In vivo assessment of canine prostate thermal ablations with magnetization transfer imaging.

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Introduction

The most common malignancy in men in the United States, prostate cancer affects over 234,000 men each year [1]. High intensity ultrasound is a potential minimally invasive treatment capable of treating it. With MR guidance, this treatment option has the potential to locally ablate prostate tissue while preserving sensitive tissues like the urethra or rectal wall. However, while temperatures can be monitored under MR guidance, using such techniques as PRF imaging, and tissue perfusion can be assessed with contrast-enhanced imaging, the best methods of directly imaging the prostate tissue changes resulting from ablation are less clear. It has previously been noted that there is also a strong magnetization transfer (MT) effect in prostate tissue [2], and the purpose of this work was to investigate whether MT imaging could provide additional information concerning tissue changes in the prostate in high intensity ultrasound lesions *in vivo*.

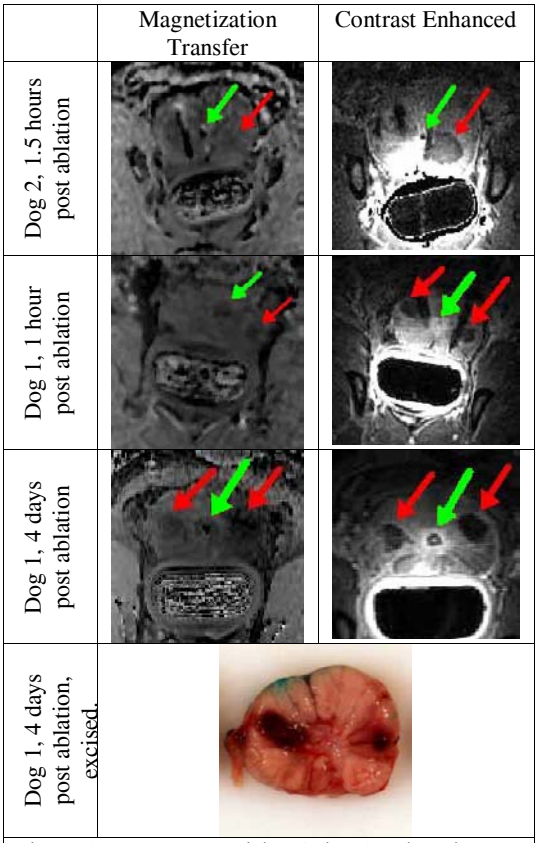

Figure 1. Images containing lesion locations in MT, contrast enhanced, and fresh excised dog tissue. Red arrows correspond to possible lesion locations in each image. Note that in Dog 1 (1 hour post ablation), the right lesion is not visible despite its presence in the contrast enhanced. Green arrows are, for reference, the urethra.

Dog #	Day	Tissue Type	Mean	St.Dev
1	0	Normal	0.1960	0.0223
		Lesion	0.1449	0.0222
1	4	Normal	0.2326	0.0580
		Right Lesion	0.1826	0.0309
		Left Lesion	0.0493	0.0549
0	0	Normal	0.2802	0.0314
		Lesion	0.2056	0.0212

Table 1. Mean Values and Standard Deviation of Tissue ROIs.

Methods

Three imaging experiments were performed with two *in vivo* canine prostates on a 0.5T Signa SP scanner (General Electric, Milwaukee, WI). Two lesions were created in both animals with high intensity interstitial ultrasound applicators (10 mm x 180° directional pattern) [3] inserted from the ventral surface. The prostate glands were imaged immediately after treatment, and one of these dogs was imaged again four days later and then sacrificed. On-resonance magnetization transfer imaging was performed with a 3D SPGR pulse sequence, alternating the MT pulse on and off from scan to scan. The on-resonance pulses were 1-2-1 binomial pulses. Magnetization ratio images were created using MATLAB (The Mathworks, Natick, MA) using equation 1 and scaled to between zero and one. Also, Gadolinium contrast enhanced images were acquired through the created lesions for comparison.

$$MTR = \frac{MT_{off} - MT_{on}}{MT_{off}} \qquad (1)$$

Regions of interest were drawn around the lesion locations and around surrounding prostate tissue near the lesions in the slice.

Results

MT images, post contrast enhanced images, and fresh excited prostate tissue are shown in Figure 1. Of the two animal studies performed, neither displayed a significant MT effect immediately upon treatment. In the first dog, one treated region was detectable approximately an hour after treatment. Imaging was not performed for this time delay after the creation of the second lesion. For the second dog, the first MT region was just noticeable with image processing approximately ninety minutes after heating. Again, the second lesion was not seen simply because imaging was not continued for this time delay after creation of the second lesion. When the first dog was imaged and sacrificed four days later, the MT effect for both lesions was prominent. The lesion locations in MT correlate well with the contrast enhanced images, as well as the fresh, unfixed tissue. ROI MTR values are provided in Table 1.

Conclusions

In this initial study of magnetization transfer imaging of *in vivo* prostates during thermal ablation, it has been found that a pronounced MT effect is seen on delayed MT imaging. When it actually becomes easily noticeable is still unclear, as imaging was not performed for more than 60-90 minutes after treatment, in order to remove the animals from anesthesia in a timely manner. However, when the dog was imaged again, 4 days after treatment, the change in MT effect was pronounced and corresponded to the lesion locations in the fresh tissue. The change in MT is not perfusion dependent, since the lesions are always visible on contrast enhanced imaging immediately after treatment. MT imaging, in addition to CE imaging, may be a valuable tool to monitor tissue changes in thermal lesions within the prostate post-treatment.

Acknowledgements

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