Using MR BOLD to Assess Rejection in Kidney Transplants

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Introduction:

The purpose of our study is to assess the oxygenation state of renal transplants and determine if these are useful in differentiating between normal, acute tubular necrosis (ATN) and rejection. In renal transplants, blood flow and tissue oxygenation change because vasoactive substances are released in certain disease states, altering the capillary flow and oxygen concentration in the cortex and, to a greater extent, in the medulla.[1] MRI is able to measure the oxygenation status in the cortex and medulla using Blood Oxygen Level Dependent (BOLD) gradient echo sequences. With these sequences, R2* can be obtained. R2* is the parameter related to the oxygen content of blood/tissue. As oxygen content decreases, the R2* value increases.[2,3] We suspect significant differences in the tissue oxygenation in the medulla between normal, ATN and rejection.

Materials and Methods:

MRI BOLD imaging was performed on 12 subjects with recent renal transplants (within 3 months). The study was approved by our human subjects review committee. Five subjects had clinically normal functioning transplants, 5 had rejection and 2 had ATN on biopsy.

MR imaging was performed on a 1.5T system (GE Signa, Waukesha, WI), using a pelvic or torso coil. BOLD was performed using a multi-echo gradient recalled echo sequence with 16 echoes at 1mm interval and 5mm slice thickness. Each set of 16 T2*-weighted images required 11 sec to obtain. The gray scale and color R2* map were generated and small ROI were recorded in both the cortex and medulla. Large ROI including the medulla and cortex over the entire kidney were recorded as well. R2* values are expressed as mean +/-std. The color maps were correlated with gray scale anatomical images to avoid placement of the ROI in an area of artifact and to visually look at the differences between subjects.

Results:

The medullary R2* values and medullary to cortical ratios were lower (R2* = 16.1+/-2.3 and m/c ratio = 1.3 +/-0.2) in the rejection group, then in normal functioning transplants and those with ATN. Using large ROI over the entire kidney gave lower R2* values in the rejection group (R2* = 13.1+/-1.3), when compared with the normal transplants and those with ATN.

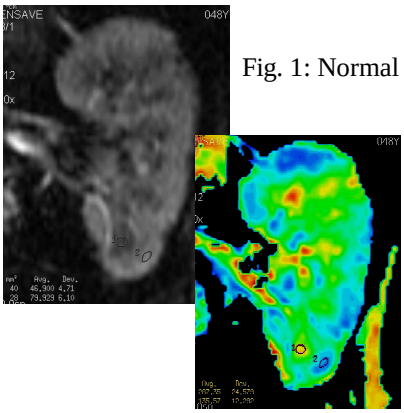

Fig. 1: Normal Transplant

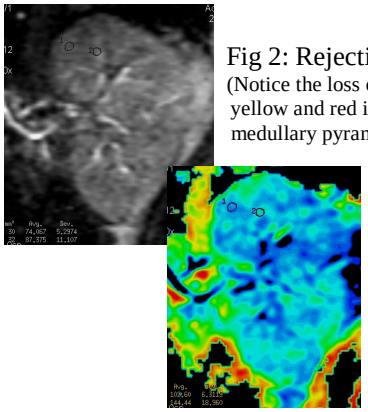

Fig 2: Rejection
(Notice the loss of yellow and red in the medullary pyramids)

Conclusion:

Decreased R2* values in the medulla of rejecting kidneys, corresponds to increased oxygen concentration. BOLD MRI may provide a rapid, non-invasive method for assessing renal oxygen status in transplanted kidneys to determine the presence or absence of rejection.

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2. Prasad, PV; Edelman, RR; Epstein, FH. Noninvasive Evaluation of Intrarenal Oxygenation with BOLD MRI. Circulation 1996; 94:3271-3275.
3. Prasad, PV; Chen, Q; Goldfarb, JW; et.al. Breath-Hold R2* Mapping with a Multiple Gradient-Recalled Echo Sequence: Application to the Evaluation of Intrarenal Oxygenation. JMRI 1997; 7:1163-1165.