Cryoablation of malignant liver tumors under MRI-guidance: retrospective study

Julien Garnon[1], Elodie Breton[2], Gorislav Erceg[2], Georgia Tsoumakidou[1], Michel de Mathelin[2], and Afshin Gangi[1]
[1]*Interventional Radiology Department, Strasbourg University Hospital, Strasbourg, France,* [2]*ICube, Strasbourg University - CNRS, Strasbourg, France*

TARGET AUDIENCE – Interventional radiologists

PURPOSE – To present our experience in complex cases of MRI-guided cryoablation of primary and metastatic malignant liver cancer.

METHODS – Between December 2009 and January 2013, MRI-guided cryoablations were performed for 11 lesions in 10 patients (59 ± 6 years) with primary or metastatic liver tumors. Tumors were not visible with other imaging modalities (CT-scan and ultrasound) and/or difficult to target and/or not candidates for radiofrequency (RF) ablation because of the vicinity of proximal bile ducts. Included patients were reluctant to have surgical treatment or surgery was contraindicated. Free-hand needle positioning was performed in a 1.5T open-bore MR system (MAGNETOM Espree/Aera, Siemens). Typical cryoablation consisted in a 10 min freezing-thawing cycle, repeated once, with an MR-compatible system (MRI SeedNet System, Galil Medical) and ultra-thin 17-gauge cryoablation probes. High-resolution 3D T2W-Blade images (12 to 30 slices) were acquired for procedure planning (number of cryoprobes and puncture points) as well as during the procedure for fine assessment of needle position. Real-time MR-guidance was used with an interactive, multi-slice balanced SSFP pulse sequence[1]. Follow-up contrast-enhanced (CE) MR or CT were performed 1, 3 and 6 months after the procedure and then every 6 months. All clinical, biological and imaging data were retrospectively recorded to look for local recurrence and complications.

RESULTS – Technical success was achieved in all patients. Maximum tumor diameter ranged from 0.6 to 4.2 cm. The number of cryoprobes per lesion ranged from 2 to 6 (2.8 ± 1.2). Time to position all cryoprobes per lesion was 15 to 143 min (66 ± 50 min). No peri-procedural or delayed complication was recorded, except one small subcapsular effusion immediately after the procedure, which was self-limited and required no treatment. Follow-up ranged from 8 to 44 months. Local tumor progression was noted in 2 patients. 3 other patients died from general progression of their disease without evidence of local recurrence.1 patient was lost to follow-up after 7 months without local recurrence. Other 4 patients remained disease free at the end of the study.

DISCUSSION – Although the number of patients is small, this study shows that MRI-guided cryoablation is feasible in complex cases of liver cancer. Our results confirm that cryoablation can be safely used to treat lesions abutting the main bile ducts, without any immediate or delayed stricture. This is a major advantage compared to other techniques such as radiofrequency ablation or microwave. Moreover, the combination of cryoablation and MRI allows the radiologist to target tumors not visible and/or difficult to access with ultrasound and CT-scan. Lesions in the upper part of the liver (segments II, VII and VIII) can be punctured with high confidence using multiplanar real-time balanced SSFP pulse sequence. Moreover, the iceball is very nicely depicted as a hypointense oval-shape structure in T1 and T2 anatomical and real-time sequences, thus showing in real-time the delineation of the ablation. This is a major advantage over MRI-guided RF ablation because the RF current interferes with the acquisition during the ablation phase. However, MRI-guided cryoablation still has some drawbacks. Cost of the procedure is high, especially because more probes are needed for cryotherapy than for RF to create the same size of ablation. In some cases, tumors are not clearly seen with non-contrast MRI, and procedure duration is not compatible with contrast agent injection. This can be overcome by using the vessels (which are well delineated on real-time imaging) as landmarks. Lastly, proximity of big vessels can decrease the efficiency of the ablation by the so-called "cold-sink effect". This might explain the local recurrence observed in this study for one lesion close to the right portal vein.

CONCLUSION – MRI, with its multiplanar capabilities and intrinsic tissue contrast, is our preferred imaging technique for guiding the probes in patients with complex cases of liver tumor. The margins of the iceball are perfectly seen with MRI, improving the radiologist's confidence in his treatment.

REFERENCES – 1. Pan L et al. "An Integrated System for Catheter Tracking and Visualization in MR-Guided Cardiovascular Interventions", ISMRM 2011:195 - 2. Miki K et al. "Percutaneous cryoablation of renal cell carcinoma guided by horizontal open magnetic resonance imaging", Int J Urol. 2006;13(7):880–4.

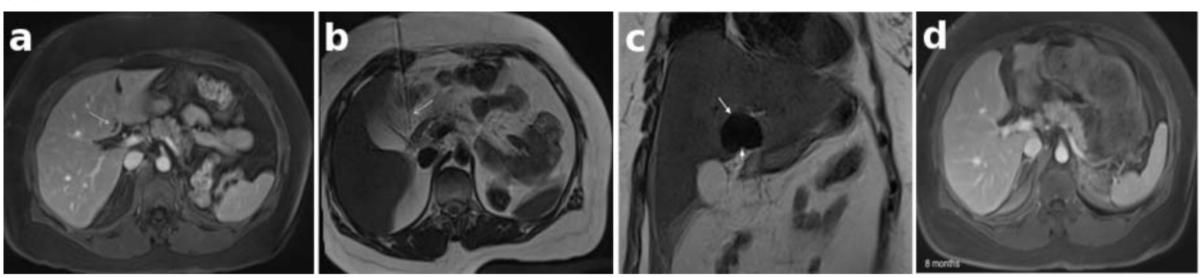

Fig. 1: Percutaneous cryoablation of a 1.3 cm single metastasis from renal carcinoma, Couinaud segment IV, 55-y.o. woman. **(a)** Preprocedural CE T1 VIBE axial image showing metastasis as an area of heterogeneous intensity (arrow). **(b)** T2-BLADE axial image showing the spinal needle (21G) (arrow) used for continuous instillation of hot sterile water in order to displace the duodenum away from the ablation zone. **(c)** Coronal T2-BLADE images showing the iceball (long arrow) with indentation at the inferior border caused by instillation of hot water (short arrow). **(d)** Follow-up axial CE T1 VIBE at 8 months, showing complete resolution of the ablation defect without new lesions.