Original Articles/นิพนธ์ต้นฉบับ

Comparison of Three Nephrometry Scoring Systems in Predicting the Patient Outcomes Following Partial or Radical Nephrectomy

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Abstract

Background: Multiple nephrometry scoring systems are developed to evaluate anatomical characteristics of renal mass and help the preoperative decision making for partial nephrectomy. However, there are limited data on the comparison among these scoring systems in predicting perioperative and postoperative outcomes after surgical treatment of renal mass.

Objective: To compare the correlation of three nephrometry scoring systems with perioperative and postoperative outcomes following surgical treatment of renal mass.

Materials and Methods: We conducted a retrospective analysis including the patients with renal mass (diameter ≤ 7 cm) who underwent partial nephrectomy or radical nephrectomy. Three nephrometry scores were evaluated in each patient, including centrality-index (C–Index), preoperative aspects and dimensions used for anatomic (PADUA) score, and radius, exophyic/endophytic, nearness, anterior/posterior, and location (R.E.N.A.L.) nephrometry scores. We evaluated the differences between the partial and radical nephrectomy groups in terms of these three mean scoring systems and analyzed the correlation with postoperative outcomes.

Results: A total of 83 patients were included. There were significant differences in the mean scores of these three systems between partial and radical nephrectomy groups (6.5 vs 8.6, $P < 0.001$ in R.E.N.A.L nephrometry score, 7.3 vs 8.7, $P < 0.001$ in PADUA score, and 2.2 vs 1.3, $P < 0.005$ in C-Index). With regard to the outcome of the partial nephrectomy, R.E.N.A.L. nephrometry score was significantly associated with the warm ischemia time (WIT) and percentage change in estimated glomerular filtration rate (eGFR) ($P = 0.001$). PADUA score was significantly associated with WIT ($P = 0.039$), whereas C-Index was significantly associated with percentage change in eGFR ($P = 0.011$). There was no significant correlation among all three scoring systems with operative time, postoperative complications and estimated blood loss.

Conclusion: All three nephrometry scores were found to be the useful tools aiding the surgeon decision between partial and radical nephrectomy. R.E.N.A.L. nephrometry score had more benefit over C-index and PADUA score in the aspect of correlation with WIT and percentage change in postoperative eGFR in the patients who underwent partial nephrectomy. However, further large-scale prospective studies are needed to confirm our results.

Keywords: partial nephrectomy, radical nephrectomy, small renal mass, nephrometry score

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Introduction

The treatment options of small renal mass include active surveillance, ablation and excision (partial or radical nephrectomy). The decision is based on tumor anatomical factors (e.g. size, location, collecting system involvement, etc.), baseline renal function and comorbidities of the patients. The treatment of choice for a healthy patient with a clinical T1a renal mass is complete surgical excision by open, laparoscopic or robotic assisted partial nephrectomy. The recent systematic reviews demonstrate similar oncological outcomes when compared between partial and radical nephrectomy[1]. Renal function is significantly preserved in the patient who underwent partial nephrectomy[2]. Radical nephrectomy is a standard alternative treatment option when partial nephrectomy is not feasible[3].

Apart from clinical tumor size, tumor anatomical complexity is considered as the major factor to predict the success rate of partial nephrectomy and can be used to predict the risk of complications[4]. Three renal nephrometry scoring systems are developed to help surgeon decision-making. Radius, exophyic/endophytic, nearness, anterior/posterior, location (R.E.N.A.L.) scoring systems and preoperative aspects and dimensions used for anatomic (PADUA) classification are developed by using anatomical features of the renal mass (tumor size, polarity, anterior/posterior location, closeness to the collecting system) and sum each component to be a total score[5,6]. The centrality index (C-Index) is the third renal nephrometry scoring system that uses the Pythagorean theorem to calculate the distance between tumor center and kidney center. The distance is divided by tumor radius to obtain the centrality index[7].

Currently, there are limited data on the comparison of each nephrometry scoring system[8]. Therefore, the primary aim of this study was to compare the correlation of each nephrometry scoring system with the perioperative and postoperative outcomes following surgical treatment of the small renal mass. The secondary aim was to assess the variability among three renal nephrometry scoring systems in predicting postoperative outcomes.

Materials and methods

Patient Population

Ethical approval for the study was obtained from the Institutional Review Board of the Faculty of Medicine Ramathibodi Hospital. We performed a retrospective analysis among patients with a renal mass (diameter ≤ 7 cm) who underwent partial nephrectomy or radical nephrectomy by either open or laparoscopic technique between January 2008 and January 2014 at Ramathibodi Hospital.

The included patients had to meet the following inclusion criteria: the availability of preoperative computed tomographic (CT) or magnetic resonance imaging (MRI) scans and underwent partial or radical nephrectomy. The exclusion criteria were the patients who were lost to follow-up and incomplete perioperative or postoperative data.

Of the 230 patients identified, 83 met all entry criteria. Data were obtained by reviewing the patient's history, imaging study, operative record and discharge summary. We retrospectively analyzed the preoperative imaging study by C-Index, PADUA, and R.E.N.A.L. scoring systems. All of the patients were subject to follow-up every 3 months in the first year after surgery and every 6 months thereafter, with physical examination, chest radiography, abdominal computed tomography, and blood chemistry panel. Estimated glomerular filtration rate (eGFR) was calculated by the Cockcroft-Gault formula, and percentage change in eGFR was calculated based on the difference between preoperative eGFR and postoperative day 1[9].

Statistical analysis

Statistical analysis was performed by using the Statistical Package for the Social Sciences (Windows version 11.5; SPSS Inc, Chicago [IL], US). Three nephrometry scoring systems were calculated by a urology resident. Continuous variables were analyzed with Student's t-test. For each scoring system, Spearman correlations were conducted with the following variables: occurrence of complications, operative time, estimated blood loss (EBL), warm ischemia time (WIT) and percentage change in eGFR.

Results

There were 230 patients who underwent partial or radical nephrectomy during January 2008 to January 2014. A total of 83 patients (52 males and 31 females) met the inclusion criteria and were included for analysis. The mean age was 61 years old, and the mean body mass index was 25.0 kg/m^2. Fifty-seven and 26 patients underwent radical and partial nephrectomy, respectively. Fifty-two and 37 patients underwent laparoscopic surgical approach and open surgical approach, respectively. The tumors were located on

Table 1 Patient demographics, operative and tumor data (n = 83)

Variables, units	No. (%) or mean (SD)
Age (years)	61 (13)
Sex	
Men	52 (62.7)
Women	31 (37.3)
Side of mass	
Right	41 (49.4)
Left	42 (50.6)
Radiological size (cm)	4.25
Pathologic size (cm)	4.19
Operative type	
Laparoscopic radical nephrectomy	39 (47.0)
Open radical nephrectomy	18 (21.8)
Laparoscopic partial nephrectomy	13 (15.6)
Open partial nephrectomy	13 (15.6)
Perirenal fat invasion	11 (13.3)
Collecting system invasion	6 (7.2)
Renal vein invasion	9 (10.8)
Pathologic type	
Clear cell	58 (69.9)
Papillary	10 (12.0)
Angiomyolipoma	6 (7.2)
Chromophobe	4 (4.8)
Transitional cell carcinoma	2 (2.4)
Oncocytoma	1 (1.2)
Epithelial neoplasm with eosinophilic cytoplasm	1 (1.2)
Cystic renal cell carcinoma	1 (1.2)

Table 2 Patient demographics and perioperative data in the partial nephrectomy group (n=26)

Variables	Mean (SD)
Preoperative eGFR (mg/dL)	74 (29.6)
Postoperative eGFR (mg/dL)	56 (27.0)
% change of eGFR (preoperative to postoperative day 1)	24 (18.4)
Estimated blood loss (mL)	413.4 (1393.3)
Operative time (minute)	153.3 (64.3)
Warm ischemia time (minute)	28 (5.1)

eGFR, estimated glomerular filtration rate

Table 3 Association between choice of surgery with nephrometry score and individual parameters

Nephrometry scores	Mean (standard deviation)		*P*
	Radical nephrectomy (n=57)	Partial nephrectomy (n=26)	
C-Index	1.3 (0.6)	2.1 (1.3)	0.003
PADUA	8.8 (1.4)	7.3 (0.8)	< 0.001
R.E.N.A.L.	8.7 (1.8)	6.6 (1.76)	< 0.001

C-Index, centrality index; PADUA, preoperative aspects and dimensions used for anatomic; R.E.N.A.L., radius.exophyic/endophytic, nearness, anterior/posterior, location.

the right kidney in 41 cases and on the left kidney in 42 cases. The mean preoperative tumor size was 4.25 cm (range 1.1-7 cm). The mean pathological size was 4.19 cm (range 1-7 cm).

The majority of histopathology of the tumors was clear-cell type of renal cell carcinoma (RCC) (n=58, 70%), and the remainders were papillary RCC (n=10, 12%), angiomyolipoma (n=6, 7%), chromophobe RCC (n=4, 5%), oncocytoma (n=1, 1%), and others (n=4, 5%).

The pathological stage of the primary tumor was pT1a in 32 cases (42.2%), pT1b in 22 cases (28.9%), and pT3 in 22 cases (28.9%), as shown in Table 1.

Overall complications were observed in 22 cases (22.6%). In radical nephrectomy group, complications were intraoperative bleeding requiring blood transfusion (n=13), splenic injury (n=1), postoperative septicemia (n=1), and fever and other medical complications (n=5). In partial nephrectomy group, complications were intraoperative bleeding requiring transfusion (n=3), splenic injury (n=1), postoperative septicemia (n=1), and fever and other medical complications (n=1). There were no conversions to open operations.

There were significant differences in mean scores of three nephrometry scoring systems between the partial and radical nephrectomy groups (6.5 vs 8.6, $P < 0.001$ for R.E.N.A.L. score; 7.3 vs 8.7, $P < 0.001$ for PADUA score; and 2.2 vs 1.3, $P < 0.005$ for C-Index).

Subgroup analysis in the partial nephrectomy patients demonstrated that R.E.N.A.L. nephrometry score was significantly associated with WIT and percentage change in eGFR. C-Index score was significantly associated with percentage change in eGFR whereas PADUA score was significantly associated with WIT. There was no significant correlation among all three renal nephrometry scoring systems regard-

Table 4 Correlations between C-index, PADUA, R.E.N.A.L. and clinical factors

	C-Index		PADUA		R.E.N.A.L.	
	Rho	*P*	Rho	*P*	Rho	*P*
Warm ischemia time	-0.350	0.080	0.408	0.039	0.862	0.001
% change in eGFR	-0.491	0.011	0.159	0.439	0.884	0.001
Operative time	0.312	0.121	-0.192	0.348	-0.271	0.180
Estimated blood loss	-0.380	0.055	-0.047	0.820	0.152	0.458
Postoperative complications	-0.077	0.710	-0.180	0.378	0.241	0.236

C-Index, centrality index; eGFR, estimated glomerular filtration rate; PADUA, preoperative aspects and dimensions used for anatomic; R.E.N.A.L., radius, exophyic/endophytic, nearness, anterior/posterior, location

ing operative time, postoperative complications and EBL.

Discussion

Nephrectomy was introduced 150 years ago, Simon successfully performed the first planned nephrectomy for the treatment of urinary fistula, and one year later he also successfully performed the first deliberate partial nephrectomy[10]. Advances in imaging and routine health checkup have led to an increase in the number of the incidentally diagnosis of the small renal mass. Because of the popularity of minimally invasive surgery and the concerns of long term consequences of chronic renal insufficiency, partial nephrectomy has become a treatment of choice for renal mass in patients who are candidates for surgery. Partial nephrectomy, however, is a complicated surgical procedure with the risks of bleeding, urine leakage, ischemic perfusion injury and positive surgical margin. Hence, various nephrometry scores are developed to predict the success rate of this surgery.

The first nephrometry score, PADUA score, has been purposed by Ficara et al.[6] in 2009. It is helpful to predict the risk of surgical and medical perioperative complications in the patients undergoing partial nephrectomy[6]. Shortly after, Kutikov et al.[5] proposed R.E.N.A.L. nephrometry score, which can be easily recognized. They found that R.E.N.A.L. nephrometry score is a reproducible standardized classification system that quantitates the salient anatomy of renal masses. One year later, Simmon et al.[7] used Pythagorythm theory to calculate the C-index, which is easier to measure as compare to the other nephrometry scores. The study showed a significant relationship between C-index score and the warm ischemic time during laparoscopic partial nephrectomy.

For R.E.N.A.L. nephrometry score, there is an evidence to support the use of this tool to assist preoperative decision for surgical treatment of renal mass[4]. The results of our study demonstrated that there were significant differences in C-index, PADUA, and R.E.N.A.L. nephrometry score when compared between partial and radical nephrectomy groups. This may imply that we can use any of these three nephrometry scores to predict the success rate of partial nephrectomy.

In the patients who underwent partial nephrectomy, we found that only R.E.N.A.L. nephrometry score was correlated with percentage change in eGFR and WIT. PADUA was significantly associated with WIT only and C-Index was significantly associated with percentage change in eGFR. This may imply that R.E.N.A.L. scoring system may be a better scoring

system to help in decision making of partial nephrectomy. Further prospective large-scale studies are needed to confirm our findings.

The results of the present study, however, did not agree with the previous studies, which dementrated the significant association between nephrometry scores and postoperative complications[11-13]. This could be due to a relatively small number of the patients in partial nephrectomy group when compared to the previous published studies.

Our study had certain limitations, since it was a retrospective study with a small sample size. In addition, laparoscopic partial nephrectomy demands skillful and experienced surgeons. There are some concerns of the selection bias by the surgeon preference, especially when they have less experience on laparoscopic partial nephrectomy. To minimize this limitation, we included all the patients who underwent either open or laparoscopic partial nephrectomy. Our results showed that there was more complexity of the tumor in both open and laparoscopic radical nephrectomy group when compared to the partial nephrectomy group.

Conclusion

All three nephrometry scores are useful tools for assisting the surgeon decision between partial and radical nephrectomy. R.E.N.A.L nephrometry score has more benefit over C-index and PADUA score in the aspect of significant correlation with warm ischemia time and percentage change in postoperative eGFR in the patients who underwent partial nephrectomy. However, further large-scale prospective studies are needed to confirm our results.

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Conflict of interest

None.

References

1. MacLennan S, Imamura M, Lapitan MC, Omar MI, Lam TB, Hilvano-Cabungcal AM, et al. Systematic review of oncological outcomes following surgical management of localised renal cancer. Eur Urol 2012;61: 972-93.
2. MacLennan S, Imamura M, Lapitan MC, Omar MI, Lam TB, Hilvano-Cabungcal AM, et al. Systematic review of perioperative and quality-of-life outcomes following surgical management of localised renal cancer. Eur Urol 2012;62:1097-117.
3. Campbell SC, Novick AC, Belldegrun A, Blute ML, Chow GK, Derweesh IH, et al. Guideline for management of the clinical T1 renal mass. J Urol 2009;182:1271-9.
4. Canter D, Kutikov A, Manley B, Egleston B, Simhan J, Smaldone M, et al. Utility of the R.E.N.A.L. nephrometry scoring system in objectifying treatment decision-making of the enhancing renal mass. Urology 2011;78: 1089-94.

5. 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.
6. Ficarra V, Novara G, Secco S, Macchi V, Porzionato A, De Caro R, et al. Preoperative aspects and dimensions used for an anatomical (PADUA) classification of renal tumors in patients who are candidates for nephron-sparing surgery. Eur Urol 2009;56:786-93.
7. Simmons MN, Ching CB, Samplaski MK, Park CH, Gill IS. Kidney tumor location measurement using the C index method. J Urol 2010;183:1708-13.
8. Okhunov Z, Rais-Bahrami S, George AK, Waingankar N, Duty B, Montag S, et al. The comparison of three renal tumor scoring systems: C-Index, PADUA, and R.E.N.A.L. nephrometry scores. J Endourol 2011;25: 1921-4.
9. Cockcroft DW, Gault MH. Prediction of creatinine clearance from serum creatinine. Nephron 1976;16: 31-41.
10. Moll F, Rather P. The surgeon and his intention: Gustav Simon (1824-1876), his first planned nephrectomy and further contributions to urology. World J Urol 1999;17:162-7.
11. Hayn MH, Schwaab T, Underwood W, Kim HL. RENAL nephrometry score predicts surgical outcomes of laparoscopic partial nephrectomy. BJU Int 2011;108:876-81.
12. Bruner B, Breau RH, Lohse CM, Leibovich BC, Blute ML.Renal nephrometry score is associated with urine leak after partial nephrectomy. BJU Int 2010;108:67-72.
13. Simhan J, Smaldone MC, Tsia KJ, Canter DJ, Li T, Kutikov A. Objective measures of renal mass anatomic complexity predict rates of major complications following partial nephrectomy. Eur Urol 2011;60: 724-30.

Original Articles/นิพนธ์ต้นฉบับ

การเปรียบเทียบการใช้ค่าเนโฟรเมทรีสามระบบเพื่อทำนายผลการรักษาในผู้ป่วยที่ผ่าตัดไตแบบบางส่วนหรือการผ่าตัดไตแบบทั้งหมด

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บทคัดย่อ

บทนำ: การคำนวณค่าเนพโฟรเมทรี (nephrometry) ระบบต่างๆ ถูกพัฒนาขึ้นเพื่อประเมินลักษณะทางกายวิภาคของเนื้องอกที่ไตขนาดเล็ก เพื่อช่วยในการตัดสินใจก่อนจะผ่าตัดว่าเหมาะสมที่จะทำการผ่าตัดไตแบบบางส่วนหรือไม่ อย่างไรก็ตาม ยังมีข้อมูลที่จำกัดสำหรับการเปรียบเทียบการใช้ค่าเนโฟรเมทรีแต่ละระบบในการทำนายผลการรักษาทั้งระหว่างการผ่าตัดและผลการรักษาหลังการผ่าตัดก้อนที่ไตขนาดเล็ก

วัตถุประสงค์: เพื่อเปรียบเทียบความสัมพันธ์ระหว่างค่าเนพโฟรเมทรีแต่ละระบบกับผลการรักษาระหว่างการผ่าตัดและหลังการผ่าตัดก้อนที่ไตขนาดเล็ก

วิธีการศึกษา: เป็นการศึกษาโดยวิเคราะห์แบบย้อนหลัง ในผู้ป่วยที่มีก้อนที่ไตขนาดเล็ก (เส้นผ่าศูนย์กลางน้อยกว่าหรือเท่ากับ 7 เซนติเมตร) และได้รับการผ่าตัดไตแบบบางส่วนหรือผ่าตัดไตออกทั้งหมด และคำนวณค่าเนพโฟรเมทรีทั้ง 3 ระบบคือ ค่า C-Index ค่า PADUA และค่า R.E.N.A.L. จากนั้นคำนวณหาความแตกต่างระหว่างการผ่าตัดไตแบบบางส่วนกับการผ่าตัดไตออกทั้งหมด และวิเคราะห์ถึงความสัมพันธ์ของค่าเนพโฟรเมทรีทั้ง 3 ระบบกับผลลัพธ์ของการผ่าตัด

ผลลัพท์: ผู้ป่วยเข้าร่วมงานวิจัยทั้งหมด 83 คน พบว่ามีความแตกต่างอย่างมีนัยสำคัญทางสถิติระหว่างค่าเฉลี่ยของค่าเนฟโฟเมทรีของการผ่าตัดไตแบบบางส่วนและการผ่าตัดไตออกทั้งหมด (ค่า R.E.N.A.L. 6.5 และ 8.6, $P < 0.001$; ค่า PADUA 7.3 และ 8.7, $P < 0.001$; ค่า C-Index 2.2 และ 1.3, $P < 0.005$) สำหรับผลการรักษาโดยการผ่าตัดไตแบบบางส่วน ค่า R.E.N.A.L. มีความสัมพันธ์กับระยะเวลาที่ไตขาดเลือดและการเปลี่ยนแปลงของการทำงานของไตที่ลดลงอย่างมีนัยสำคัญ ($P = 0.001$) ค่า PADUA จะสัมพันธ์กับระยะเวลาที่ไตขาดเลือดอย่างมีนัยสำคัญ ($P = 0.039$) ในขณะที่ค่า C-Index สัมพันธ์กับการเปลี่ยนแปลงของการทำงานของไตที่ลดลงอย่างมีนัยสำคัญ ($P = 0.011$) ค่าเนโฟรเมทรีทั้งสามระบบไม่มีความสัมพันธ์อย่างมีนัยสำคัญกับระยะเวลาการผ่าตัด การเกิดภาวะแทรกซ้อนหลังการผ่าตัด และปริมาณที่เสียเลือดระหว่างผ่าตัด

สรุป: ค่าเนโฟรเมทรีทั้งสามระบบมีประโยชน์ในการช่วยแพทย์ตัดสินใจเลือกการผ่าตัดไตแบบบางส่วนหรือการผ่าตัดไตออกทั้งหมด ค่า R.E.N.A.L. จะมีประโยชน์มากกว่าค่า C-Index และค่า PADUA ในแง่ความสัมพันธ์กับระยะเวลาที่ไตขาดเลือด และการเปลี่ยนแปลงการทำงานของไตที่ลดลงในผู้ป่วยที่ได้รับการผ่าตัดไตแบบบางส่วน อย่างไรก็ตาม การศึกษาขนาดใหญ่ในอนาคตที่เก็บข้อมูลแบบไปข้างหน้ายังมีความจำเป็นเพื่อยืนยันผลลัพธ์ของการวิจัยนี้

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