

QUANTIFICATION OF TUMOR NECROSIS USING FUNCTIONAL MR IMAGING WITH PATHOLOGIC CORRELATION

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Objective: To compare ADC values of Vx-2 tumors implanted in the rabbit liver to the degree of cellular necrosis at pathology.

Materials and Methods: Twelve New Zealand white rabbits had Vx-2 tumors implanted in the left lobe of the liver according to our institutional guidelines. To induce variable degrees of necrosis 7 rabbits were treated with TACE, while the remaining 5 rabbits were not treated. MR Imaging was performed using a 1.5-T MR scanner and extremity coil. Imaging protocol included fast spin echo (FSE) T2 images (matrix 256 x 256; field of view 16-20 cm, slice thickness 4 mm with 1 mm interslice gap; TR 5000 msec; TE 100 msec), and diffusion-weighted echoplanar images (matrix, 128 x 128; thickness, 5 mm; B value, 500; TR, 5000-6500; TE, 110). Immediately following imaging the rabbits were sacrificed and the tumor was sliced at 5-mm intervals in the axial plane to correspond to the slice thickness and plane of the MRI. To maintain proper orientation, the dorsal and medial sides of each slice were stained with different colors. Tumor sections of 4 microns thickness were stained with hematoxylin and eosin. MR images were evaluated by consensus of 2 radiologists. Tumor size and ADC values were recorded. Histologic sections were evaluated to quantify tumor necrosis. A Nikon SMZ800 microscope was coupled with a Nikon digital sight DS-U1 camera (resolution 1376 x 1032). Images of the tumors were captured at a magnification of $\times 10$. Digital images were first converted to jpeg format and then imported into ImageJ. ImageJ 1.37v (NIH, Bethesda, MD) software was used to estimate the percentage of necrosis within the tumor. The mean ratio of necrotic/total tumor was calculated for each liver tumor.

Results: Mean tumor size was 2 cm (SD 0.8 cm). Mean ADC value for the treated and untreated tumors was $1.98 \text{ E}^{-3} \text{ mm}^2/\text{sec}$, and mean ADC value for the background liver was $2.20 \text{ E}^{-3} \text{ mm}^2/\text{sec}$. The ratio of tumor to liver ADC was 0.93. Mean tumor necrosis at pathology was 49% (CD 24%). The correlation between liver ADC and tumor necrosis at pathology had r value of 0.67. Similarly, the correlation between the ratio of tumor to liver ADC and tumor necrosis at pathology had r value of 0.69.

Conclusion: Functional MR imaging using diffusion-weighted acquisitions and ADC values has good correlation with tumor necrosis at pathology.

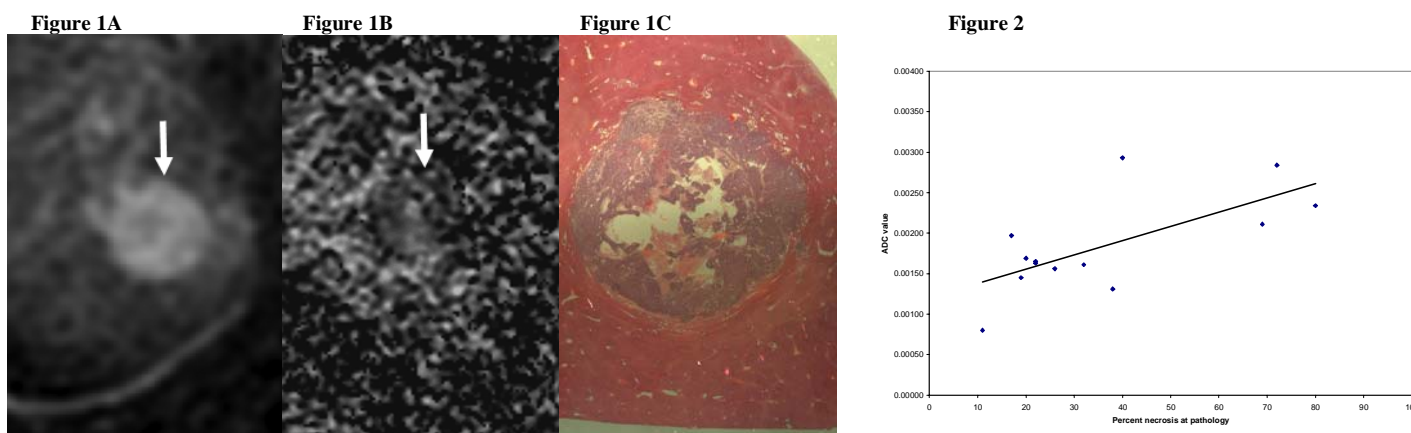


Figure 1. Vx-2 tumor implanted in the left lobe of a rabbit liver. (A) FSE T2 images (TR 5000 msec; TE 100 msec) showing a slightly hyperintense lesion in the left lobe (arrow). (B) ADC map generated from the DWI had a value of $1.31 \times 10^{-3} \text{ mm}^2/\text{sec}$. (C) Pathology specimen revealed 38% necrosis.

Figure 2. Correlation between ADC value and the degree of necrosis at pathology. R value was 0.67.