Can preoperative clinicoradiological parameters predict the difficulty during laparoscopic retroperitoneal simple nephrectomy? – A prospective study

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Abstract

Introduction: Urologists tend to prefer retroperitoneal approach for open nephrectomy and transperitoneal route for laparoscopic nephrectomy. Urologists consider retroperitoneal laparoscopic approach difficult to learn and perform. There is a need to objectively define predictors of difficulty during laparoscopic retroperitoneal simple nephrectomy (LRSN) for the proper preoperative selection. To the best of our knowledge, this is the first study to prospectively assess the factors associated with difficulty during LRSN.

Materials and Methods: All adult patients of nonfunctioning kidneys (due to benign causes) planned for simple nephrectomies from November 2014 to January 2017 were included in the study. Various clinical and radiological parameters were noted along with intraoperative difficulty parameters (difficulty score, total operative time, and estimated blood loss). Renal and perirenal parameters were assessed and noted on computed tomography scan. Difficulty scale was calculated based on the three difficulty parameters and was used to objectively categorize the patients in easy and difficult group.

Results: A total of 44 patients were included in the study. There were 23 patients in Group I (Easy) and 21 patients in Group II (Difficult). Various preoperative clinical and radiological parameters were analyzed and compared between these two groups. History of pyonephrosis and presence of nephrostomy tube were the only two statistically significant factors associated with difficult cases (Group II). None of the factors were statistically significant in multivariate analysis.

Conclusion: Based on the findings of our study, history of pyonephrosis and presence of nephrostomy are the most significant factors predicting difficulty during LRSN.

Keywords: Difficulty, factors, laparoscopic nephrectomy, prediction, retroperitoneal nephrectomy

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INTRODUCTION

Contrary to the practice of performing open renal surgeries through retroperitoneal route, the laparoscopic approaches in urology have remained predominantly transperitoneal.[1] The advantages of remaining in an extraperitoneal space were conveniently overpowered by the ease and familiarity of transperitoneal route because

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laparoscopic renal surgeries developed as an extension of common transperitoneal laparoscopic surgeries. Although retroperitoneoscopy was introduced later, it was considered difficult and never became popular because of small working space and lack of clear-cut anatomical landmarks. Some centers have continued to believe in retroperitoneal approach and have consistently mastered the increasingly complex procedures such as nephroureterectomy,[2] pyeloplasty,[3] and partial nephrectomy.[4]

As laparoscopic nephrectomy is one of the first procedures to be taught in urological training, case selection according to difficulty level is of prime importance. Selecting easier cases during learning phase of retroperitoneoscopic nephrectomy is important to keep the interest in this approach alive, but the difficulty is usually unpredictable. We sought to determine predictors of difficulty during laparoscopic retroperitoneal simple nephrectomy (LRSN).

MATERIALS AND METHODS

All adult patients (>18 years) of nonfunctioning kidneys (due to benign causes) with GFR <10 ml/min planned for simple nephrectomy from November 2014 to January 2017 were included in the study, after taking written informed consent from each patient. Institutional ethical committee approval was taken. Patients with a history of ipsilateral open renal surgery[5] or suspected XGPN[6] or GUTB[7] were excluded from the study.

We assessed the clinical, radiological, and operative parameters (difficulty grade, total operative time, and estimated blood loss [EBL]) of each patient. Renal and perirenal parameters were noted on computed tomography (CT) scan [Table 1 and Figure 1].

Table 1: Renal and perirenal parameters measured by computed tomography scan

Measurements	Definition
Renal size	
AP - Ia	Maximum renal AP diameter at the level of hilum
Transverse - Ib	Maximum renal transverse diameter at the level of hilum
Craniocaudal - Ic	Largest craniocaudal renal distance
Perirenal fat thickness – anterior (IIa)	Distance from the anterior renal capsule to the closest overlying bowel or posterior peritoneum at the level of renal hilum
Perirenal fat thickness – posterior (IIb)	Distance from the posterior renal capsule to the anterior layer of lumbodorsal fascia over psoas or quadratus lumborum muscle at the level of renal hilum
Perirenal fat thickness – lateral (IIc)	Distance from the renal capsule laterally to the inner surface of abdominal wall at the level of renal hilum
Renal hilum thickness (III)	Thickness of renal hilum 2 cm proximal to the level of entry of vessels into the kidney. In gross hydronephrotic kidneys, hilum thickness was measured at a point where renal vessels appeared to be inserting into the kidney
Abdominal wall thickness (lateral)	
Total abdominal wall thickness (IVa)	Thickness at the lateral border of erector spinae muscle at the level of hilum
Subcutaneous (IVb)	Subcutaneous fat thickness at lateral border of erector spinae muscle at the level of hilum
Perirenal fat stranding	

AP: Anteroposterior

Operative technique

LRSN was performed with patient in the lateral decubitus position. Three ports were used routinely with fourth one as and when required. Approximately 2.5 cm–3 cm of incision was given at a point, three fingerbreadths from the renal angle just below the 12th rib near the posterior axillary line. After division of underlying muscles and lumbodorsal fascia, retroperitoneal space was created bluntly using the index finger. Further development of space was done using Gaur's method,[8] that is, with the help of balloon dilator keeping balloon inflated with 400–500 cc saline for approximately 5 min. First, 12-mm port was placed at the renal angle. Second, port-camera (12 mm) was inserted at the initial incision site, and purse-string suture was taken to narrow the incision. A 5-mm port was placed at the anterior-axillary line, in-line with previous two ports. Thereafter, the surgery proceeded in four phases, that is, identification of ureter (Phase I), dissecting vessels at the hilum, clipping, and dividing them (Phase II), freeing the kidney all around (Phase III), and retrieval of kidney (Phase IV).

Dissection of the kidney was done along the Gerota's fascia except at the upper pole where the adrenal gland was left behind. In giant hydronephrotic kidneys, dissection was done along the renal capsule. Retroperitoneal pressures were kept at 15 mmHg during the surgery; higher pressures were sometimes required in cases of giant hydronephrotic kidneys. Giant hydronephrotic kidneys were decompressed when further dissection was not feasible or increased airway pressures were noted by the anesthetist.

Evaluation of operative difficulty

A single surgeon performed all the nephrectomies. An independent observer who was himself well versed with the operative procedure and was blinded to the clinical history and examination of the case along with CT findings, graded the operative difficulty of each phase (difficulty grade)

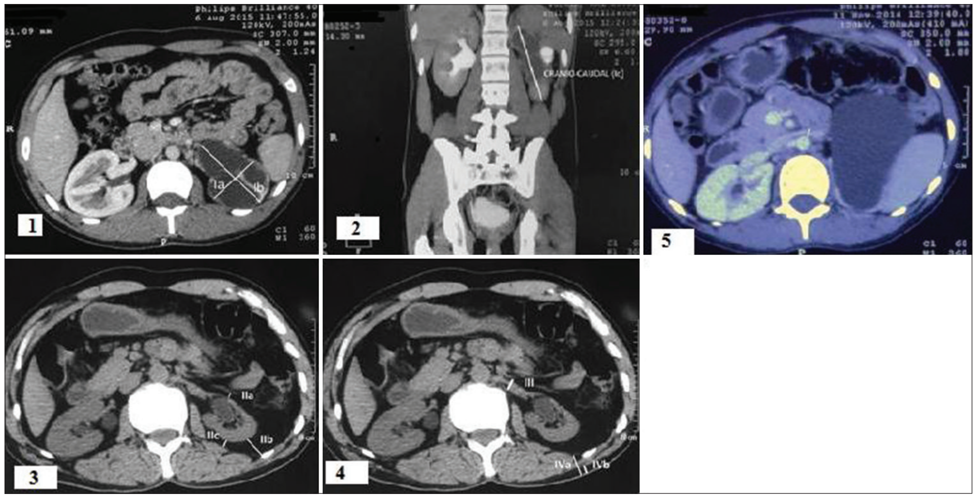

Figure 1: Picture 1. Anteroposterior (Ia) and transverse (Ib) renal size, Picture 2. Craniocaudal renal size (Ic), Picture 3. Perirenal fat thickness: Anterior (IIa), Lateral (IIb), and Posterior (IIc), Picture 4. Hilum thickness (III), Total (IVa) and Subcutaneous (IVb) abdominal wall thickness, Picture 5. Hilum thickness in giant hydronephrosis

on the scale of 1–4 (1-very easy, 2-easy, 3-difficult, and 4-very difficult). Patients who were converted to open were given a score of four for each phase after conversion.

"Difficulty score" was given by adding the difficulty grade of each phase.

Difficulty score (4–16) = Difficulty grade (Phase I [1–4] + Phase II [1–4] + Phase III [1–4] + Phase IV [1–4]).

Total operative time (T_o), EBL, and the need for conversion to open were noted as other surrogate markers for difficulty.

"Difficulty scale" was used to objectively categorize the patients in easy and difficult group. It was calculated based on three parameters, that is, difficulty score, total operative time, and EBL. Each parameter was given points from 1 to 3 depending on the percentile, that is, <25th percentile of the parameter – 1 point, 25th to 75th percentile – 2 points, and >75th percentile – 3 points [Table 2].

Difficulty scale (3–9) = Difficulty score (1–3) + Total operative time (1–3) + EBL (1–3).

Out of total 9 points in difficulty scale, the cases with a total point of 5 or less were included in Group I (easy), and patients with 6–9 total points were included in Group II (difficult).

Statistical analysis

Normally distributed continuous variables were compared using the unpaired *t*-test. Mann–Whitney U-test was used for nonnormally distributed continuous variables. Categorical variables were analyzed using either the Chi-square test or Fisher's exact test. The correlations between continuous variables were investigated by simple regression analyses using Spearman's rank correlation coefficient. Multivariate analysis was done using logistic regression model, or stepwise multiple regression approach was used. Statistical analysis was performed by the SPSS program for Windows, version 17.0 (IBM corporation, NY, USA).

Table 2: Parameters used in evaluating the level of difficulty of operation (difficulty scale)

Difficulty points (1-3)	1	2	3
Difficulty score	5-7	8-10	11-16
Total operative time	<130	130-230	>230
Estimated blood loss	<150	150-400	>400

RESULTS

A total of 64 patients were admitted for simple nephrectomy, out of which 20 patients were excluded (previous open surgery in ten, XGPN in six, and GUTB in four).

Table 3 describes clinical parameters of all the patients. All patients (44) were started laparoscopically.

Difficulty score (subjective parameter) and various other surrogate markers for difficulty such as operative time, EBL, and conversion to open (objective parameters) were analyzed for validation and association with each other [Table 4]. All the variables measured for assessing difficulty were significantly associated with each other indicating the aptness of each factor for assessing the difficulty.

Six patients (13.6%) required conversion to open, five patients due to dense adhesions and inability to progress. Uncontrollable hemorrhage was the reason in one patient.

Table 3: Clinical parameters of patients

Variables	Value
Patients (*n*)	44
Age (mean±SD)	39.2±15.76
Sex (male/female)	21/23
Side (left/right)	23/21
BMI (mean±SD)	24.52±2.88
Disease (stone/nonstone)	24/20
Pyonephrosis (yes/no)	9/35
Nephrostomy tube (yes/no)	10/34

BMI: Body mass index, SD: Standard deviation

Table 4: Correlation of various difficulty parameters with each other

	Difficulty score	Total time	EBL	Conversion to open
Difficulty score				
r	1			
P	-			
Total time				
r	0.800	1		
P	<0.001	-		
EBL				
r	0.635	0.744	1	
P	<0.001	<0.001	-	
Conversion to open				
r	0.602	0.47	0.55	1
P	<0.001	0.001	<0.001	-
Spearman's coefficient				

EBL: Estimated blood loss

Two patients were converted to open in Phase 1, two in Phase 2, one each in Phase 3 and 4.

All the patients were divided into two groups depending on Difficulty scale. There were 23 patients in Group I (Easy) and 21 patients in Group II (Difficult). Various preoperative clinical and radiological parameters were analyzed and compared between these two groups, to evaluate their predictive value in estimating the difficulty during retroperitoneal laparoscopic nephrectomy [Table 5]. History of pyonephrosis and presence of nephrostomy tube were the only two statistically significant factors associated with difficult cases (Group II) in univariate analysis. All factors with $P < 0.1$ were considered for multivariate analysis. None of the factors were statistically significant in multivariate analysis [Table 6].

DISCUSSION

For laparoscopic procedures, many urologists shy away from the retroperitoneal approach, due to its perceived difficulties. For every surgical operation, it is advocated to learn and perform simpler cases first and then endeavor for more difficult cases, hence making categorization of cases as easy or difficult an important aspect in centers imparting training.

Researchers in the past have tried to assess difficulty of a surgical procedure based on clinicoradiological parameters. Laparoscopic cholecystectomy has been the most well-studied surgery in this regard,[9] but there has been a dearth of studies to assess difficulty during laparoscopic nephrectomy and more so in retroperitoneoscopy. In most of the prospective studies on laparoscopic nephrectomy, surgeon's grading of difficulty score is used as end point for assessing intraoperative difficulty.[10] Retrospective studies because of the obvious reason of inability to give surgeon's grading of difficulty score, used surrogate markers of difficulty such as operative duration, EBL and peri-operative complications.[11] To the best of our knowledge, this is the first study to prospectively assess the factors predicting difficulty during LRSN.

Hagiwara *et al*.[12] analyzed the effect of body mass index (BMI) and visceral fat area (VFA) on perioperative outcome on patients undergoing laparoscopic radical nephrectomy and found that high VFA was an independent risk factor for prolonged operative time, whereas BMI was not. There was no significant difference between the BMI of easy and difficult cases. BMI necessarily did not reflect regional body fat distribution, so we also measured total and subcutaneous lateral wall thickness along with perirenal fat distribution (anterior, posterior, and lateral).

In our study, we determined the perirenal fat thickness in three directions anterior, posterior, and lateral. Difficulty scale had almost significant association with anterior ($P = 0.068$) and posterior ($P = 0.056$) perirenal fat thickness; this association may become more significant with increasing number of cases. We had hypothesized that measurement of perirenal parameters would help predict the amount of laparoscopic working space. However, working space also seems to be a function of more complex elements, such as laxity of abdominal musculature as well as anatomy.

Kumazawa *et al*., in their study, retrospectively investigated the association of various obesity indices and intraoperative factors in (transperitoneal or retroperitoneal) laparoscopic donor nephrectomy.[13] Perirenal fat area measured using CT scan imaging, influences operating time and EBL in retroperitoneal approach but not in transperitoneal approach. In a similar study by Akaihata *et al*., anterior perirenal fat distance showed a significant association with operative difficulty during retroperitoneal laparoscopic radical nephrectomy, on both univariate and multivariate analysis.[11]

Dissection at the hilum is the most crucial step during LRSN, thus we included and evaluated hilar thickness as an

Table 5: Univariate analysis of preoperative binary and continuous variables

Variables	*n*	Easy (*n*)	Difficult (*n*)	*P* value#
Sex#				
Male	21	12	9	0.537
Female	23	11	12	
BMI*				
≤25	27	15	12	0.583
>25	17	8	9	
Pyonephrosis*				
No	35	23	12	<0.001
Yes	9	0	9	
PCN tube*				
No	34	22	12	0.003
Yes	10	1	9	
Stone disease*				
No	20	13	7	0.123
Yes	24	10	14	
Side*				
Right	21	10	11	0.555
Left	23	13	10	
Fat stranding*				
No	36	21	15	0.126
Yes	8	2	6	
Variables	**Total (mean±SD)**	**Group I (easy), mean±SD**	**Group II (difficult), mean±SD**	***P* value$**
Age	39.2±15.76	36.86±15.48	41.76±16.04	0.335
Renal size (AP)	7.67±4.74	6.65±4.16	8.77±5.17	0.129
Renal size (CC)	12.08±6.49	11.69±5.06	12.51±7.87	0.751
Renal size (T)	7.55±4.83	7.06±4.54	8.08±5.17	0.431
Perirenal fat thickness anterior	3.08±2.9	2.5±2.80	3.70±2.93	0.068
Perirenal fat thickness Posterior	4.74±3.72	3.50±2.23	6.1±4.53	0.056
Perirenal fat thickness lateral	9.76±7.65	8.33±6.94	11.32±8.23	0.188
Hilum thickness	17.15±5.07	17.39±5.09	16.89±5.14	0.832
Subcutaneous fat thickness	14.84±8.42	13.52±6.40	16.28±10.14	0.48
Total wall thickness	30.05±11.29	30.47±10.80	29.56±12.05	0.86

*Fisher exact test, #Chi-square test, $Mann–Whitney U-test. BMI: Body mass index, SD: Standard deviation, PCN: Percutaneous nephrostomy, AP: Anteroposterior

Table 6: Multivariate analysis

	Beta	*P*
Pyonephrosis	21.927	0.999
Nephrostomy tube	0.024	0.989
Perirenal fat thickness anterior (mm)	0.108	0.488
Perirenal fat thickness posterior (mm)	0.235	0.101

independent parameter for difficulty. We chose a point 2 cm from the entry point of renal vessels in the hilum with the view that vessels are dissected and clipped in approximately this area. This aspect has not been studied before. However, we did not find any significant difference in hilar thickness between easy and difficult groups. In a prospective study earlier, the presence of enlarged hilar lymph nodes also was not associated with increased intraoperative difficulty during nephrectomy.[10]

Laparoscopic nephrectomy for atrophic kidney may be difficult because of dense perinephric adhesions and difficulty in identifying the kidney itself. High rates of blood transfusion (7%–12%) and conversion to open (5%–17%) have been reported.[14-16] Akaihata *et al*. did a retrospective study of 96 patients to assess the preoperative factors affecting operative difficulty during retroperitoneal laparoscopic radical nephrectomy and found that anteroposterior renal diameter was associated significantly with the operative time on univariate analysis, but not on multivariate analysis.[11] In our study, though the patients converted to open had smaller kidneys with mean craniocaudal diameter of 5.9 cm and mean transverse diameter of 3.8 cm, none of the renal size dimensions were significantly different between the two groups.

In this study, history of pyonephrosis came out to be as one of the most important factors predicting difficulty as its presence was significantly associated with higher difficulty scale. More number of patients with the history of pyonephrosis were noted in Group II (difficult cases). In these patients, higher difficulty level could be explained by ill-defined tissue planes and densely adhered kidneys due to infection.

Fat stranding can be easily diagnosed on CT scan and is a sign of chronic inflammation. It is proven to be “sticky fat” during nephrectomy.[17] Fat stranding increases difficulty during LRSN due to difficulty in dissection; however, in our study, it was not found to be associated significantly with difficulty scale. This may be due to less number of cases in our study.

The presence of nephrostomy can lead to dense adhesions and difficulty during perirenal dissection. Shah *et al*. in their prospective study of 77 patients to predict difficulty during transperitoneal nephrectomy found that the presence of nephrostomy was not associated with increased intraoperative difficulty.[10] However, in our study, the presence of nephrostomy was associated significantly with higher difficulty scale as the tract being posteriorly limits the development of initial working space, whereas in transperitoneal approach, it comes off as any other perirenal adhesion toward the end of the procedure.

In our study, we found no association between gender and difficulty scale. This finding is in accordance with the study by Sammon *et al*., who analyzed the effect of gender on complications in open and laparoscopic radical or partial nephrectomy.[18] They found that female patients had higher rates of blood transfusion but significantly lower rates of postoperative complications and in-hospital mortality. No statistically significant differences were recorded when accounting for intraoperative complications and length of stay beyond the median.

No association was found between diseased side with mean operative time and EBL in the study by Akaihata *et al*.[11] Similarly, in our study, the diseased side was not significantly associated with the difficulty scale.

In our study, we did not find any association of patient age with difficulty scale. Similarly, Matin *et al*. in their retrospective study to determine whether age and comorbidity are predictors of outcome in patients undergoing laparoscopic renal and adrenal surgery did not find any significant correlation.[19]

Tepeler *et al*. published their prospective study in 2012, examining the effect of renal calculi as a reason of nonfunctioning kidney on the progress and complication rates of retroperitoneoscopic nephrectomy.[20] They concluded that mean operative time was prolonged due to dense adhesions. In our study, there was no significant association of the renal calculus disease with difficulty scale. This may be due to the more number of cases of infected kidneys in our study nullifying the effect of stone disease on difficulty.

In our study, history of pyonephrosis and presence of nephrostomy came out to be the only two significant preoperative factors predicting difficulty on univariate analysis. On multivariate analysis, none of the factors were significant, which could be because of colinearity between various preoperative parameters.

Limitation of this study is small sample size, which may have underpowered the associations between patient characteristics and intraoperative difficulty parameters. Another limitation of our study was that, being a tertiary government center, we manage wide variety of referred, complicated, and more of difficult cases which may not be representative of the whole population.

CONCLUSION

Based on the findings of our study, history of pyonephrosis and presence of nephrostomy are the most significant factors predicting difficulty during LRSN.

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Conflicts of interest

There are no conflicts of interest.

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