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Letter to the Editor

Re: Three-dimensional-printed soft kidney model for surgical simulation of robot-assisted partial nephrectomy: A proof-of-concept study

Hongo *et al*. recently reported the usefulness of the 3-D-printed models using a flexible material for surgical simulation of robot-assisted partial nephrectomy.[1] They showed four pilot cases of T1a renal tumors that underwent 3-D reconstruction with a soft renal model. Before real surgery, robot-assisted partial nephrectomy was carried out on the 3-D physical models, allowing the surgeon to easily understand the renal anatomy and prepare in real-time the most challenging steps: identification of a tumor's feeding artery to increase selective clamping; enucleation with reduction of positive surgical margin; and the need for urinary collecting system opening, predicting the need of suture to avoid urinary leakage. In our experience, we routinely use 3-D virtual renal models,[2] even with the aid of augmented reality technology[3] for better surgical planning and as a real-time intraoperative guide. We previously showed that 3-D models improve surgical outcomes, including increasing the selective and super-selective clamping.[4] 3-D physical models might reduce the learning curve of robotic surgeons, as they can simulate the interventions to improve surgical outcomes. Furthermore, 3-D models are essential in the case of complex anatomy (i.e. horseshoe kidney), even for experienced surgeons. Ideally, surgery carried out on the 3-D model might prevent possible intraoperative complications, reduce surgical time and improve patient outcomes.

However, the availability of 3-D printers with flexible materials is limited, and the cost ($1800 per model) should be considered. Furthermore, the type of soft materials that exactly reproduce the real consistency of human tissue should be improved. The use of 3-D-printed models might also be useful for education, training and counseling. In our clinic, we are recruiting patients in a case–control study to evaluate whether the counseling before robot-assisted partial nephrectomy might be improved by the visualization of 3-D-printed models (Fig. 1). In the preliminary phase, 20 patients were counseled with conventional imaging and 20 patients were counseled with a 3-D-printed renal model. An 8-point questionnaire was given to patients at the end of the counseling, evaluating with a 5-point Likert scale the understanding of the following: (i) renal anatomy; (ii) renal tumour; (iii) size of the tumor; (iv) location of the tumor; (v) type of surgery; (vi) surgical complications; (vii) satisfaction of counseling; and (viii) confidence with the surgical team. We found that patients counseled with a 3-D model had a significantly higher comprehension of the type of surgery ($P = 0.02$) and higher satisfaction with preoperative counseling ($P = 0.003$). Finally, we recently developed a soft 3-D-printed model to plan percutaneous cryoablation of renal tumors for patients unfit for surgery. The use of a 3-D model before the procedure allows the surgical team to correctly identify the targeted volume of ablation, and to select the number, the position and the orientation of the cryoprobe to achieve the optimal area of ablation.

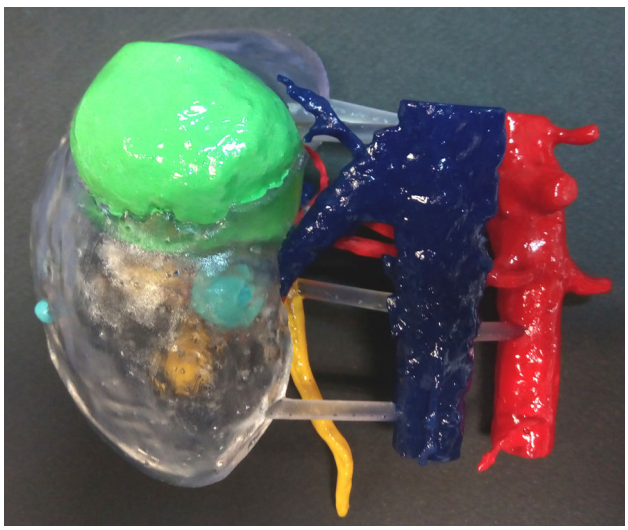

Fig. 1 Example of a 3-D-printed model of a 5-cm right renal tumor. The model is showed to the patient during the patient's counseling.

In conclusion, the use of physical renal models is useful for planning robot-assisted partial nephrectomy or percutaneous renal ablation, to train surgeons, to improve precision of surgery and for patient counseling.

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Conflict of interest

None declared.

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