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Original Article

Evaluation of Knee Cartilage Defects with an Add Up Sequence of Three-dimensional Spoiled Gradient-recalled Echo Fat-saturated to Routine Magnetic Resonance Imaging of Knee

B Ashraf Ahmed[1], Alex Daniel Prabhu Arul Pitchai[2], Abdul Khader Farook[3], Lakshmi Aparna Kandru[4], Vivek Elangovan[5], Abubacker Sulaiman Farook[6]

[1]Assistant Professor, Department of Radiology and Imaging Sciences, Chettinad Hospital and Research Institute, Kanchipuram, Tamil Nadu, India, [2]Associate Professor, Department of Radiology and Imaging Sciences Department of Radiology and Imaging Sciences, Chettinad Hospital and Research Institute, Kanchipuram, Tamil Nadu, India, [3]Assistant Professor, Department of Orthopaedics, Shri Sathya Sai Medical College and Research Institute, Ammapettai, Chengalpet, Kanchipuram, Tamil Nadu, India, [4]Under-graduate, Department of Radiology and Imaging Sciences, Chettinad Hospital and Research Institute, Kelambakkam, Kanchipuram, Tamil Nadu, India, [5]Post-graduate, Department of Radiology and Imaging Sciences, Chettinad Hospital and Research Institute, Kelambakkam, Kanchipuram, Tamil Nadu, India, [6]Professor, Department of Radiology and Imaging Sciences, Chettinad Hospital and Research Institute, Kelambakkam, Kanchipuram, Tamil Nadu, India

Abstract

Introduction: Hyaline cartilage defects are one of the causes of knee pain because they may produce symptoms confused with meniscal tears. Articular cartilage pathology may be due to degenerative changes or acute injury. Conventional radiography can be used to identify gross loss of cartilage, evident as narrowing of the space in the joint, but it does not image cartilage directly. Only arthrography or combined study of arthrography with conventional radiography and computed tomography are mildly invasive and provides information limited to the contour of the cartilage surface. Magnetic resonance imaging (MRI) is the best imaging technique presently available for the evaluation of articular cartilage.

Materials and Methods: A retrospective analysis of the patients with the history of knee injury, knee pain, and features suggestive of osteoarthritis referred to MRI knee has been taken for the study. An informed consent will be obtained from the patients before any study related procedure. Patients will be imaged in GE Signa 1.5 HDxt MRI modality equipped with transmit-receive knee coil with the routine MRI knee protocol and with an extra sequence of three-dimensional (3D) spoiled gradient-recalled echo (SPGR) fat-saturated (FS). The results obtained were subjected for radiological interpretation.

Results: In all the patients who were evaluated in our study with both routine MRI knee sequences and 3D SPGR FS sequence statistically, the visibility of the evaluated structures and major cartilage pathology was excellent for routine MRI sequences and 3D SPGR FS, respectively. However, 3D SPGR FS has the sensitivity to diagnose degeneration changes and other major cartilage pathology of knee when compared to routine MRI sequences (75-85% vs. 29-38%, $P < 0.001$ for each comparison).

Conclusion: The additional FS 3D spoiled gradient echo sequence gives better diagnostic information of cartilage defects of knee when compared to routine MR imaging protocol of knee.

Key words: Degenerative changes, Fat-suppressed spoiled gradient-recalled echo, Hyaline cartilage, Magnetic resonance imaging, Three dimensional imaging

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INTRODUCTION

Hyaline cartilage defects are one of the causes of knee pain because they may produce symptoms confused with meniscal tears. Articular cartilage pathology may be due to degenerative changes or acute injury. Osteoarthritis is an important cause in our society and is marked by degeneration of articular cartilage.

Corresponding Author: Dr. Abubacker Sulaiman Farook, Department of Radiology and Imaging Sciences, Chettinad Hospital and Research Institute, Kelambakkam, Kanchipuram - 603 103, Tamil Nadu, India. Phone: +91-9710754999. E-mail: fasulaiman@hotmail.com

Many imaging methods are available to evaluate articular cartilage. Conventional radiography can be used to identify gross loss of cartilage, evident as narrowing of the space in the joint, but it does not image cartilage directly. Secondary changes like osteophyte formation can be seen, but the conventional radiography is not sensitive to early chondral damage detection. Only arthrography or combined study of arthrography with conventional radiography and computed tomography are mildly invasive and provides information limited to the contour of the cartilage surface.

Magnetic resonance imaging (MRI) has excellent soft-tissue contrast, so it is the best imaging technique presently available for the evaluation of articular cartilage. Recent advances in the treatment of hyaline cartilage disease have coincided with technological advances in MRI. Acute injury to cartilage can be identified using MRI. Whether the results are from degeneration or injury, MRI offers a non-invasive method of assessing the degree of damage to cartilage imaging regions of cartilage damage has the potential to provide morphologic information, like fissuring and the presence of partial- or full-thickness cartilage defects. MRI has the possibility to provide the biochemical and physiologic information about the cartilage.

Standard MRI pulse sequences used routinely for the detection of meniscal and ligamentous injuries are not adequate for assessing hyaline cartilage defects. MRI for hyaline cartilage defects with fat-suppressed (FS) spoiled gradient-recalled echo (SPGR) show hyaline cartilage with positive contrast (higher signal intensity) relative to adjacent structures.

MATERIALS AND METHODS

MRI images of 44 patients with the age group of 18-65 years from January 2016 to May 2016 (retrospective analysis) with clinical suspicion of osteoarthritis and with the history of knee injuries from Chettinad Hospital and Research Institute were included in the study. An informed consent will be obtained from the participating subjects. Patients referred to MRI knee were imaged in GE Signa 1.5 HDxt scanner with the routine knee protocol (proton-density [PD]-weighted sagittal and axial series, T2-weighted sagittal and coronal series, and T1-weighted coronal series) and with an add up sequence of three-dimensional (3D) SPGR for the evaluation of the knee cartilage. MR routine protocol images and 3D SPGR images of knee cartilage were assessed for focal lesions. The images obtained were subjected to radiological analysis and interpretation.

Sample Selection

Inclusion criteria

- Patients suffering from knee pain
- Patients with the history of knee injury.

Exclusion criteria

- Patients with any H/O metallic implants
- Patients with known cardiac pacemaker
- Pregnant women
- Claustrophobic patients.

Image Acquisition and Image Processing

All our patients were imaged on 1.5 Tesla GE Signa HDxt scanner. An eight channel knee coil was used. The data obtained were examined by the two radiologists independently for qualitative analysis.

RESULT

We had included 44 patients for this research after getting informed consent. Out of 44 patients, 3D SPGR FS sequence identified cartilage defects in 12-14 patients. Hence, routine sequences of knee in MRI with an add up sequence 3D SPGR FS sequence is better for detection of major cartilage defects in knee (Figure 1).

A patient of age 29 years old male came with the complaints of a knee injury, and the patient was referred for the MRI knee. First, the patient was screened with the routine sequences of MRI knee PD FS, T1-weighted image, T2-weighted image and then the additional sequence 3D SPGR FS was added.

The image shows chronic near complete tear noted in the anterior cruciate ligament near its femoral insertion site. Severe reduction of tibiofemoral joint space noted with near complete loss of chondral cartilage. Fraying of chondral surface noted in medial patellar facet (Figure 2).

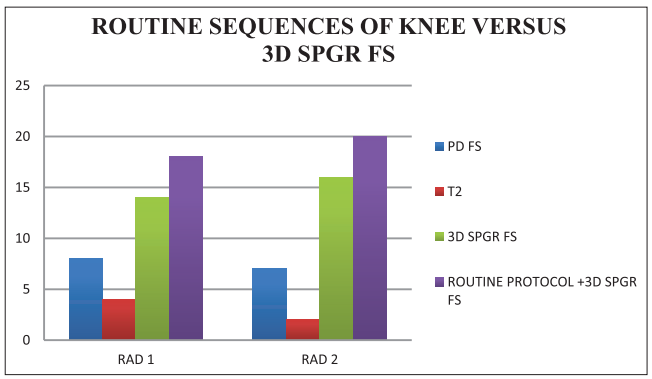

Figure 1: Radiologist comparison between two sequences

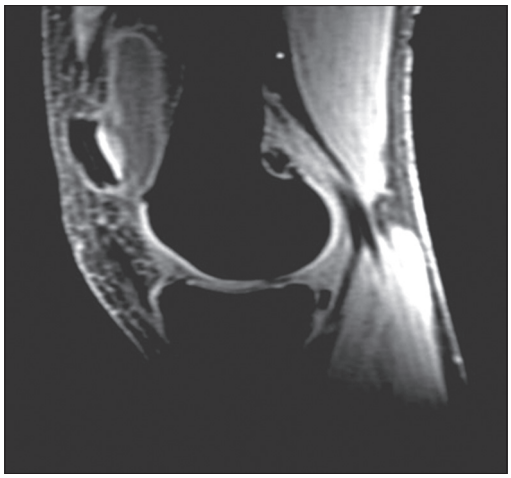

Figure 2: Three-dimensional spoiled gradient-recalled echo fat-saturated image of knee showing severe reduction of tibiofemoral joint space noted with near complete loss of chondral cartilage

DISCUSSION

This study revealed that articular cartilage defects of the knee could be accurately identified on 3D SPGR FS imaging. FS 3D SPGR imaging increased the sensitivity for the identification of the articular cartilage abnormalities over routine MR protocol. Identifying hyaline cartilage defects in the knee is important because symptoms and signs are related with such defects can be confused clinically with the meniscal tears. Meniscal tears were easily cured but the treating chondral defects are difficult and of limited prediction value, because hyaline cartilage does not regenerate rather repairs within growth of fibrocartilage from subchondral mesenchyme. Increasing numbers of these studies explained the common incidence of hyaline cartilage injuries, their mimicking of cartilage pathology with meniscal tears, and clinicians lack of ability to recognize the hyaline cartilage injuries with the routine MRI techniques.

The sensitivity for assessing the lesions of the patella which was usually injured articular surface, the sensitivity was low for routine MRI protocol (21-31%), but the sensitivity is high for the 3D SPGR FS sequence (87-100%). other investigations using routine MRI pulse sequences were unable to assess Grade 1 and 2 lesions of articular cartilage. However, our data showed that such lesions of hyaline cartilage could be assessed using the 3D SPGR FS sequence.

CONCLUSION

The additional FS 3D SPGR sequence gives better diagnostic information of major cartilage defects of the knee when compared to routine MRI protocol of knee.

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