

## MRI-Guided Cryoablation of Small Renal Tumors

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### Introduction

Incidental discovery of renal cell carcinoma at an early stage has risen substantially in recent years owing to increased use of cross-sectional imaging and image-guided minimally invasive percutaneous approaches to treatment, such as cryoablation, are widely considered acceptable management options for carefully chosen lesions. MRI is a real-time modality that provides images of exquisite soft-tissue contrast for planning, targeting, monitoring and verification of therapy in any arbitrarily oriented scan plane without a radiation dose [2]. The majority of clinical experience with MRI-guidance of cryoablation has been reported in lower field “open” MRI systems (0.2 to 0.5 T), but reports at higher fields ( $\geq 1.5$  T) are beginning to appear. Here, we report on our initial clinical experience with a prospective study of the feasibility and safety of MRI-guided ablation of small ( $<4.5$  cm) renal tumors within a cylindrical bore 1.5 T clinical MRI in which MRI was used for all facets of the intervention.

### Methods

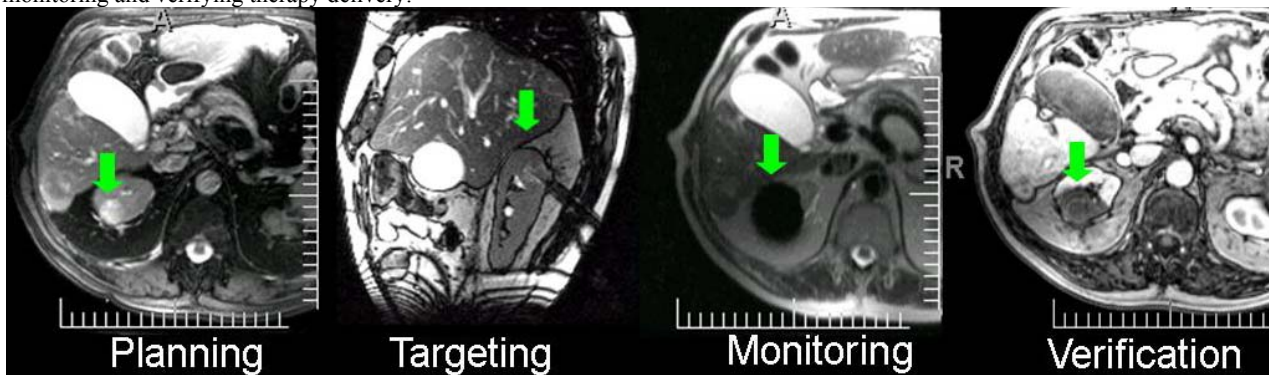
Over 15 patients underwent MRI-guided cryoablation of single, small renal tumors in a compact length (124 cm) and wide (70 cm) bore, 1.5 Tesla cylindrical bore MRI scanner (MAGNETOM Espree, Siemens Medical Systems, Erlangen, Germany). Planning was accomplished using multi-planar balanced steady state free precession imaging (bSSFP). The wide bore facilitated real-time manipulation of the probes, so multi-planar bSSFP acquisitions were used to guide cryoprobe placement with real-time or intermittent imaging. Real-time bSSFP utilized a pre-commercial sequence (BEAT\_IRTTT) which allowed the technologist to manipulate the scan orientation in real-time to best display the relationship of needle to target for the radiologist. Intermittent imaging between manipulations used standard bSSFP or HASTE acquisitions and were primarily used to accommodate metal artifacts associated with placement of multiple cryoprobes ( $>2$ ). Cryotherapy was delivered using an MR compatible system (Galil Medical, Yokneam, Israel) with 1-4 cryoprobes using 2 freeze cycles (10-15 minutes) with active thawing (5-8 minutes) between cycles. For monitoring, multiplanar images of iceball formation using bSSFP or HASTE were collected every 3 minutes and reformatted to assess the iceball relative to surrounding anatomy relative to the target pathology. Ablation was followed by multi-phase contrast enhanced 3D gradient-echo acquisition with fat saturation to verify the perfusion deficit region predicted by the iceball. Patient follow up consisted of clinical evaluation and renal protocol CT or MRI at 1, 6, 12, 18 and 24 mo, and once a year thereafter. Patient demographics, technical success, and complications were recorded and compiled.

### Results

For the first 15 patients, mean tumor size was 2.6cm (1.5–4.4 cm) requiring 1-4 cryoprobes (mean: 3). All treatments (100%) were considered a technical success in that MRI safely provide adequate planning, targeting, monitoring and post-treatment verification of the target tissue in a single session. Real-time guidance was used in 12 patients and intermittent imaging in the remaining 3. Hydrodissection was successfully accomplished under MRI guidance in 2 patients. Freeze rates and time for each probe were modulated based on MRI feedback of the iceball until the visualized iceball extended adequately beyond the targeted tumor boundaries (mean: 5.0 cm; range: 3.0 to 6.0 cm). MRI provided consistent contrast of the iceball edges in all tissue environments, including fatty tissue, which is problematic for CT. Post-treatment dynamic contrast-enhanced MRI demonstrated perfusion deficits within the expected area of damage based on correlation with the location of iceball visualization. Contrast within regions of tumor were contained completely within the ablation zone and were absent on follow-up imaging (mean: 8.6 months; median: 6 months).

### Conclusions

MRI-guided cryoablation of small renal tumors in a 1.5T cylindrical bore MRI has been performed safely and successfully in our first 15 patients. Preliminary results indicate outcomes comparable to CT-guidance without radiation. MRI guidance appears to be a viable non-ionizing option to CT for image-guided cryoablation of renal cell carcinoma which integrates real-time multiplanar imaging and soft tissue contrast for planning, targeting, monitoring and verifying therapy delivery.



**Figure 1:** Example treatment of RCC demonstrating use of bSSFP for Planning based on hyperintense presentation of the lesion against the background, one plane of a real-time bSSFP sequence during placement of a second cryoprobe into the lesion in an oblique sagittal plane during Targeting. One plane of a HASTE acquisition for Monitoring sequence showing the edges of the iceball versus the Planning image, and the perfusion deficit in the area of ablation on a T1W contrast enhanced 3D gradient echo image acquired post-treatment for Verification.

### References

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- [2] Morrison PR, et al., ‘MRI-guided cryotherapy’, *J Magn Reson Imaging*, 2008, 27: 410–420.