#197 Anatomical accuracy of 3D-printed patient-specific kidney models used for Robot-Assisted Partial Nephrectomy pre-operative planning

- UroCCR study N° 39 : Rein 3D-PRINT -

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OBJECTIVES

- 3D printing is being used for surgical assistance during Robot-assisted Partial Nephrectomy (RAPN). We have also been using **patient-specific 3D printed kidney models** for patient education as well as a radiology education tool for medical students.
- The objective of this study was to assess the **anatomical accuracy** of our 3D printed models used for RAPN and assess the quality of our workflow protocol (Figure 1) behind the making of a 3D printed kidney model, from segmentation to postprocessing of the fabricated model.

METHODS

- We prospectively included patients who underwent 3D printing-assisted RAPN and anonymized computed tomography (CT).
- Patient consent for prospective collection of clinical data including imaging data inside UroCCR database was obtained (NCT03293563–CNIL DR 2013-206).
- The preoperative CT was segmented with Synapse 3D® (Fujifilm®). 3D files were processed before printing on the Stratasys®-J750 3D printer, with vascular, urinary, parenchymal and tumor elements.
- The 3D printed model was then scanned (Fig.2-4).
- Six quantitative judgement criteria (major axis of the kidney and tumor, volume of the tumor, 3 measurements between arterial branches were used to blindly compare the initial patient CT and the 3D printed model CT (Figure 2).
- The correlation of the arterial distribution between the CT and the 3D model was also evaluated on a Likert scale.

RESULTS

- The first 16 patients of our 3D printing RAPN series were included between December 2017 and March 2018 (Table 1).
- Between the initial CT scan and the 3D model, the major renal axis varied on average by 1.8%, the major tumor axis varied by 2.4%, mean tumor volume variation was 14.7%. Arterial inter-branch measurements, with 3 measurements performed on each kidney, ranged from 1.8%. (Table 2)
- The Likert scale evaluation of the correlation of the vasculature resulted in a median of 5[4;5]/5.

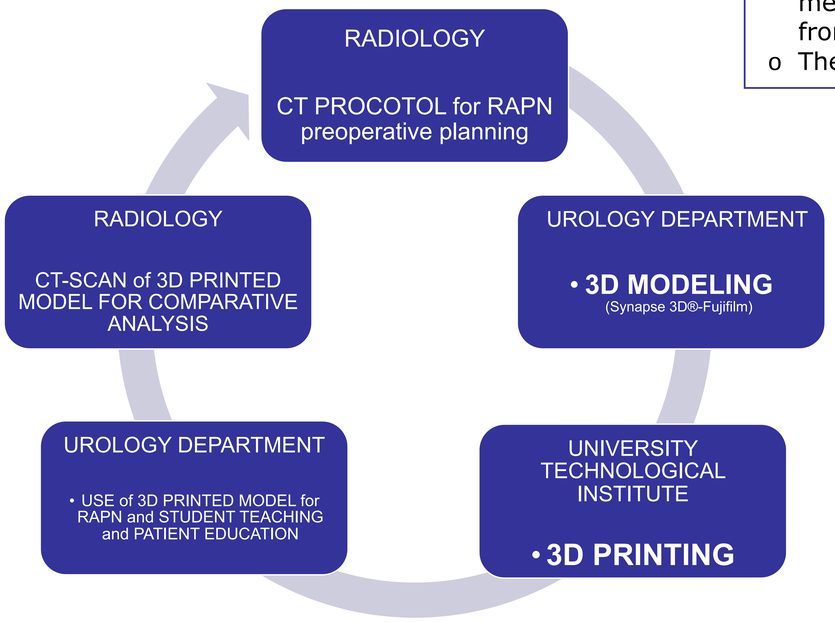

Figure 1 : Workflow protocol of Rein 3D-PRINT : anatomical accuracy

Patient Characteristics		n=16
Age		62 [52;66,5]
Gender (M/F)		11/5
Elective indication		63%
Mean Tumor size (cm)		5
Tumor Complexity		
RENAL score		8 [7 ; 10]
PADUA score		10 [9 ; 11]
RENAL	Low	13%
	Moderate	53%
	High	33%
PADUA	Low	7%
	Moderate	33%
	High	60%

Table 1 : Patient characteristics

	Initial CT-scan measurements	3D model CT-scan measurements	Relative disparity (%)
Tumor Volume (cm3)	33 [14-107]	27 [13-81]	**14.7[11.5;25.2]**
Renal major axis (cm)	11.8 [11-12.8]	11.6 [10.9-12.3]	**1.8[0.8;4.23]**
Tumor major axis (cm)	4.7 [3.9-6.5]	4.5 [3.7-6.2]	**2.35[0.45;8.6]**
Inter-arterial branch distance (mm)	15.9 [10.3-20]	15.7 [10.6-19.8]	**1.8[1;3.25]**

Table 2 : Comparative measurements between initial CT and 3D-model

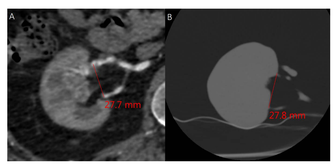

Figure 2 : Comparative inter-arterial-branch measurements

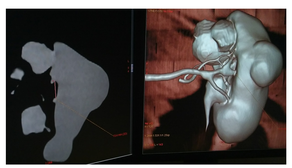

Figure 3 : CT-slice of 3D model and volume rendering of the 3D model CT scan

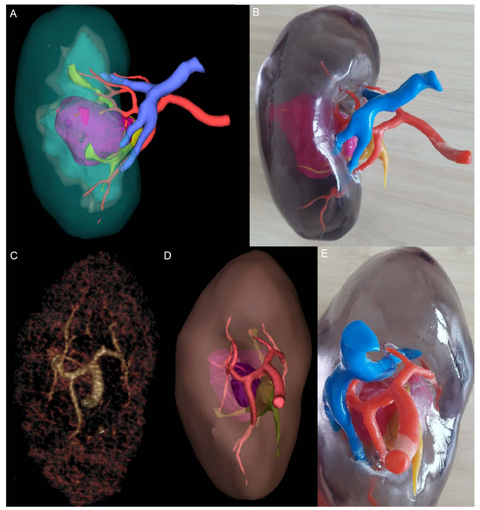

Figure 4 : a.3D model ; b.3D printed model ; c. Volume rendering of CT-angiogram ; d.3D model same viewpoint ; e. 3D printed model same viewpoint

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CONCLUSIONS

Our 3D-models are accurate to the anatomical reality. We need quality assurance protocols like this, with radiologists, to enable appropriate medical practice regarding 3D printing. Evaluation of security of surgical assistance with 3D printed models comes next.