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Preoperative Risk Factor Analysis of Prolonged Retroperitoneoscopic Radical Nephrectomy

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Background: This study aimed to investigate the preoperative risk factors for prolonged operating time in retroperitoneoscopic radical nephrectomy (RRN) for renal cell carcinoma (RCC).

Methods: We retrospectively reviewed patients treated for RRN between January 2015 and December 2021. Clinical data, including radiological findings such as visceral fat area (VFA), subcutaneous fat area (SFA), and posterior perirenal fat thickness (PFT) were collected. The operating time for RRN was analyzed using univariate and multivariate logistic regression analyses.

Results: A total of 79 patients were included. The median age was 66 (range: 28-88) years and 48 (60.8%) had right-sided tumors. The median tumor size was 52 (range: 12-100) mm. Median BMI, VFA, SFA, and posterior PFT were 22.9 (range: 16.3-42.2) kg/m^2, 102 (range: 14-290) cm^2, 124 (range: 33-530) cm^2, and 6 (range: 1-35) mm. The median operating time was 248 (range: 140-458) min. Univariate logistic regression analyses revealed that a right tumor (p=0.046), tumor size >7 cm (p=0.010), and posterior PFT >25 mm (p=0.006) were preoperative risk factors for prolonged operating time in RRN. Multivariate logistic regression analyses revealed that a posterior PFT of >25 mm was an independent preoperative risk factor for prolonged operating time for RRN (p=0.008, OR: 7.29, 95% CI: 1.69-31.5).

Conclusions: A posterior PFT >25 mm was an independent preoperative risk factor for the operating time of RRN. In RRN, for patients with a posterior PFT >25 mm, surgeons should develop surgical strategies, including the selection of a transperitoneal approach to surgery, to avoid prolonging the operating time. (J Nippon Med Sch 2024; 91: 377–382)

Key words: renal cell carcinoma, retroperitoneoscopic radical nephrectomy, operating time, perirenal fat

Introduction

Laparoscopic radical nephrectomy (LRN) and retroperitoneoscopic radical nephrectomy (RRN) have been performed globally as standard minimally invasive treatments for patients with clinical T1 and selected clinical T2 and T3 renal cell carcinomas (RCC)[1,2]. LRN involves a ventral approach via the peritoneum to reach the kidney, while in RRN a dorsal approach via the retroperitoneum is used (**Fig. 1**). Recently, robot-assisted laparoscopic radical nephrectomy (RARN) is being increasingly performed in various countries[3]. However, the perioperative advantages of RARN over LRN and RRN have not been proven[3], so LRN and RRN still remain as necessary procedures worldwide.

Prolonged surgery is associated with an increased risk of major intra-and postoperative complications such as deep venous thrombosis, pulmonary embolism, and rhabdomyolysis[4,5]. Moreover, a prolonged surgery can cause fatigue in the surgical team, resulting in technical errors[6]. Therefore, it is important for surgeons to identify the preoperative risk factors for prolonged operative times. A high body mass index (BMI) and a large amount

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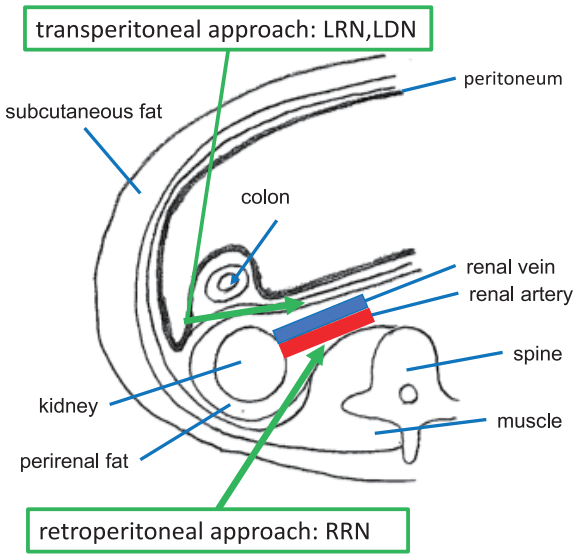

Fig. 1 Methods of LRN and RRN
The green arrows show direction of surgical approach.

of visceral fat have been reported as risk factors for prolonged operating time in LRN[7,8]. However, few studies have been conducted on the risk factors of prolonged operating time for RRN. Therefore, studies on the preoperative factors associated with prolonged operating time for RRN are required.

In our long-term experience with RRN, we have often encountered cases in which a large amount of posterior perirenal fat prevented securing the surgical field during dissection of the renal hilum. Therefore, we hypothesized that the amount of posterior perirenal fat may affect the operative time for RRN. This study aimed to investigate preoperative risk factors for prolonged operative time in RRN.

Materials and Methods

Patient Selection and Clinicopathological Data

We retrospectively reviewed the medical records of consecutive patients with non-metastatic RCC who were treated for RRN at our institution between January 2015 and December 2021. Patients who underwent open conversion were excluded. We collected clinical information including age, sex, BMI, laterality and location of tumors, tumor size, clinical T stage, CT findings associated with fat, presence or absence of ipsilateral adrenalectomy, operative time, number of renal vessels transected at the renal portal, estimated blood loss, and severe intraoperative and postoperative complications. Severe intraoperative and postoperative complications were defined as grade III or higher Clavien-Dindo complications. We also measured time for first-port placement, which was defined as time from incision to the start of pneumoretroperitoneum.

Ethics Committee Approval: This study was conducted in accordance with the principles of the Declaration of Helsinki and was approved by the Ethics Committee of our institution (approval number: 29-11-861). Written informed consent was not obtained from the patients because this was a retrospective study. However, all the patients had the opportunity to opt out.

Surgical Methods

During RRN, the patients were placed in the kidney position. Retroperitoneoscopic procedures were performed according to the standard procedure using four trocars. After the retroperitoneoscopic procedure, a small ipsilateral abdominal incision was made to remove the diseased kidneys. Ipsilateral adrenalectomy is performed when tumors are located near the adrenal gland. At our institution, three experienced surgeons who had performed > 100 retroperitoneoscopic surgeries supervised all RRN procedures and performed a part of the procedure when necessary.

Imaging Evaluation

A board-certificated radiologist (T.S.) with > 15 years of experience in genitourinary radiology, who was blinded to the patients' surgical information, retrospectively analyzed the preoperative images. Clinical T stage was diagnosed using contrast-enhanced CT or MRI. The visceral fat area (VFA) and subcutaneous fat area (SFA) were measured at the level of the umbilicus on preoperative CT using a Synapse Vincent three-dimensional computed tomography (Fujifilm Co. Ltd., Tokyo, Japan) (**Fig. 2**). Posterior perirenal fat thickness (PFT) was measured at the level of the renal vein on preoperative CT, according to the method described by Davidiuk et al.[9] (**Fig. 3**).

Statistical Analysis

Statistical analyses were performed using JMP® 16 (SAS Institute Inc., Cary, NC, USA). Statistical significance was set at $p<0.05$. Continuous variables were analyzed using the t-test or Mann-Whitney U test, depending on the results of the one-sample Kolmogorov-Smirnov test. Univariate and multivariate analyses were performed using a logistic regression model to determine independent factors predicting prolonged operating times for RRN. The cutoff value for the operating times of the RRN was defined as the median operating time. To identify independent preoperative factors predicting prolonged operating times of RRN, factors of age (>65 years vs. 65≤ years), sex, BMI (>25 kg/m^2 vs. ≤25 kg/m^2), laterality, tumor size (>7 cm vs. ≤7 cm), clinical T stage (3a

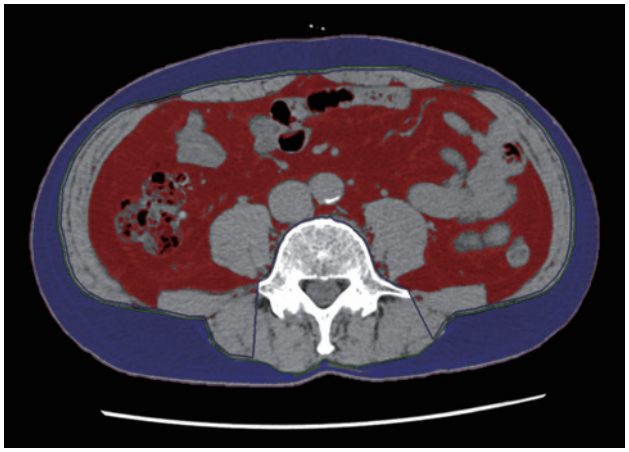

Fig. 2 Method of measuring VFA and SFA on CT
The VFA and SFA were measured at the level of the umbilicus on preoperative CT. The red and blue areas indicate the VFA and SFA, respectively. VFA, visceral fat area; SFA, subcutaneous fat area

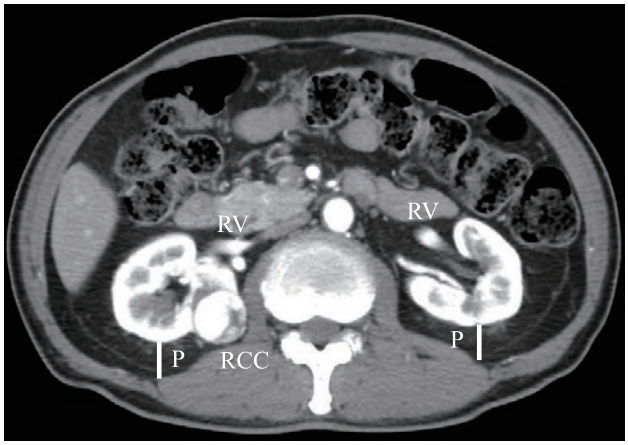

Fig. 3 Method of measuring posterior PFT
Posterior PFT was measured at the renal vein on preoperative CT.
P: posterior PFT, RV: renal vein, RCC: renal cell carcinoma

vs. ≤2a), SFA (>150 cm^2 vs. ≤150 cm^2), VFA (>150 cm^2 vs. ≤150 cm^2), and posterior PFT (>25 mm vs. ≤25 mm) were included.

Results

Patient Population

A total of 81 patients were treated with RRN. Two patients converted to open surgery due to massive intraoperative hemorrhage were excluded from this study. Ultimately, 79 patients were included.

The median age of the patients was 66 years (range, 28-88). Of the 79 patients, 48 (60.8%) had tumors on the right side. The median tumor size was 52 (range: 12-100) mm. The median BMI, VFA, SFA, and posterior PFT were 22.9 (range: 16.3-42.2) kg/m^2, 102 (range: 14-290) cm^2, 124 (range: 33-530) cm^2, and 6 (range: 1-35) mm, respectively. Of the 79 patients, seven (8.9%) underwent ipsilateral adrenalectomy (**Table 1**). Thirteen surgeons participated in RRN. The median operating time was 248 minutes (range: 140-458). The median time for first-port placement was 21 minutes (range: 7-35). The median number of renal vessels transected at the renal portal was 2 (range: 2-6). The median amount of intraoperative bleeding was 10 (range: 5-483) mL. All patients underwent RRN without major intraoperative complications or transfusions. One patient developed postoperative rhabdomyolysis but recovered without any need of surgical intervention or hemodialysis.

Evaluation of Risk Factors of Prolonged Operating Time of RRN

Univariate logistic regression analyses revealed that a right tumor (p=0.046), tumor size >7 cm (p=0.010), and posterior PFT >25 mm (p=0.006) were preoperative risk factors for prolonged operating time in RRN. Multivariate logistic regression analyses revealed that a posterior PFT >25 mm was an independent preoperative risk factor for prolonged operating time of RRN (p=0.008, OR: 7.29, 95% CI: 1.69-31.5) (**Table 2**). In addition, there was no significant difference in the estimated blood loss between patients with a posterior PFT >25 mm and those with a posterior PFT ≤25 mm (p=0.154). No intraoperative or postoperative complications of Clavien-Dindo grade III or higher were observed in either the posterior PFT >25 mm group or posterior PFT ≤25 mm group.

Discussion

We have previously reported that a heavy surgical specimen is a factor in prolonging the operating time in RRN[10]. However, information about the weight of the surgical specimen is only obtained postoperatively, so we investigated preoperative factors in the present study. As a result, we revealed that thicker posterior perirenal fat is a preoperative factor in prolonging operating time.

The surgical procedures for laparoscopic donor nephrectomy (LDN) and LRN are almost the same. In LDN, Anderson et al.[11] reported that it is not the amount of abdominal wall fat that increases the operating time of LDN, but rather the perirenal fat, particularly the anterior perirenal fat, that is most closely associated with operating time. They speculated that once the surgeon enters the abdominal cavity, the amount of abdominal wall fat should have minimal effect on the surgery, whereas the amount of fat around the kidney obscures anatomic

Table 1 Patient characteristics

Variables		n=79 (%)
Age (years)	Medinan (IQR 25-75)	66 (52-75)
Gender	Male/female	48 (70.8)/31 (39.2)
BMI (kg/m^2)	Medinan (IQR 25-75)	22.9 (21.0-25.5)
Laterality	Right/left	48 (70.8)/31 (39.2)
Tumor location	Posterior/anterior	38 (48.1)/41 (51.9)
Tumor size	>7 cm/≤7 cm	20 (25.3)/59 (74.7)
clinical T stage	cT1a	19 (24.1)
	cT1b	23 (29.1)
	cT2a	7 (8.8)
	cT2b	0 (0)
	cT3a	30 (38.0)
VFA (cm^2)	Medinan (IQR 25-75)	102 (63-151)
SFA (cm^2)	Medinan (IQR 25-75)	124 (80-152)
Posterior PFT	Medinan (IQR 25-75)	6 (3-12)
Ipsilateral adrenalectomy	(+)/(–)	7 (8.9) /72 (91.1)
Time for first port placement (min)	Medinan (IQR 25-75)	21 (16-26)
Operating time (min)	Medinan (IQR 25-75)	239 (215-284)
Number of renal vessels transected at the renal portal		2 (2-3)
Intraoperative bleeding (mL)	Medinan (IQR 25-75)	15 (10-60)
Grade III or higher of Clavien-Dindo complications		0 (0.0)

IQR: interquartile range, BMI: Body mass index, VFA: visceral fat area, SFA: subcutaneous fat area, PFT: perirenal fat thickness

Table 2 Univariate and multivariate logistic regression analysis on preoperative factors of prolonged operating time

	Operating time			
	Univariate	Multivariate		
	P-value	OR	95% CI	P-value
Age (years)>65	0.301			
Man	0.435			
BMI (kg/m^2)>25	0.750			
Right tumor	*0.046	1.62	0.59-4.44	0.347
Posterior tumor	0.914			
Tumor size>7 cm	*0.010	1.91	0.63-5.77	0.250
cT3a	0.335			
VFA>150 cm^2	0.678			
SFA>150 cm^2	0.415			
Posterior PFT>25 mm	*0.006	7.29	1.69-31.5	*0.008
>2 renal vessels transected	0.069			
Ipsilateral adrenalectomy (+)	0.242			

BMI: Body mass index, OR: Odds ratio, CI: Confidence interval, VFA: visceral fat area, SFA: subcutaneous fat area, PFT: perirenal fat thickness, *p<0.05

landmarks and makes it more difficult to identify the renal vessels and their tributaries[11]. Dissection of the renal hilum is time-consuming because it includes the identification and dissection of renal vessels, which require careful surgical manipulation. It is reasonable to assume that the amount of perirenal fat present on the side to be dissected could affect the operating time during renal vessel dissection, a procedure that requires careful surgical maneuvers. However, no studies have investigated the effect of perirenal fat on the operating time for LRN or RRN. To the best of our knowledge, this is the first study to investigate the association between perirenal fat and operative time in RRN.

In the present study, a posterior PFT >25 mm was an

independent preoperative risk factor for prolonged operative time in RRN. The working space of RRN is generally narrow. However, in obese patients, RRN avoids the thick subcutaneous and visceral fat in the abdomen[12]. This study showed that BMI, VFA, and SFA did not significantly affect the operative time for RRN. VFA reflects the amount of visceral fat in the abdominal cavity (**Fig. 2**). In RRN, the retroperitoneal cavity is the working space; therefore, the amount of visceral fat in the abdominal cavity has little effect on the surgical procedure. SFA reflects the amount of subcutaneous fat (**Fig. 2**). The amount of subcutaneous fat may affect the process of first-port placement in RRN, but since this placement accounts for only a small percentage of the total operating time (**Table 1**), SFA has little effect on operating time. In RRN, dissection of the renal hilum requires careful surgical manipulation. During dissection of the renal hilum, the posterior perirenal fat was retracted to the lateral side using a retractor. A large amount of posterior perirenal fat can prevent the surgical field of the renal hilum from being secured, resulting in difficulty in identifying and dissecting the renal vessels. The present study showed that the number of renal vessels transected at the renal portal is not a significant risk factor for prolonged operating time, while posterior PFT had more impact on the operating time than the number of renal vessels transected at the renal portal. Anderson et al.[11] reported that in LDN, anterior PFT correlated more strongly with operating time than posterior PFT. They mentioned that the amount of anterior perirenal fat obscures anatomic landmarks and makes it more difficult to identify the renal vessels and their tributaries, resulting in longer operative time. The surgical procedures for LDN and LRN are almost the same. From the results of this previous study[11] and the present study, it is reasonable to conclude that the presence of a large amount of perirenal fat on the side of the renal hilum to be dissected prevents securing of the surgical field and results in a prolonged operating time. In terms of operative time, it might be appropriate to select LRN or RRN depending on the anterior and posterior PFT. The present study had several limitations. This study was conducted at a single institution. Therefore, the cohort size in this study was small. Because the study was a retrospective analysis, there might have been a selection bias for surgeons. Ten inexperienced surgeons participated in RRN. This may have affected the operating times. However, three experienced surgeons supervised all RRN procedures and performed parts of the procedure when necessary. Therefore, we believe that the selection of surgeons did not strongly affect the ranking of the operating times. In the present study, there was no significant increase in blood loss or intraoperative complications in the patients with a posterior PFT>25 mm compared to the patients with posterior PFT ≤25 mm. However, no definitive conclusions could be drawn because of the small cohort size in this study and the extremely small number of RRN complications at our institution. Therefore, further studies with larger cohorts are required to determine the impact of thick posterior PFT on intraoperative and postoperative complications.

In conclusion, a posterior PFT>25 mm was an independent preoperative risk factor for the operating time of RRN. In RRN, for patients with a posterior PFT>25 mm, surgeons should develop surgical strategies, including the selection of a transperitoneal approach to surgery, to avoid prolonging the operating time.

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Conflict of Interest: The authors have no conflicts of interest to declare.

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