Original Research Article

T2 mapping [Cartigram] in the evaluation of the articular cartilage in traumatic knee injury

Safna M A[1], Sunil M[2*], Keshav Kumar A D T[3]

[1]Post Graduate Resident, [3]Professor, Department of Radio diagnosis, Kannur Medical College, Kannur, INDIA.
[2]Associate Professor, Department of Radio diagnosis, Al Azhar Medical College and Super Specialty Hospital, Thodupuzha, INDIA.
Email: sunil_mm@yahoo.com

Abstract

Background: Injury to articular cartilage of the knee is recognized as a cause of significant musculoskeletal morbidity as it progressively leads to secondary osteoarthritis. Routine MRI sequences are not optimal for imaging articular cartilage and hence many lesions can be missed. Cartigram is an optional application available in 1.5 T/3 T MRI to see changes in the composition of articular cartilage before changes in the thickness can be seen **Objectives:** [1]To know the role of T2 mapping [Cartigram], in the evaluation of the articular cartilage of the knee joint, as an adjuvant to routine sequences in patients with traumatic knee injury. [2]To describe the articular cartilage changes in above patients using T2 mapping. **Methodology:** A descriptive study was conducted in the Department of Radiodiagnosis, Kannur Medical College, Anjarakandy, among 60 consecutive-consenting patients with knee joint trauma, referred for MRI with suspicious ligament/ meniscal tears, during the period March 2016 to September 2017. Details of each patient, including personal details as well as details of trauma was collected using a semi structured questionnaire. Routine MRI and T2 Mapping were performed in all study subjects. Data was coded and entered in Microsoft excel and analyzed using SPSS version 20. **Results:** Using PDFS articular cartilage damage was noted in 21.7 % of which sagittal PDFS alone demonstrated 20 % of the lesions. Using T2 mapping articular cartilage damage was noted in 50% which was higher than with the PDFS sequences. T2 maps showed all the lesions detected on routine PDFS sequences. Most of the articular cartilage lesions (38.33%) were noted in lateral femur. ACL tear [58 %] was the commonest associated finding. **Conclusion:** This study further strengthens the role off T2 mapping as a useful adjuvant in MRI of traumatic knee for early detection of articular cartilage damage.
Key Word: Knee joint trauma; MRI; Cartigram; Articular cartilage.

***Address for Correspondence:**
Dr. Sunil M, Associate Professor, Department of Radio diagnosis, Al Azhar Medical College and Super Specialty Hospital, Thodupuzha, INDIA.
Email: sunil_mm@yahoo.com
Received Date: 15/12/2018 Revised Date: 21/01/2019 Accepted Date: 10/02/2019
DOI: https://doi.org/10.26611/1013926

Access this article online	
Quick Response Code:	Website: www.medpulse.in
	Accessed Date: 18 February 2019

INTRODUCTION

Articular cartilage is the highly specialized connective tissue and that lines the ends of the bones forming any joint in the body. Its principal function is to provide a smooth, lubricated surface for articulation and to facilitate the lymphatics, and nerves and has a limited capacity for intrinsic healing and repair. Damaged cartilage rarely heals spontaneously, and its subsequent degeneration impairs the normal biomechanics and hastens the degeneration of other articular tissues and may lead to knee osteoarthritis, called as secondary osteoarthritis which is both a cartilaginous and a whole-organ disease and one of the most common joint affected by OA are the knees. The unique and complex structure of articular cartilage makes treatment and repair difficult. Hence identification of the damages to the articular cartilage at the earliest and its repair is important in prevention of osteoarthritis of the affected joint.[1,2] Evolution of MRI revolutionized the imaging of articular cartilage. But routine MRI sequences are now regarded as sub optimal for imaging of articular cartilage as many of the early lesions are missed.[3,4] Cartigram is an optional application available in 1.5 T/3 T MRI to see changes in the composition of articular cartilage before changes in the thickness can be seen.[5-8]

How to cite this article: Safna M A, Sunil M, Keshav Kumar A D T. T2 mapping [Cartigram] in the evaluation of the articular cartilage in traumatic knee injury. *MedPulse – International Journal of Radiology*. February 2019; 9(2): 59-62.
http://www.medpulse.in/Radio%20Diagnosis/

Hence this study was conducted with the objective to know the role of T2 mapping [Cartigram], in the evaluation of the articular cartilage of the knee joint, as an adjuvant to routine sequences in patients with traumatic knee injury and to describe the prevalence of articular cartilage changes in patients with traumatic knee injury using T2 mapping.

MATERIALS AND METHODS

After getting approval from the Institutional ethical committee, a descriptive study was conducted in the Department of Radiodiagnosis, Kannur Medical College, Anjarakandy, among 60 patients with knee joint trauma [acute and chronic] referred for MRI with suspicious ligament/ meniscal tears, during the period March 2016 to September2017.

Sample Size: In a study conducted by Dutova and Karpenko, assessing the role of T2-mapping for identifying and grading sites of cartilage injury in the knee in young professional athletes, articular cartilage changes in knee joint was found in 77% using T2 mapping.[9] Using this data minimum sample required for the current study was calculated using the formula

$$n = \frac{Z\alpha^2 PQ}{d^2},$$

taking 'd' as 11% which is less than 20% of P, n =57

Hence this study was conducted among 60 patients with knee joint trauma [acute and chronic] with suspicious ligament/meniscal tears.

Sampling Technique: 60 consecutive, consenting patients with knee joint trauma [acute and chronic] referred for MRI with suspicious ligament/meniscal tears were recruited into the study.

Study Procedure: After getting approval from the Institutional ethical committee and Head of the department-Radiodiagnosis, Kannur Medical College, Anjarakandy, a descriptive study was conducted among 60 patients with knee joint trauma [acute and chronic] referred for MRI with suspicious ligament/meniscal tears. Informed consent was taken from all the study participant after excluding those with patients with history of inflammatory or infectious arthritis of knee joint as well as those with past history of surgery to knee joint. Details of each patient, including personal details as well as details of trauma was collected using a semi structured questionnaire. MRI of the knee joint was performed in 1.5 T MR imaging HDXT machine, GE medical systems, Milwaukee, Sconsin. Routine sequences- Axial PDFS, Oblique Sagittal PDFS, Oblique Sagittal T2, Oblique Coronal STIR, Oblique Coronal PDFS, Oblique Sagittal 2D MERG, and Oblique Coronal T1 FSE were used to evaluate the morphology of the knee. The compositional MR imaging technique of the articular cartilage- Cartigram [T2 mapping-sagittal and axial] were also done. MR Images were evaluated for presence or absence of cartilage lesions on each articular surface, first by using the routine MR protocol alone and then by using the routine MR protocol with T2 maps [Cartigram]. Cartigram with colour map with a colour scale ranging between red and blue [25- to -107msec] was created from the T2 mapping source data. If cartilage lesions were visualized on routine images then corresponding T2 colour map was evaluated for colour change and T2 values of the affected articular cartilage was measured by ROI method. If cartilage lesions were not visualized on routine images then T2 colour map were evaluated for any colour abnormality and ROI method was used to calculate the T2 relaxation values at three locations in each cartilage, to identify any of cartilage changes. The cartilage changes were considered abnormal if any area in the cartilage shows at least one colour scale higher than adjacent normal cartilage and also showing T2 relaxation values higher than upper limit of normal reference values. Any associated ligament/ meniscal/ bony and other soft tissue injury seen on MRI images were also recorded.

Statistical Analysis: The data was properly coded and entered in Microsoft Excel. Further analysis was done using the software SPSS version 20.0. Qualitative variables were expressed as percentages and quantitative as mean with standard deviation. Proportion of articular lesions identified in routine MRI as well as in T2 Mapping was notedand the statistical significance in the difference between the two was assessed using Mc Nemar test. Association between qualitative variables were assessed using Chi square test. Statistical significance was set a p value <0.05.

OBSERVATIONS AND RESULTS

The study sample consisted of 60 patients with knee joint trauma [acute and chronic] with suspicious ligament/ meniscal tears. Mean age of the study population was 30.50 years (SD=9.47 years) and majority (65%) were males. 53.3% gave history of acute knee injury(injury within six months) and rest(46.7%) were with chronic knee injury(injury before 6 months). Routine MRI sequences (PDFS) detected articular damage in 13patients (21.67%). Among the various sequences, sagittal PDFS detected damage in 12 patients (20%), axial PDFS in 6 patients (10%) and coronal PDFS in 1 patient (1.7%).On the other hand T2 Mapping detected articular damage in 30 patients(50%).T2 mapping showed all the lesions detected on routine PDFS sequences. An exact McNemar's test determined that there was a statistically significant difference (p=0.026) in the proportion of articular damage as detected by T2 Mapping(50%) when compared to

routine MRI sequences (21.7%) Among the patients detected to have articular damage by T2 mapping most common anatomical site of injury identified was lateral femur (38.33%) followed by medial femur (35%) and medial tibia (25%). Least commonly injured site was medial patella (8.3%) **(Table:1)** In addition to the articular damage as mentioned above, the most common associated finding was ACL tear-which was present in 35 patients [58.3%], followed by bone oedemain 26 patients [43.3%], medial meniscus tear in 22 patients [36.7%] and lateral meniscus tear in 20 patients [33.3%]**(Table:2)**There was no significant difference in the anatomic site of cartilage injury or associated injuries based on whether the knee injury was acute or chronic.

Table 1: Distribution of study subjects according to anatomical site involved as per T2 mapping

Anatomical Site	No of cases(%)
Medial femur	21 (35.0%)
Lateral femur	23 (38.3%)
Medial tibia	15 (25.0%)
Lateral tibia	9 (15%)
Medial patella	5 (8.3%)
Lateral patella	10 (16.7%)

Table 2: Distribution of study subjects according to associated imaging findings

Finding	No of cases(%)
ACL Tear	35 (58.3%)
PCL Tear	7 (11.7%)
Medial Meniscus Tear	22 (36.7%)
Lateral Meniscus Tear	20 (33.3%)
MCL Tear	6 (10.0%)
LCL Tear	5 (8.3%)
Tendon Tear	3 (50%)
Bone Oedema	26 (43.3%)
Fracture	5 (8.3%)

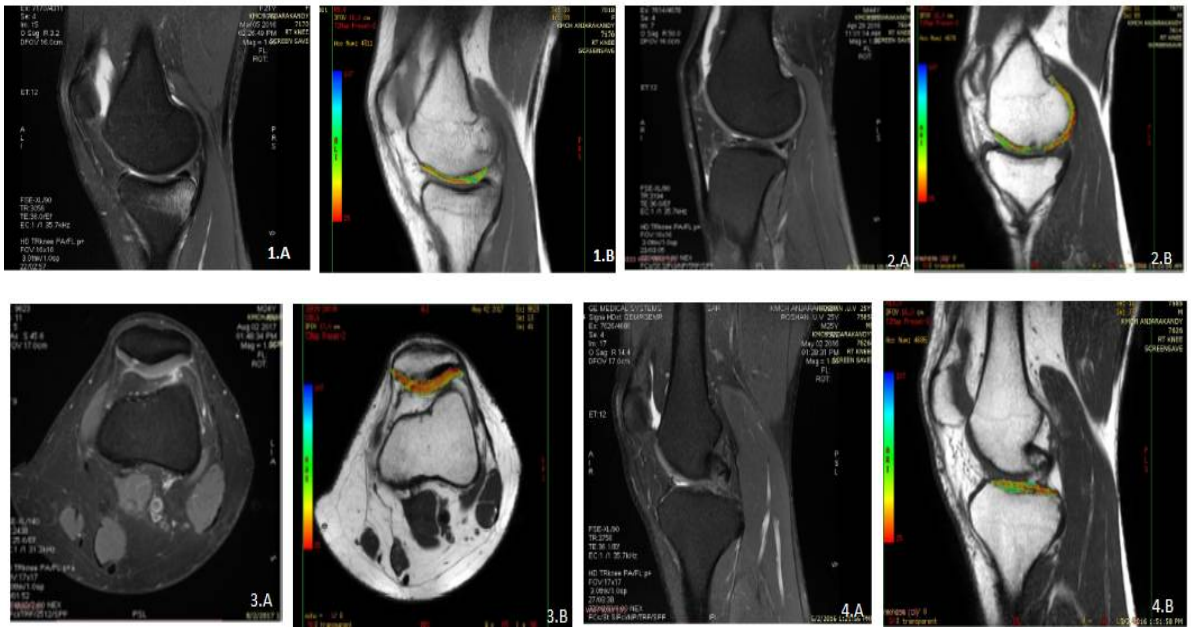

Figure 1: (A)-shows Normal PDFS whereas in same patient in **(B)**-Cartigram shows focal cartilage signal change with increased T2 relaxation
Figure 2: (A)-PDFS shows mild thinning of medial femoral cartilage whereas in **(B)**-Cartigram shows a well appreciated defect
Figure 3: (A)-PDFS shows defect in the medial patellar cartilage whereas in **(B)**- Cartigram shows a well appreciated defect
Figure 4: (A)-PDFS –cartilage changes difficult to comment whereas in **(B)**- Cartigram- cartilage morphology and defect noted as higher colour in tibia

DISCUSSION

Current study was conducted in 60 patients with knee joint trauma and all of them were evaluated using routine MRI sequences and T2 mapping. Majority (65%) of the study population were males and increased incidence of sports related trauma and road traffic accidents in men could account for this higher proportion of males in the study population. Using PDFS articular cartilage damage was noted in 21.7 %. Sagittal PDFS detected more damage (20%) when compared to axial PDFS (10%) and coronal PDFS (1.7%). Where as in a study conducted by F. AbubackerSulaiman*et al* comparing PDFS, cartilage lesions were noted with same frequency using axial and sagittal PDFS.[10] Using T2 mapping articular cartilage damage was noted in 50% which was higher than with PDFS sequences. Richard Kijowski *et al* also reported a better diagnostic efficacy for routine MR protocol with T2 mapping rather than routine MR protocol alone.[6] T2 maps showed all the lesions detected on routine PDFS. Imaging appearances in T2 maps were very characteristic. Cartilage lesions appeared as areas of signal loss in T2 maps, surrounded by high signal intensity areas compared to adjacent normal cartilage. The corresponding areas of high signal intensity were showing higher T2 values compared to the normal references. The margins of the lesions were appearing well defined as compared to PDFS. Also the total area of the cartilage damage was evidently larger in many of the lesions in T2 maps as compared to PDFS. Many cartilage lesions were noted only in T2 maps as compared to PDFS. They appeared as areas of higher signal in T2 maps. These areas were also showing higher T2 values and possibly represent early changes of cartilage damage. Most common site of articular cartilage lesions as identified by T2 mapping was lateral femur. Another incidental finding was that, in patients with traumatic knee injury ACL tear [58.3%] was the commonest injury followed by bone oedema.

CONCLUSION

Current study further strengthens the role of T2 mapping in early identification of cartilage lesions in knee trauma. The articular cartilage matrix changes visualized on T2 colour map as higher scale colour, will help in quick and easy identification of cartilage damage as cartilage lesions appeared more defined. Thus T2 mapping is an important non – invasive modality and should be added as a routine sequence in patients with knee joint trauma, so that many number of early cartilage lesions in traumatic knee injury which are otherwise missed in routine MRI sequences could be picked up and could prevent the progression of cartilage damage and secondary osteoarthritis.

REFERENCES

1. Sophia Fox A, Bedi A, Rodeo S. The Basic Science of Articular Cartilage: Structure, Composition, and Function. Sports Health. 2009;1[6]:461-468.
2. Messner K, Maletius W. The long-term prognosis for severe damage to weight-bearing cartilage in the knee: a 14-year clinical and radiographic follow-up in 28 young athletes. ActaOrthop Scand. 1996 Apr;67[2]: 165–8.
3. Recht M, Resnick D. MR imaging of articular cartilage: current status and future directions. American Journal of Roentgenology. 1994;163[2]: 283-290.
4. McCauley TR, Disler DG. Magnetic resonance imaging of articular cartilageof the knee. J Am AcadOrthop Surg. 2001 Feb;9[1]:2–8.
5. Michel D. Crema, MD; Frank W. Roemer, MD; Monica D. Marra, MD; Deborah Burstein, PhD; Garry E. Gold, MD, MSEE; Felix Eckstein, MD Thomas Baum, MD; Timothy J. Mosher, MD; John A. Carrino, MD, MPH Ali Guermazi, MD; Articular Cartilage in the Knee: Current MR Imaging Techniques and Applications in Clinical Practice and Research; RadioGraphics 2011
6. Kijowski R, Blankenbaker D, Munoz del Rio A, Baer G, Graf B. Evaluation of the Articular Cartilage of the Knee Joint: Value of Adding a T2 Mapping Sequence to a Routine MR Imaging Protocol. Radiology. 2013;267[2]:503-513.
7. Sandeep S, Reddy R. Qualitative Analysis of Articular Cartilage of the Knee Joint on a 1.5 T MRI is Highly Sensitive and Correlates with Arthroscopic Assessments. Indian Journal of Public Health Research and Development. 2017;8[1]:172.
8. Farook A, Aparna Kandru L. Diagnostic Evaluation of Articular Cartilage of the Knee Joint: Value of Adding T2 Mapping Sequence to a Routine Magnetic Resonance IDiagnostic Evaluation of Articular Cartilage of the Knee Joint: Value of Adding T2 Mapping Sequence to a Routine Magnetic Resonance Imaging Protocol. IJSS. 2016;4[2]:233-236.
9. Karpenko A. Knee cartilage T2-mapping of young professional Russian athletes.European Society of Radiology. 2013
10. Farook AK, Kandru LA, Elangovan V, Farook AS, Magudeeswaran PK. Diagnostic Evaluation of Articular Cartilage of the Knee Joint: Value of Adding T2 Mapping Sequence to a Routine Magnetic Resonance Imaging Protocol. Int J Sci Stud 2016;4(2):233-236.

Source of Support: None Declared
Conflict of Interest: None Declared