

Prostate MRS in the presence of gold seed fiducial markers

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Introduction

MR Spectroscopy (MRS) has great potential for guiding radiotherapy of prostate cancer by identifying bulky and/or high grade tumors suitable for dose escalation (1,2). However, image guided therapy typically employs permanently implanted gold seed fiducial markers (GSFM), which aid in daily prostate localization prior to treatment. The impact of these gold seed markers on the quality of MRS is unknown. This study will present the potential impact of GSFM on the quality of ¹H MRS data at 1.5T and 3T.

Methods

A spherical glass phantom (diameter = 120mm) was filled with an agar solution containing Cho (conc.~ 3 mM), Cr (conc.~ 10 mM) and NAA (conc.~ 12.5 mM). One gold seed fiducial marker (Best Medical International, Springfield, Virginia, USA: size = 0.8mm x 3mm) was placed in the center of the phantom through a small channel left in the cooled down agar, which was filled after the placement of the gold seed with hot agar.

Single-voxel (PRESS, TE = 35ms, TR = 1.5s, Vol = 1ml) as well as CSI (PRESS, TE = 35ms, TR = 1s, Vol = 0.42ml at 3T, 1ml at 1.5T) spectra were acquired on a whole body 1.5T and 3T scanner (GE Healthcare, Milwaukee, WI, USA) using a standard quadrature head coil. The local homogeneity was optimized using linear shims (additional high order shims were used at 3T). Data were reviewed and analyzed using peak fitting algorithms implemented in SAGE (Spectroscopy Analysis of GE, GE Healthcare).

Results

The gradient-echo image (figure 1) clearly shows the centered position of the fiducial marker in the phantom. The resulting quality of single voxel and CSI spectra acquired at 1.5T and 3T found to be significantly different. SV spectra acquired at 3T on top of the seed and next to it (distances = 0mm, 8mm, 15mm) show degraded quality, mainly due to decreased SNR (figure 2). The normalized SNR referenced to the spectrum acquired on top of the seed was found to be 1 (reference: distance = 0mm), 2.6 (distance = 8mm) and 3.1 (distance = 15mm), confirming up to 3-fold SNR decrease in the vicinity to the gold seed.

While the visual inspection of CSI spectra at 3T (figure 3, left) indicates decreased metabolite amplitudes in the vicinity of the marker only the central voxel is affected at 1.5T (figure 3, right). At 3T the coefficient of variation of the peak amplitude (CV[%]) of the largest peak over all 49 spectra was found to be 12% compared to 6% for the white area (approximate distance from gold seed > 1.5cm) and 15% yellow area (approximate distance from gold seed ~ 0.75cm) in figure 3. Signal drops of up to 47% compared to the average were observed in the direct vicinity of the GSFM.

At 1.5T the CV[%] of the largest peak over all 25 spectra was found to be 10% compared to 8% for the white area (approximate distance from gold seed > 2cm) and 8% yellow area (approximate distance from gold seed ~ 1cm) in figure 3. Findings were similar for other peaks, peak areas and ratios.

Discussion

Prostate MRS is possible despite the placement of gold seed fiducial marker; however the quality of the spectra depends on field strength and the distance to the GSFM. While at both field strength the spectra of the voxel touching the marker are heavily distorted, only at 3T decreased spectral quality in the nearest neighbor voxels can be observed. Further investigations will have to show if advanced processing tools (3) can be utilized to recognize or partially correct these artifacts and enable the use of MRS in radiotherapy treatment planning and subsequent MRS studies during surveillance of prostate cancer.

References

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2. Gao et al, Prostate **31(4)**: 264-281 (1997).
3. Pels et al, NMR Biomed. **19(2)**: 188-197 (2006)

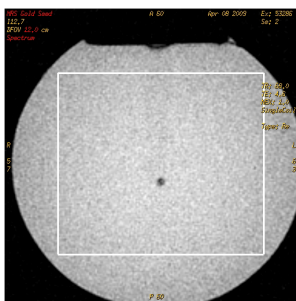


Figure 1: Artifact in center of phantom image caused by gold seed fiducial marker

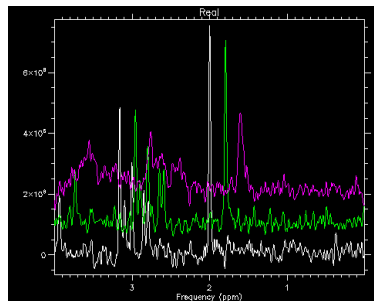


Figure 2: Decreasing spectral quality with SV placement at distance (white, 15mm), nearby (green, 8mm) and on top (pink) of the gold seed.

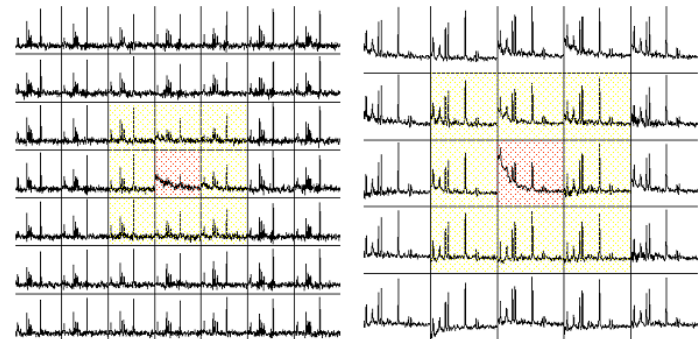


Figure 3: CSI spectra acquired at 3T (left) and 1.5T (right). Decreased spectral quality in the vicinity (yellow) of gold seed in CSI experiment at 3T. Gold seed marker location is marked in red.