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

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Objective: Focal laser ablation (LA) of the prostate can be performed under direct MR image guidance. The laser fiber does not cause any image distortion [1] and MR thermometry can be used to observe the ablation process to limit damage to nearby critical structures. So far, all reported MR-guided focal LA procedures in patients with prostate cancer were performed with transperineal insertion of the laser fiber [2-4]. A lot of experience is gained at our institution in performing transrectal MR-guided prostate biopsies. This transrectal approach combined with a laser fiber instead of a biopsy needle has two major advantages. First, a transrectal approach has a shorter pathway for the fiber compared to transperineal. Second, local anesthesia of the prostate is sufficient instead of an extensive block or general anesthesia. This may create a faster, less expensive and less invasive procedure for the patient.
Purpose of our study was 1) to test the clinical feasibility and time efficiency of an integrated workflow for MR-guided transrectal laser treatment and real-time treatment monitoring 2) to evaluate temperature stability at 3T in prostate cancer patients using a fast gradient echo (GRE) echo planar imaging (EPI) sequence.

Materials and methods: Informed consent was waived by the Institutional Review Board. Fifteen consecutive males with suspicion for prostate cancer (recurrence) after a previous diagnostic multi-parametric MRI and scheduled for MR-guided prostate biopsy were included. Procedures were performed at a 3T MR scanner (MAGNETOM Trio, Siemens). Three perpendicular 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 back to the MR console (figure 1). For real-time temperature visualization TMAP@IFE was used [5]. Relative temperature was measured for two minutes using a multi-slice GRE EPI MR thermometry 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=1.95 sec per slice).
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. Base line temperature was set to 37.2°C. Median relative temperature and median deviation from base line temperature per patient was calculated with and without B0 drift correction. Total procedure time, TMAP planning time, and navigation time for positioning the needle guide were determined.

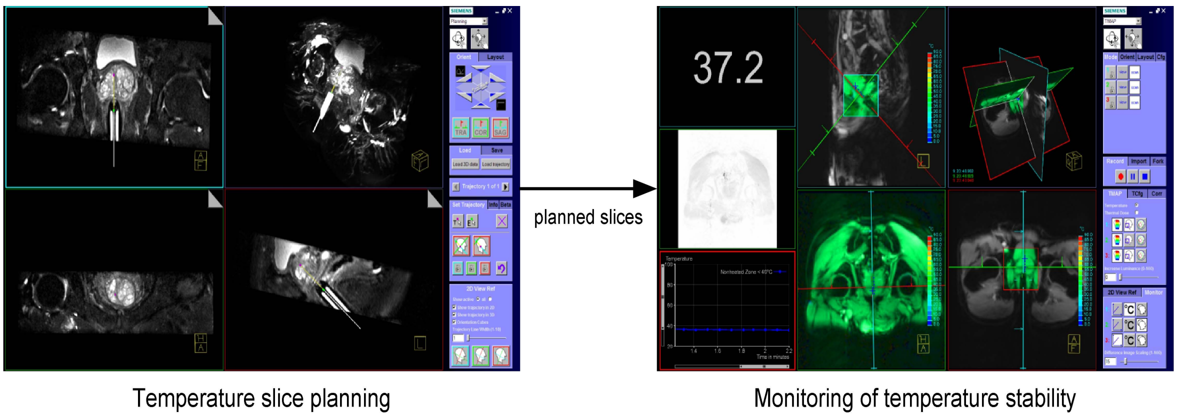

Figure 1(A). Screenshot of Planning@IFE. Temperature imaging slices are planned using a high-resolution dataset and are automatically transferred to the MR console for online temperature monitoring. **(B)** Screenshot of TMAP@IFE. Temperature was measured for two minutes using a multi-slice gradient echo EPI sequence.

Results: The integrated workflow was feasible in all patients. The median measured relative prostate temperature was 37.0°C (range, 34.8°C – 38.0°C) with B0 drift correction, and 36.9°C (range, 30.8°C – 43.2°C) without B0 drift correction (P=0.931). Median deviation from the baseline temperature was 0.8°C (range 0.5°C – 2.6°C) with B0 drift correction and 1.6°C (range 0.4°C – 6.4°C) without B0 correction (P=0.027). The median total procedure time was 35 minutes (range, 29 – 46 min), median TMAP planning time was 0:33 min (range, 0:05 – 2:23 min), and median navigation time for positioning the needle guide was 8 min (range, 2:09 – 12:08 min).

Conclusion: Our initial experience suggests that the proposed integrated workflow is clinically feasible, time-effective and supports accurate and stable temperature monitoring during an MR-guided focal laser ablation procedure. Furthermore, the results highlight the importance of B0 drift correction.

References: **[1]** Bozzini et al, Urol Oncol 2012, Epub ahead of print. **[2]** Raz et al, Eur Urol 2010;58:173-7. **[3]** Woodrum et al, Urology 2010;75:1514-6. **[4]** Woodrum et al, JVIR 2011;22:929-34. **[5]** Rothgang et al, Proc. ISMRM 2012, p1561.