The Egyptian Journal of Radiology and Nuclear Medicine (2015) 46, 1175–1181

Egyptian Society of Radiology and Nuclear Medicine

The Egyptian Journal of Radiology and Nuclear Medicine

www.elsevier.com/locate/ejrnm
www.sciencedirect.com

ORIGINAL ARTICLE

Role of RENAL nephrometry scoring system in planning surgical intervention in patients with localized renal masses

Mohamed Samir Shaaban [a,*], **Tamer Mohammed Abou Youssif** [b], **Ahmed Mostafa** [b], **Hossam Eldin Hegazy** [b], **Mohammed Adel Atta** [b]

[a] *Diagnostic and Interventional Radiology Department, Faculty of Medicine, Alexandria University, Egypt*
[b] *Urology Department, Faculty of Medicine, Alexandria University, Egypt*

Received 6 April 2015; accepted 1 August 2015
Available online 19 August 2015

KEYWORDS

Nephrometry;
Nephron-sparing;
Radical;
Renal tumor;
Scoring system

Abstract *Purpose:* The study was designed to validate the value of preoperative planning using RENAL nephrometry scoring system in patients having organ confined renal tumors and undergoing surgical intervention and to assess its correlation with the surgical technique.
Patient and methods: Forty patients with organ-confined renal masses underwent RENAL nephrometry scoring which was correlated with the surgical technique either radical or nephron-sparing surgery.
Result: RENAL nephrometry scoring system shows correlation with the type of surgery of resection of the renal tumors.
Conclusion: RENAL nephrometry score system is an objective method to help in the decision of surgical approach to resect organ confined renal tumors.

1. Introduction

Renal cell carcinoma accounts for about 3.5% of all malignancies in the body, and is ranked the third most common cancer of the urinary tract (1). Surgical excision has been the standard treatment for renal masses, especially the renal cell carcinomas, especially if large and extensive (2). However, due to advancements in imaging techniques, especially ultrasonography and multi-detector computed tomography, their wide availability and the growing experience, more and more of the renal tumors are discovered in their early stages, which favored a more conservative surgical approach, and hence "nephron-sparing surgeries" (NSS) and even non-surgical interventions such as percutaneous image-guided ablation (3–6).

Partial nephrectomy (PN) is a preferred treatment for localized RCC; unfortunately, treatment depends largely on

* Corresponding author at: 27 Ahmad Foad Nour Str., Camp Caesar, Alexandria 21525, Egypt. Tel.: +20 1001948320.
E-mail addresses: mohamed.shaban@gmail.com (M.S. Shaaban), tamer.abouyoussif@alexmed.edu.eg (T.M.A. Youssif), ahmedmostafamoh@hotmail.com (A. Mostafa), hossamhegazy2002@yahoo.com (H. Eldin Hegazy), m_adelatta@hotmail.com (M.A. Atta).
Peer review under responsibility of Egyptian Society of Radiology and Nuclear Medicine.

http://dx.doi.org/10.1016/j.ejrnm.2015.08.002

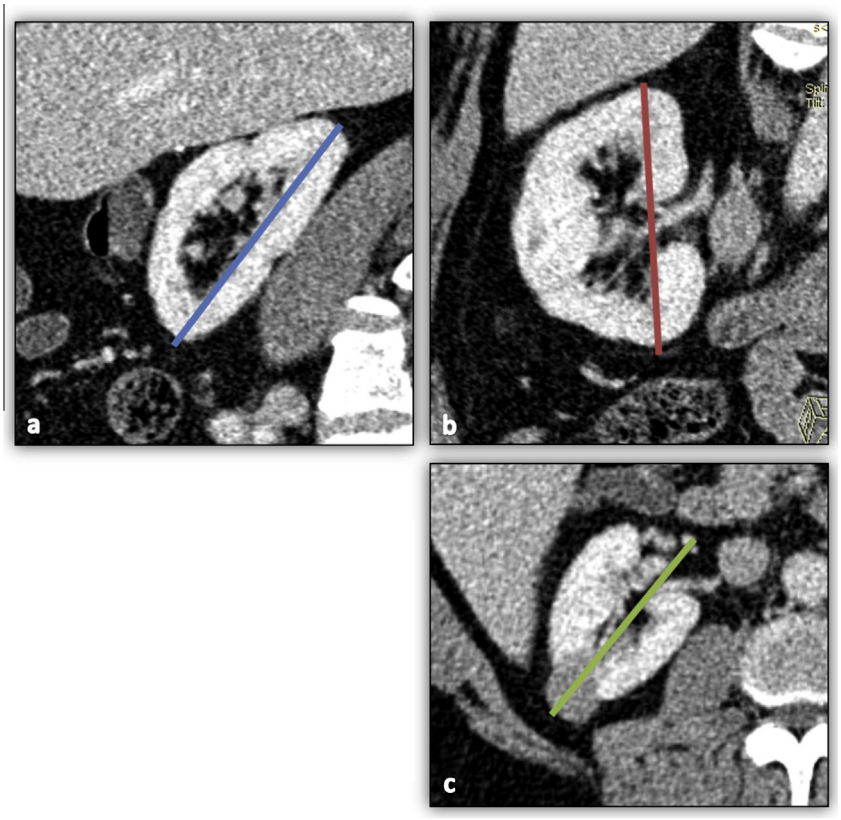

Fig. 1 Post-contrast cuts of the right kidney in (a) sagittal, (b) coronal, and (c) axial planes with lines showing the typical planes of the kidneys; coronal oblique (blue line in a and green line in c), and sagittal oblique (red line in b).

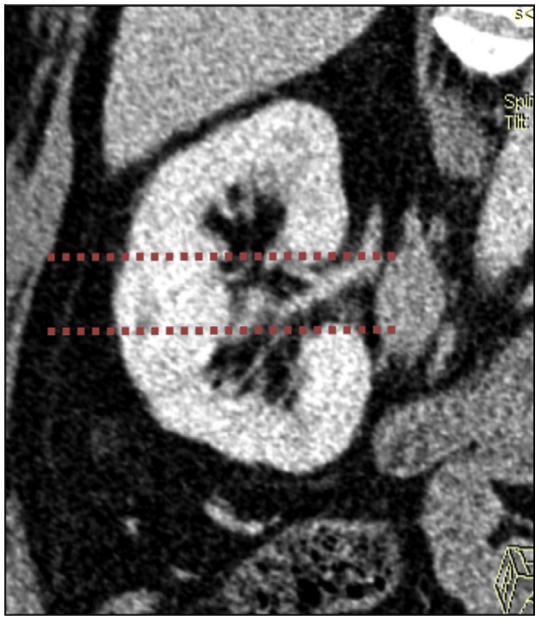

Fig. 2 Coronal cut of the kidney showing the polar lines (dashed arrows).

Fig. 3 Coronal section of a kidney with a focal lesion, curved line is drawn along the virtual outline of the kidney to determine the exophytic component of the mass.

qualitative data including the tumor's anatomy and the surgeon's experience with difficult PN, and the decision whether to go for a nephron-sparing procedure or a radical operation has been for long a subjective decision of the surgeon (2).

Several systems have been developed to assess the feasibility of nephron-sparing surgeries (NSS) in a rather objective manner.

The RENAL system was initially described in 2009 by Kutikov and Uzzo (7). RENAL system assesses (R)adius, (E)xophytic extent, (N)earness to the renal sinus, (A)nterior/-posterior location, and (L)ocation relative to the polar lines.

Similarly, Preoperative Aspects and Dimensions Used for Anatomical Classification or 'P.A.D.U.A' system was reported in 2009 by Ficarra et al. (8). This system is very close to RENAL methodology with a few notable differences.

Lastly, C-index system was reported in 2010 by Simmons et al. (9). Unlike the RENAL and P.A.D.U.A. systems it provides a numerical score based on the combination of tumor diameter and distance from tumor edge to the kidney center.

Nephrometry systems achieve two primary goals: methodological analysis of tumor location and standardization of reporting of tumor data. Secondary goals of nephrometry scoring are to predict success of partial nephrectomy, risk of postoperative complications, and functional and oncologic outcomes (10,11).

We designed the study to validate the value of preoperative planning using RENAL nephrometry scoring system in patients undergoing surgical intervention for organ confined renal tumors and to assess its correlation with the surgical technique.

Fig. 4 Coronal section of a kidney with a focal lesion in delayed phase, to estimate distance of mass from the collecting system (dashed yellow line).

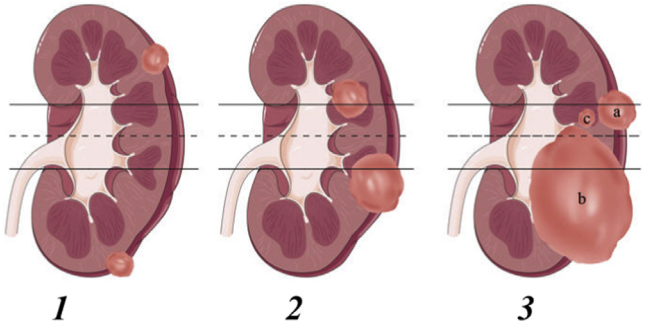

Fig. 5 Relation of the tumor to polar lines (7).

2. Materials and methods

The study was conducted upon 40 patients, all having a parenchymal renal neoplastic process, provisionally diagnosed as renal cell carcinoma, and scheduled for surgery.

Inclusion criterion is an organ-confined tumor, with no metastasis or local invasion.

All patients were subjected to the following:

I. Preoperative multiphasic renal CT, with assessment of the renal tumors by RENAL scoring system and assigned a nephrometry score as follows:

1. Kidney is aligned into its sagittal, axial and coronal planes which are different from the orthogonal planes of the body: (Fig. 1)
   - Coronal plane of the kidney passes through the upper and lower poles, and through the hilum medially and the farthest point in the lateral border of the kidney (as seen in axial cuts).
   - Sagittal plane of the kidney passes through both its poles, perpendicular to the coronal plane.
   - Axial plane of the kidney is perpendicular to both the previous coronal and sagittal planes.
2. Polar lines are assigned in the coronal plane of the kidney, pass in the axial plane and intersect the lips of the hilum (Fig. 2).
3. *Maximal diameter in cm (Radius)*: tumor will be assigned one point if its maximal diameter is equal to or less than 4 cm. Two points if between 4 and 7 cm and three points if equal to or more than 7 cm.
4. *Exophytic component of the mass*: tumor will be assigned one point if at least half of it is exophytic, two points if less than its half is exophytic, and three points if all the mass is completely endophytic (Fig. 3).
5. *Distance of the mass to the renal sinus or collecting system*: the mass will be assigned one point if the distance is 7 mm or more, two points if the distance is between 4 and 7 mm, and three points if the distance is 4 mm or less. (Fig. 4).
6. *Anterior or posterior location*: Mass assigned a descriptor of a (anterior), p (posterior), or x (lateral edge).
7. *Location relative to the polar lines*: the mass will be assigned one point if it lies above or below the upper or lower polar lines respectively, two points if the mass extends into the distance between a polar line and the mid-section of the kidney, and three points if the completely lies between the two polar lines (Fig. 5).

II. Surgical excision of the renal mass either by radical nephrectomy, or nephron-sparing technique, the decision will be made by the operating surgeons during the

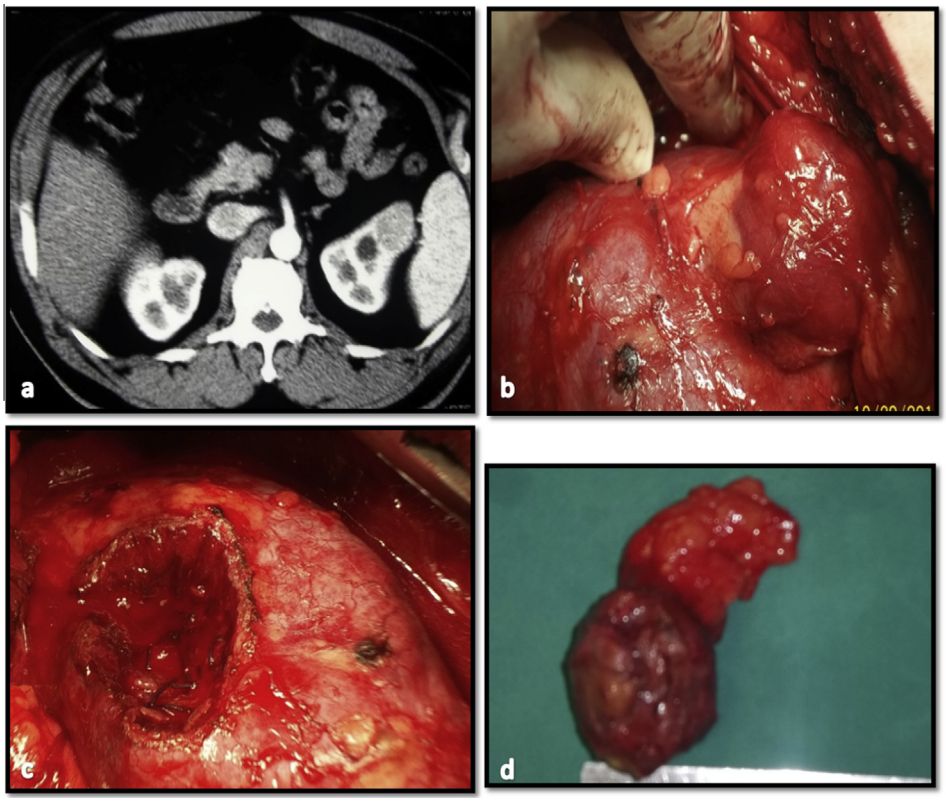

Fig. 6 Axial CT image of a left renal exophytic renal mass (a) and the corresponding intraoperative pictures before (b) and after (c) resection of the mass. Picture of the mass after resection (d).

operation, totally blinded to the nephrometry score of the patient.

III. Correlation between the nephrometry scores of the patients and the type of surgery, using the appropriate statistical tests.

An informed consent is taken from each patient, and the ethical regulations of the institution were the study took place are considered.

3. Results

The study was conducted upon 40 patients, 25 males (62.5%) and 15 females (37.5%), and their ages ranged between 23 and 86 years. The patients were divided into two groups, according to the type of operation: (1) Group A for patients who underwent radical nephrectomy (RN), which included 13 males (65% of this group) and 7 females (35% of this group), and (2) Group B for patients who underwent nephron sparing surgery (NSS), which included 12 males (60% of this group) and 8 females (40% of this group). The age range for group A was 35–75 years and for Group B was 23–86 years.

Pathological types of the tumors: 38 patients (95%) had renal cell carcinoma while 2 patients (5%) had renal oncocytoma. In Group A, 19 patients (95%) had renal cell carcinoma, and only one patient (5%) had renal oncocytoma, while in Group B, also 19 patients (95%) had renal cell carcinoma, and only one patient (5%) had renal oncocytoma.

RENAL Nephrometry score ranged from 4 to 12 for all patients in the study. Ten patients (25%) had RENAL Nephrometry score from 4 to 6 (low surgical complexity for NSS) and all of them underwent NSS (Fig. 6), 9 patients (22.5%) had RENAL Nephrometry score from 7 to 9 (moderate surgical complexity for NSS), from them 6 patients (15%) underwent NSS and 3 patients (7.5%) underwent RN (Fig. 7), and finally 18 patients (45%) had RENAL Nephrometry score from 10 to 12 (high surgical complexity for NSS), from them 4 patients (10%) underwent NSS and 14 patients (35%) underwent RN (Fig. 8). Three patients (7.5%) have hilar location and all of them underwent RN (Fig. 9).

RENAL nephrometry scores in Group (A) ranged from 8 to 12, while in Group (B) they ranged from 4 to 11, with P value <0.001 which means there is statistical difference between the 2 groups, Table 1.

4. Discussion

RENAL nephrometry scoring system was initially described in 2009 by Kutikov and Uzzo to assess the tumor radius, exophytic extent, nearness to the renal sinus, anterior/posterior location, and location relative to the polar, to determine the feasibility of nephron-sparing for localized renal tumors (7).

However, recent studies have used RENAL nephrometry scoring system in predicting tumor upgrading between core biopsies and surgical specimens (12), comparing perioperative

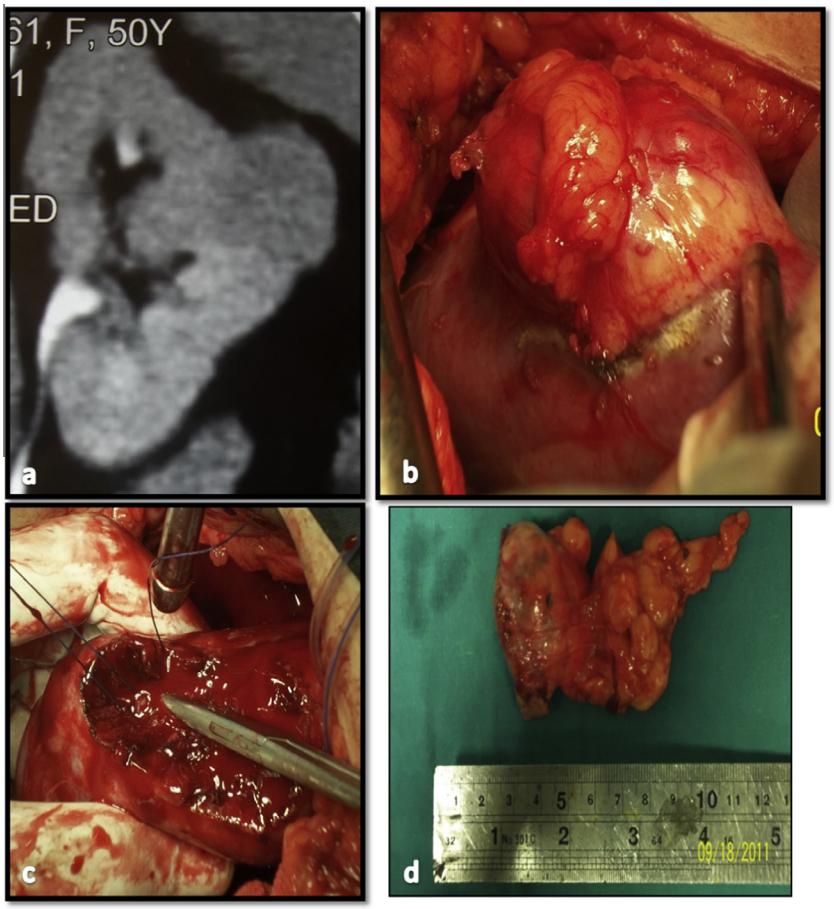

Fig. 7 Coronal CT image of a right renal midzonal exophytic renal mass (a) and the corresponding intraoperative pictures before (b) and after (c) wedge resection of the mass. Picture of the mass after resection (d).

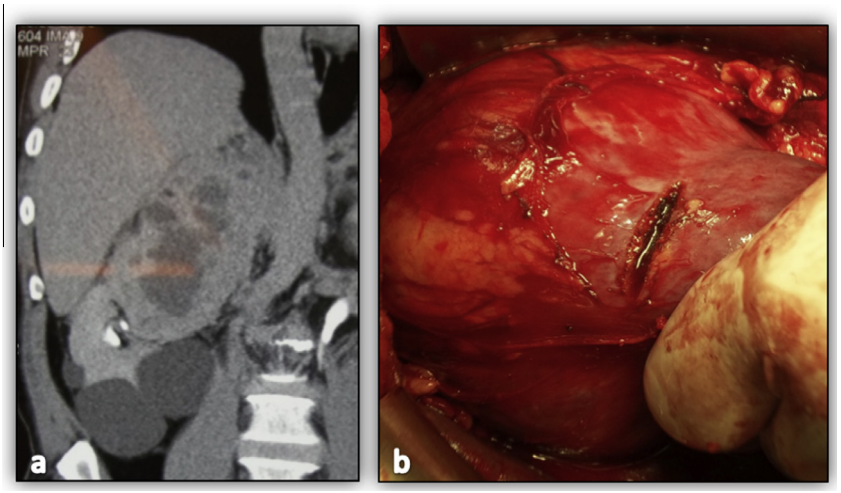

Fig. 8 Coronal CT image of a right renal upper polar mass (a) and the corresponding intraoperative picture (b).

outcomes of robotic versus laparoscopic partial nephrectomy for complex renal tumors (13), and in prediction of complications after partial nephrectomy (14).

In the original study by Kutikov and Uzzo (7), they applied the RENAL nephrometry score to 50 patients with localized renal masses, and divided their patients into Low (nephrometry sum 4–6) and moderate (nephrometry sum 7–9) tumors more often underwent PN, primarily using a minimally invasive approach, while high complexity (nephrometry sum 10–12) lesions were more likely to undergo open partial or

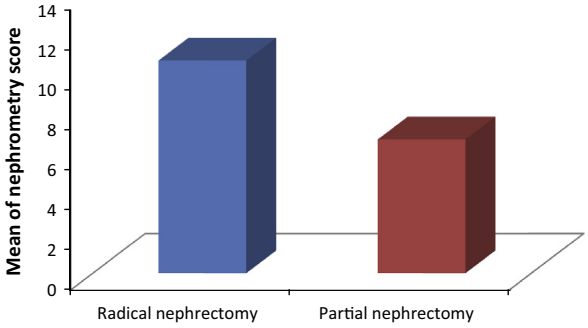

Fig. 9 Bar-chart displaying the comparison between the two studied groups according to mean nephrometry scores.

laparoscopic radical nephrectomy, while in our study, following this classification, we found that all patients (100%) who have a low (4–6) nephrometry score, and 66% of patients with moderate (7–9) score, underwent partial nephrectomy, while 33% of moderate nephrometry score and all patients (100%) of high (10–12) score underwent radical surgery. Two points should be noted, the first is that the total sample size for Kutikov et al. study was 50 patients, while in our study it was 40 patients, and the other point is that all our patients underwent open surgery (both the partial and radical nephrectomies), while in Kutikov et al. study, 31 patients underwent laparoscopic or robotic surgeries (14 radical and 17 partial surgery), and only 19 had open surgery (5 radical and 14 partial nephrectomy) (7).

Naya et al. (15) studied a larger sample size of patients with cT1aN0M0 renal lesions (142 patients) and compared RENAL nephrometry score with the diameter-axial-polar nephrometry (DAP) in correlation with the decision of the type of resection of the renal tumor, and though they did not classify their patients into complexity groups, they concluded that the mean RENAL nephrometry score in the radical nephrectomy group was significantly higher than that in the partial nephrectomy group (9 vs. 7; with $p < 0.0001$), which matches with our results.

Also Oh et al. (16) in 2013 retrospectively performed RENAL nephrometry scoring for 206 patients who had underwent resection of their renal tumors in different techniques and approaches, divided into open radical nephrectomy (53 patients), laparoscopic radical nephrectomy (83 patients), open partial nephrectomy (31 patients), and laparoscopic partial nephrectomy (39 patients). They found a statistically significant difference between the mean score in radical nephrectomy group (score = 8.89) and the partial nephrectomy group (score = 6.09) with a $p < 0.0001$. Oh et al. also noted that the choice of laparoscopic versus open radical nephrectomy depended upon the R and L scores, while the choice of laparoscopic versus open partial nephrectomy depended upon the E score.

In a more recent study in 2014, Cost et al. (17) applied RENAL nephrometry score upon 65 patients of children, adolescents, and young adults, all with renal tumors, and correlated the surgical technique, radical or nephron-sparing with the complexity of the renal mass, and even though they classified the renal masses into low, moderate and high complexity groups based upon the same nephrometry scores as in our study, two out of five patients of low complexity groups underwent radical nephrectomy, in contrast to our low complexity group patients who underwent nephron-sparing procedure, while three out of 48 patients in the high complexity group of Cost et al., underwent nephron-sparing procedure, in contrast to our high complexity group who all underwent radical surgery. An explanation for this is the different sample size and demographic characteristics, our study included adults only, while Cost et al. study was based upon children, adolescents and young adults, and another explanation is the different pathologies of the resected renal tumors, as 95% of the renal tumors in our study were renal cell carcinoma and 5% were oncocytoma, while in Cost et al. study the renal tumor pathologies were more diverse, including Wilms tumor (62.7%), renal cell carcinoma (16.4%), clear cell sarcoma (5.9%), congenital mesoblastic nephroma (4.5%), rhabdomyosarcoma (3%), multilocular cystic nephroma (1.5%), inflammatory myofibroblastic tumor (1.5%), Fibrosarcoma (1.5%), juxtaglomerular apparatus tumor (1.5%) and metanephric adenoma (1.5%).

Based upon our results and the results of the available published studies considering RENAL nephrometry score system as an objective method to help in the decision of surgical approach to resect renal tumors, we can conclude that RENAL nephrometry scoring system is correlated with the surgical technique in cases of renal cell carcinoma in adults, and helps as an objective method in the decision of type of surgery, and the degree of its complexity.

5. Conclusion

RENAL nephrometry score system is an objective method to help in the decision of surgical approach to resect organ confined renal tumors.

Conflict of interest

We have no conflict of interest to declare.

Table 1 Distribution of nephrometry scores among study patients.

	The whole studied group	Group A radical nephrectomy ($n = 20$)	Group B partial nephrectomy ($n = 20$)	P value
Preoperative nephrometry score Min.–Max.	4.0–12.0	8.0–12.0	4.0–11.0	$< 0.001^{*}$

* Statistically significant at $p \leqslant 0.05$.

References

(1) Chen DY, Uzzo RG. Optimal management of localized renal cell carcinoma: surgery, ablation, or active surveillance. J Natl Compr Canc Netw 2009;7(6):635–42.

(2) Delakas D, Karyotis I, Daskalopoulos G, Terhorst B, Lymberopoulos S, Cranidis A. Nephron-sparing surgery for localized renal cell carcinoma with a normal contralateral kidney: a European three-center experience. Urology 2002;60(6):998–1002.

(3) Sivarajan Ganesh, Huang William C. Current practice patterns in the surgical management of renal cancer in the United States. Urol Clin N Am 2012;39:149–60.

(4) Georgiades C, Rodriguez R. Renal tumor ablation. Tech Vasc Interv Radiol 2013;16(4):230–8.

(5) Gervais DA. Cryoablation versus radiofrequency ablation for renal tumor ablation: time to reassess? J Vasc Interv Radiol 2013 Aug;24(8):1135–8.

(6) Saksena M, Gervais D. Percutaneous renal tumor ablation. Abdom Imaging 2009;34(5):582–7.

(7) Kutikov A, Uzzo RG. The R.E.N.A.L. nephrometry score: a comprehensive Standardized system for quantitating renal tumor size, location and depth. J Urol 2009;182:844–53.

(8) Ficarra V, Novara G, Secco S, et al. Preoperative aspects and dimensions used for an anatomical (PADUA) classification of renal tumours in patients who are candidate for nephron-sparing surgery. Euro Urol 2009;56:786–93.

(9) Simmons MN, Ching CB, Samplaski MK, et al. Kidney tumor location measurement using the C index method. J Urol 2010;183:1708–13.

(10) Lifshitz DA, Shikanov S, Jeldres C, et al. Laparoscopic partial nephrectomy: Predictors of prolonged warm ischemia. J Urol 2009;182:860–5.

(11) Porpiglia F, Volpe A, Billia M, et al. Assessment of risk factors for complications of laparoscopic partial nephrectomy. Eur Urol 2008;53:590–6.

(12) Zhang GM, Zhu Y, Gan HL, Wang HK, Shi GH, Zhang HL, et al. Use of RENAL nephrometry scores for predicting tumor upgrading between core biopsies and surgical specimens: a prospective ex vivo study. Medicine (Baltimore) 2015;94(8): e581.

(13) Jang HJ, Song W, Suh YS, Jeong US, Jeon HG, Jeong BC, et al. Comparison of perioperative outcomes of robotic versus laparoscopic partial nephrectomy for complex renal tumors (RENAL nephrometry score of 7 or higher). Korean J Urol 2014 Dec;55(12):808–13.

(14) Reddy UD, Pillai R, Parker RA, Weston J, Burgess NA, Ho ET, et al. Prediction of complications after partial nephrectomy by RENAL nephrometry score. Ann R Coll Surg Engl 2014 Sep;96(6):475–9.

(15) Naya Yl, Kawauchi A, Oishi M, Ueda T, Fujihara A, Naito Y, et al. Comparison of diameter-axial-polar nephrometry and RENAL nephrometry score for treatment decision-making in patients with small renal mass. Int J Clin Oncol 2014;27 [Epub ahead of print].

(16) Oh JH, Rhew HY, Kim TS. Factors influencing the operative approach to renal tumors: analyses according to RENAL nephrometry scores. Korean J Urol 2014;55(2):97–101.

(17) Cost NG1, DeFoor Jr WR, Crotty EJ, Geller JI. The initial experience with RENAL nephrometry in children adolescents and young adults with renal tumors. Pediatr Blood Cancer 2014;61(8):1434–9.