First clinical experience with navigated RF ablations of the liver in a closed-bore 1.5T MRI

D. Seider[1], H. Busse[1], N. Garnov[1], G. Thörmer[1], S. Heinig[1], T. Riedel[1], T. Kahn[1], and M. Moche[1]
[1]Diagnostic and Interventional Radiology, Leipzig University Hospital, Leipzig, Germany

Purpose

MR imaging is becoming more important as a diagnostic tool for the liver due to its excellent soft tissue contrast. MRI is also increasingly used to control minimally invasive diagnostic or therapeutic interventions of the liver. Such interventions are often assisted by corresponding guidance systems [1]. The CT-guided placement of probes for thermal therapy and the subsequent ablation of liver lesions in an MR environment has already been reported [2]. In this work, we present a technique for the navigated placement of an RFA probe and the subsequent thermoablation of liver lesions in a standard, diagnostic 1.5T MRI and report on the preliminary clinical experience with four procedures in three patients.

Materials und Methods

RF ablation under MRI control was indicated when the liver lesions were not visible on native or late-phase contrast-enhanced CT images (Fig. 1). The applied navigation technique (Fig. 2, Localite GmbH, St. Augustin) has been described elsewhere [3]. Navigation is based on intraprocedurally acquired image data in breath hold using a pulse sequence (VIBE, HASTE, TrueFISP) that was most appropriate for visualization of the tumor. In addition, three MR-visible markers were scanned, automatically detected and their absolute coordinates determined. These reference markers were mounted in a fixed geometry with respect to the patient and three optical markers (reflective spheres).

A sterilizable tool (instrument tracker) with three other optical markers was attached to the RFA needle. This combination could then be guided and arrested in a sterilizable instrument holder. All optical markers are continuously tracked by a stereoscopic camera (Polaris Spectra, NDI, Waterloo, Ontario). This allows a continuous registration of the needle position with respect to the patient. The position of the moving needle is then calculated in real time and shown to the interventionalist as a virtual overlay on the anatomical image being displayed on a large 35" x 27" screen inside the MR room.

Placement of the RFA probe (StarBurst Semi-Flex XL, 1500X generator, AngioDynamics) occurs outside the magnet. For control imaging, the patient could be moved back into the bore at any time. RF ablation of the tumor was performed as a function of tumor size and relied on the standardized ablation protocols of the manufacturer. Three different pulse sequences (VIBE, TSE, HASTE) were used for planning and control imaging.

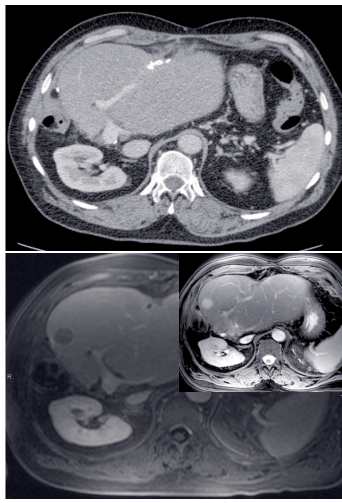

Fig. 1: Top: Post contrast CT image in portal venous phase; the tumor can not be delineaed. **Bottom:** T1-weighted VIBE image post contrast (Gd-EOB-DTPA); hypointense tumor can be delineated. Small inset shows hyperintense tumor region on T2-weighted image.

Fig. 2: Top: Typical system setup during intervention. **Bottom:** Placement of RFA needle (left) and view into the bore during control imaging (right).

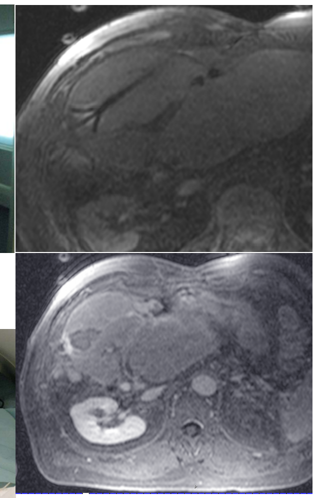

Fig. 3: Top: T1-weighted VIBE used to control the position of the deployed electrodes (hooks) prior to RF ablation. **Bottom:** post contrast T1-weighted VIBE used to visualize the size of the induced RFA lesion.

Tab. 1: Summary of patient details and results. NET: neuroendocrine tumor; CCC: cholangiocellular carcinoma; MM: (malignant) melanoma.

Pat. #	Age	Sex	BMI [kg/m^2]	Histology	Liver segment	Tumor volume [ml]	Type of anesthesia	Time for preparation and anesthesia [min]	Time for needle placement and ablation [min]	Total time [min]
1	61	m	30	Metastasis to NET	3	4.4	local	37	40	77
2	72	f	26	CCC	3	18.0	general	54	46	100
3	43	m	30	Metastasis to MM	4	2.6	general	60	42	
					8	0.2			51	153

Results

Four liver lesions in three patients have been treated. In patient #1, the intervention was performed under local anesthesia which required a short special breathhold training to ensure a sufficient targeting accuracy. This patient received additional sedation with 2 mg lorazepam, local anesthesia with 20 ml lidocaine and a systemic analgesia with 15 mg piritramide. Patients #1 and #3 were obese. Table 1 shows a summary of the patient details and required times. The involved anethesists were not familiar with establishing a general anesthesia in an MR environment which required an extra time of ≈30 min. The deployed electrodes could be reliably localized with a VIBE sequence (Fig. 3). A VIBE sequence after administration of Gd-EOB-DTPA was best suited to visualize the induced RFA volume. Three lesions could be treated completely and one lesion only subtotally due to the vicinity of the gall bladder.

Discussion and Conclusion

The presented method allows to reliably RF ablate liver lesions in a conventional closed-bore 1.5T MRI in cases where the lesions are poorly CT-visible. The commercially available RFA probes were compatible with the presented naviagtion technique and hardware. The higher technical efforts and the uncommon environment for general anesthesia have resulted in a relatively long preparation time. The time required for an exact needle placement and subsequent thermal ablation, however, appears to be comparable to that observed for CT-guided placements.

References [1] M. Moche et al., JMRI 2008, 27:276. [2] T. J. Vogl et al., Endoscopy 1997, 29:577. [3] H. Busse et al., In: Proc. ISMRM 2008, Toronto, #1214.