

A Method to Improve the Spectral Resolution in Prostate Spectroscopy

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Introduction

Prostate cancer is the second leading cause of cancer type among men [1,2]. MR Spectroscopy is commonly used in diagnosis and prognosis of the disease. Flexible balloon-type endorectal coils [3] are generally employed for this purpose to provide better SNR. These coils are inflated with air before the scan to provide wider coverage. However, at the tissue-air interface spectral resolution deteriorates due to susceptibility. This coincides with the peripheral zone where approximately 70% of cancer occurs. In this work we show that if the coil inflated with perfluorocarbon (PFC) compound, the spectral resolution can be improved considerably. This leads to an improved sensitivity and specificity in prostate cancer diagnosis.

Theory

This techniques has three basic advantages: (i) improved spectral resolution, (ii) improved coverage of the peripheral zone of the prostate, and (iii) reduction in scan time due to the decrease in shimming time. The second and third advantages are direct consequence of (i), i.e improved field homogeneity in the ROI. PFC (FC-77™) [4] is a colorless, odorless and inert fluid that also has been the basis of artificial blood substitute compounds because of its oxygen carrying ability and intoxicity. PFC is also a good electrical insulator with magnetic permeability very close to tissue. All these properties make it a perfect candidate to be used to inflate the endorectal coil.

Methods

Experiments were performed on a 1.5T MR scanner (Signa Lx, GE Medical Systems, Milwaukee, WI). Two patient populations (N=30 each) were scanned using air-inflated and PFC -inflated endorectal coils. Approximately 90 ml of PFC was used to inflate the coil's balloon. Whole PFC was completely recovered after the examination. Hi-Res T1 and T2-weighted anatomical images were acquired using a 4-channel TORSO PA and regular SE sequence followed by a 3D prostate MRSI using a water-and lipid-suppressed double SE PRESS sequence (TR=1100ms, TE=130ms, 11cm FOV, 16x8x8 matrix). The voxel volume was in the range of 0.24 to 0.34cm³ depending on the size of the prostate. The total acquisition time was 17mins.

Results

The mean spectral bandwidth decreased from 14Hz ($\sigma=1.2\text{Hz}$) to 7Hz ($\sigma=0.8\text{Hz}$) with air and PFC inflated coils, respectively. A two-sample t-test (N=30) has shown a statistically significant difference ($p<<0.05$). Figure 1 shows two spectra for each population. Figure 1A is an example spectrum with an air-inflated coil, whereas Figure 1B is a typical example acquired using PFC-inflated coil. In Figure 1B, the peaks of polyamines can also be discriminated due to improved spectral resolution. This gives more degrees of freedom in the evaluation of choline increase relative to creatine and reduction in polyamines in cancerous regions.

Conclusion

In prostate spectroscopy exams using "balloon" type endorectal RF coil, inflating the coil with a PFC compound improves the spectral resolution and thereby the coverage. We believe this technique is easy to apply in a clinical set-up, and improves the diagnostic value of the MRS. Although experiments were conducted at 1.5T, spectroscopic studies done at any field strength can benefit from the susceptibility-reduction, especially higher field systems in which tissue-air and tissue-bone interfaces create more pronounced field distortion (i.e. susceptibility).

References:

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