Relaxometric Maps: Sequence Development and Clinical Impact. Initial Observations.

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Purpose

To evaluate the usefulness and the applicability of relaxometric maps (T2 and T2# map) for the study of joint knee cartilage obtained with a new dedicated sequence protocol on a dedicated open MRI system.

Methods and Materials

In 24 patients who came to our institution to perform an MRI of knee on a dedicated open system MRI (Esaote G-Scan - 0.25 T), two optimized 3D steady-state free precession sequences (SST1 and Sharc) have been added to the standard acquisition protocol. The 3D SSFP images (fig 1) were acquired on a sagittal plane (FOV: 200x200x180 mm3; Resolution: 1x1x2.5 mm3; total duration of both sequences: 12') and then reconstructed via zero-filling on a high-resolution matrix (512x512 pixels).

The knowledge of the spin populations of the fundamental phase states allowed a numerical voxel-by-voxel inversion of the related signal equations to obtain quantitative PD, T1, T2 and T2# maps of the whole joint.

The maps were evaluated in consensus by two radiologists on an Osirix DICOM PACS workstation. Both T2 (fig 2) and T2# (fig 3) maps were evaluated at fixed range scales (T2 ranging from 0 to 150 ms; T2# from 0 to 300 ms) with the Osirix NIH colorimetric scale to find cartilage focal defects.

The number of focal or diffuse cartilage alterations detected by means of each relaxometric map was then compared to the number of anomalies in original Sharc images.

Also bone focal or diffuse anomalies were analyzed to test map sensitivity and correlation between cartilage and bone defects was evaluated.

Images for this section:

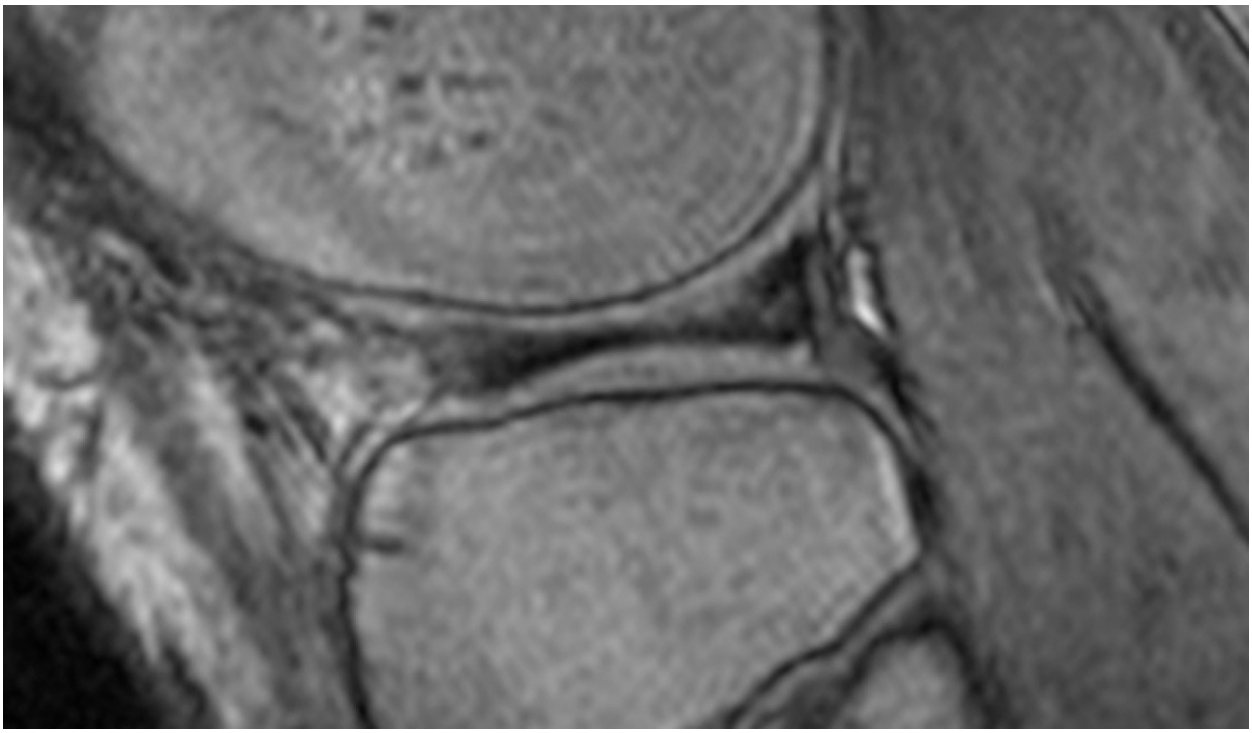

Fig. 1: Sagittal 3D Sharc

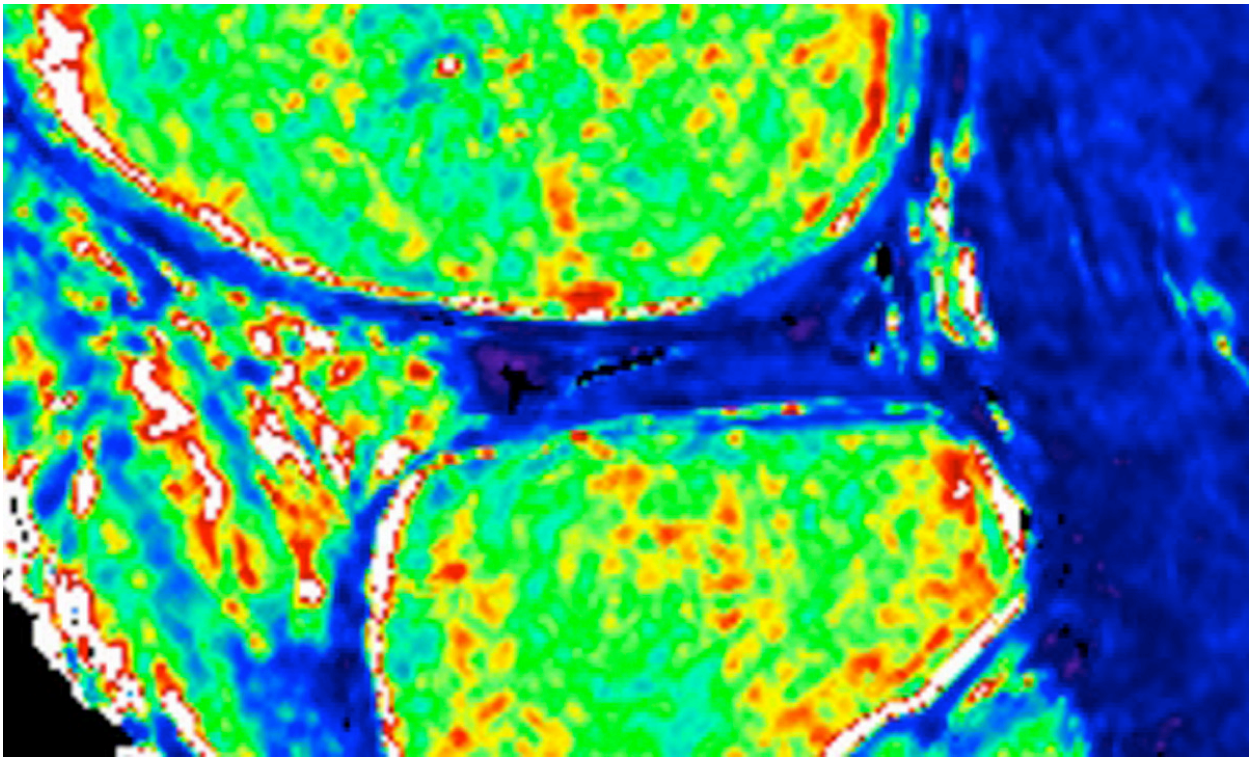

Fig. 2: Sagittal T2 Map with the Osirix NIH colorimetric scale (T2 ranging from 0 to 150 ms); same patient of fig 1.

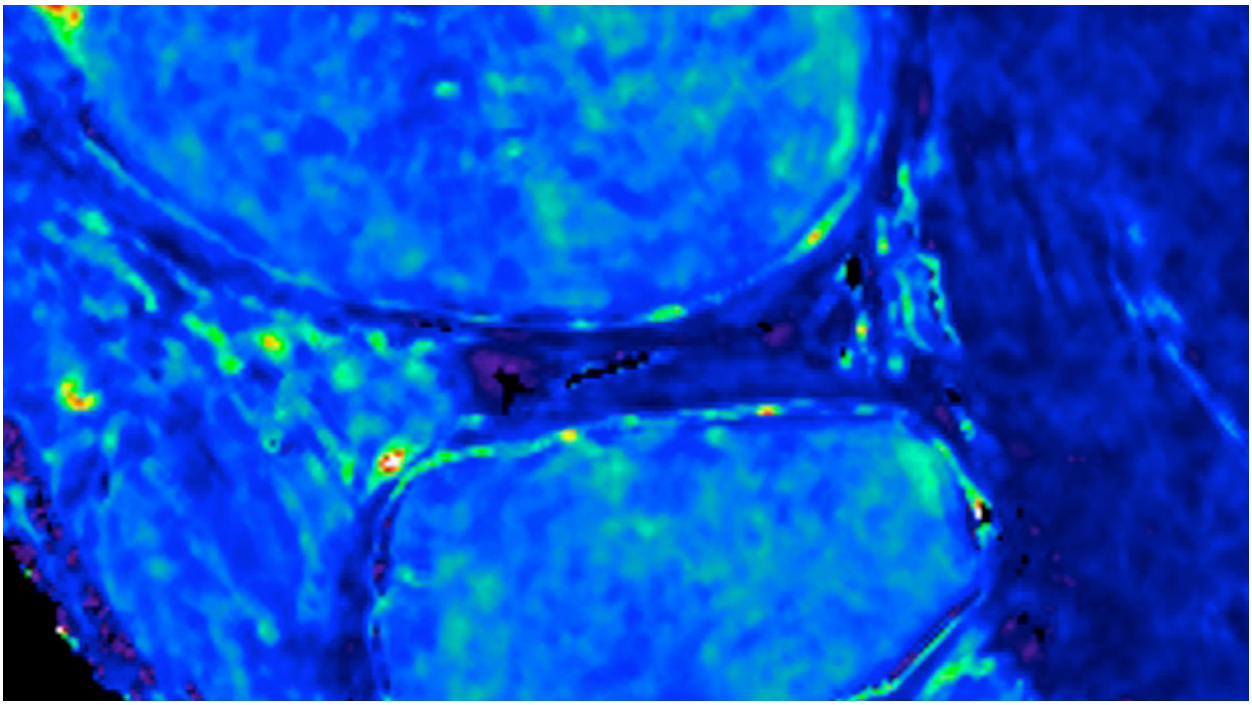

Fig. 3: Sagittal T2# Map with the Osirix NIH colorimetric scale (T2# ranging from 0 to 300 ms); same patient of fig 1.

Results

In the evaluation of diffuse cartilage alteration the Sharc images were positive in 1 case, T2map in 10 cases and T2# in 7. Moreover Sharc sequence found 1 focal cartilage alteration, T2 map 15 focal defects and T2# 22 focal alterations.

In the bone evaluation the Sharc images showed 1 diffuse bone signal anomaly, T2# 3. No diffuse bone alterations were evident in T2Maps. The Sharc showed 12 focal bone cortical/subcortical anomalies, T2map 3 and the T2# 14.

The correlation between cartilage and bone anomaly was found in 1 case with Sharc and T2Map, and in 8 cases with T2# images.

Images for this section:

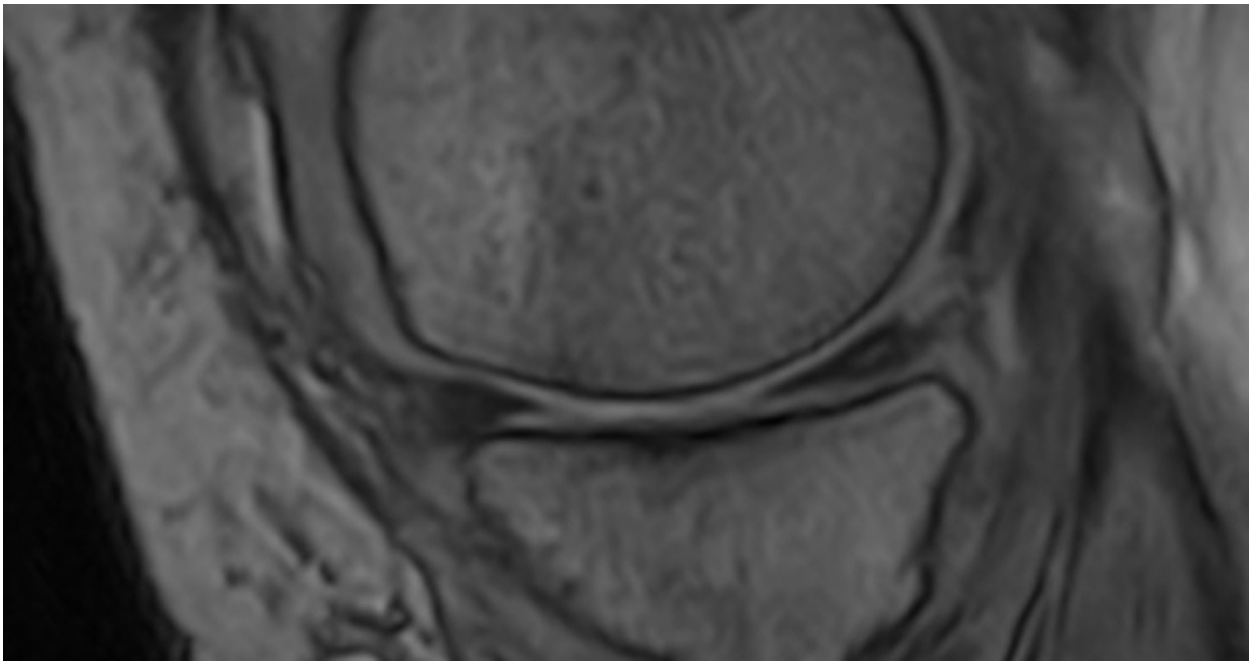

Fig. 1: Negative 3D Sharc sagittal plane.

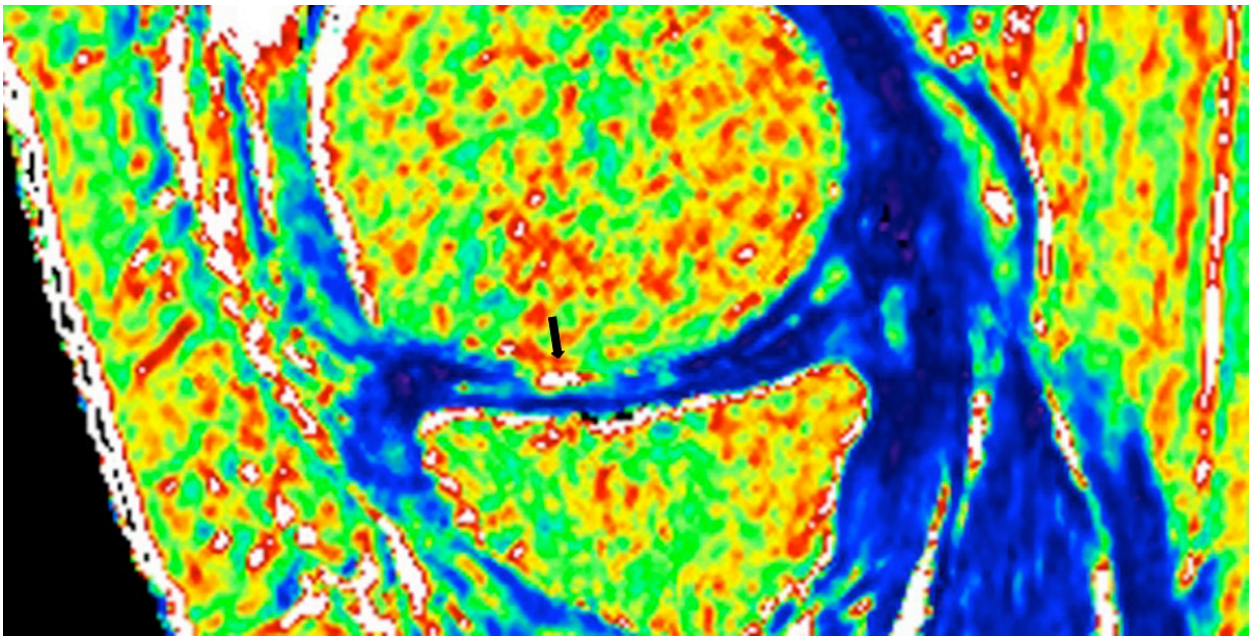

Fig. 2: The T2 map of same subject of Fig. 1 shows focal alteration (arrow) in the femoral cartilage.

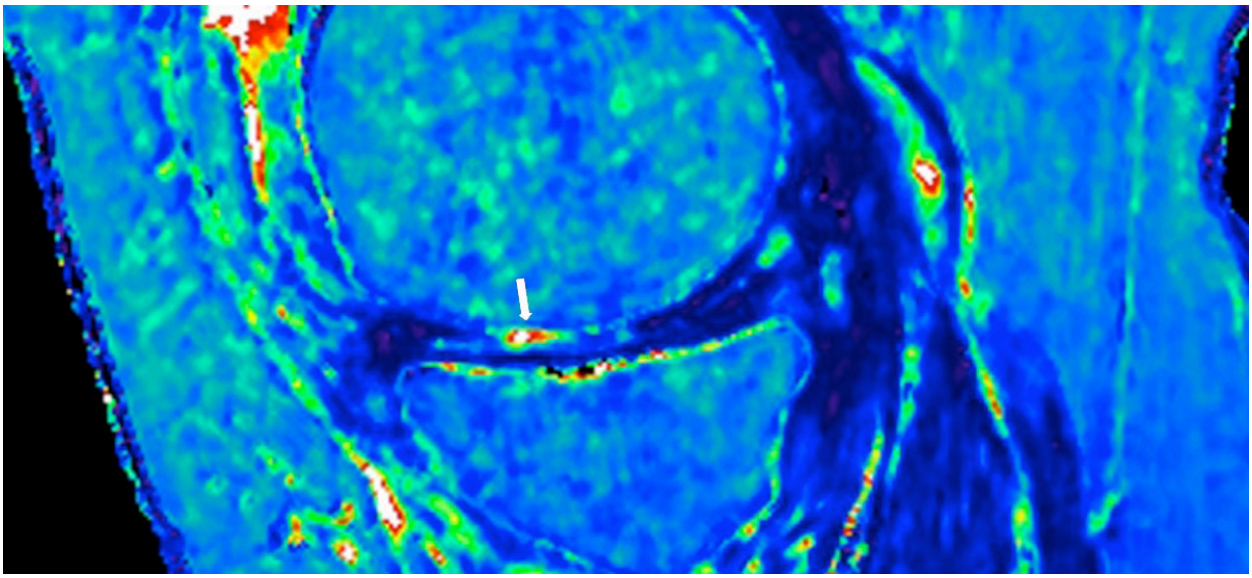

Fig. 3: The T2# map of same subject of Fig. 1 shows focal alteration (arrow) in the femoral cartilage.

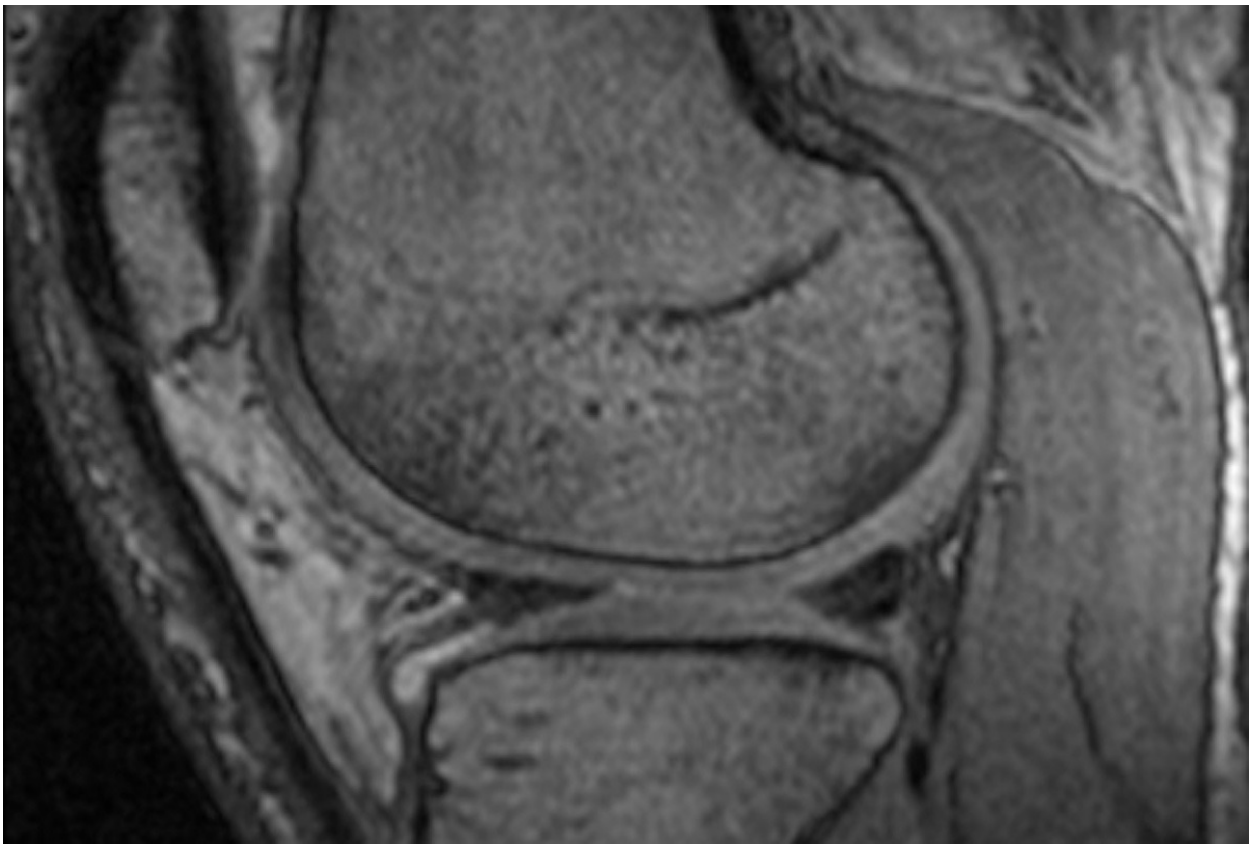

Fig. 4: 3D Sharc with no abnormal cartilage evidence; bone marrow ipointensity is slightly appreciable in the posterior area of femoural condyle.

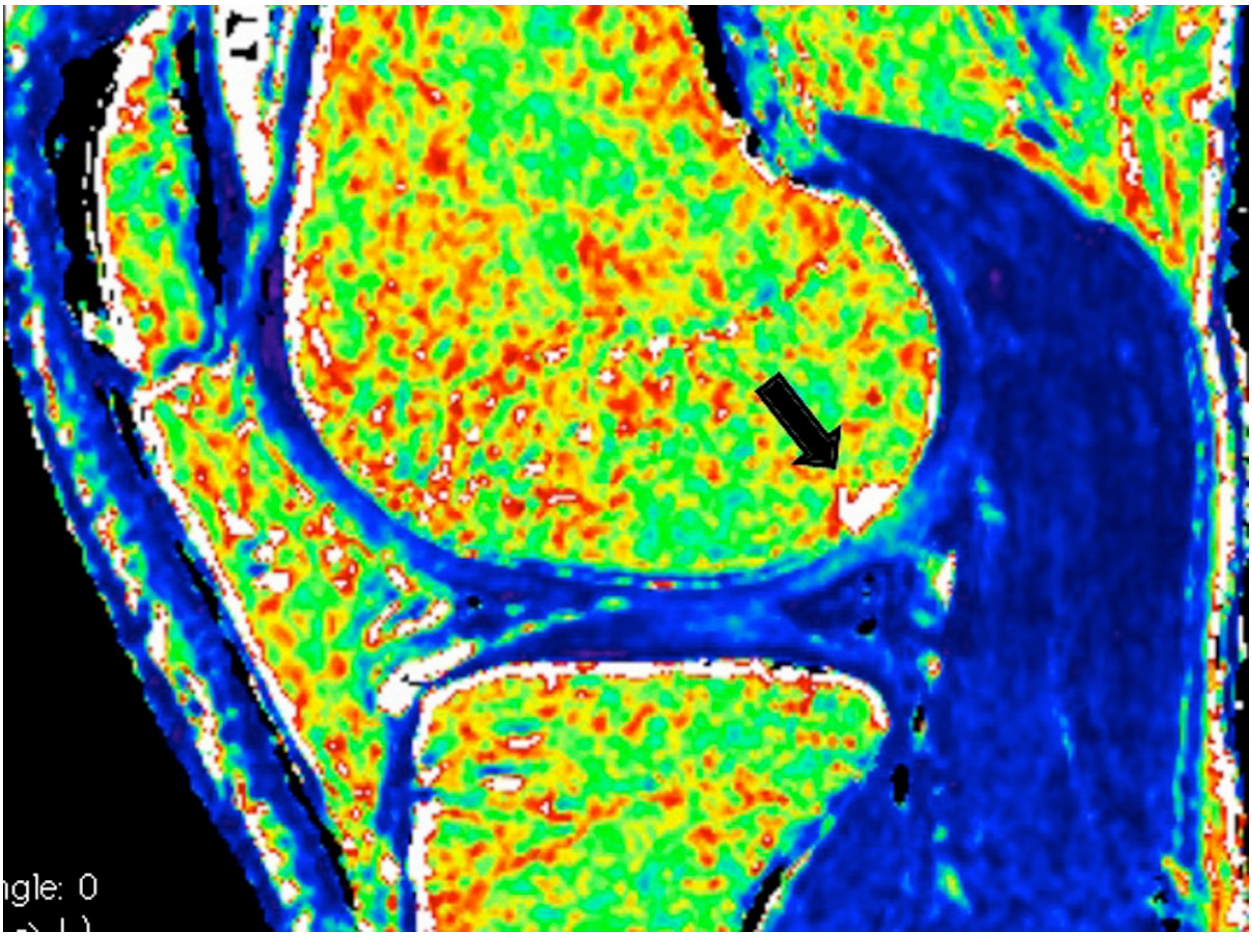

Fig. 5: The T2 map of same patient of Fig. 4 shows focal alteration (arrow) in the femoral cartilage not seen in the 3D Sharc; also in the adjacent bone marrow it showed an intense focal signal alteration.

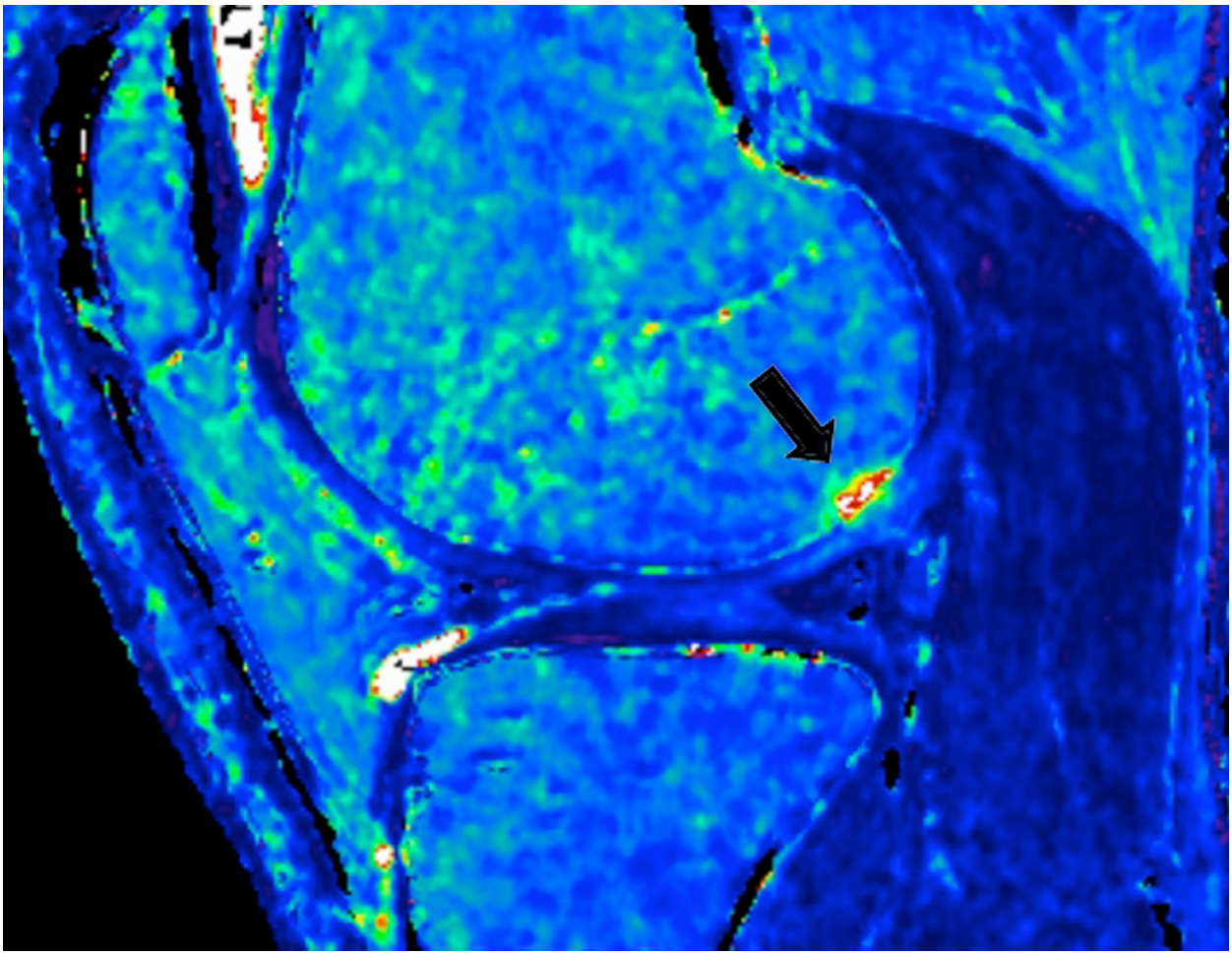

Fig. 6: The T2# map of same patient of Fig. 4-5 shows focal alteration (arrow) in the femoral cartilage not seen in the 3D Sharc; also in the adjacent bone marrow showed an intense focal signal alteration.

Conclusion

The study of cartilage is one of the limits of dedicated systems; the possibility to obtain not only morphological information but also structural data is an important goal to be achieved, so as to qualify dedicated system as practical and complete tool for the study of the knee.

Our initial results show that both the T2 and T2# relaxometric maps are suitable to give extra information on the healt status of knee cartilage, even in absence of morphological evidence of alteration in native 3D sequence; in particular, the T2# sequence appeared more sensitive if compared to the T2 maps.

The sequences used not only gave structural information about the cartilage, but also allow to evaluate bone pathology; in pathologic cases T2 and T2# images showed more and more clearly bone alteration if compared to the 3D Sharc sequence.

If our data are confirmed by orthopedics' arthroscopy, these sequences will be used to have an early cartilage defect evaluation, allowing for non surgical drug therapy follow up in the study of cartilage degeneration in selected patients.

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