T2 & T2# maps: Sequence Development and Clinical Impact on Joint Study

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Purpose

T2- and T2 #- maps are quantitative images that, by the measurement of relaxation times, give the amount of water content of tissue. In the specific case of cartilage, the presence of water has an inverse correlation with the presence of proteoglicans, the fundamental constituents of cartilage itself.The value of T2-maps on high-field MRI apparati has already been assessed in literature.

We tested a 3D Steady State and a 3D Gradient echo on a low field dedicated MRI equipment and correlated our observations with 3D dedicated commercial sequences and with the results obtained by the arthroscopic evaluation.

Methods and Materials

We studied 36 patients scheduled for arthroscopy on a dedicated MRI system(Esaote G-Scan - 0.25 T) with two optimized Steady-State Free-Precession (Sharc and SST1) sequences (fig.1). The related signal equations were inverted voxel-by-voxel to obtain quantitative T1- and T2-maps (fig.2-3) of the whole joint.

The T2#-map of the joint was derived as harmonic mean of T1 and T2. Sharc, T2- and T2#-maps were evaluated in consensus by two radiologists, on an Osirix DICOM PACS workstation, at fixed range scales to find cartilage defects.

The number of focal or diffuse cartilage alterations detected by MRI images by means of each kind of map was compared to the number cartilage defects found by Sharc sequence and the alterations found by surgeons during arthroscopy.

To standardize the evaluation and the localization of alteration found, radiologists and orthopedics compiled a standardized evaluation form (table 1). In this kind of form the joint cartilage is subdivided in sectors and the defects is quantified in extension and tipology (e.g. full thickness defect, superficial fibrillation, etc.).

Images for this section:

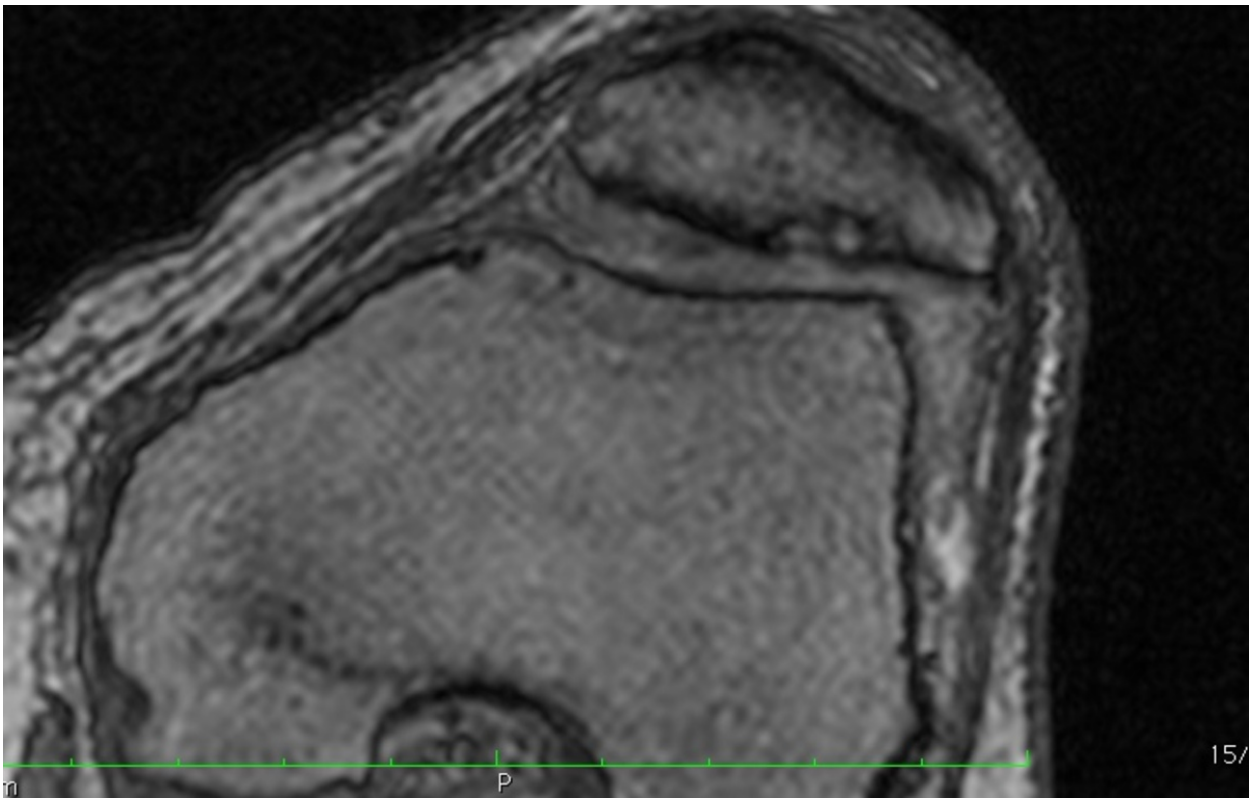


Fig. 1: 3D SHARC

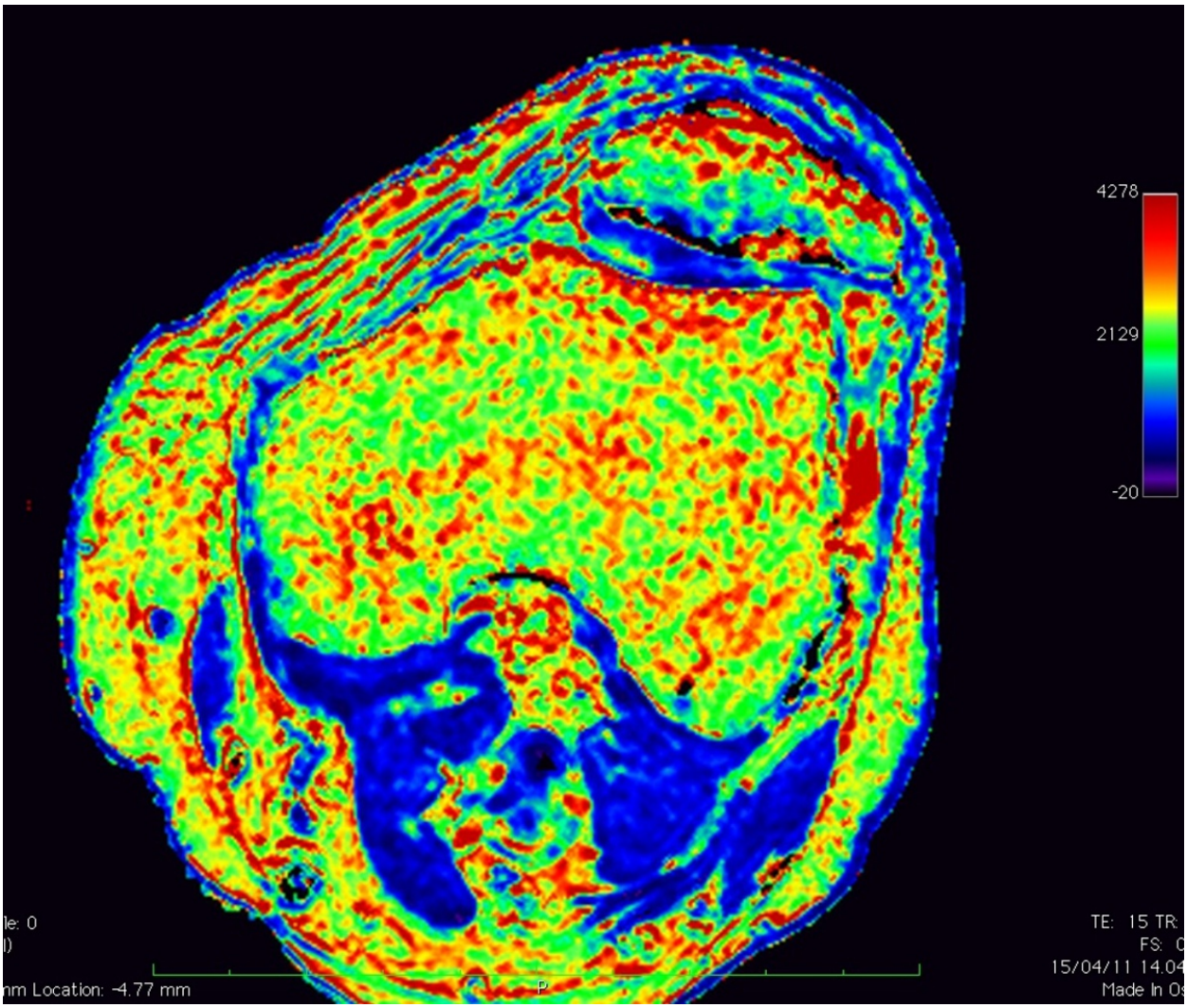


Fig. 2: T2 MAP

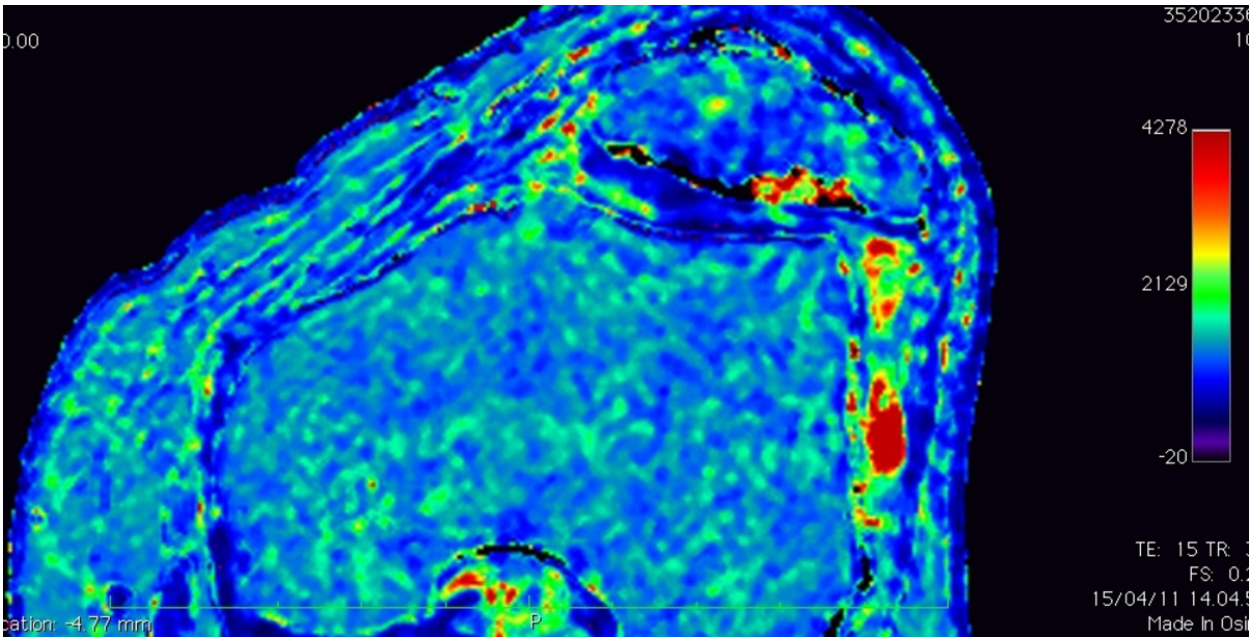
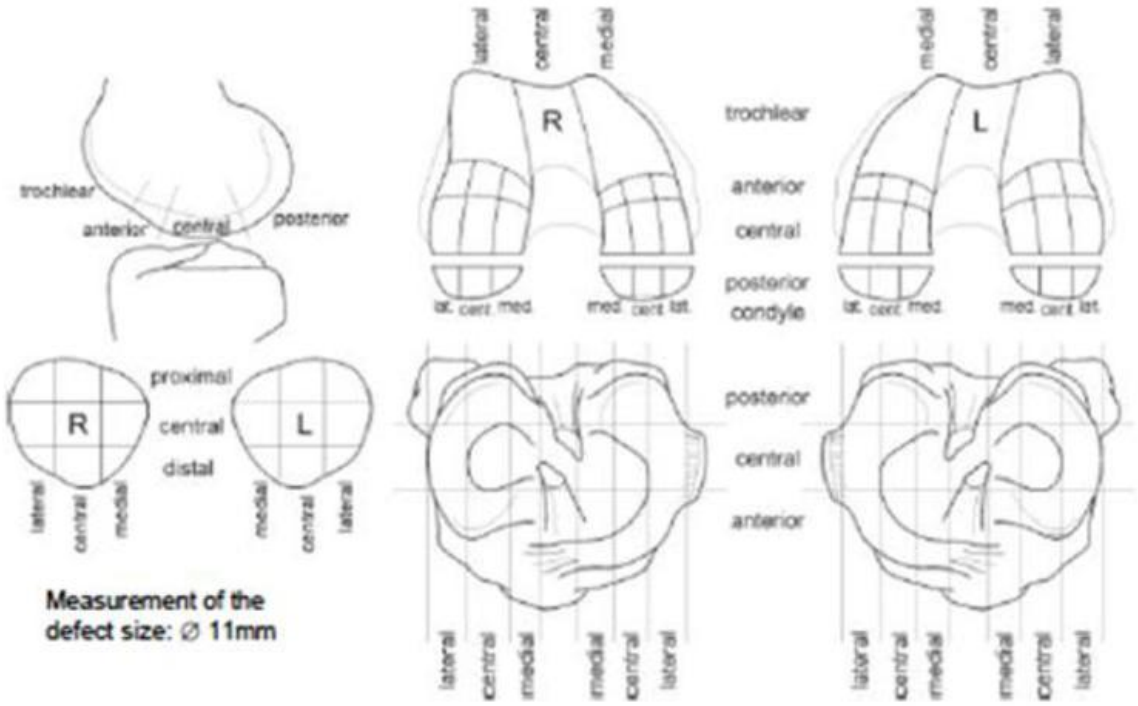


Fig. 3: T2rho MAP



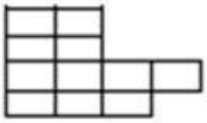
Measurement of the defect size: ∅ 11mm

Femur

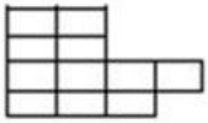
Side	Right	Left		
Condyle	medial	lateral		
Sagital plane	trochlear	anterior	central	posterior
Frontal plane	lateral	central	medial	

Cartilage lesion (Grade) (*)
Defect size pre-debridement mm
Defect size post-debridement mm

First lesion



Second lesion

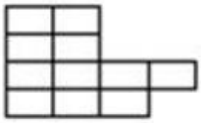


Tibia

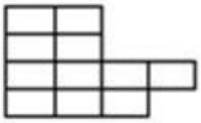
Side	Right	Left	
Plateau	medial	lateral	
Sagital plane	anterior	central	posterior
Frontal plane	lateral	central	medial

Cartilage lesion (Grade) (*)
Defect size pre-debridement mm
Defect size post-debridement mm

First lesion



Second lesion

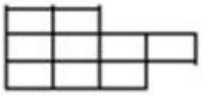


Patella

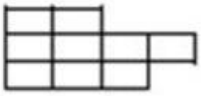
Side	Right	Left	
Sagital plane	distal	central	proximal
Frontal plane	lateral	central	medial

Cartilage lesion (Grade) (*)
Defect size pre-debridement mm
Defect size post-debridement mm

First lesion



Second lesion



Diagnosis: ☐ Traumatic cartilage lesion ☐ OD ☐ OA ☐ AVN ☐ Others

Biopsy/Osteochondral Plugs: Location: Number of Plugs: Diameter of Plugs:

Treatment: ☐ Shaving ☐ Drilling Others:
☐ Mosaic-Plasty ☐ Microfracture
☐ Autologous Chondrocyte Implantation (ACI)

Notes:

Table 1: Evaluation form

Results

As for the evaluation of diffuse cartilage alterations, Sharc, T2-maps and T2#-maps were positive in 8, 41 and 35 cases, respectively. Moreover Sharc revealed 16, T2-maps revealed 68 and T2#-maps revealed 71 focal cartilage alterations.

The arthroscopy surgeons found 73 focal cartilage lesions, so the correlation was poor for the SHARC images (20% of agreement) and good with T2- and T2 #-maps (81- 95% of agreement).

Moreover, when a the lesion was found, there was a good correlation in the space localization between MRI (both Sharc and maps) and arthroscopy.

Conclusion

Our initial results show that both T2- and T2#-maps provide good extra information on the health status of knee cartilage, even in absence of morphological evidence of alteration on native 3D images; in particular, T2#-maps appeared more sensitive than T2-ones.

Our data, confirmed by orthopaedics' arthroscopy, open new functional possibility for the dedicated MRI equipments in the cartilage defects evaluation, allowing an early diagnosis and a accurate follow up with new therapeutic opportunities. In addition the information given by the MRI, can selectively guide the orthopaedic to test a specific region of cartilage and, eventually, to repair it.

Images for this section:

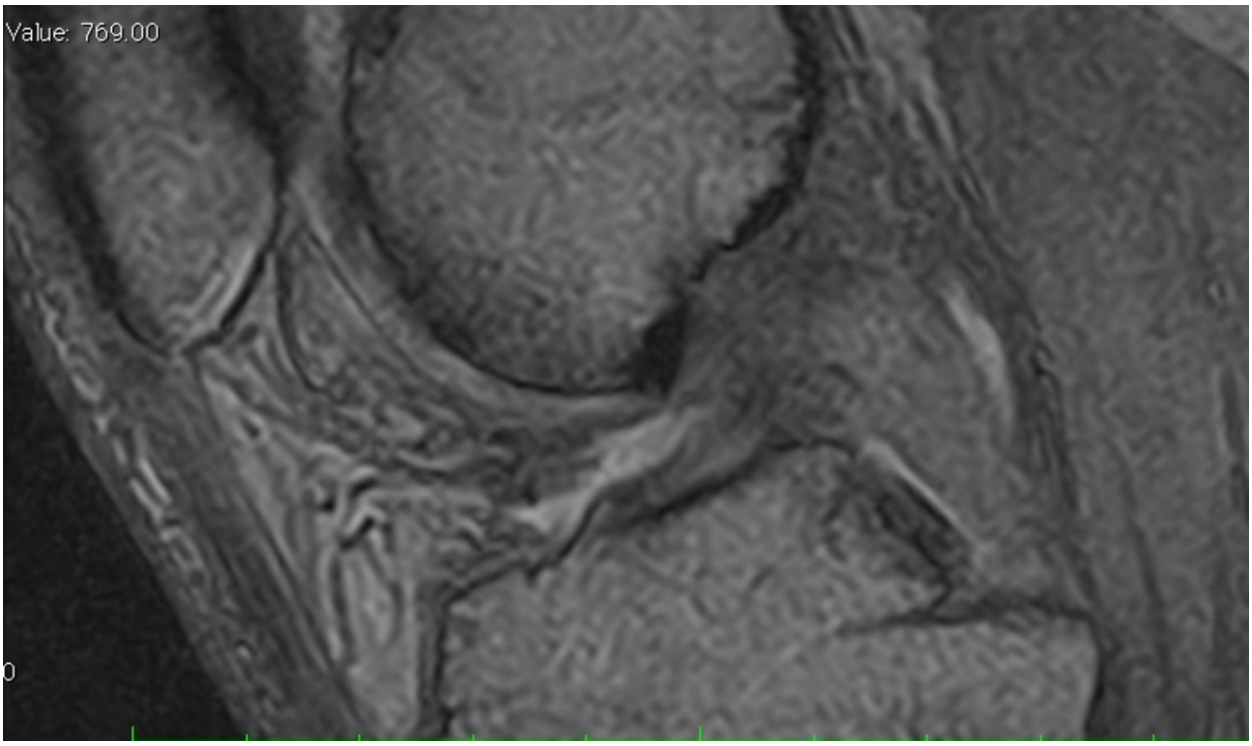


Fig. 4: 3D SHARC

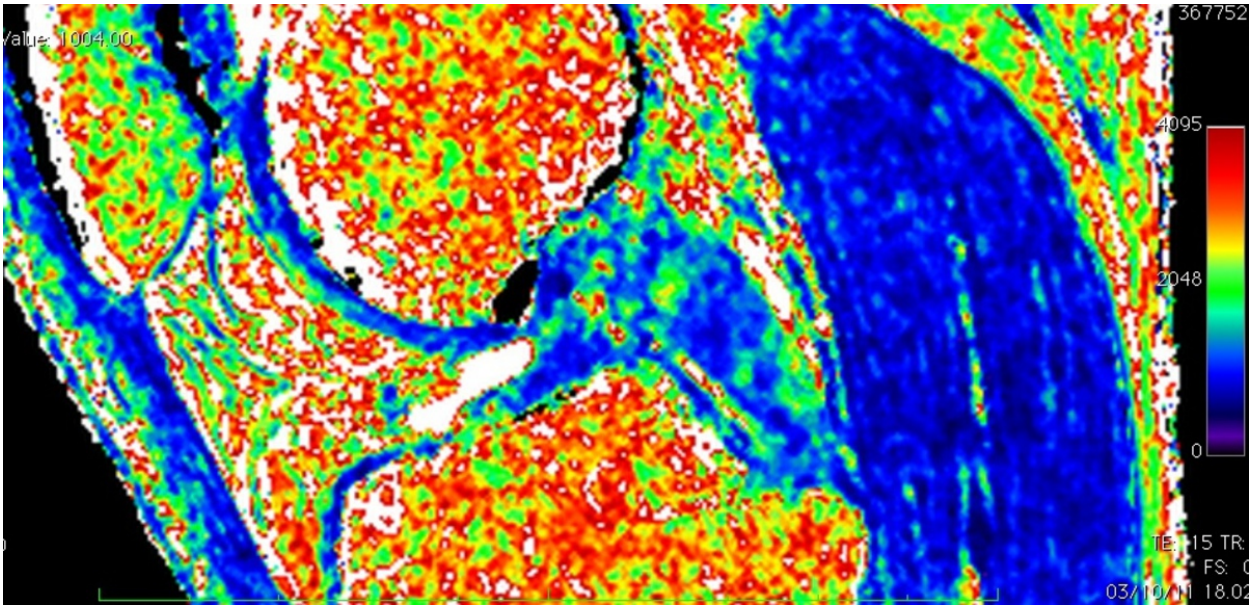


Fig. 5: T2 MAP

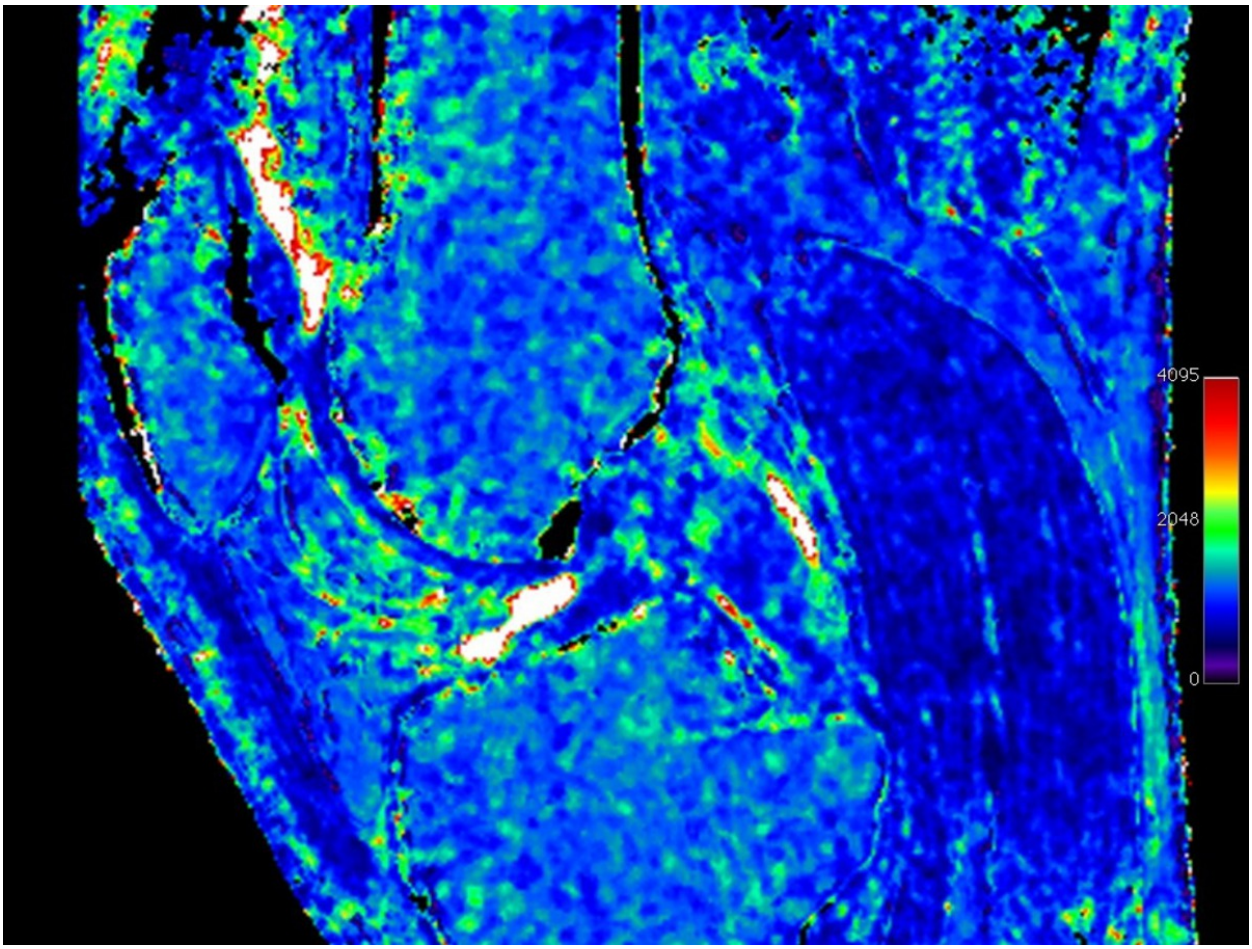


Fig. 6: T2rho

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