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Original Article

Application of modified R.E.N.A.L. nephrometry score system in evaluating the retroperitoneal partial nephrectomy for T1 renal cell carcinoma

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Abstract: Objective: This study aims to investigate the application of the modified R.E.N.A.L. nephrometry score system in evaluating the operation difficulty of retroperitoneal partial nephrectomy in T1 renal cell carcinoma patients. Methods: A total of 52 patients with T1 renal cell carcinoma were enrolled. They all had retroperitoneal partial nephrectomy. Their clinical data was retrospectively analyzed. R.E.N.A.L. nephrometry score system was modified based on the features of retroperitoneal partial nephrectomy. The specificity, sensitivity and Youden index were compared between R.E.N.A.L. nephrometry score system and the modified R.E.N.A.L. nephrometry score system. The effect of the modified R.E.N.A.L. nephrometry score system on perioperative outcomes was analyzed. Results: Three degrees of operation difficulty were defined by the modified R.E.N.A.L. nephrometry score system, which included the low, medium and high degree of operation difficulty. The specificity, sensitivity and Youden index of the modified R.E.N.A.L. nephrometry score system were better than those of the original R.E.N.A.L. nephrometry score system. Compared with low degree of operation difficulty, patients with medium and high degree of operation difficulty had significantly higher levels of operative time, warm ischemia time, and intraoperative blood loss ($P < 0.05$). And, the levels of operative time, warm ischemia time, and intraoperative blood loss in patients with high degree were significantly higher than those in patients with medium degree ($P < 0.05$). Conclusions: The modified R.E.N.A.L. nephrometry score system has a good effect in evaluating the operation difficulty of retroperitoneal partial nephrectomy.

Keywords: T1 renal cell carcinoma, retroperitoneoscopy, partial nephrectomy, modified R.E.N.A.L. nephrometry score system

Introduction

Retroperitoneal partial nephrectomy has many advantages, such as shorter hospital stay, shorter healing time, less postoperative pain, reduced use of analgesic drugs, and better incision appearance, compared with traditional surgery [1, 2]. It is considered to be the preferred method for treating renal tumors. EUA guidelines on renal cell carcinoma in 2010 [3] suggest that partial nephrectomy is a gold standard for the treatment of T1a renal cell carcinoma and that partial nephrectomy should be performed under peritoneoscope. Retroperitoneal partial nephrectomy is also recommended for the treatment of T1b renal cell carcinoma. Studies have reported that the retroperitoneal partial nephrectomy has achieved good efficacy in treating T1 renal cell carcinoma [4, 5]. However, due to different tumor location, the degree of difficulty of each procedure is also different.

R.E.N.A.L. nephrometry score system was first introduced by Kutikov et al [6] in 2009. It is a reproducible standardized classification system that quantitates the salient anatomy of renal tumors and evaluates renal tumors preoperatively. In R.E.N.A.L. nephrometry score system, the following parameters are used: tumor location (ventral/dorsal), tumor relationship with the veins in the renal hilum, tumor location relative to the longitudinal axis of kidneys, exophytic/endophytic properties of the tumor, maximum tumor diameter, and nearness of tumor deepest portion to the collecting system or

sinus. According to the scores, the degree of difficulty of operation for renal tumors is divided into three levels of low complexity, moderate complexity, and high complexity. The variables in this system are simple. Tumor scores can be evaluated based on CT or magnetic resonance imaging examination of patients preoperatively. Thus, the difficulty of operation can be graded accordingly. Studies have shown that R.E.N.A.L. nephrometry score system is closely related with the choice of surgical approach, intraoperative warm ischemia time, radical treatment, and perioperative outcomes [7-10]. However, Mufarrij et al [11] reported that nephrometry-graded tumor complexity was not related to surgical outcomes of patients underwent robot-assisted partial nephrectomy, suggesting that the nephrometry system may be not suitable for predicting surgical outcomes.

In clinics, we observed that there were limitations in R.E.N.A.L. nephrometry score system for evaluating T1 renal cell carcinoma preoperatively. Therefore, based on the anatomical characteristics of retroperitoneal partial nephrectomy and years of clinical experience, R.E.N.A.L. nephrometry score system was modified in this study. And, the efficacies of R.E.N.A.L. nephrometry score system and modified R.E.N.A.L. nephrometry score system were compared.

Materials and methods

Clinical data

A total of 52 cases of patients with T1 renal cell carcinoma admitted to Department of Urology, First Affiliated Hospital, School of Medicine, Shihezi University during the period from Jan 2007 to Mar 2014 were enrolled in this study. They underwent retroperitoneal partial nephrectomy performed by the same group of surgeons. There were 27 male cases and 25 female cases. Their average age was 54.3 ± 12.0 years old. Preoperatively, 18 cases of patients had mild hypertension and diabetes. No subject had severe underlying disease. The preoperative and postoperative creatinine values were normal. The average body mass index (BMI) value was 25.8 ± 3.8 kg/m^2. The information, including the patient's medical history, preoperative imaging data, operation time, warm ischemia time, intraoperative blood loss, postoperative complications, length of hospital stay, was collected. The imaging data was analyzed by a professional radiology physician.

Prior written and informed consent were obtained from every patient and the study was approved by the ethics review board of Shihezi University.

Difficulty of operation evaluated by operation time and warm ischemia time

According to the operation time and warm ischemia time, the difficulty of operation was divided into low degree of operation difficulty, medium degree of operation difficulty, and high degree of operation difficulty. The criteria were as follows. Low degree of operation difficulty was defined as operative time ≤ 90 min and/or warm ischemia time ≤ 15 min. Medium degree of operation difficulty was defined as 90 min < operative time ≤ 120 min and/or 15 min < warm ischemia time ≤ 25 min. High degree of operation difficulty was defined as operative time > 120 min and/or warm ischemia time > 25 min.

Modified R.E.N.A.L. nephrometry score system

According to the characteristics of retroperitoneal partial nephrectomy, R.E.N.A.L. nephrometry score system was modified in this study. The modified R.E.N.A.L. nephrometry score system was shown in **Table 1**. According to the scores, the degree of operation difficulty was defined as follows. Scores between 7 and 11 were defined as low degree of operation difficulty. Scores between 12 and 16 were defined as medium degree of operation difficulty. Scores between 17 and 21 were defined as high degree of operation difficulty.

Statistical analysis

All data and was analyzed by SPSS17.0 (SPSS Inc., Chicago, Illinois, USA). Measurement data was expressed as mean ± standard deviation (SD) and count data was presented as percentages. Pairwise comparisons of multiple samples were analyzed using SNK test. $P < 0.05$ indicated significant difference.

Results

Patients' general condition and imaging data

To modify the R.E.N.A.L. nephrometry score system, the general condition and imaging data

Table 1. The modified R.E.N.A.L. nephrometry score system

	Sore 1	Score 2	Score 3
Body mass index (BMI)	≤ 24	24 < BMI ≤ 28	> 28
Tumor diameter (d)	≤ 2	2 < d ≤ 4	> 4
Tumor location	Upper polar	Medium polar	Lower polar
Growth properties of tumor	Exophytic properties > 50%	Exophytic properties ≤ 50%	Endophytic properties
Relationship to the collecting system (L)	L ≥ 0.7 cm	0.4 cm ≤ L < 0.7 cm	L < 0.4 cm
Number of renal artery	1	2	3
Degree of exposure under retroperitoneoscopy	At dorsal lateral side of the Brodel line	On the Brodel line	At dorsal medial side of the Brodel line

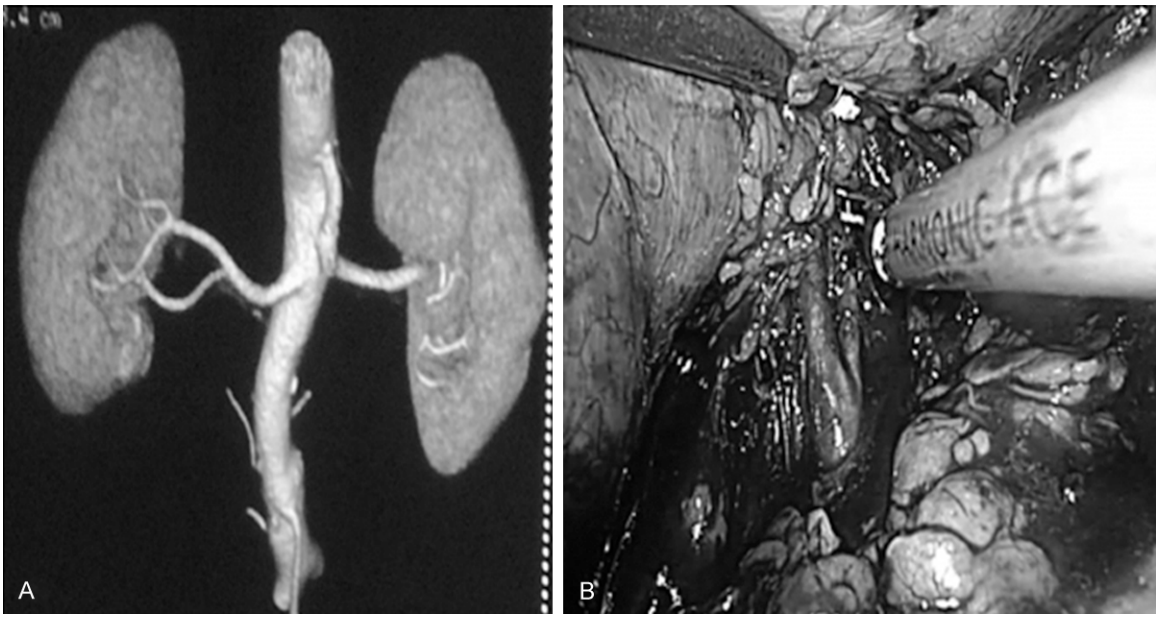

Figure 1. Representative imaging data of patients. A. Preoperative CTA imaging data of one patient. B. Imaging data of one patient during surgery.

Table 2. Evaluation results of operation difficulty

Score system	Number of patients (n)		
	Low degree of operation difficulty	Medium degree of operation difficulty	High degree of operation difficulty
Operation difficulty evaluated with operation time and warm ischemia time	23	21	8
R.E.N.A.L. nephrometry score system	29	22	1
Modified R.E.N.A.L. nephrometry score system	22	20	10

of patients were analyzed. They did not have serious underlying disease. And, the creatinine values were normal. The average BMI was 24.8 ± 4.8 kg/m^2. The average maximum tumor diameter was 3.4 ± 1.2 cm. The average closest distance from tumor margin to the collection system was 5.0 ± 2.3 mm. After operation, the mean hospitalization time was 6.5 ± 1.5 day. There was leakage of urine in 1 patient. After drainage with ureteral catheter for 7 days, the symptoms disappeared. Postoperative bleeding was observed in 1 patient. This patient was treated with embolization and recovered without serious complications. At the first day after operation, the creatinine values were normal.

The representative imaging data of patients was shown in **Figure 1**. **Figure 1A** showed the preoperative CTA image of one patient. The number and branches of renal arteries were observed on these CTA images. **Figure 1B** showed the isolation of renal arteries in one patient during surgery. The difficulty of surgery was affected by the variations of renal arteries.

Evaluation results of operation difficulty with different score systems

The degree of operation difficulty was evaluated according to operation time and warm ischemia time and with score systems of R.E.N.A.L. and modified R.E.N.A.L. The number of patients with low degree of operation difficulty, medium degree of operation difficulty and high degree of operation difficulty was calculated. The evaluation results were shown in **Table 2**. For evaluation with operation time and warm ischemia time, the number of patients with low, medium and high degree of operation difficulty was 23, 21 and 8. For evaluation with R.E.N.A.L. neph-

Table 3. Comparison between R.E.N.A.L. and modified R.E.N.A.L. nephrometry score system

Score system	Sensitivity			Specificity			Youden index		
	Degree of operation difficulty			Degree of operation difficulty			Degree of operation difficulty		
	Low	Medium	High	Low	Medium	High	Low	Medium	High
R.E.N.A.L. nephrometry score system	100%	57.1%	12.5%	69.7%	67.7%	100%	0.697	0.248	100%
Modified R.E.N.A.L. nephrometry score system	95.5%	90.5%	80%	96.7%	96.7%	93.6%	0.92	0.872	0.736

Table 4. Effect of modified R.E.N.A.L. nephrometry score system on preoperative period outcome

Index	Degree of operation difficulty evaluated by modified R.E.N.A.L. nephrometry score system			F	P
	Low	Medium	High		
Operation time (min)	83.0 ± 5.3	102.5 ± 11.1*	134.1 ± 14.1*,#	79.531	0.000
Warm ischemia time (min)	13.3 ± 0.8	20.0 ± 3.0*	27.9 ± 4.9*,#	92.095	0.000
Blood loss (ml)	73.6 ± 13.0	124.5 ± 11.7*	177.5 ± 11.6*,#	165.212	0.000
Postoperative hospital stays (day)	6.1 ± 0.5	6.8 ± 1.8	6.2 ± 0.4	1.673	0.198

Note: Compared with low degree of operation difficulty, *P < 0.05. Compared with medium degree of operation difficulty, #P < 0.05.

rometry score system, there were 29 patients with low degree, 22 patients with medium degree and 1 patient with high degree. For evaluation with modified R.E.N.A.L. nephrometry score system, 22 patients were with low degree, 20 patients were with medium degree, and 10 patients were with high degree. These results indicate that the evaluation results of modified R.E.N.A.L. nephrometry score system is more similar to those evaluated according to operation time and warm ischemia time.

Comparison between R.E.N.A.L. and modified R.E.N.A.L. nephrometry score systems in sensitivity, specificity and Youden index

To determine the accuracy of score systems in evaluating operation difficulty, the sensitivity, specificity and Youden index were compared between R.E.N.A.L. and modified R.E.N.A.L. nephrometry score systems. As shown in **Table 3**, the specificity, sensitivity and Youden index of the modified R.E.N.A.L. nephrometry score system were better than those of the original R.E.N.A.L. nephrometry score system These results indicate that the modified R.E.N.A.L. nephrometry score system is better than the original R.E.N.A.L. nephrometry score system in sensitivity and specificity of evaluation.

Effect of modified R.E.N.A.L. nephrometry score system on preoperative period outcome

To determine the effect of modified R.E.N.A.L. nephrometry score system on preoperative period outcome, the indexes of operation time, warm ischemia time, blood loss, and postoperative hospital stays were compared among patients with low, medium and high degree of operation degree. As shown in **Table 4**, the indexes of operation time, warm ischemia time, and blood loss were significantly higher in patients with medium degree of operation difficulty than those in patients with low degree of operation difficulty (102.5 ± 11.1 min VS 83.0 ± 5.3 min; 20.0 ± 3.0 min VS 13.3 ± 0.8 min; 124.5 ± 11.7 ml VS 73.6 ± 13.0 ml) (P < 0.05). Compared with patients with low degree of operation difficulty, the indexes of operation time, warm ischemia time, and blood loss were also significantly higher in patients with high degree of operation difficulty (134.1 ± 14.1 min VS 83.0 ± 5.3 min; 27.9 ± 4.9 min VS 13.3 ± 0.8 min; 177.5 ± 11.6 ml VS 73.6 ± 13.0 ml) (P < 0.05). Patients with higher degree of operation difficulty had significantly higher indexes of operation time, warm ischemia time, and blood loss than patients with medium degree of operation difficulty (P < 0.05). There was no significant difference in postoperative hospital stays. These results indicate that the modified R.E.N.A.L. nephrometry score system is better than the original R.E.N.A.L. nephrometry score system in evaluation effects.

Discussion

In this study, according to the characteristics of retroperitoneal partial nephrectomy (such as

anatomical approach and surgical view), we modified the quantization parameters of R.E.N.A.L. nephrometry score system. And, some quantitative indicators showing the unique features of retroperitoneal partial nephrectomy were added. The modified parameters and the reasons underlying these modifications were listed as follows. 1) The maximum diameter of the tumor. Because that the operating space in retroperitoneal partial nephrectomy is very small, the size of the tumor has a great impact on operation difficulty. R.E.N.A.L. nephrometry score system could not effectively reflect the difficulty of operation [2]. Thus, the maximum diameter of the tumor in each degree of operation was lowered. 2) BMI. In clinical practice, we found that the perirenal fat in patients with high BMI was less than that in patients with low BMI. Therefore, in patients with high BMI, the time of dissecting fat and exposing the kidney and renal hilus was relatively longer. And, the exposure was poor, which further increased the operation difficulty and prolonged the operation time. Thus, BMI was included in the modified R.E.N.A.L. nephrometry score system. 3) Number of renal artery. Normally, there is 1 branch of renal artery. However, in some patients, there are 2 or 3 branches of renal artery. Temporary blockage of renal artery is primary to the success of retroperitoneal partial nephrectomy [12-14]. The operation difficulty for patients with variations in renal artery will increase. 4) Tumor location and exposure extent under peritoneoscope. Unlike open surgery, the field of retroperitoneal partial nephrectomy is limited and its viewing angle is fixed. Operation difficulty is significantly affected by tumor location and exposure extent under peritoneoscope [15].

In the present study, operation difficulty was evaluated according to the modified R.E.N.A.L. nephrometry score system. Compared with the original R.E.N.A.L. nephrometry score system, the evaluation results of the modified R.E.N.A.L. nephrometry score system was more consistent with the actual clinical evaluation results. And, the specificity, sensitivity and Youden index of the modified R.E.N.A.L. nephrometry score system were better than those of the original R.E.N.A.L. nephrometry score system. In addition, patients with higher degree of operation difficulty (evaluated by the modified R.E.N.A.L. nephrometry score system) had significantly higher levels of operation time, warm ischemia time, and blood loss.

In conclusion, we consider that the modified R.E.N.A.L. nephrometry score system is suitable for evaluating operation difficulty of retroperitoneal partial nephrectomy in patients with T1 renal cell carcinoma. In the modified R.E.N.A.L. nephrometry score system, the operation difficulty was divided into 3 degrees: low, medium and high. Accurate evaluation of operation difficulty may ensure the safety of patients during surgery and reduce surgical rick and the incidence of medical disputes. However, studies are needed to further verify the effects of the modified R.E.N.A.L. nephrometry score system.

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Disclosure of conflict of interest

None.

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