Magnetic resonance imaging follow-up after percutaneous radiofrequency ablation of renal cell cancer: Short- and midterm imaging findings in eighteen consecutive patients

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Purpose: The purpose of this study is to evaluate the short-term and midterm MR findings after thermal ablation of renal cell cancer.

Patients and Methods: Twenty one radiofrequency thermal ablation procedures were performed on 18 consecutive patients (mean age 71.2 years) with renal cell cancer under MR guidance using an open 0.2T MR system (Magnetom Open, Siemens Medical Solutions, Germany). One patient had two foci of renal cell cancer, another patient had a contralateral renal cell carcinoma, and a third patient was treated a second time after incomplete ablation. Follow-up imaging was performed in all patients immediately after completion of the radiofrequency ablation (with the patients still in the open MR system), and at two weeks, three months and six months post ablation. The follow-up imaging consisted of a standard renal protocol including turbo spin-echo T2-weighted, in- and opposed-phase GRE T1-weighted, and dynamic contrast-enhanced GRE T1-weighted MR images acquired 3 minutes after contrast initiation using a closed 1.5T MR system (17 patients). One patient was followed up using an open 0.2T MR scanner due to claustrophobia. Thermal lesion size was analyzed and contrast-to-noise ratios (CNRs) were calculated between the signal amplitudes from the thermal lesion and normal renal cortex divided by the standard deviation of the background noise.

Results: Mean thermal lesion size in biplanar dimensions was 6.8 cm^2 (0.8 cm^2 – 12.7 cm^2) on immediate follow-up imaging, 7.0 cm^2 on two-week follow-up imaging, 6.1 cm^2 after three months, and 4.7 cm^2 after six months follow-up. Thermal ablation lesions within the kidney appeared consistently hypointense with surrounding bright rim on T2-weighted imaging, and were inhomogeneously bright on T1-weighted imaging. Marginal enhancement with central hypointensity was noticed on the post gadolinium scans. On immediate follow-up imaging using the 0.2T MR scanner, mean CNRs between thermal lesions and renal cortex were 4.8 ± 4.2 (range: 0.4 to 16.0), 14.7 ± 6.1 (range 3.1 to 27.0), and 12.5 ± 5.1 (range: 4.2 to 21.9) on unenhanced SE T1-weighted, TSE T2-weighted, and Gadolinium enhanced SE T1-weighted scans, respectively. Table 1 shows CNRs in the course of high field MR follow up over 6 months. Residual tumor following RF thermal ablation was detected in two cases. In these cases, residual renal cancer was best seen on turbo spin echo T2-weighted and contrast enhanced T1-weighted images (Figure 1).

	2 weeks	3 months	6 months
TSE T2-weighted	13.6 ± 6.9 (0.2 – 26.3)	17.1 ± 7.5 (5.9 – 30.9)	16.1 ± 6.0 (7.3 – 27.3)
T1w GRE in phase	13.2 ± 10.8 (1.3 – 30.7)	13.6 ± 12.8 (0.4 – 40.2)	14.5 ± 14.4 (1.6 – 39.0)
T1w GRE opposed phase	26.8 ± 8.5 (19.1 – 38.3)	23.8 ± 10.2 (10.4 – 39.0)	21.1± 8.5 (16.5 – 33.9)
Gd enhanced T1w GRE	30.6 ± 25.8 (5.1 – 90.4)	29.1± 23.1 (6.3 – 98.5)	20.3 ± 13.0 (4.7 – 44.3)

Table 1: Mean contrast-to-noise ratios ± standard deviations (ranges in brackets) between thermal lesions and renal cortex after renal radiofrequency ablation. Values are based on the magnitude of the difference between the signal intensities of the thermal lesion and the renal cortex.

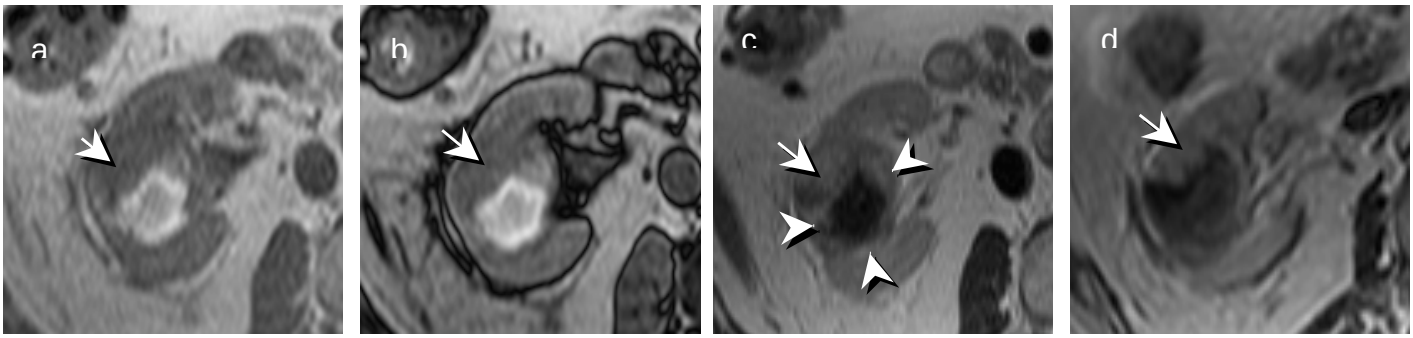

Figure 1: Axial in-phase (a) and opposed-phase (b) GRE T1w, TSE T2w (c), and Gd-enhanced FS GRE T1w (d) images of the right kidney obtained 2 weeks following partial RF ablation of a 4 x 4.3 cm^2 clear cell RCC. Induced thermal lesion demonstrates bright signal on GRE T1WI and low signal on T2WI and Gd-enhanced GRE T1WI. Note the thin bright rim surrounding the thermal lesion on T2WI (c, arrowheads). Note also the isointense residual tumor at the anterior aspect of the thermal lesion (a-d, arrows). This part was attempted during a second ablation session.

Conclusion: RF thermal lesions in the kidneys follow the same pattern as RF thermal lesions in the liver in terms of temporal evolution of lesion size. After an initial growth within the first two weeks, shrinkage is observed in the further course of follow up imaging. While signal characteristics on T2-weighted imaging are the same as in the liver after RF thermal treatment (both appear hypointense), RF lesion appearance is different on T1-weighted images where lesions are much brighter than in the liver. This is best appreciated on the gradient echo opposed phase images and most likely reflects diffuse hemorrhage within the thermal lesion. The high vascularity and the purely arterial blood supply of the kidneys (as compared to the mainly portal venous hepatic blood supply) may explain this finding. Overall, signal characteristics of renal RF thermal lesions make MR imaging very helpful in the follow up of renal cell carcinoma after RF thermal ablation, as this tumor entity generally appears slightly hypointense on T1-weighted images and slightly hyperintense on T2-weighted images relative to the renal cortex.