

3D VIRTUAL MODELS FOR PLANNING PERCUTANEOUS CRYOABLATION OF SMALL RENAL MASSES

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Objective

- To evaluate the impact of 3D models for **planning of percutaneous renal Cryoablation (Cryo)** in terms of number and type of cryoprobes needed to be used and the **effectiveness of a 3D-based approach for Cryo**.

Patients & methods

- 10 patients** prospectively enrolled with clinical **T1a** renal mass unfitted for surgical treatment, scheduled for computed tomography (CT)-guided percutaneous Cryo.
- all patients underwent **3D virtual reconstruction** (including tumor, renal parenchyma, arterial and venous branches and urinary collecting system) based on preoperative CT.
- The 3D virtual model was used for **planning** the percutaneous **orientation** of the probes, the use of **specific type of cryoprobe**, the **number of cryoprobes** needed, and for the **simulation of the ideal necrosis** area generated by the iceball according to the planned type of cryoprobe.
- The **maximum size of the predicted iceballs at 3D model** and the **maximum size of the ablated area at CT imaging** after procedure were compared using the McNemar test.

Results

Table 1. Preoperative, intraoperative and follow up data in the overall population (n=10)

	Overall	Overall
Age (years)		
Mean ± SD	80±4.8	
BMI (Kg/m²)		
Mean ± SD	25.7±2.2	
ASA score, n (%)		
1-2	3 (30)	
3-4	7 (70)	
Previous history of kidney cancer, n (%)	3 (30)	
Pre-operative eGFR (ml/min)		
Mean ± DS	57 ± 23.1	58.5 ± 23.6
PADUA risk, n (%)		
Low	5 (50)	
Intermediate	4 (40)	
High	1 (10)	
RENAL risk, n (%)		
Low	5 (50)	
Intermediate	5 (50)	
High	0 (0)	
Tumor size (cm)		
Mean ± SD	2.85 ± 0.7	
Histological behavior at previous biopsy, n (%)	9 (90)	
Clear cell RCC	1 (10)	
Papillary Type 1 RCC		
Time of treatment (min)		
Mean ± SD	38.6±13.1	
Number of cryoprobes, n (%)		
1		3 (30)
2		4 (40)
3		3 (30)
Type of cryoprobes		
Icerod™		3 (30)
Iceforce™		4 (40)
Icesphere™		2 (20)
Icerod™+ Iceforce™		1 (1)
Postoperative eGFR (ml/min)		
Mean ± SD		58.5 ± 23.6
Postoperative complications, n (%)	2 (20)	
Type of complications (bleeding), n (%)		
Clavien II		1 (50)
Clavien III		1 (50)
Persistent disease at 3 months CT, n (%)	1 (10)	
Re-treatment, n (%)	1 (10)	

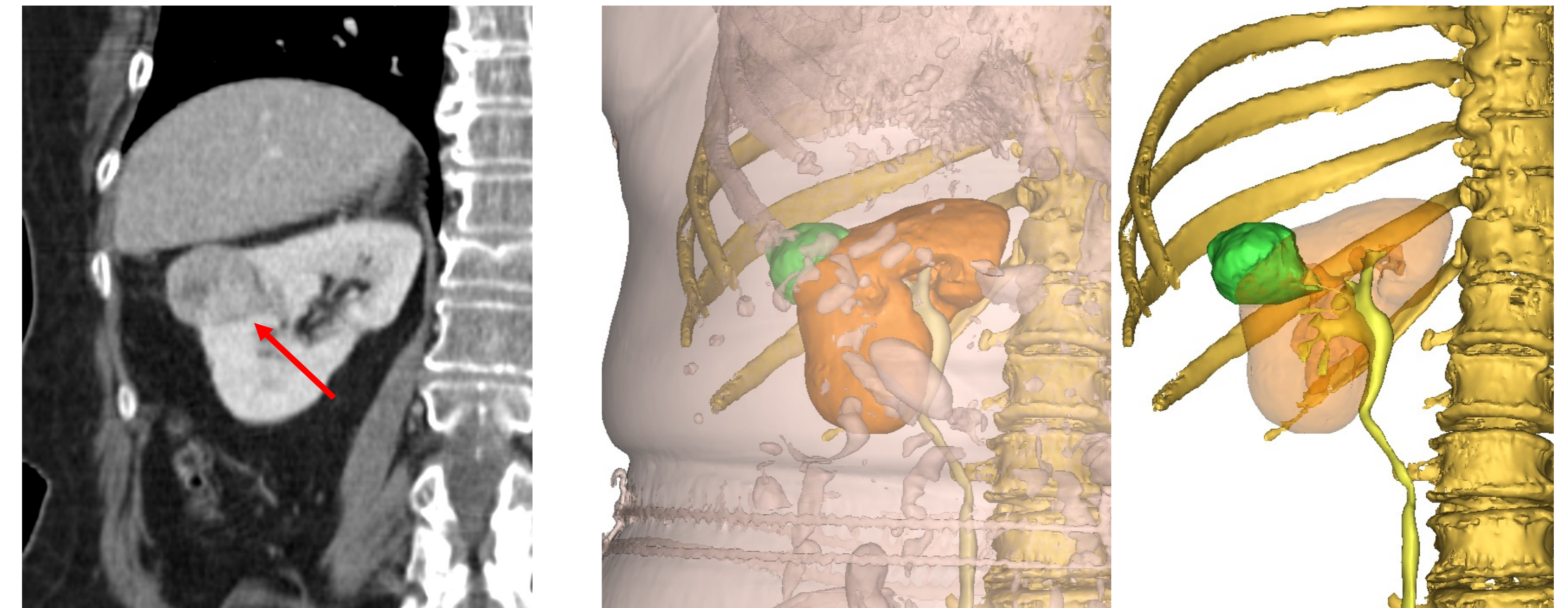
- Renal bleeding was the main **postoperative complication** occurred in 2 patients (20%): **conservative management** (Clavien 2) was applied in 1 case and arterial embolization (Clavien 3) was performed in the other one.
- At 3 months, **1 patient (10%)** experienced **persistent disease** due to incomplete ablation, that was re-treated with further percutaneous Cryo with **complete ablation and no post-procedural complications**.

Conclusions

- The use of 3D virtual reconstruction of renal models may **help the planning of percutaneous Cryo** to choose the **ideal type and number of cryoprobes** that should be used to achieve the **adequate ablative area**.

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Figure 1.

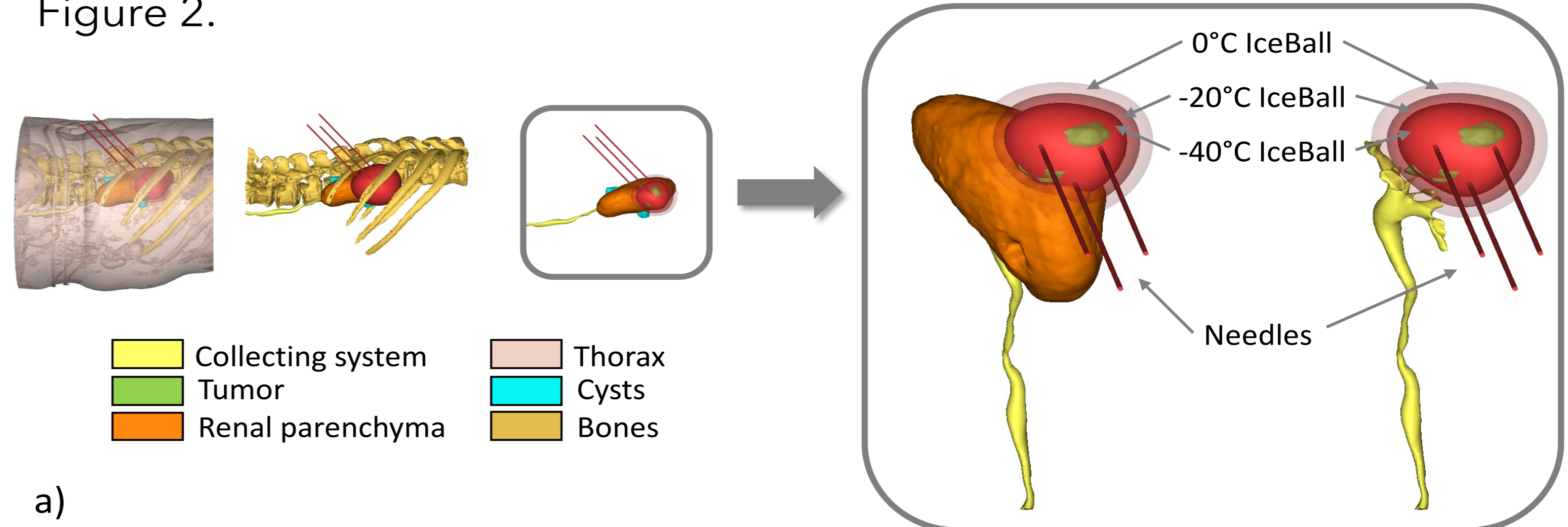


a)

b)

a) Coronal venous phase CT image showing a 37 mm lesion in the right kidney with contrast enhancement. **b)** 3D virtual model with segmentation and reconstruction of the renal tumor, renal parenchyma, urinary collecting system and skeletal markers

Figure 2.



a)



b)

c)

d)

a) The 3D virtual model used for virtual simulations of percutaneous orientation of the probes, type of cryoprobe, number of cryoprobes needed, and for the simulation of the ideal necrosis area generated by the iceball. **b)** Three IceFORCE™ needles were placed in the lesion with patient in prone position. **c)** Axial venous phase CT scan at the end of the freezing cycle showing a complete ablation of the lesion. **d)** Six-month follow-up CT depicting a complete response (no contrast enhancement).



Figure 3. Disposition of cryoprobes during procedure.

Table 2. Comparison between the predicted size of the iceball at 3D model and the effective size of the ablated area at post-procedure CT imaging

	Size of Iceball at 3D model (mm)	Ablated area at post-procedure CT (mm)	P value
Mean ± SD	45.7 ± 9	41.3 ± 8	0.06 *