In vivo assessment of canine prostate cryoablations with magnetization transfer imaging.

A. B. Holbrook[1], D. M. Bouley[2], M. Alley[3], B. Daniel[3], and K. Butts Pauly[3]

[1]Bioengineering, Stanford University, Stanford, CA, United States, [2]Comparative Medicine, Stanford University, Stanford, CA, United States, [3]Radiology, Stanford University, Stanford, CA, United States

Introduction

Prostate cancer is the most common invasive neoplasm in men in the United States; each year over 234,000 men are diagnosed with it [1]. A potential minimally invasive treatment is cryoablation. With MR guidance, this treatment option could prove to be effective in locally ablating prostate tissue while preserving sensitive tissues like the urethra or rectal wall. However, while iceball formation can be easily monitored under MR guidance, assessment of tissue treatment is less clear. Perfusion can be assessed with contrast enhanced imaging, but further tissue characterization as the tissue is remodeled is desired. There is 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 in the assessment of cryoablation lesions *in vivo* many weeks after treatment.

Methods

Two imaging experiments were performed in *in vivo* canine prostate on a 0.5T Signa SP scanner (General Electric, Milwaukee, WI). Two beagles were cryoablated and imaged and later sacrificed at 14 days and 53 days after treatment. 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 clipped to between zero and one. Also, Gadolinium contrast enhanced images were acquired through the created lesions for comparison.

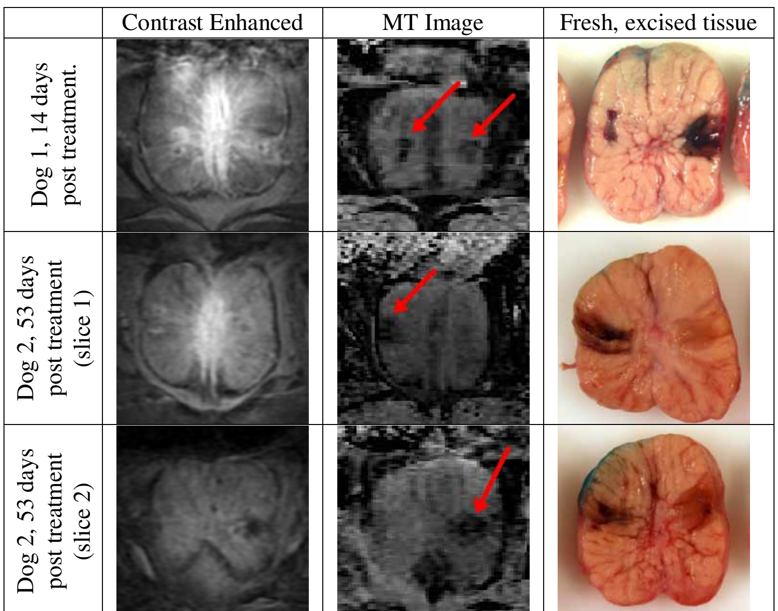

Figure 1. Images containing lesion locations in MT, contrast enhanced, and fresh excised dog tissue. Red arrows indicate the lesion locations in each MT slice.

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

ROIs were manually drawn for MTR measurements.

Results

Compared to the contrast enhanced images, the MTR images were able to delineate lesion locations many weeks following the initial cryoablation, even when the enhanced images lose their lack of perfusion contrast as the tissue remodels. Figure 1 shows the MTR images compared to the contrast enhanced slice and a fresh, excised tissue roughly cutting through the same slice. A decrease in MTR is seen, corresponding well to the gross pathology. Quantification of the MTR in each lesion and timepoints is provided in Table 1. Histological analysis demonstrated an increase in fibrous connective tissue structure throughout each lesion, which could be the principle inducer of the lessening MT effect.

Dog #	Day	Tissue Type	Mean	St.Dev
1	14	Normal	0.3265	0.0426
		Right Lesion	0.0917	0.0746
		Left Normal	0.2096	0.0415
2	53	Normal	0.2387	0.0354
		Right Lesion	0.087	0.0382
2	53	Normal	0.3372	0.0441
		Left Lesion	0.0808	0.0600

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

Conclusion

The prostate has been shown to have a significant MT effect in *ex vivo* tissue after heating[2]. However, cryoablated prostate tissue actually exhibits a smaller MT effect, leading to lesion visibility. MT-based lesion contrast is seen for the duration studied, two months after initial treatment in cryoablation and possibly will remain due to the increased collagen structure found in the lesions compared to normal prostate tissue.

Acknowledgements

NIH R01 CA092061, P41 RR009784

References

1. Prostate Cancer Foundation. *About Prostate Cancer*. 2006. 13 November 2006. <http:// www.prostatecancerfoundation.org/prostate_cancer>

2. Graham, SJ, GJ Stanisz, A Kecojevic, MJ Bronskill, RM Henkleman. Analysis of Changes in MR Properties of Tissues After Heat Treatment. Magn Reson Med 1999; 42:1061-1071.