BJUI
BJU International

Editor's Choice

Will three-dimensional models change the way nephrometric scoring is carried out?

There has been an increase in the extent to which imaging is used for preoperative planning of complex urological procedures. For partial nephrectomy, this has been mostly using three-dimensional (3D) modelling, whereby the preoperative scan, most commonly contrast-enhanced CT, is segmented and converted into a 3D model of the patient's renal anatomy, which can then be 3D-printed or visualized by the surgeon using a computer screen.

In this issue of *BJUI*, Porpiglia et al. [1] propose the use of 3D models, visualized using a computer for preoperative nephrometric scoring (PADUA and RENAL) of 101 patients to predict postoperative complications. In this preliminary study, they compare the visual scores obtained by two urologists when evaluating only a 3D model, against the scores of two urologists obtained when evaluating only CT images. They found that nephrometric scores obtained when looking at 3D models were lower for half of the cases than when scored using conventional two-dimensional CT images. Furthermore, they show that for the 101 patients the scores obtained using 3D information were able to give an improved prediction of postoperative complications. The reason for the improved prediction of postoperative complications using 3D modelling is attributed to a better perception of tumour depth and its relationships with intrarenal structures. The authors also point out that because both 3D models and CT scans are scored by visual evaluation there is a risk of inter-observer variability affecting the results. Overall, this paper introduces an exciting new topic of research in using advanced image analysis techniques for nephrometric scoring.

Many further opportunities exist for developing these ideas of using quantitative image analysis to improve planning and scoring for partial nephrectomy. Before any 3D model can be created, the CT scan has to be 'segmented' or labelled according to the different renal structures (tumour, kidney, collecting system, veins, arteries). Once a scan has been segmented, the computer has all the information that it needs to build an accurate representation of the patient's anatomy, understanding different structures and their inter-relationships, and thus being able to precisely calculate derived measurements, such as digital volumetry or nephrometric scores based on the exact PADUA/RENAL criteria. Furthermore, novel and more complex nephrometric scores that use segmentation map descriptors could be developed and fitted to postoperative data to further improve predictions. Assuming that the segmentation (labelling of the input scan) is accurate and consistent, such a method would be fully deterministic and not be subject to any inter-observer variability.

Nevertheless, in the present paper [1] and other recent 3D renal modelling papers [2,3], image segmentation is not yet fully automatic and instead is performed semi-automatically with significant human input, making the process impractical and the output dependent on the operator. In other specialities, such as cardiology and neurology, the challenge of automation is being tackled successfully through the creation of large public annotated datasets [4,5], allowing robust and fully automatic machine-learning segmentation algorithms ('A.I.') to be developed [4]. The creation of a multi-institutional open-source dataset of annotated renal CT scans would pave the way for increased research and progress towards automatic, reliable and quantitative image analysis tools for kidney cancer. In particular, research on 3D nephrometric scoring [1], image-based volumetry (segmentation) and tracking of tumours to assess the response of therapy [6], and CT volumetry to predict 6-month postoperative estimated GFR [7] could be developed into fully automatic and robust software that finds its way into clinical practice.

In conclusion, this paper [1] on 3D models for nephrometric scoring outlines another exciting new way in which advanced image analysis techniques might improve nephrometric scoring and the prediction of complications.

Conflicts of Interest

Dr Lorenz Berger is a Director at Innersight Labs Ltd.

Lorenz Berger* **and Faiz Mumtaz,†**

**Innersight Labs Ltd, and †Royal Free London NHS Foundation Trust, London, UK*
E-mail: lorenz@innersightlabs.com

References

1 **Porpiglia F, Amparore D, Checcucci E et al.** Three-dimensional virtual imaging of the renal tumors: a new tool to improve the accuracy of nephrometric scores. *BJU Int* 2019; 124: 945–54

BJU International © 2019 BJU International | doi:10.1111/bju.14907, 14914, 14918, 14937, 14945
Published by John Wiley & Sons Ltd. www.bjui.org

2 **Hyde ER, Berger LU, Ramachandran N et al.** Interactive virtual 3D models of renal cancer patient anatomies alter partial nephrectomy surgical planning decisions and increase surgeon confidence compared to volume-rendered images. *Int J Comput Assist Radiol Surg* 2019; 14: 723

3 **Shirk JD, Kwan L, Saigal C.** The use of 3-dimensional, virtual reality models for surgical planning of robotic partial nephrectomy. *Urology* 2019; 125: 92–7

4 **Suinesiaputra A, Sanghvi MM, Aung N et al.** Fully-automated left ventricular mass and volume MRI analysis in the UK Biobank population cohort: evaluation of initial results. *Int J Cardiovasc Imaging* 2018; 34: 281

5 **Menze BH, Jakab A, Bauer S et al.** The multimodal brain tumor image segmentation benchmark (BRATS). *IEEE Trans Med Imaging* 2015; 34: 1993–2024

6 **Smith AD, Lieber ML, Shah SN.** Assessing tumor response and detecting recurrence in metastatic renal cell carcinoma on targeted therapy: importance of size and attenuation on contrast-enhanced CT. *Am J Roentgenol* 2010; 194: 157–65

7 **Corradi R, Kabra A, Suarez M et al.** Validation of 3-D volumetric based renal function prediction calculator for nephron sparing surgery. *Int Urol Nephrol* 2017; 49: 615

Threading the cost–outcome needle after radical cystectomy

I commend Borza et al. [1] on their timely study, which seeks to identify predictors of bounceback (≤3-day) vs 30-day readmissions after radical cystectomy. As the authors allude to in their paper, value-based health reforms being undertaken in the USA seek to improve the quality of care delivery while simultaneously bending the healthcare cost curve [2]. For example, the Hospital Readmission and Reduction Program (HRRP), originally introduced in fiscal year 2013 for targeted medical conditions, has more recently been applied to a limited number of surgical procedures, whereby providers receive financial penalties for higher than expected 30-day readmission rates [3]. While urological conditions/procedures are not currently targeted by programmes such as the HRRP, it is easy to envision a future where procedures with disproportionately high readmission rates, such as radical cystectomy, fall within the crosshairs of policy-makers and insurers, alike.

The fact that nearly one in five patients undergoing cystectomy experiences a readmission within 3 days of index hospitalization discharge is staggering, and it is incumbent upon urologists as specialists to devise methods by which to improve the morbidity associated with cystectomy. For example, the findings of Borza et al. implicate postoperative infection as a major driver of early readmission. As evidenced by the work of Krasnow et al. [4], urologists have historically been poor stewards of peri-operative antibiotic prophylaxis, and the development/implementation of strategies to improve guideline adherence represents a potentially simple yet effective means of reducing post-cystectomy readmission rates. In a similar vein, there is an emerging body of literature demonstrating the important role that enhanced recovery after surgery (ERAS) protocols may play in improving peri-operative complications and convalescence after radical cystectomy. However, there is inconsistency across the literature with regard to the precise components of ERAS, making cross-institutional comparisons and adoption by other groups difficult [5]. Unless greater standardization and subsequent implementation of these enhanced recovery protocols occurs, progress in the field will remain incremental at best. Recent work by Mossanen et al. [6] further demonstrates the need for improving post-cystectomy readmission rates, which, in addition to driving down healthcare costs/utilization, may actually reduce postoperative mortality. For example, they found that a readmission complication after cystectomy nearly doubled the predicted probability of postoperative mortality as compared to an initial complication (3.9% vs 7.4%; $P < 0.001$).

It is essential that urologists spearhead research such as that undertaken by Borza et al., which in turn can be used to develop strategies to develop value-based reforms within the specialty that ‘thread the needle’ of physician autonomy, cost containment, and respect for the patient experience. In doing so, urologists will find themselves driving the conversation surrounding payment/quality reform rather than sitting on the figurative policy-making sidelines while administrators/bureaucrats implement reforms with potentially profound effects on day-to-day clinical practice and the patient experience. Radical cystectomy is likely to fall within the crosshairs of the aforementioned reforms given the procedure’s high complication/readmission rate and the significant cost burden associated with these complications. An intuitive yet effective first step in combating the morbidity associated with radical cystectomy is the development, validation and implementation of standardized peri-operative care pathways such as ERAS.

Conflict of interest

None declared.