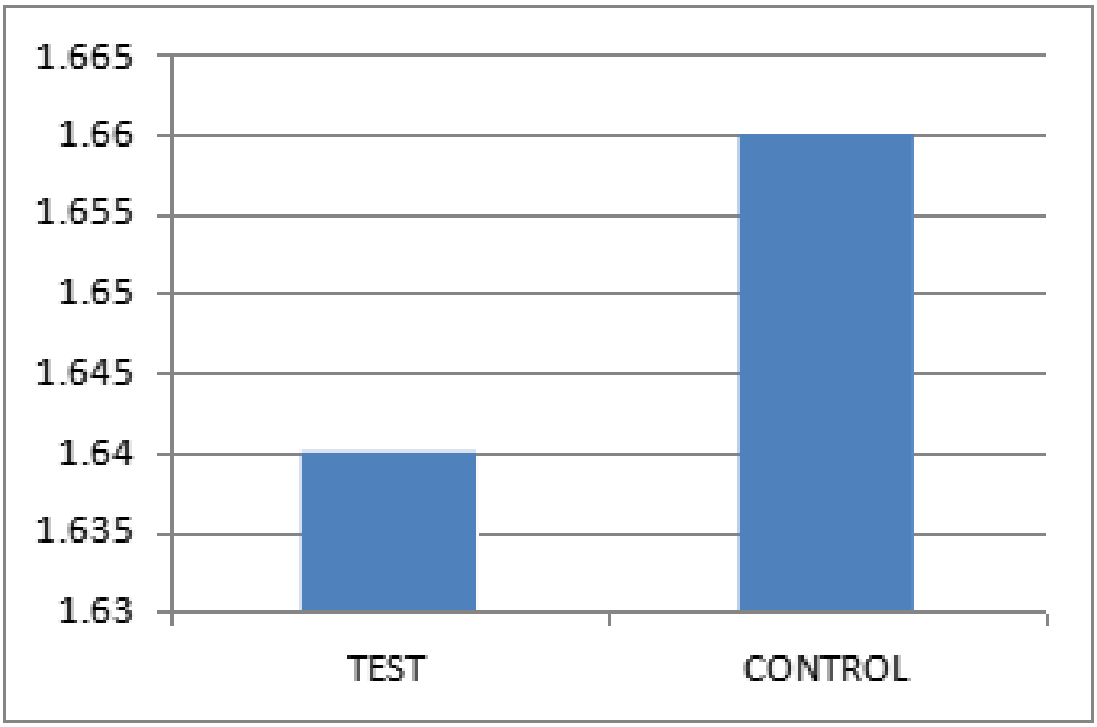

Fig1 4 :-Bardiagramdepictthecomparisonofthicknessofcartilageamongboth groups in lateral tibial plateau.

The mean cartilage thickness (measuredatmidpoint oflateraltibial plateau)in testand controls were 1.37+/-0.15 and 1.40+/- 0.22mmrespectively.

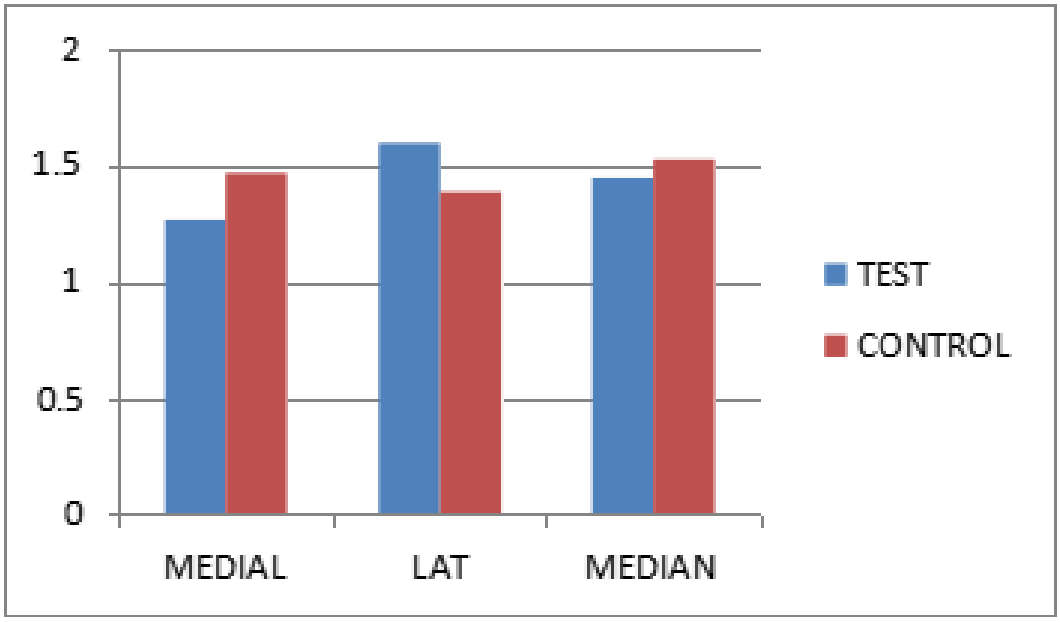

Fig 15:-Bar diagram depict thecomparison of average thickness of cartilage among both study groupsin various regions of patella.

In controls, the maximum cartilage thickness (1.66 +/- 0.22 mm) was observedin lateral facetofretropatellar cartilage while lowest thickness (1.28 +/-0.12 mm)was observedinmedialfacet.Thecartilagethicknessin medianridgewas1.47 +/- 0.16 mm.

Inthe test group, the maximum cartilage thickness (1.64 +/- 0.43 mm) was observed in lateral facetofretropatellar cartilage while lowest thickness (1.38 +/-0.15 mm) wasobservedinmedialfacet.The cartilagethickness inmedianridge was 1.44+/-0.12 mm.

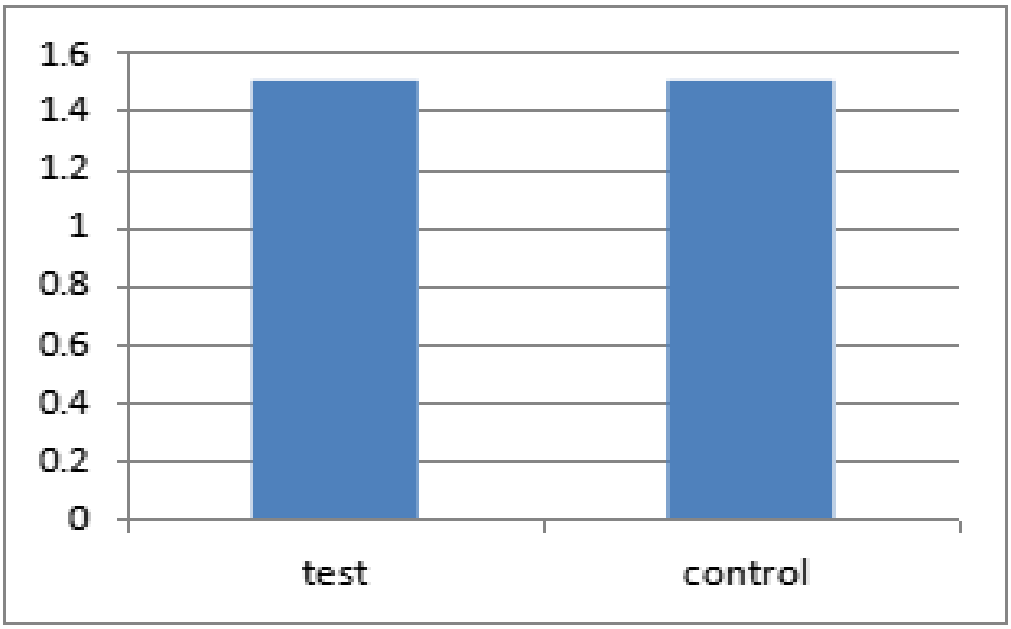

Fig 16:-Bar diagramdepict thecomparison of average thickness of cartilage in tests and controls of the study group which were 1.50+/- 0.29and 1.50+/- 0.19 mm respectively. And , the difference was not statistically significant.

For T2 Values (Statistical Significance): (P value <0.05).Thissuggeststhat therearesignificant differences in T2 values between the two groups.

For Cartilage Thickness (Lack of Statistical Significance) : (P value > 0.05). This indicates that there are no significant differences in cartilage thickness between the two groups.

Discussion:-

In current study, we observed a statistically significant increase in average T2 values (P = 0.0005) in early osteoarthritis patients compared to controls. This is consistent with findings from Liebl et al. (6)who indicated in a study involving 130 subjects that knees developing tibiofemoral osteoarthritis showed notably higher average T2 values in every compartment compared to the control group. The increased T2 valueis due to increase in water component in the early stages of osteoarthritis due to degeneration in matrix .

This finding is also consistent with previous studies, such as that by Richard Kijowski et al., (7) which demonstrated that elevated T2 values correlate with cartilage lesions seen via arthroscopy, particularly in areas showing more than a two- fold increase in color scale as well as those affecting the entire thickness ofdeep cartilage layer.

Earlier reports by Mosher et al.(8) and Dunn et al. (9)have also noted increased T2 values in cartilage, observed in both animal models and human subjects in laboratory settings. The average T2 values (49.9 for OA vs. 27.2 for controls)obtained in our study align with these findings. Interestingly, previous in vitro studies found a poor correlation between T2 values and proteoglycan (PG) concentration, instead emphasizing the influence of collagen content, water content, and collagen orientation on T2 values

While commonly increased T2 values are associated with cartilage degeneration, a study by Jun Hirose et al reporting no significant change in T2 values with cartilage degeneration relative to normal cartilage does exist in the literature(10).They state that OA in this joint is a rare clinical finding, and morphometricandhistologicalstudieshaveshownthehyalinecartilageofthePTFJto be of good quality even in elderly cadavers .

Inourstudy,weobservedastatisticallysignificantpositivecorrelation($p<0.01$) between age and T2 values in patients with early osteoarthritis of the knee. This finding aligns with the research conducted by Çağlar et al.(11), which similarly demonstrated that T2 values increase with age across various knee compartments in both patient and control groups. Çağlar et al. highlighted that as individuals age, theretendstobeanelevationinT2relaxationtimesinarticularcartilage,indicativeof age-related changes in cartilage composition and structure. This correlation underscores the influence of aging on cartilage health and the potential for T2 mapping as a sensitive tool to detect these changes non-invasively.

In our study, we found no significant difference in T2 values and cartilage thickness between males and females , indicating that gender did not influence T2 relaxationtimesinpatientswithearlyosteoarthritisoftheknee.Thisobservation

aligns withfindings fromthestudybyMosheretal. (12),whichsimilarlyinvestigated T2 values in healthy men and women and reported no significant differences between genders. Mosher et al.'s research underscores that, in healthy individuals, gender does not appear to be a significant factor affecting T2 mapping values of articular cartilage intheknee..T2 mappingof articularcartilagedoesnottypicallyshow gender differencesduetothesimilarcompositionofcartilagebetweenmalesandfemales and the microscopic nature of the MRI technique. Factors influencing T2 relaxation times are more likely related to individual variations within each gender group rather than gender itself

In our study, we found that there wasno significant difference ($p > 0.05$) inthe meanT2values among thedifferentkneejoint compartmentsinpatientswith early osteoarthritis(OA).This finding isconsistentwiththeresultsreported byDautryetal.,(13)who also observedthe same.

Conversely, MosherTJ et al. (14)conducted research involving individuals with and without radiographic knee osteoarthritis and found a positive correlation between higher T2 values in the medial compartment cartilage and increased knee pain. This suggests that elevated T2 values in specific compartments may correlate with symptomatic knee osteoarthritis, particularly in the medial compartment.

The study also examined the average thickness of articular cartilage in different knee compartments for early OA patients(diagnosed clinically by joint line tenderness) and radiologically (Kellgren-Lawrence (KL) grades 0 and 1)and without OA. Interestingly, no significant difference in thickness of the cartilage was observed among OA patients and controls across any knee compartment ($p > 0.05$). Our study findings align with theMittal et al. (15) and Li et al(16). whom reported no significant difference in average articular cartilage thickness between osteoarthritis patients and controls($p> 0.05$).Theabsenceofsignificantdifferences incartilagethickness during theearlystagesofosteoarthritis(OA)canbeattributedtoseveralfactorsrelatedto the pathophysiology and progression of the disease:

1. **EarlyStageChanges**:Intheinitialphasesofosteoarthritis,structuralchanges within the cartilage may not yet be pronounced enough to cause measurable differences in cartilage thickness. Early OA is characterized by subtle biochemical and microstructural alterations, such as increased water content and collagen degradation, rather than significant loss of cartilage volume or thickness.
2. **Sensitivity of Measurement Techniques**: Cartilage thickness measurements in early osteoarthritis require highly sensitive and accurate imagingtechniques, such as high-resolution MRI or ultrasound. Conventional imaging methods may not detect subtle changes in thickness that occur early in the disease process.
3. **Compensatory Mechanisms**: During early osteoarthritis, the joint may undergo compensatory changes to maintain cartilage thickness. These mechanisms can include alterations in joint loading patterns or increased production of extracellular matrix components to preserve cartilage integrity.
4. **Variability and Sampling Issues**: Variability in cartilage thickness exists even within healthy individuals and between different regions of the joint.This inherent variability can obscure early changes in cartilage thickness associated with osteoarthritis, making it challenging to detect significant differences in early stages without large sample sizes or longitudinal studies.
5. **Patient Heterogeneity**: Individual variability in disease progression and response to earlychanges in joint health can also contribute to the difficultyin detecting significant differences in cartilage thickness across early OApatients.

In conclusion, the lack of significant differences in cartilage thickness in early osteoarthritis reflects the complex and multifaceted nature of the disease process. Early changes may be subtle and may not yet manifest as measurable alterations in cartilage thickness, particularly with conventional imaging methods

Retrospective cross-sectional CT arthrography study by Omoumi et al.(17) , which involved 535 consecutive knees and demonstrated that the cartilage of the posterior aspect of the medial condyle was significantly thicker in knees with osteoarthritis compared to those without ($p < 0.001$).As OA advances, there is progressive degradation of the articular cartilage. This degradation can lead to measurable reductions in cartilage thickness, particularly in weight-bearing areas of the joint where mechanical stress is highest. The loss of cartilage thickness is often a hallmark of structural damage in OA.

The slow progression of OA poses challenges in precisely timing the assessment of cartilage morphology, complicating the identification of optimal windows for evaluating disease progression and treatment efficacy .These insights underscore the variability in cartilage thickness among individuals and highlight the need for longitudinal studies to better understand structural changes in OA, essential for advancing effective therapeutic strategies

In contrast to some studies in the literature that explore the impact of physical activityonT2mappingvalues,suchastheresearchconductedbyMosherTJetal. ,(18) which examined the effects of running and training on T2 mapping values, our studytook adifferentapproach.To mitigatethepotential influenceof physicalactivity on T2 mapping values, we implemented a protocol requiring all patients to rest for an average of 30-45 minutes prior to their MRI examination. The intention behind this approach was to minimize the effects of knee loading and other physical activities, thereby focusing specifically on studying the degenerative changes in the knee joint withoutinterferencefromexternalfactors.Thismethodologicalchoiceaimedtoprovide a clearer understanding of the degenerative processes affecting the knee, allowing for a more focused analysis of T2 mapping values associated with early osteoarthritis.

Bazaldua etal.(19),correlatedT2 mappingvaluesdirectlywitharthroscopicfindings, ourstudydidnothaveanimmediateplanforarthroscopicvalidation.Bazalduaetal. found that T2 mapping identified 88 out of the total 95 lesions detected by arthroscopy, achieving a sensitivity of 92.6%. In comparison, conventional T2 sequences identified 83 lesions, with a sensitivity of 87.3%. This highlights the potential of T2 mapping to effectively detect cartilage lesions compared to traditional MRI sequences. In our study, the focus was on utilizing MRI, including T2 mapping, to assess early osteoarthritis and guide conservative management decisions. Although directcorrelationwitharthroscopicfindings was notpartofourimmediatestudyplan, our approach aimed to investigate the utility of T2 mapping in identifying degenerative changes in the knee joint, which could informtreatment strategies aimed at preserving joint function and managing symptoms conservatively.

The discrepancy between studies underscores the complex nature of osteoarthritisprogressionanditsmanifestationacrossdifferentknee compartments .Thesevaryingresults emphasizetheneed forfurther research toclarifytheroleof T2 mapping in understanding regional differences in cartilage degeneration and its correlation with clinical symptoms in osteoarthritis patients. Such insights are critical for developing targeted interventions and improving management strategies for knee osteoarthritis.

Conclusion:-

Our study highlights the utility of T2 mapping as a non-invasive imaging technique capable of detecting early cartilage matrix degeneration in osteoarthritis (OA), specifically alterations in the collagen network during the initial stages of pathogenesis. Unlike routine MRI sequences that primarily detect morphological cartilagelesionsatlaterstagesofirreversibledamage,T2mappingoffersthepotential to diagnose cartilage damage earlier in the disease process. The incorporation of T2 mapping into routine MRI protocols enhances sensitivity for detecting cartilage lesions. This capability is particularly beneficial in evaluating patients with unexplained knee pain as well as assessing cartilage status following repairprocedures or arthroscopic surgery for knee derangements.

In conclusion, T2 mapping represents a significant advancement in the field of musculoskeletal imaging, particularly in the assessment of articular cartilage. Our studyunderscoresitseffectivenessinenhancingsensitivitytoearly degenerative changesinkneejoints,offeringcomprehensivediagnosticbenefitsthroughqualitative and quantitative data. By facilitating early therapeutic planning, T2 mapping holds promise in reducing the morbidity associated with knee osteoarthritis

and improving the overall management of this prevalent condition. Continued research and clinical integration of T2 mapping are essential for maximizing its potential in improving patient care and outcomes in orthopedic practice

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