

# Wide-bore 1.5 Tesla MR-system for Monitoring of Hepatic Radiofrequency Ablation: Initial Experience in the Treatment of 60 Metastases

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## Introduction

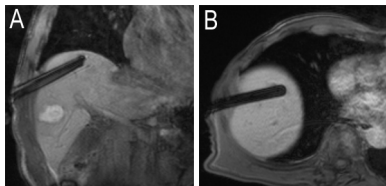
Image-guided radiofrequency (RF) ablation of liver tumors is a minimally invasive treatment option. Image guidance should ensure a precise ablation therapy leading to a complete coagulation of the tumor tissue with a safety margin and without injury of critical structures. Therefore, the capabilities of the imaging technique during the ablation procedure have an important impact on the accuracy and efficacy of image guided RF ablation [1-2]. Interventional open MR scanners typically operate at a lower field strength compared to diagnostic MR-systems [3-4]. Wide-bore 1.5 T MR-systems may enable to combine the advantages of diagnostic and interventional MR-systems and fulfill all capabilities for guidance of hepatic RF ablation.

## Purpose

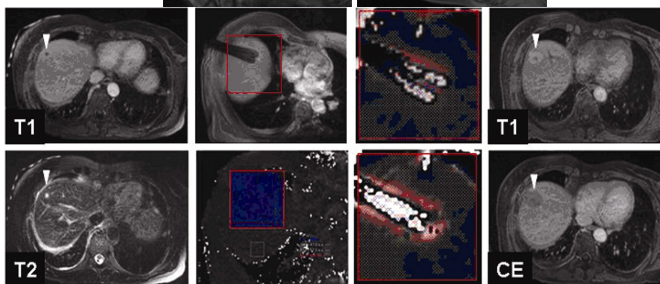
To evaluate effectiveness of MR-guided radiofrequency (RF) ablation using a wide-bore 1.5 Tesla MR-system in the therapy of hepatic metastases.

## Materials and Methods

In 30 patients (female: 3; male: 27) with a mean age of 65.0 years a total number of 60 liver metastases were treated by 41 sessions of MR-guided RF ablation. The largest subgroups of primary tumors were colorectal carcinoma (21 patients; 46 tumors) and malignant melanoma (5 patients; 7 tumors). Tumor diameter ranged between 0.5 – 3.8 cm (mean: 1.6 cm). The entire ablation procedure was performed at a 1.5 Tesla MR-system with a wide-bore of 70 cm (Magnetom Espree, Siemens Medical Solutions, Germany). Placement of RF-applicators was performed under MR-fluoroscopy. Subsequent to confirmation of a correct applicator placement (**Figure 1**), RF energy was applied by using MR-compatible monopolar or bi-/multipolar internally cooled RF applicators. Monitoring of induced coagulation was performed by T1-weighted and/or T2-weighted sequences, in addition MR temperature mapping by using the proton resonance frequency shift (PRF) method was applied (**Figure 2**). Technical success was assessed at the end of each session. Completeness of coagulation was assessed by dynamic MR-imaging at a mean follow-up of 5 months (range: 1 – 12 months).



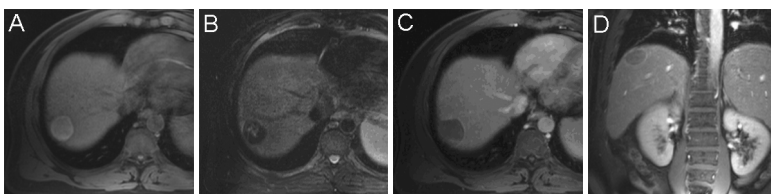
**Figure 1:** Verification of the applicator position below the diaphragm. The images show an oblique coronal (A) and oblique transversal plane (B) along the RF electrode by using T1-weighted spoiled [FLASH] gradient echo sequences under breath-hold.



**Figure 2:** Metastasis before RF ablation showing a T1-weighted hypointense and T2-weighted hyperintense signal (left). Multipolar applicator placement and thermometry reference image with proton resonance frequency shift method (middle). Temperature development during RF ablation (enlarged), Native and contrast enhanced T1-weighted images of induced coagulation (right).

## Results

MR-guided RF ablation was technical successful in 39/41 (95.1%) assessed at the end of each session. Interventional MR imaging was accurate to visualize the RF applicator position and to monitor the extent of induced coagulation being supportive to guide overlapping coagulations if necessary. During the available follow-up 58/60 (96.7%) metastases showed a complete coagulation (**Figure 3**). To achieve complete coagulation 54/58 (93.1%) tumors were treated in a single session and 4/58 (6.9%) tumors were treated twice. Subsequent to 41 interventions of MR-guided RF-ablation one (2.4%) major complication (pneumothorax) and 4/41 (9.8%) minor complications (2 x subcapsular hematoma; 2 x bilioma) occurred. In 8 of 30 (26.7%) patients heterotopic liver metastases (n=7) and/or extrahepatic metastases (n=4) were detected.



**Figure 3:** Images show a complete coagulation of HCC four months after RF ablation. On native T1-weighted images the induced coagulation is hyperintense (A). On T2-weighted images the zone of coagulation is hypointense (B). Contrast enhanced T1-weighted images show an ablation zone without enhancement (C + D).

## Conclusion

MR-guided RF ablation using a wide-bore 1.5 Tesla MR-system is a safe and effective therapy in the local treatment of hepatic metastases. MR imaging at 1.5 Tesla offers an accurate monitoring of induced coagulation and may reduce the number of required sessions for complete ablation therapy.

## References:

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