Articular cartilage grading of the knee ; Diagnostic value of fat suppressed 3D volume isotropic turbo spin echo acquisition

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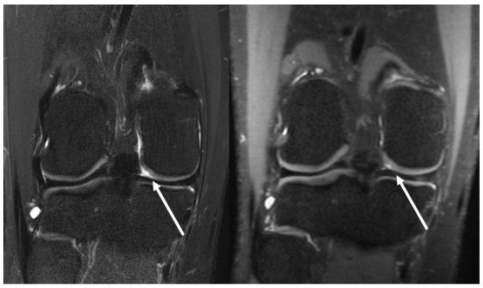
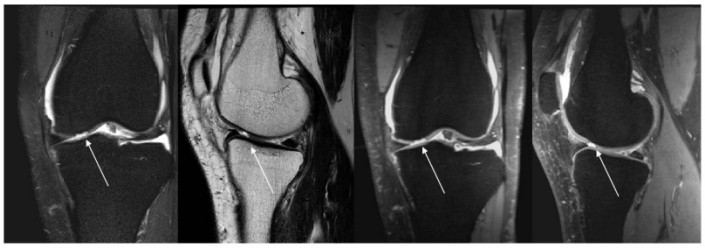
Introduction: Accurate assessment of cartilage grading of the knee on MRI is clinically important. MR protocol consist of 2D intermediate-weighted and T2-weighted fast spin-echo(FSE) sequence is used in clinical cartilage imaging at most institutions at most institutions. This sequence has high in plane spatial resolution, but relative thick slice and gaps, thus may obscure the cartilage morphology because of partial volume averaging artifact. 3 dimensional (3D) techniques based on gradient echo sequences has high sensitivity and specificity for detecting cartilage lesions in knee joint. However they have a limited role due to insufficient tissue contrast. Recent studies have shown that 3D isotropic sequence based on FSE have the similar diagnostic performance and image quality in evaluation of internal derangement of knee compared to that of conventional 2D sequence. And there were few studies about cartilage detecting and grading using 3D isotropic FSE sequences. Thus, the purpose of our study is to assess the diagnostic value of fat suppressed (FS) 3D volume isotropic turbo spin echo acquisition (VISTA) imaging cartilage grading of the knee. **Methods:** From November 2010 to August 2011, total eighty one patients with arthroscopically confirmed cartilage lesions were included in this study. All patients underwent both standard 2D and FS 3D VISTA imaging. We used 3T MRI system (Achieva, Philips Healthcare, Best, Netherlands) with eight channel SENSE knee coil, Time interval between MR examination and arthroscopic surgery was one to fifty 50 days. The details of the MR protocol are summarized in Table 1. The imaging protocol consisted of 2D images including axial T1WI, axial FS T2WI, coronal FS T2WI, and sagittal T2WI that were obtained using conventional 2D MR sequences. FS isotropic sagittal 3D FSE IM MR Images with a voxel size of 0.5 x 0.5 x 0.5mm were obtained for VISTA. Two Musculoskeletal radiologist retrospectively reviewed MR images in consensus by the two separate sets of MRI. In the 1st session, only reviewed conventional 2D images and in second session, reviewed only FS 3D VISTA images. To reduce recall and learning bias, there was time interval of 2 weeks between 1st and 2nd session. Radiologist was blind to original report of knee MRI and arthroscopic findings. Knee cartilage surfaces were divide into 6 regions (medial/lateral femoral condyle, medial/lateral tibial plateau, patella, trochlea).Cartilage grading were divided into 4 grade, grade 1; Signal heterogeneities within the cartilage in a smooth surface., grade 2; Fibrillation or erosion composing less than 50% of the cartilage thickness, grade 3; Defects of more than 50% of the cartilage thickness and grade 4; Extended full-thickness lesions with denudation of the bone. All statistical analyses were carried out with the SAS version 9.2 (SAS Institute Inc., Cary, NC, USA) By kappa statistics, inter modality agreement for cartilage grading between arthroscopic grade and MRI grade were calculated. The Sensitivity, specificity, positive predictive value(PPV), negative predictive value(NPV) and accuracy in conventional 2D and FS 3D VISTA image were evaluated. The arthroscopic findings were used for the standard reference. For comparing diagnostic performance, Generalized Estimating Equation (GEE) was used. **Results:** For grade 1 cartilage lesion, there were exactly the same values in diagnostic values. For grade 2 lesions higher in sensitivity and PPV, NPV in 3D VISTA. For Grade 3 and 4 lesions, there was not statistically difference in 2D and FS 3D VISTA image. For each cartilage surface, there were not statistically difference in diagnostic values between 2D and FS 3D VISTA image. In intermodality agreement between arthroscopic grading and MRI, there was substantial agreement of kappa value in both conventional 2D image and FS 3D VISTA imaging in all cartilage surfaces (Kappa=0.729 vs 0.776). For each cartilage surface, except lateral tibial plateau in conventional 2D MRI, there were substantial or good agreement at conventional 2D and 3D VISTA. In lateral tibial plateau, there was lowest agreement of all cartilage surface of knee. (Table 2) **Conclusion:** FS 3D VISTA imaging has comparable diagnostic value to 2D conventional sequence in cartilage grading in knee joint. There were higher diagnostic values in FS 3D VISTA in grade 2 cartilage lesion.



A. Coronal FS T2 WI B. Reformatted coronal images

Figure 1 Images of 20-year old male patient with arthroscopic proven grade 2 cartilage lesion that was detected at both 2D MR image and FS 3D VISTA image



A. Coronal FS T2WI B. Sagittal T2 WI C. reformatted coronal D. Sagittal FS3D VISTA

Figure 2. Images of 58-year old female patient with arthroscopic proven grade 4 cartilage lesion that was detected at both 2D MR imaging and iso–volumetric 3D fat suppressed VISTA imaging

Table 1 Parameters for MRI

Parameter	Axial T1WI	Axial FS T2WI	Coronal FS T2WI	Sagittal T2WI	Sagittal FS 3D VISTA
Repetition time (msec)	610	2500	3100	2800	1400
Echo time (msec)	9	62	62	100	32
Matrix size (cm)	384x308	384x300	384x308	384x308	320x320
FOV(cm)	14	14	14	14	16
Section thickness (mm)	3	3	3	3	0.5
Bandwidth (kHz)	298	230	233	371	353
Echo train length	3	15	15	17	63
NEX	1	2	2	2	1

Table 2. Inter-modality agreement value at each cartilage surface of knee.

	Artrho vs. Conventional 2D	Arthro vs. FS 3D VISTA
MFC	0.755 (0.645 – 0.865)	0.826 (0.742 – 0.91)
LFC	0.761 (0.628 – 0.893)	0.846 (0.731 – 0.961)
TRO	0.702 (0.571 – 0.833)	0.703 (0.565 – 0.842)
PAT	0.71 (0.59 – 0.83)	0.768 (0.666 – 0.871)
MTP	0.769 (0.662 – 0.876)	0.79 (0.684 – 0.896)
LTP	0.585 (0.428 – 0.742)	0.632 (0.478 – 0.787)