MR-guided temperature mapping in prostate cancer patients: stability and feasibility

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Purpose: To evaluate temperature stability in prostate cancer patients using a fast gradient echo (GRE) echo planar imaging (EPI) sequence and to test the clinical feasibility of an integrated workflow for MR-guided laser ablation in prostate.

Methods: Informed consent was waived by the Institutional Review Board. Nine consecutive patients with suspicion for prostate cancer (recurrence) after a previous diagnostic multi-parametric MRI and scheduled for MR-guided prostate biopsy (MRGB) were included. Procedures were performed at a 3T MR scanner (MAGNETOM Trio, Siemens).

After biopsy needle guide placement (DynaTrim, InVivo), temperature was measured for two minutes using a multi-slice proton resonance frequency [1] GRE EPI sequence (TR = 22 msec , TE = 12 msec, resolution = 3.1x3.0x5.0 mm, matrix = 128 x 128, flip angle = 25°, BW=601 Hz/Pixel, TA=0.5 sec per slice). For real-time temperature visualization TMAP@IFE [2] was used. Temperature imaging (TMAP) slices were aligned based on the position of the needle guide in a high-resolution 3D dataset using Planning@IFE and sent directly to the MR console (see Figure 1).

For temperature stability evaluation, six seed points were placed in each of the three TMAP slices in line with the needle guide. Temperature was measured 20 times during TMAP image acquisition. Median temperature per patient was calculated with and without B0 drift correction. TMAP slice alignment setup was done during DWI acquisition which was part of the standard MRGB protocol. Extra time needed for setting up the TMAP slices was measured.

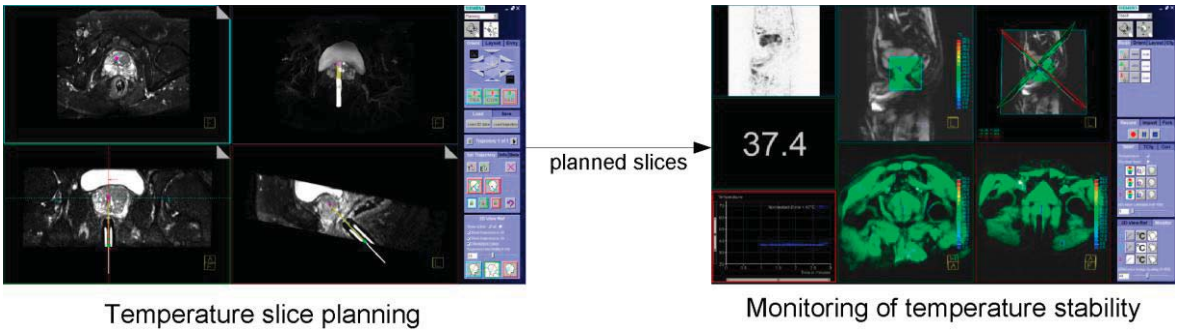

Figure 1. *Temperature imaging slices are planned using a high-resolution dataset and are automatically transferred to the MR console for online temperature monitoring.*

Results: Temperature measurement was feasible in 8 patients, 1 patient was excluded due to extensive patient motion. The median temperature was 37.2°C (range, 36.5°C-38.0°C) with B0 drift correction, and 36.5°C (range, 35.3°C-43.2°C) without B0 drift correction. Median deviation from the baseline temperature was 0.73°C and 1.19°C, respectively. The median extra time needed for TMAP slice alignment setup was 0:50 min (range 0:05 – 2:23 min).

Conclusion: MR thermometry using a fast GRE EPI sequence allows stable and fast temperature measurement in the prostate at 3T. The results further highlight the importance of B0 drift correction. Our initial experience suggests that the proposed integrated workflow is clinical feasible and supports accurate ablation monitoring.

[1] Ishihara et al. MRM, vol. 34, 1995. [2] Rothgang et al. Proc. ISMRM 2012, p. 1561.