Original Research Article

MR imaging of cartilage and cartilaginous lesions of knee using T2 mapping and conventional sequences - A prospective study

Amol Bandgar[1*], Abhimanyu Kelkar[2], Aditi Singh[3]

Department of Radiology, Bharati Vidyapeeth Medical College Pune, Maharashtra, INDIA.
Email: asbandgar@yahoo.co.in

Abstract

Aims: Knee joint is one of the most commonly involved joint in traumatic injury as well as osteoarthritis. MRI is the modality of choice for evaluation of traumatic and degenerative cartilaginous lesion of knee joint. Aim of our study was to determine the morphology of normal cartilage and elicit signs of cartilaginous lesions in knee joint, using MRI, as well as to evaluate T2 characteristic of normal and abnormal cartilage by relaxometry/ colour mapping. **Methods and Material:** This was an prospective observational study conducted on 25 patients referred for MRI of the knee. In addition to routine sequences following dedicated sequences Proton Density Fat Saturation, Proton Density Non Fat saturation and T2 Gradient Echo with MT pulse were taken for cartilage evaluation. **Results and Conclusions:** Conventional MR imaging detects cartilage abnormalities and is considered the best non-invasive method for assessing the joint cartilage for chondral thickness, chondral surface, morphological changes and changes in signal of cartilage. Right knee was involved in 56% cases while in 44% left knee joint was involved. On MRI, articular cartilage lesion was found positive in 48% of cases while 52% of cases had normal articular cartilage. Maximum cases i.e 28% had either medial femoral condyle involvement or medial patellar facet involved on MRI. In our study, the addition of a T2 mapping sequence added value to routine MR imaging protocol. It significantly increased the sensitivity for detecting early cartilage lesions.
Key-words: Knee, cartilage, MRI, cartilage loss, T2 mapping.

[*]**Address for Correspondence:**
Dr. Amol Bandgar, Assistant Professor, Department of Radiology, Bharati Vidyapeeth Medical College Pune, Maharashtra, INDIA.
Email: asbandgar@yahoo.co.in
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INTRODUCTION

Knee joint is one of the commonly involved joint in traumatic and sports injuries. Injuries may involve ligament, soft tissues, ligaments, cartilage and tendons or bones.[1] MRI helps in direct visualization as well as evaluation of the hyaline cartilage and reflects its biochemical and histological complexity. It is the best non-invasive method available for assessing the joint cartilage due to its high soft tissue contrast. [2]T2 mapping helps in detecting the changes in water content and collagen matrix ultra-structure associated with early cartilage degeneration. T2 mapping can also detect the changes in the chemical composition and structure of the cartilage and can serve as image marker of cartilage degeneration. [3]Our aim was to determine the morphology of normal cartilage and elicit signs of cartilaginous lesions in knee joint, using MRI, as well as to evaluate T2 characteristic of normal and abnormal cartilage by relaxometry/ colour mapping.

SUBJECTS AND METHODS

This was an prospective observational study conducted on 25 patients at a tertiary care teaching hospital over a period of 2 years. The patients were adults (>18 years) of either sex with history of knee injury/pain. Patients with history of previous knee surgery and those with contraindications for MRI were excluded from our study.Multiplanar, multiecho MRI of the knee was performed using PHILIPS MR machine with a superconducting magnet and field strength of 1.5 Tesla.

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An axial acquisition through patello-femoral joint is used as initial localizer for subsequent sequences. The planes in which the MRI is acquired are axial, coronal and sagittal. The slice thickness used is 4mm for axial plane, 3mm for coronal and sagittal planes and 0.7 mm for PD VISTA. In addition to the routine sequences following dedicated sequences were also used and are presented in table 2.

The images were evaluated for associated injuries.

Images were analysed as below:

1) Articular cartilage defect.
2) Whether the injury extends to the subchondral bone plate (osteochondral or transchondral injury).
3) Chondral defects at the surface or deep to the surface.
4) Flap tears or chondromalacia.
5) The defects are full-thickness or nearly full-thickness defects.

The patient's identity was masked and data used purely for the study purpose.

RESULTS

Table 1: The MR protocol used is shown in table

Sequence	plane	Timeof repetition(ms)	Time of echo (ms)	Slice thickness	matrix
PD Fat Sat	axial	3000	30	4.0 mm	480x480
PD Fat Sat	Coronal	3000	30	3.0 mm	560x560
PD Fat Sat	Sagittal	3000	30	3.0 mm	560x560
T2	Sagittal	5450	100	3.0 mm	384x384
T1	Sagittal	510	17	3.0 mm	560x560
T1	Coronal	510	17	3.0 mm	560x560
T1	axial	510	17	4.0 mm	512x512
GRE	Coronal	495	14	3.0mm	320x320
STIR	Coronal	7000	30	3.0	512x512
PD Vista	Sagittal	1300	24	0.7mm	432x432

Table 2

Sequence	plane	Time of repetation (ms)	Time of echo(ms)	Slice thickness (mm)	matrix
sT2Cal_TSE	Axial	2000	13	2.5	512 x512
sT2Cal_TSE	COR	2000	13	2.5	512x512
sT2Cal_TSE	Sagittal	2000	13	2.5	512x512

Age and sex distribution of patients with or without trauma is presented in table 3. History of trauma was revealed in 44% cases.

Table 3:

	Variable	Frequency	Percent
Age Group (years) (n=25)	Upto 30	7	28.0
	31 to 40	4	16.0
	41 to 50	7	28.0
	More than 50	7	28.0
Gender (n=25)	Female	10	40.0
	Male	15	60.0

Right knee was involved in 56% cases while in 44% left knee joint was involved. On MRI, articular cartilage lesion was found positive in 48% of cases while 52% of cases had normal articular cartilage. Out of 25 cases, 32% had Grade IV cartilage loss, 12% had Grade III and 8.3% had Grade I cartilage loss while in 52% of cases no cartilage loss was noted.

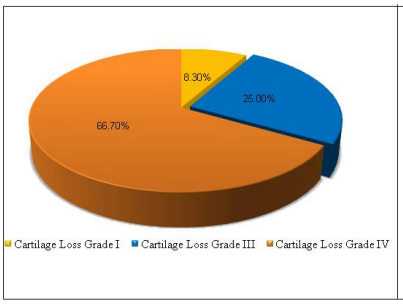


Figure 1

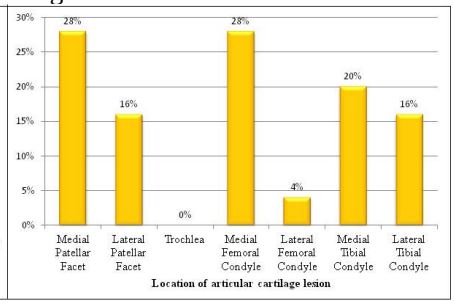


Figure 2

Maximum cases i.e 28% had either medial femoral condyle involvement or medial patellar facet involved on MRI. (Graph1). Medial meniscus tear was most commonly noted associated finding in 68% cases along with 44% having

osteoarthritic changes, 32% had mild effusion and 24% with ACL tear. Out of 15 cases with abnormal T2 mapping values it was found that 80% cases also had abnormality and were detected of articular lesion positive on routine MRI while 20% cases though having risen and abnormal T2 values had negative finding on routine MRI.

DISCUSSION

Hyaline cartilage is a specialised connective tissue seen lining the articular surfaces of joints. The basic role of articular cartilage is to reduce friction, distribute force, and prevent wear and tear of the joint.[4]MRI is the modality of choice and best imaging technique for assessment of articular cartilage and its injury due to excellent soft-tissue contrast.[5]It also provides significant information regarding morphology of articular cartilage. Availability of cartilage- specific sequences allows sensitive prediction of the mechanical integrity of the articular cartilage [6]

Age and Gender distribution:

Our study group comprised of 25 patients of more than 18 years age. 28% of these were up to 30 years. Another group of patient between 41 to 50 years also formed 28% of the total number. Only 16% cases were within 31 to 40 years age group. Craig W *et al* [7] found that Osteoarthritis is the most common cause of chondral lesions after age 40. The gender distribution in our study showed a male preponderance. Boeth H *et al* [8] found that males had a significantly higher proportion of osteophytes in the MFTJ (12/17, 71%) than females and cartilage abnormalities, tended to be commoner in males than in females.

Presence of Trauma:

History of trauma was present in 44% cases. Bianchi G *et al* [9] found that the cause of Osteochondritis dissecans in 60% of patients was recurrent microtrauma to femoral condyles.

Distribution of articular cartilage lesions: (Figure 1)

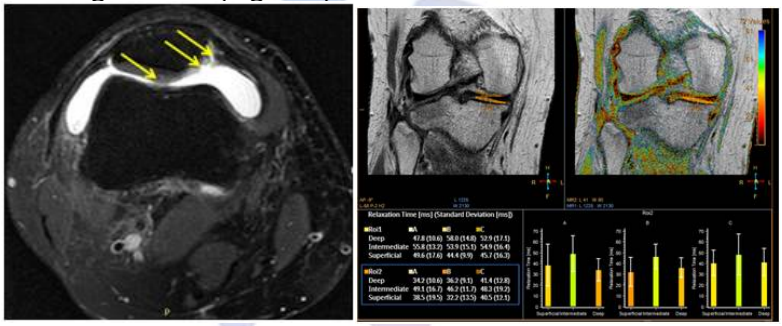


Figure 1: 44year old male with history of pain and trauma to the right knee joint.
MRI PD FAT SAT axial image showing near full thickness cartilage ulceration, cartilage irregularity and focal hyperintensity of the cartilage in the central ridge (Fig-A). On T2 mapping – Sampling of the cartilage in medial compartment yields abnormal T2 values (Fig-B).

Out of 25 cases that underwent MRI, maximum cases i.e 28% had either medial femoral condyle involvement or medial patellar facet involved on MRI. Boden BP *et al*[10] reported that injury leads to osteochondral fracture and is responsible for 40–50% of osteochondral lesions around the femoral condyles. Bianchi G *et al* [9] reported that Osteochondritis dissecans is caused in 60% of patients by recurrent microtrauma to femoral condyles and is located in the lateral aspect of the medial femoral condyles in 85% of cases.

Other associated findings: (Figure2)

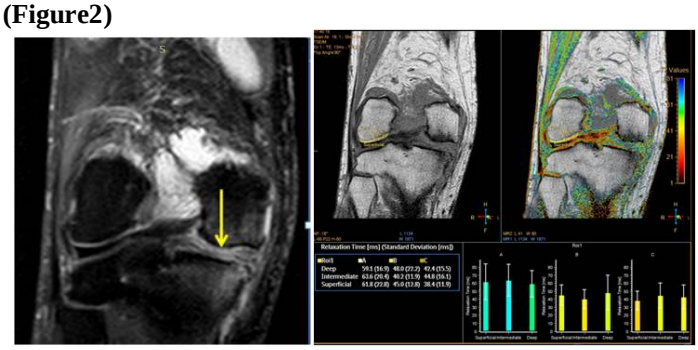
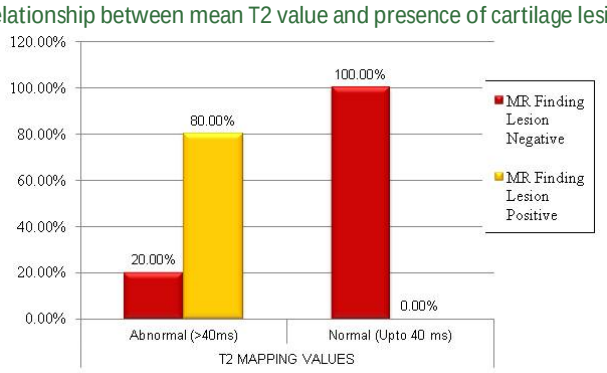


Figure 2: 55year old with history of pain and swelling over right knee joint.
MRI PD FAT SAT coronal image showing -medial compartment replaced by fluid because of diffuse marked cartilage loss with meniscal degeneration with subarticular erosion/edema(Fig-A). Lateral compartment found to be involved yields abnormal T2 value(Fig-B).

In our study medial meniscus tear was noted, in 68% cases, the commonest abnormality along with 44% having osteoarthritic changes, 32% having mild effusion and 24% with ACL tear. Lewandrowski *et al* [11] reported that articular cartilage lesions were accompanied by meniscal tears in 76% of cases. Loss of biomechanical function due to meniscal tears and loss of knee stability due to ligament damage (particularly the ACL) result in increased cartilage injury. Curl WW *et al* [12] reported that Sixty-five percent of the patients had accompanying meniscal or ligament lesions, mostly ACL tear.



Out of 15 cases with abnormal T2 mapping values it was found that 80% cases had morphological abnormality detected on routine MRI. 20% cases having abnormal T2 values had negative MRI study. **(**Figure-3)

Figure 3A **Figure 3B** **Figure 3C**

Figure 3: 48year old female with history of pain left knee joint.
MRI PD FAT SAT coronal and sagittal images shows normal appearance of articular cartilage(Fig-A,B) but on relaxometry we found abnormality of the cartilage.(Fig-C).

A few cases with normal T2 cartilage values also had negative routine MRI findings. Kijowski R *et al*[8] reported that the addition of a T2 mapping sequence to a routine MR imaging protocol significantly increased the sensitivity for detecting cartilage lesions within the knee joint, with the greatest improvement occurring in the identification of early cartilage degeneration. The present study has demonstrated the feasibility of using a T2 mapping sequence with a relatively short imaging time to evaluate the articular cartilage of the knee joint at 1.5 T. The addition of a T2 mapping sequence to a routine MR imaging protocol increased the sensitivity for detecting cartilage abnormality even before it gets detected on routine MR imaging, with the greatest improvement occurring in the identification of early cartilage degeneration, and so may be used as a prognostic tool. T2 relaxometry adds new dimension to imaging assessment of cartilage. A T2 mapping sequence may be especially useful for evaluating articular cartilage in certain patient populations where the identification of early cartilage degeneration is clinically important (eg, individuals with knee pain and no meniscal tear or cartilage lesions detected with the routine MR imaging protocol or individuals with persistent knee pain after meniscal resection or anterior cruciate ligament reconstruction surgery).

REFERENCES

1. Kapur S, Wissman RD, Robertson M, Verma S, Kreeger MC, Oostveen RJ. Acute knee dislocation: review of an elusive entity. Current problems in diagnostic radiology. 2009 Dec 31;38(6):237-50.
2. Recht MP, Resnick D. Magnetic resonance imaging of articular cartilage: an overview. Top Magn Reson Imaging, 9 (6) (1998), pp. 328-336.
3. Nieminen MT, Rieppo J, Toyras J, *et al*. T2 relaxation reveals spatial collagen architecture in articular cartilage: a comparative quantitative MRI and polarized light microscopic study. Magn Reson Med 2001;46:487-493.

4. Buckwalter JA, Mankin HJ. Articular cartilage: tissue design and chondrocyte-matrix interactions. Instructional course lectures. 1998;47:477-86.
5. Gold GE, Chen CA, Koo S, Hargreaves BA, Bangerter NK. Recent advances in the articular cartilage. AJR Am J Roentgenol. 2009;193:628–38.
6. Katta J, Jin Z, Ingham E, Fisher J. Biotribology of articular cartilage: A review of the recent advances. Med Eng Phys. 2008;30:1349–63.
7. Craig W, David JW, Ming HZ. A current review on the biology and treatment of the articular cartilage defects (part I and part II) J Musculoskelet Res. 2003;7(3and4):157–181.
8. Kijowski R, Blankenbaker DG, del Rio AM, Baer GS, Graf BK. Evaluation of the Articular Cartilage of the Knee Joint: Value of Adding a T2 Mapping Sequence to Routine MR Imaging Protocol. Radiology. 2013, Volume 267: Number 2.
9. Bianchi G, Paderni S, Tigani D, Mercuri M (1999) Osteochondritis dissecans of the lateral femoral condyle. Chir Organi Mov 84(2):183–187.
10. Boden BP, Pearsall AW, Garrett WE Jr, Feagin JA Jr. Patellofemoral instability: evaluation and management. J Am Acad Orthop Surg. 1997:5(1):47–57.
11. Lewandrowski KU, Müller J, Schollmeier G. Concomitant meniscal and articular cartilage lesions in the femorotibial joint. Am J Sports Med. 1997 Jul-Aug; 25(4):486-94.
12. Curl WW, Krome J, Gordon ES, Rushing J, Smith BP, Poehling GG. Cartilage injuries: a review of 31,516 knee arthroscopies. Arthroscopy. 1997 Aug; 13(4):456-60.

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