



## Improving pre-operative planning of robot assisted nephron sparing surgery using three-dimensional anatomical model

A. Piasentin, G. Rebez, N. Pavan<sup>\*</sup>, A. Lissiani, F. Claps, M. Rizzo, L. Ongaro, C. Trombetta, G. Liguori

*Urological Clinic, Department of Medicine, Surgery and Health Sciences, University of Trieste, Trieste, Italy*

### ABSTRACT

**Introduction:** Despite the introduction of robot-assisted surgery in daily clinical practice, complex renal masses are still challenging even for expert surgeon. In this scenario 3D anatomical models and augmented reality represent valuable tools for the surgeon.

**Materials and methods:** We present a challenging case where PN was mandatory to preserve the overall renal function. The patient was 69 years old, with indwelling catheter for BPH and Parkinson disease. After a single episode of hematuria with negative cystoscopy, a cT1N0M0 renal cancer was diagnosed (38 mm maximum diameter). Pre-operative three-dimensional (3D) model was obtained.

After multidisciplinary discussion robot-assisted partial nephrectomy was proposed. The surgery was planned according to the anatomical model.

**Results:** Before the procedure a 7Ch single loop ureteral stent was placed. The surgery was carried out in 220 minutes. Selective ischaemia was performed for 24 minutes. Estimated blood loss was 400cc. No post-operative complications were observed.

Ureteral stent was removed 4 days after the surgery. Definitive histological examination described a pG2-3 T1a Nx R0 clear cell renal carcinoma.

**Conclusion:** In selected cases 3D model result to be a useful tool for the pre-operative planning of the surgery.

### Introduction

Nephron-sparing surgery (NSS) is widely spread and can be considered the gold standard for T1 renal cell carcinoma [1]. In recent years, the expanding use of a robotic approach has reduced postoperative pain and morbidity, even in T1–T2 cases. Despite the introduction of robot-assisted surgery in daily clinical practice, complex renal masses are still challenging. The planning of a partial nephrectomy is complex and multiple factors must be considered: renal vessels anatomy, tumor size and the relationship of the mass with adjacent structures. In this scenario, 3D anatomical models and augmented reality represent valuable tool to improve preoperative planning and surgical technique [2]. We present a single case of complex renal tumor in which the 3D model helps us to correctly plan the surgery.

### Materials and methods

The patient was 69 years old, with an indwelling catheter for BPH and Parkinson disease. No previous major abdominal surgeries were reported. After a single episode of hematuria, routine diagnostic exams were performed. US and high accuracy CT with contrast medium scan showed a cT1N0M0 right renal cancer (38 mm maximum diameter).

RENAL score [3] was 9a while PADUA [4] score was 11a. Pre-operative three-dimensional (3D) model was obtained. All images in DICOM format were processed by MEDICS srl ([www.medics3d.com](http://www.medics3d.com)) and the final 3D model was upload to a dedicated website. No personal data of the patient were provided to the company. The surgery was planned according to this model, used as visual guidance. A step-by-step surgical plan was approved by all the members of the surgical team. Three surgical issues were highlighted: the closeness of the mass to the renal pelvis, the presence of two tributary arteries and that endophytic position of the mass. A ureteral single loop stent was placed before the surgery, and the use of indocyanine green was required to identify the mass' tributary artery.

### Results

The patient was positioned in modified right plank position, with the surgical table mildly flexed. Before the procedure a 7 Ch right single loop ureteral stent was positioned, because of the nearness of the mass to the urinary system. The operative time was 220 minutes. One of the two arteries described was resected after indocyanine green test, and the other one was selectively clamped. A selective ischemia was maintained for 24 min. The collecting system was minimally resected without post-

<sup>\*</sup> Corresponding author.

E-mail address: [nicpavan@gmail.com](mailto:nicpavan@gmail.com) (N. Pavan).

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operative complications. The indocyanine test was repeated after the renorrhaphy, confirming the correct reperfusion of the kidney. Intraoperative estimated blood loss was 400cc. The ureteral catheter was removed in the fourth post-operative day. No intraoperative nor post-operative complications occurred. The patient was discharged after five days. Histological examination described a pG2-3 T1a Nx R0 clear cell renal carcinoma.

6 months eGFR was 66.4 ml/min/1.73 m<sup>2</sup> (while pre-operative eGFR was 71,6 ml/min/1.73 m<sup>2</sup>)

## Discussion

Achieving oncological safety and minimizing the loss of healthy perilesional parenchyma, represent the real goal of NSS. Maximum functional recovery appears to be related to the remnant number of nephrons after the surgery [5]. Some studies show that the reduction of healthy nephrons may be related to worse overall survival because of the decrease of renal volume [6]. Three-dimensional anatomical models are becoming widely used in clinical practice to optimize surgical planning to achieve the best clinical and oncological outcomes. Moreover, they represent a useful tool to prevent unexpected intra-operative and short-term postoperative complications, thus avoiding radical nephrectomies.

These 3D reconstructions models are sold with a dedicated software that allows the surgeon to modulate transparency of each anatomical structure. This allows the surgeon to study the anatomy and tailor the procedure to avoid complication. Considering this, the placement of a ureteral catheter can be questionable, and in this case useless. We hope that the use of anatomical models will enrich our experience, avoiding additional procedures, such as this one, and shortening the surgical time.

In our experience, thanks to the 3D models, critical points of the surgery were enlightened earlier in the pre-operative planning leading to a better schedule of additional procedures (such as ureteral stent positioning and the need of indocyanine green). Further applications of these models including intraoperative surgical navigations that are now available for Da Vinci robotic platform: Porpiglia F. et al. reported good oncological and functional outcomes in the use of 3D reconstruction overlapped to in vivo anatomy [7].

## Conclusion

Three-dimensional anatomical model represents a valuable tool for planning nephron-sparing renal surgery. Foreseeing possible

complications is the key factor of minimally invasive renal surgery.

## Patient consent statement

Informed consent for publication of the patient's case was obtained. All images used for the publication of this article are anonymous. The patient was informed that we obtain a 3D static model of his kidney, and he was not charged for this additional tool. The patient agreed.

The video related to this article can be found online at: [doi:10.1016/j.urolvj.2022.100144](https://doi.org/10.1016/j.urolvj.2022.100144).

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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