Original Articles/นิพนธ์ต้นฉบับ

Anatomical Parameters of the Renal Mass that Effect the Treatment Outcomes of Laparoscopic Partial Nephrectomy

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Abstract

Objectives: Partial nephrectomy is the newly treatment of choice for management of small renal mass. The warm ischemic time (WIT) is the most important factor that affects postoperative renal function. In this study, we explored the anatomical factors of the renal mass that influence warm ischemic time and perioperative outcomes during laparoscopic partial nephrectomy (LPN).

Materials and Methods: We performed a single institutional, retrospective analysis in the patients who underwent LPN at Ramathibodi Hospital from 2007 to 2013. The anatomy of the renal mass was evaluated preoperatively by computed tomography or magnetic resonance imaging according to R.E.N.A.L. nephrometry scoring system (radius, exophytic/endophytic, growth pattern, nearness of the collecting system, anterior/posterior and location). Statistical analysis was performed to evaluate the associations between the anatomy of renal mass and WIT, operative time (OT), estimated blood loss (EBL) and postoperative complications.

Results: A total of 28 patients underwent LPN from 2007 to 2013. The average tumor size was 3.75 cm (range 0.8-8.5 cm), 62.3% of these masses were < 4 cm in diameters, 21.4% were 4-7 cm and 16.3% were > 7 cm. For growth pattern of the renal mass: 25% were exophytic ≥ 50% and 75% were exophytic < 50%. The location of the tumors: 67.9% were in anterior part of the kidney, 24.9% were in posterior part and 14.3% were located between the anterior and posterior part of the kidney. In addition, 35.7% were upper pole tumors, 28.6% were in the lower pole, and 35.7% were in interpolar location. According to R.E.N.A.L. scoring system, the nearness of the collecting system was the only factor that was found to be significantly correlated with EBL (P = 0.036). From our results, anatomical factors of renal mass could not predict OT and WIT.

Conclusions: The nearness of collecting system of renal mass is a useful parameter for the prediction of EBL during LPN.

Keywords: laparoscopic partial nephrectomy, small renal mass, R.E.N.A.L. nephrometry score

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Introduction

To date, abdominal ultrasound and computer tomography are commonly used as routine diagnostic modalities. More than 60% of renal tumors nowadays are diagnosed incidentally during routine health check-up[1]. Renal cell carcinoma (RCC) is an aggressive tumor. The early diagnosis and treatment ultimately improve the survival of the patients.

Based on American Urological Association guideline for the management of clinical T1a enhancing renal mass, partial nephrectomy or nephron sparing surgery is the treatment of choice for the clinical T1a patients who are healthy enough for surgery[2]. Partial nephrectomy preserves patient renal function better than radical nephrectomy[3], whereas oncological outcomes and cancer specific survival of the patients are equal to the patients undergoing radical nephrectomy[4].

There are various factors that potentially affect the success rate of partial nephrectomy such as tumor size, location of tumor and nearness of the collecting system. Hence, R.E.N.A.L. nephrometry score (RNS) was developed in 2009 by Kutikov and Uzzo to evaluate the anatomical complexity of kidney tumor[5]. The R.E.N.A.L. stands for (R)adius; (E)xophytic/endophytic growth; (N)earness of the deepest tumor part to collecting system or sinus; (A)nterior/posterior; and (L)ocation relative to the polar line. RNS is scored based on a 1, 2, or 3-point scale. From their report, partial nephrectomy was often performed in the patients who had RNS lower than 9. Furthermore, a recent study also supports that open partial nephrectomy is suitable for the patients with high RNS[6].

RNS is a widely accepted tool for the evaluation of small renal mass before undergoing partial nephrectomy. RNS, however, has not been studied in Thai population. Therefore, we aimed to evaluate the potential benefit of RNS for the prediction of perioperative outcomes of laparoscopic partial nephrectomy (LPN).

Materials and Methods

Patient population

We retrospectively reviewed the data between 2007 and 2013. Inclusion criteria were patients who underwent LPN for the small renal mass and their CT scan or MRI were available for RNS evaluation. Patients with complete imaging information and congenital renal anomalies (eg. horse-shoe kidney, pelvic kidney, etc.) were excluded from the study. The RNS was retrospectively evaluated by a single doctor, a well trained Urology resident, using the criteria as previously described[5]. We analyzed each anatomical parameter of RNS that affected the operative outcomes such as operative time (OT), warm ischemic time (WIT), estimated blood loss (EBL), as well as postoperative complications. The study was approved from the Institutional Review Board of the Faculty of Medicine Ramathibodi Hospital.

Statistical Analysis

The anatomical factors of renal mass and patient demographics were reported with descriptive statistics. The data were analyzed using SPSS version 11. The Fisher's linear discriminant functions and Chi-square test were used to evaluate differences between groups and $P < 0.05$ was considered statistically significant.

Results

Between 2007 and 2013, there were 31 patients with clinical T1 and T2 underwent LPN for renal mass. However, 3 patients were excluded because of incomplete imaging studies; thus, 28 patients were included for analysis. There were 8 (28.6%) male and 20 (71.4%) female patients. Mean age of the patients

Table 1 Characteristics of the patients underwent laparoscopic partial nephrectomy (n=28)

Characteristic	No. (%) or median (range)
Sex	
Male	8 (28.6)
Femal	20 (71.4)
Age (years)	59.6 (40-74)
BMI (kg/m^2)	25.6 (18.1-37)
Chief complaint	
Flank pain	4 (14.3)
Incidental findings	24 (85.7)
Smoking	5 (17.9)
Preoperative diagnosis	
Renal cell carcinoma	14 (50)
Angiomyolipoma	11 (39.3)
Cystic renal cell carcinoma	3 (10.7)
Preoperative creatinine (mg/dL)	0.89 (0.48-1.86)
Postoperative creatinine (mg/dL)	1.05 (0.51-2.0)
Previous surgery	
Open abdominal surgery	11 (39.3)
Laparoscopic abdominal surgery	3 (10.7)
ASA classification	
class 1	3 (10.7)
class 2	11 (39.3)
class 3	14 (50)
Year of surgery	
2008	1 (3.6)
2009	2 (7.2)
2010	2 (7.2)
2011	7 (25)
2012	9 (32)
2013	7 (25)

was 59.6 years old. The chief complaints before LPN treatment were flank pain in 4 patients (14.3%) and incidental findings from routine health check-up in 24 patients (85.7%). Preoperative diagnosis was RCC in 14 cases (50%), angiomyolipoma (AML) in 11 cases (39.3%) and cystic malignancy in 3 cases (10.7%).

Table 2 Underlying diseases of the patients

Underlying diseases	No.
None	1
Hypertension	16
Diabetes mellitus type 2	6
Coronary artery disease	1
Dyslipidemia	12
Pulmonary embolism with on warfarin	1
Deep vein thrombosis with on warfarin	1
Old cerebrovascular disease	1
Allergic rhinitis	1
Obstructive sleep apnea	1
Gout	2
Hepatitis B carrier	1
Benign prostatic hyperplasia	1
Asthma	1
Thyroid goiter	1
Colon cancer	1
Lung cancer	1

Eleven patients (39.3%) had previous open abdominal surgery and 3 patients (10.7%) had previous laparoscopic abdominal surgery. The patient characteristics are summarized in the Table 1 and the underlying diseases of the patients are shown in the Table 2.

The average tumor size was 3.75 cm (range 0.8-8.5 cm). Tumor size was < 4 cm in 18 cases (62.3%), 4-7 cm in 6 cases (21.4%) and > 7 cm in 4 cases (16.3%). The RNS showed low complexity renal mass in 9 cases (32.1%), intermediate complexity in 17 cases (60.7%) and high complexity in 2 cases (7.2%). Anatomical parameters of renal mass are summarized in the Table 3. Intraoperative and postoperative data are shown in the Table 4.

The correlation of renal mass parameters and perioperative outcomes is presented in the Table 5. The anatomical parameters were not significantly correlated with the WIT and OT. The nearness of the

Table 3 Anatomical factors of renal mass

Parameter	No. (%)
Abnormal renal vessel	5 (17.9)
Number of mass	
1	26 (92.8)
2	1 (3.6)
3	1 (3.6)
Side	
Right	15 (53.6)
Left	13 (46.4)
Multiple renal masses	
2 masses	1 (3.6)
3 masses	1 (3.6)
Size	
< 4 cm	18 (62.3)
4-7 cm	6 (21.4)
> 7 cm	4 (16.3)
Growth pattern	
Exophytic ≥ 50%	7 (25)
Exophytic < 50%	21 (75)
Endophytic	0 (0)
Nearness of the collecting system	
> 7 mm	8 (28.6)
4-7 mm	8 (28.6)
< 4 mm	12 (42.8)
Location (anterior/posterior)	
Anterior	19 (67.9)
Posterior	5 (17.8)
Between the anterior and posterior part	4 (14.3)
Location (polar)	
Upper	10 (35.7)
Lower	8 (28.6)
Interpolar	10 (35.7)
Location (medial/lateral)	
Medial	4 (14.3)
Lateral	24 (85.7)
Renal nephrometry score	
Low	9 (32.1)
Intermediate	17 (60.7)
High	2 (7.2)

Table 4 Intraoperative and postoperative data

Variables	No. (%) or median (range)
Clamp renal vessel	
Clamp	21 (75)
Zero	6 (21.4)
No record	1 (3.6)
Warm ischemic time (min)	33.1 (13-76)
Estimate blood loss (mL)	342.9 (50-1500)
Intraoperative complications	8 (28.6)
Blood loss ≥ 500 mL	6 (21.4)
Tear diaphragm	2 (7.2)
Tear pleura	1 (3.6)
Inadequate clamp	1 (3.6)
Slipping of renal vessel	1 (3.6)
Renal vein injury	2 (7.2)
Postoperative complications	
Abdominal hernia	5 (17.9)
Conversions	5 (17.9)
Laparoscopic radical nephrectomy	3 (10.7)
Open partial nephrectomy	1 (3.6)
Laparoscopic hand assist partial nephrectomy	1 (3.6)
Blood transfusion (No. of patients)	3 (10.7)
Operative time (min)	174 (120-300)
Pathology results	
Renal all carcinoma	11 (39.3)
Angiomyolipoma	16 (57.1)
Oncocytoma	1 (3.6)
RCC subtypes	
Clear cell	8 (28.5)
Papillary	1 (3.6)
Chromophobe	1 (3.6)
No report	18 (64.3)
Postoperative NPO time (day)	1.2 (1-2)
Hospital stay (day)	7 (3-14)
Duration of drain (day)	3.9 (0-6)

Table 5 Correlation of renal mass characteristics and perioperative outcomes

	WIT	OT	EBL	Conversion	Intraoperative complications	Postoperative complications
Tumor size	0.35	0.378	0.458	0.393	0.67	0.271
Growth pattern	0.88	0.648	0.669	0.29	0.639	0.574
Nearness of collecting system	0.5	0.219	0.036*	0.8	0.854	0.335
Location anterior/posterior	0.63	0.895	0.853	0.601	0.959	0.448
Polar location	0.45	0.876	0.582	0.25	0.552	0.896
Location medial/lateral	0.31	0.36	0.766	0.135	0.253	0.568
Pathology	0.89	0.69	0.959	0.322	0.678	0.286

*$P < 0.05$

EBL, estimated blood loss; OT, operative time; RNS, R.E.N.A.L. nephrometry score; WIT, warm ischemic time

collecting system parameter was significantly associated with EBL ($P = 0.036$). Lastly, the RNS was not significantly associated with intraoperative and postoperative complications.

A total of 8 (28.6%) intraoperative complications occurred, including intraoperative bleeding (≥ 500 ml) (n = 6) and conversions (n = 5). The reasons for conversion were renal vein injury (n = 2), slipping of lumbar vein clip (n = 1), and inadequate clamp of the renal vessel (n = 1). One case was converted to laparoscopic hand assisted partial nephrectomy, because the liver obscured the laparoscopic view. Incisional hernia occurred in 5 patients. The correlation analysis of the RNS and the intraoperative complications, conversion and postoperative complications is shown in the Table 5. The anatomical parameters of the RNS were not statistically significance associated with intraoperative complications, conversion and postoperative complications.

Discussion

Currently, the standard of care for clinically localized RCC is surgical treatment, preferably with nephron-sparing surgery or partial nephrectomy[2]. Partial nephrectomy results in equal oncologic outcomes when compared to radical nephrectomy with better preservation in renal function[3,7]. Active surveillance and minimally invasive ablative therapy have emerged as potential alternatives to surgery in same selected patients[8].

RNS was developed by Kutikov et al to evaluate the anatomical complexity of the renal mass[5]. This score can be used to predict the perioperative outcomes of LPN. Hayn et al[9] calculated RNS in 141 patients who underwent LPN for the treatment of solitary renal mass. The authors found that the patients with a higher RNS are significantly associated with an increase of EBL, WIT and length of hospital stay[9]. Similarly, the study by Ellison et al[10] has shown the association between the higher RNS and an increase of length of hospital stay, EBL, WIT, and a greater proportion of major complications. These results were also confirmed by the other studies. Rosevear et al[11] found that the patients who developed complications after partial nephrectomy had significantly higher RNS than those who did not have complications. The authors have concluded that RNS can be used to predict complication risks for the patients who are candidate for partial nephrectomy[11].

In this study, we evaluated RNS in the patients

who underwent LPN. We found that the nearness of the collecting system was the only parameter of RNS that is significantly correlated with EBL (P = 0.036). The average EBL was 425 mL when the renal mass located closed to the collecting system (< 4 mm) and the average EBL decreased to 337 ml when the mass located > 4 mm from the collecting system. Our results support the results from the previously published studies that the nearness of the collecting system can be used to predict EBL. Therefore, risk of increased perioperative blood loss should be promptly concerned when the nearness of the collecting system is less than 4 mm.

We found that OT, WIT, postoperative complications as well as surgical conversion could not be predicted by RNS. These results were different from the previous published studies. This could be due to small sample size in this study. Furthermore, most of the patients were in the low and intermediate complexity group. Only 6.4% of the patients had high complexity renal mass. We believe that the perioperative and postoperative outcomes would be significantly correlated with the RNS if we could include more patients with more complexity renal mass in the study.

This study represented the outcomes of the early experience of LPN. However, the results were limited by the retrospective analysis and small sample size.

Conclusion

The nearness of collecting system of renal mass is a useful parameter to predict EBL during LPN. Our study showed the promising correlation between RNS and perioperative outcomes in the early experience of LPN. We suggest surgeons to evaluate all small renal mass patients with RNS before LPN.

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Conflicts of Interest

None.

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Original Articles/นิพนธ์ต้นฉบับ

ปัจจัยทางกายวิภาคของเนื้องอกในไตที่มีผลต่อการรักษาโดยวิธีการส่องกล้องผ่าตัดเนื้อไตออกบางส่วน

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บทคัดย่อ

วัตถุประสงค์: การผ่าตัดเอาเนื้อไตออกบางส่วนเป็นวิธีการใหม่ที่เริ่มได้รับการยอมรับมากขึ้นในการรักษาก้อนที่ไตขนาดเล็ก ปัจจัยที่สำคัญที่สุดที่ส่งผลต่อการทำงานของไตหลังการผ่าตัดคือ warm ischemic time ในการศึกษานี้ต้องการศึกษาถึงปัจจัยทางกายวิภาคของก้อนที่ไตที่อาจส่งผลต่อ warm ischemic time และผลของการผ่าตัดเอาเนื้อไตออกบางส่วนโดยวิธีการส่องกล้อง

วิธีการ: ศึกษาทบทวนเวชระเบียนย้อนหลังในผู้ป่วยทุกรายที่ได้รับการรักษาโดยการส่องกล้องผ่าตัดเอาเนื้อไตออกบางส่วนในโรงพยาบาลรามาธิบดี ตั้งแต่ปี ค.ศ. 2007-2013 โดยเก็บข้อมูลปัจจัยทางกายวิภาคของเนื้องอกที่ไตจากการตรวจเอกซ์เรย์คอมพิวเตอร์หรือเอกซ์เรย์คลื่นแม่เหล็กก่อนการผ่าตัด โดยพิจารณาตามระบบการประเมินก้อนที่ไตขนาดเล็ก R.E.N.A.L. nephrometry scoring system (tumor size, growth pattern, nearness of the collecting system, anterior/posterior, medial/lateral, and polar location) ว่ามีความสัมพันธ์กับ warm ischemic time ระยะเวลาในการผ่าตัดและปริมาณเลือดที่เสียขณะผ่าตัดอย่างไร

ผลการศึกษา: ได้ทำการศึกษาในผู้ป่วยทั้งหมด 28 รายที่รักษาโดยการผ่าตัดเอาเนื้อไตออกบางส่วนระหว่าง ค.ศ. 2007-2013 ขนาดก้อนเนื้องอกเฉลี่ย 3.75 ซม. (0.8-8.5 ซม.) ร้อยละ 62.3 ของก้อนเนื้องอกมีขนาด < 4 ซม. ร้อยละ 21.4 ของก้อนเนื้องอกมีขนาด 4-7 ซม. และร้อยละ 16.3 ของก้อนเนื้องอกมีขนาด > 7 ซม. สำหรับ growth pattern พบว่าร้อยละ 25 ของก้อนเนื้องอกอยู่ตำแหน่งเกินขอบของไต ≥ 50% และมีร้อยละ 75 ของก้อนเนื้องอกอยู่เกินขอบของไต < 50% พบว่าร้อยละ 67.9 ของก้อนเนื้องอกอยู่ทางด้านหน้าของไต ร้อยละ 24.9 ของก้อนเนื้องอกอยู่ทางด้านหลังไต และร้อยละ 14.3 อยู่ระหว่างหน้าและหลังของไต ร้อยละ 35.7 ของก้อนเนื้องอกอยู่ส่วนบนของไต ร้อยละ 28.6 ของก้อนเนื้องอกอยู่ส่วนล่างของไต และร้อยละ 35.7 ของก้อนเนื้องอกอยู่ตำแหน่งตรงกลางไต จากการศึกษาพบว่าปัจจัยทางกายวิภาคของเนื้องอกที่ไต ระยะใกล้ collecting system (nearness of the collecting system) มีผลต่อปริมาณเลือดที่เสียขณะผ่าตัดอย่างมีนัยสำคัญทางสถิติ (*P* value = 0.04) และปัจจัยทางกายวิภาคอื่นๆ ของเนื้องอกที่ไต ไม่สามารถใช้ทำนายเวลาที่ใช้ในการผ่าตัดและ warm ischemic time ได้

สรุป: ระยะใกล้ collecting system ของก้อนเนื้องอกที่ไต เป็นค่าที่สามารถใช้ทำนายปริมาณเลือดที่ออกในขณะทำการผ่าตัดเอาเนื้อไตออกบางส่วนโดยวิธีการส่องกล้อง

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