

CORRECTION OF DYNAMIC B₀ FIELD CHANGES IN MRSI OF THE PROSTATE AT 7T USING AN INTERNAL FIELD PROBE

Catalina S. Arteaga de Castro¹, Vincent O. Boer¹, Mariska P. Luttje¹, Marco van Vulpen¹, Peter R. Luijten¹, Uulke A. van der Heide², and Dennis W.J. Klomp¹
¹Imaging Division, University Medical Center Utrecht, Utrecht, Utrecht, Netherlands, ²Radiotherapy, The Netherlands Cancer Institute, Amsterdam, Amsterdam, Netherlands

Introduction: ¹H MRSI of the prostate has the potential to detect metabolite concentrations, which change in the presence of disease, hence aiding in the specificity of prostate cancer diagnostics. At high field strength like 7 Tesla, the spectral resolution increases and peaks that overlap at lower fields can be differentiated, offering extra information. Susceptibility effects influence the line broadening of the MRSI that can be detrimental for the signals. These dynamic susceptibility effects can be physiology or patient dependent. Therefore, we propose to use a field probe inside the endorectal coil (ERC) to monitor and correct the field changes without prior knowledge of the origin of these effects. The corrections are expected to reduce artifacts and line width in MRS.

Methods: All measurements were performed in a 7 Tesla Achieva system (Philips, Best, The Netherlands). In-vivo measurements were performed in clinical prostate cancer patients with a two-element ERC transceiver^[1] (2x2kW peak power) that included a field probe (FP) tuned at 280 MHz corresponding to the ¹⁹F frequency at 7T. The probe was positioned

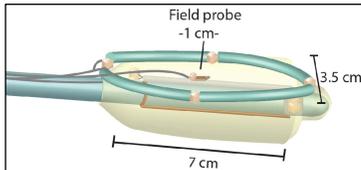


Figure 1: ERC schematics showing the positioning and size of the field probe inside the outer balloon (not shown).

inside the outer balloon of the ERC (Figure 1). The inner balloon of the ERC was inflated with perfluorocarbon fluid (¹⁹F containing fluid). The FP was used to monitor the zero order terms of the B₀ field using fast pulse acquire

segments (block pulse, 0.1 ms duration, 3.4μT) synchronized to the MR sequences. The FP recorded the B₀ changes during a fast dynamic B₀ map scan (2D FFE, TR/TE=10/1.97 ms, 144x144 mm² FOV, 150 dynamics, 2.25 x 3 x 10 mm³ voxel) and during the MRSI measurements (2D nsLASER^[2], TR/TE= 56/3600 ms, 100x35 mm FOV, 30x300 VOI, 5x5x5 voxel, 20x70 matrix, 2048 samples, 4000 Hz bandwidth). Retrospective B₀ corrections were applied on the MRSI data set using the FP data.

Results and discussion: As expected from the close location of the FP to the prostate, the pattern as well as the intensity of the field changes detected by the FP, match well to the changes measured by the fast dynamic B₀ map (Figure 2). The dynamic variation ranges in both cases up to 10Hz. The pattern of the B₀ changes during the MRSI was different than for the dynamic B₀ map, however the variation range was also 10Hz, which affects the line widths of the spectra. Figure 3 shows the MRSI results from the prostate of a patient. One voxel is highlighted to compare the non-corrected spectrum with the corrected one (Fig. 3 a, b). The corrected spectrum does not contain the artifact present at 3.9 ppm in the non-corrected one. The line width decreases in the corrected case up to 40% (based on the citrate peaks), therefore more peaks can be resolved (pointed by the arrows).

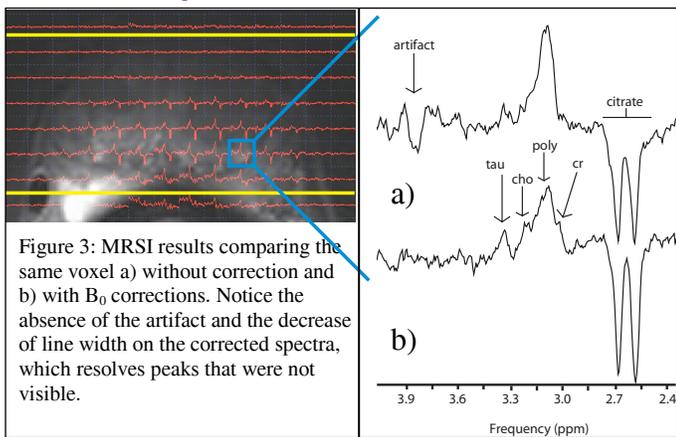


Figure 3: MRSI results comparing the same voxel a) without correction and b) with B₀ corrections. Notice the absence of the artifact and the decrease of line width on the corrected spectra, which resolves peaks that were not visible.

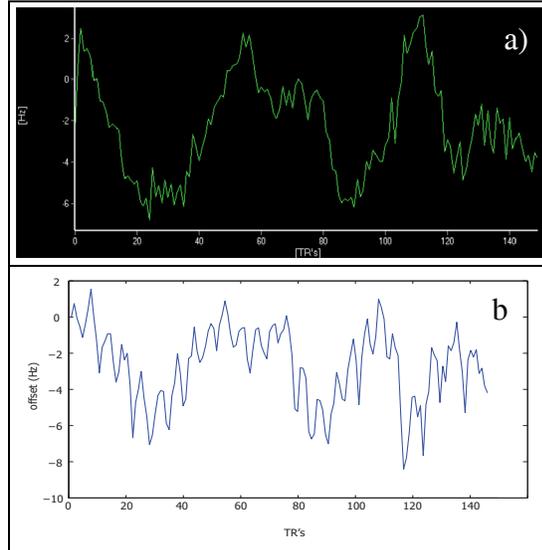


Figure 2: Comparison between a) the monitored zero order terms of the B₀ field using the field probes and b) the acquired dynamic fast B₀ map which shows the mean over a region of interest per dynamic. Both measurements correspond with each other, monitoring in both cases a range of 10 Hz variations.

segments (block pulse, 0.1 ms duration, 3.4μT) synchronized to the MR sequences. The FP recorded the B₀ changes during a fast dynamic B₀ map scan (2D FFE, TR/TE=10/1.97 ms, 144x144 mm² FOV, 150 dynamics, 2.25 x 3 x 10 mm³ voxel) and during the MRSI measurements (2D nsLASER^[2], TR/TE= 56/3600 ms, 100x35 mm FOV, 30x300 VOI, 5x5x5 voxel, 20x70 matrix, 2048 samples, 4000 Hz bandwidth). Retrospective B₀ corrections were applied on the MRSI data set using the FP data.

Conclusions: by using a small and non invasive internal field probe, zero order B₀ field terms can be monitored during prostate cancer scan sessions. Without prior knowledge of where the dynamic susceptibilities are originating from, retrospective B₀ corrections can be applied accurately. Although it is expected to be useful for MRI as well, here we already demonstrated substantial improvements in prostate cancer MRSI results, offering more accurate metabolic information at 7T.

References: [1] Arteaga de Castro, C.S. et al. Magn Res Med 2012. 68(1): p.311-318
 [2] Arteaga de Castro, C.S. et al. NMR in Biomed, 2012. Early view