Original Article

Prospective study of preoperative factors predicting intraoperative difficulty during laparoscopic transperitoneal simple nephrectomy

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Abstract

Objective: To prospectively study and identify, the preoperative factors which predict intraoperative difficulty in laparoscopic transperitoneal simple nephrectomy.

Patients and Method: Seventy seven patients (41 males and 36 females) with mean age of 43 ± 17 years, undergoing transperitoneal laparoscopic simple nephrectomy at our institute between February 2012 to May 2013 were included in this study. Preoperative patients' characteristics recorded were: Gender of patients, history of intervention, palpable lump, BMI, urine culture, side, size of kidney, fixity of kidney on USG, perinephric fat stranding on preoperative CT scan, periureteral fat stranding, perinephric collection, enlarged hilar lymph nodes, renal vascular anomalies, differential renal function on renogram. Preoperative factors of these patients were noted and intraoperative difficulty in the surgery was scored between 1 (easiest) to 10 (most difficult or open conversion) by a single surgeon (who was a part of all studies either as operating surgeon or assistant). Using SPSS 15.0 software, multivariate and univariate analysis was done.

Results: In multivariate analysis presence of pyonephrosis on preoperative evaluation and BMI < 25kg/m^2 were found to be statistically significant factors predicting intraoperative difficulty during laparoscopic simple nephrectomy. On univariate analysis following factors were associated with increased surgeon's score: Lower BMI, palpable kidney, pyonephrosis, history of renal intervention, perinephric fat stranding, right side, fixity of kidney on USG with surrounding structures.

Conclusion: Our findings suggest that presence of pyonephrosis as identified on preoperative imaging and a BMI of less than 25 Kg/m^2 are the most significant factors predicting intraoperative difficulty during laparoscopic simple nephrectomy.

Key Words: Factors, intraoperative difficulty, laparoscopic, simple nephrectomy, transperitoneal

INTRODUCTION

In the modern era, minimally invasive surgery has become the

standard of care. Laparoscopy, over time, has gained popularity. Credit of doing first transperitoneal laparoscopic nephrectomy goes to Clayman et al. in 1991.[1] Transperitoneal laparoscopic nephrectomy has gradually gained wide spread acceptance.[2] Laparoscopic nephrectomy has many advantages over open approach, which includes decreased postoperative pain, shorter hospital stay, quicker return to normal activities and improved cosmesis.[3-6]

Laparoscopic nephrectomy has a learning curve ranging from 20 to 50 nephrectomies in various studies.[7-11] Though it is called

simple nephrectomy (due to benign causes of nonfunctioning kidney), it is not always simple. Often it is challenging due to adhesions even in the hands of highly experienced surgeons. As the surgeon ascends the learning curve, it is prudent to select proper cases, which can be completed without complications. At our center, transperitoneal laparoscopy is the preferred approach for any nephrectomy. There is a paucity of literature, which emphasizes preoperative factors, which predict intraoperative difficulty during laparoscopic "simple" nephrectomy. In this prospective study, we aim to identify preoperative factors, which predict intraoperative difficulty during laparoscopic transperitoneal simple nephrectomy.

MATERIALS AND METHODS

The study was conducted at Department of Urology, Muljibhai Patel Urological Hospital, Nadiad, Gujarat, from February 2012 to May 2013. Ethical Committee approval was taken prior to initiation of the study.

Selection of patients
Inclusion criteria
All patients planned for laparoscopic simple nephrectomy (for benign conditions) at Department of Urology, Muljibhai Patel Urological Hospital, Nadiad during the study period were included in this study.

Exclusion criteria
Those patients who refused to give consent for participation in the study were excluded.

The procedure
The approach of choice was transperitoneal in all. A total of 77 patients were included in the study. For all patients relevant preoperative factors were noted. The salient features of the procedure were as follows.

All patients were kept nil by mouth overnight and were given bowel enema on the previous night. Preoperative antibiotic was given.

After general anesthesia and perurethral catheter placement, patients were given lateral position. Three ports were kept, one for camera (12 mm) and two for working instruments. On the right side, in addition, midline 5 mm epigastric port was kept for liver retraction. One 5 mm port was kept in flank (for both sided surgeries) for retraction of ureterogonadal packet and lower pole of the kidney whenever required during the course of surgery. Bowel reflection was done using sharp and blunt dissection. The ureterogonadal packet was lifted up from retroperitoneum and dissection progressed superiorly toward hilum. Upper pole dissection was done to isolate upper pole of kidney from the surrounding region and adrenal gland. Hilar

dissection was done and renal artery (or arteries) and vein (or veins) were dissected with branches or tributaries. Thereafter, the artery and vein were clipped using Hem-o-lok clips (two clips on the patient side and one on specimen side) and cut. All surrounding attachments were freed. Ureter and gonadal vein were clipped and secured. The specimen was entrapped in endogenously made bag. All surgeries were done or assisted by a single surgeon.

After each surgery, the surgeon (single surgeon) Arvind P Ganpule (APG) scored the difficulty during the surgery in the range from 1 (easiest) to 10 (most difficult). This was termed "surgeon's score." Conversion to open surgery was considered score 10 (most difficult).

Statistical analysis
A correlation was sought between the preoperative factors and the surgeon score. In the multivariate analysis the surgeon score was kept as a constant and the following factors were kept as variables: Gender of patients, history of intervention, palpable lump, body mass index (BMI), urine culture, side, size of kidney, fixity of kidney on ultrasonography (USG), perinephric fat stranding on preoperative computed tomography (CT) scan, periureteral fat stranding, perinephric collection, enlarged hilar lymph nodes, renal vascular anomalies, differential renal function on renogram. Multivariate analysis was performed using stepwise multiple regression analysis. Univariate analysis was performed between individual factor and surgeon's score using *t*-test or Chi-square test.

Analysis was done using computer software SPSS 15.0 (IBM corporation, NY, USA) by a bio-statistician.

RESULTS

During the study period total 77 transperitoneal simple nephrectomies were done. All were included in the study.

In four patients, there was conversion to open approach due to dense adhesion leading to nonprogressive laparoscopic dissection and presumed increased risk of injury to surrounding organs by the operating surgeon. All patients with open conversion were given surgeon's score on 10.

Table 1 describes patients' general demography and presence of specific preoperative factors.

In multivariate analysis presence of pyonephrosis on preoperative evaluation and BMI < 25 kg/m² were found to be statistically significant factors predicting intraoperative difficulty during laparoscopic simple nephrectomy. Rest of the factors (as listed below) was not found to be significant in multivariate analysis. Tables 2 and 3 detail the statistical values.

On univariate analysis following factors was associated with increased surgeon's score: Lower BMI, palpable kidney, pyonephrosis, history of renal intervention, perinephric fat stranding, right side, and fixity of kidney on USG with surrounding structures. Table 4 details results of univariate analysis.

DISCUSSION

The term "simple nephrectomy" is a misnomer. The term was presumably coined as such a procedure would not involve removal of the adrenal, extragerotal dissection and lymph nodes as done in radical nephrectomy. In fact, it is a common experience that "simple nephrectomy" in fact turns out to

be challenging. This fact assumes importance for the novice as it would not be prudent for a novice to embark on such a procedure in the initial part of the learning curve.

A total of 77 patients were included in this study. Of 77 patients, 4 required open conversion. In all 4, cause of conversion was nonprogressive dissection and presumed possibility of injury to surrounding structures. Conversion rate (5.19%) is similar to conversion rates of 4-6.1% in various series.[8,12,13]

Of them, 41 were male, while 36 were female patients. In their study Sammon *et al.*[14] in 2012 found in his study there was no difference in intraoperative difficulty during nephrectomy between two sex, but they found increased blood transfusions rates and less chance of postoperative complications and shorter hospital stay in females. Similarly in our study also, no difference was found in intraoperative difficulty between males and females.

Laparoscopic nephrectomy was found feasible and safe in elderly in studies done by Aguilera *et al.*[15] In our study,

Table 1: General demography and preoperative factors

Patients (*n*)	77
Age; years (mean±S.D)	43±17 years
Sex (male/female)	41/36
Side (left/right)	35/32
Previous history of intervention	18
Palpable kidney	11
Flank tenderness	13
Average BMI	22.17±4.41 kg/m²
Average distance between xiphisternum and umbilicus	16.58±1.58 cm
Positive urine culture	18
Positive PCN culture	15 s
Average size of kidney	11.4±4.52 cm
Presence of internal echoes or drainage of pus on nephrostomy placement (pyonephrosis)	19
Absence of movement on USG	33
Perinephric collection	6
Perinephric fat stranding	
Periureteral fat stranding	
Enlarged hilar lymph nodes	9
Renal hilar vascular anomalies	6
Differential split function	6±0.6%

BMI: Body mass index, SD: Standard deviation, PCN: Preoperative percutaneous nephrostomy, USG: Ultrasonography

Table 2a: Results of multivariate analysis

Model	Unstandardized coefficients		Standardized coefficients	*t*	Significant
	Beta	Standard error	Beta		
1 (constant)	0.108	0.060	0.559	1.806	0.077
Pus	0.559	0.121		4.617	0.000
(Constant)	0.203	0.071		2.847	0.007
Pus	0.522	0.117	0.522	4.453	0.000
BMI	0.235	0.105	−0.263	−2.244	0.030

BMI: Body mass index

Table 2b: Results of multivariate analysis

Model	95% confidence interval for beta	
	Lower bound	Upper bound
(Constant)	−0.012	0.229
Pus	0.315	0.802
(Constant)	0.060	0.347
Pus	0.286	0.758
BMI	−0.445	−0.024

BMI: Body mass index

Table 3: Multivariate analysis-factors not found to be significant

Factor	*P* value
Gender	0.897
History of intervention	0.597
Palpable lump	0.915
Urine culture	0.648
Side	0.242
Size of kidney	0.592
Fixity of kidney on USG	0.255
Perinephric fat stranding on CT	0.256
Periureteral fat stranding	0.433
Perinephric collection	0.078
Enlarged hilar lymph nodes	0.119
Renal vascular anomalies	0.080
Differential split function on renogram	0.639

USG: Ultrasonography, CT: Computed tomography

Table 4: Results of univariate analysis

Preoperative factor (X)	Average surgeon's score in patients with X	Average surgeon's score in patients without X	*P* value
Gender	3.93±2.42 (males)	4.53±2.55 (females)	0.822
h/o intervention	5.13±2.83	3.81±2.23	0.021
Pyonephrosis	6.86±2.37	3.21±1.67	0.034
Palpable lump	5.09±3.59	4.06±2.52	0.002
BMI≥25 kg/m²	3.46±1.86	4.55±2.66	0.021
Positive urine culture	5.06±2.69	3.95±2.38	0.404
Preoperative nephrostomy	4.3±2.56	3.85±2.28	0.33
Positive PCN fluid culture	5.0±2.97	3.14±2.06	0.192
Side	4.55±2.65	3.8±2.23	0.037
Size of kidney (≥15 cm)	3.31±2.69	4.39±2.42	0.969
Fixity of kidney	5.82±2.53	3.0±1.63	<0.001
Perinephric fat stranding	6.18±2.64	3.08±1.51	<0.001
Perinephric collection	7.83±3.13	3.9±2.19	0.387
Periureteral fat stranding	3.73±2.53	4.29±2.49	0.774
Enlarged hilar lymph nodes	5.11±2.85	4.09±2.43	0.413
Renal vascular anomalies	6.33±3.26	4.03±2.33	0.246

BMI: Body mass index, PCN: Preoperative percutaneous nephrostomy

statistically no difference was found in surgeons score of all ages ($P = 0.407$). Hence, age is not found to have any effect in intraoperative difficulty during laparoscopic simple nephrectomy in our study.

In a study by Parson *et al.*,[16] it was seen that prior abdominal surgery is not associated with any increase in intraoperative blood loss, conversion to open or rate of operative complications. In this study, history of prior renal surgery was present in 18 patients. Some patients had more than one surgery in the past. Prior renal surgery was associated with higher surgeon's score on univariate analysis, but not in multivariate analysis.

In this study, there were 19 patients who had a fever on presentation. Fever may be an indicator of pyelonephritis, but was not found to be important on analysis.

In the study by Lipke *et al.*[17] it was shown that larger specimen size (>3500 g) was associated with a higher likelihood of open conversion. In this study, 11 patients had palpable mass preoperatively. Average surgeon's score in patients with palpable kidney was significantly higher in patients with palpable kidney than in patient without palpable kidney in univariate analysis but not in multivariate analysis.

In this study, flank tenderness was present in 13 patients and was not found to be statistically significant for intraoperative difficulty.

In clinical practice of our institute, senior consultants have found distance between the umbilicus and xiphisternum may be an important factor during laparoscopic nephrectomy especially for assessment of upper pole dissection. On statistical analysis though it was not found to be a significant factor ($P = 0.079$).

Obesity was initially considered to be a relative contraindication for transperitoneal nephrectomy, but it is proven to be feasible now. Lafranca *et al.*[18] have shown that higher BMI of > 29.9 kg/m^2 is associated with increased duration of surgery, increased chance of conversion and greater rise in s creatinine in live donor nephrectomies. In study[19] by Kumazawa *et al.* visceral obesity was not associated with an increase in any intraoperative adverse event. In our study, average BMI was 22.68 ± 4.41 kg/m^2 (13.95-32.76). On using Chi-square test and comparing surgeon's scores of patients with BMI ≥ 25 kg/m^2 and < 25 kg/m^2, surgeon's score was less (3.46 ± 1.86) in patients with higher BMI than in patients with less BMI (4.55 ± 2.66), with $P = 0.021$. On multivatiate analysis also it was found to be significant ($P = 0.030$). In clinical practice also, senior consultants at our institute have found that dissection of correct planes is more difficult in

thin patients than in obese patients. However, this finding will require further confirmation as patient with highest BMI in this study is 32.76 kg/m^2.

Though positive preoperative urine culture is associated with increased conversion rates in past,[20] but it was not found to be a significant factor in our study.

Preoperative percutaneous nephrostomy (PCN) was placed in 27 patients before nephrectomy for pyonephrosis or for large sized kidney, and it was not associated with increased intraoperative difficulty.

Size of the kidney is shown to affect intraoperative difficulty. In the study by Lipke *et al.*[17] it was shown that larger specimen size (>3500 g) was associated with a higher likelihood of open conversion. In our study size of the kidney was not found to be a significant factor in both univariate ($P = 0.225$).

In our study, we found that the presence of pyonephrosis in 19 patients. Pyonephrosis, detected by the presence of echogenic material in pelvicalyceal system of hydronephrotic kidney or by drainage of pus on PCN placement, was associated with higher surgeon's score (6.86 ± 2.37), than in patients without pyonephrosis (3.21 ± 1.67). This difference was found to be significant in both univariate ($P = 0.034$) and multivariate ($P < 0.001$) analysis. In this study, presence of pyonephrosis was the most important factor associated with difficulty in laparoscopic transperitoneal simple nephrectomy.

Fixity of kidney on ultrasound (as evident by the absence of movements of kidney with respiration) was not a significant factor predictive of intraoperative difficulty.

Perinephric fat standing, described on CT scan is a sign of chronic inflammation.[21] It is proven to be predictive of sticky fat during nephrectomy.[22] Surgeon's score were found to b higher in 28 patients with perinephric fat stranding than those without it in this study. The difference was statistically significant in univariate analysis, but not in multivariate analysis.

Periureteral fat stranding (found in 11 patients) was not a significant factor.

Renal hilar vascular anomalies were detected in six patients on preoperative imaging. Presence of hilar vascular anomaly was not associated with any increase in difficulty of laparoscopic nephrectomy.

Enlarged hilar lymphnodes were present in nine patients in this study. In this study, there was no difference between scores of patients with (5.11 ± 2.85) and without (4.09 ± 2.43)

enlarged hilar lymphnodes ($P = 0.413$). Hence, presence of enlarged hilar lymphnodes was not associated with increased intraoperative difficulty during nephrectomy.

Perinephric collection was found in five patients. Average surgeon's score was higher (7.8 ± 3.49) in patients with a collection than without collection (3.96 ± 2.22). Scores were not different in patients with or without perinephric collection ($P = 0.168$). So presence of perinephric collection was not associated with increased intraoperative difficulty in nephrectomy.

Renogram split function value of >10 mL/min was associated with higher rates of failure of transperitoneal laparoscopic nepherectomy in the study by Shoma *et al.*[20] In our study, we did not find any difference between the scores of patients with various split function on statistical analysis ($P = 0.558$).

In a similar study by Shoma *et al.*,[20] which was published in 2004, it was shown that for laparoscopic transperitoneal nephrectomy had more chance of failure (conversion) in the presence of positive urine culture, renographic clearance of the removed kidney (>10 mL/min), and learning curve. In comparison we found that on multivariate analysis presence of pyonephrosis and BMI < 25 kg/m² were predictive of more difficulty in laparoscopic transperitoneal simple nephrectomy.

To summarize, on univariate analysis following factors were associated with increased surgeon's score: Lower BMI, palpable kidney, pyonephrosis, history of renal intervention, perinephric fat stranding, right side, and fixity of kidney on USG with surrounding structures.

On multivariate analysis using multiple regression analysis, it was found that among all factors, two factors were associates with significantly higher surgeon's scores. These factors were the presence of pyonephrosis and BMI of < 25 kg/m².

Multivariate analysis results had better clinical correlation. In addition, multivariate analysis is considered to be more reliable than univariate analysis as it takes in to consideration effect of all factors simultaneously. Hence, we decided to conclude our study based on multivariate analysis results.

The findings of this study have following clinical implications:
1. It is well-known that laparoscopic nephrectomy has a learning curve
2. The novice surgeon needs to identify cases beforehand, which can be completed successfully without complications using laparoscopic approach
3. Identification of factors which predict difficulty during

laparoscopic transperitoneal simple nephrectomy will help decision making in such situation.

CONCLUSION

Our findings suggest that the presence of pyonephrosis as identified on preoperative imaging and a BMI of < 25 kg/m² are the most significant factors predicting intraoperative difficulty during laparoscopic simple nephrectomy.

REFERENCES

1. Clayman RV, Kavoussi LR, Soper NJ, Dierks SM, Meretyk S, Darcy MD, *et al*. Laparoscopic nephrectomy: Initial case report. J Urol 1991;146:278-82.
2. Eraky I, el-Kappany H, Shamaa MA, Ghoneim MA. Laparoscopic nephrectomy: An established routine procedure. J Endourol 1994;8:275-8.
3. Dunn MD, Portis AJ, Shalhav AL, Elbahnasy AM, Heidorn C, McDougall EM, *et al*. Laparoscopic versus open radical nephrectomy: A 9-year experience. J Urol 2000;164:1153-9.
4. McDougall E, Clayman RV, Elashry OM. Laparoscopic radical nephrectomy for renal tumor: The Washington University experience. J Urol 1996;155:1180-5.
5. Shalhav AL, Dunn MD, Portis AJ, Elbahnasy AM, McDougall EM, Clayman RV. Laparoscopic nephroureterectomy for upper tract transitional cell cancer: The Washington University experience. J Urol 2000;163:1100-4.
6. Kercher KW, Heniford BT, Matthews BD, Smith TI, Lincourt AE, Hayes DH, *et al*. Laparoscopic versus open nephrectomy in 210 consecutive patients: Outcomes, cost, and changes in practice patterns. Surg Endosc 2003;17:1889-95.
7. Fahlenkamp D, Rassweiler J, Fornara P, Frede T, Loening SA. Complications of laparoscopic procedures in urology: Experience with 2,407 procedures at 4 German centers. J Urol 1999;162:765-70.
8. Gill IS, Kavoussi LR, Clayman RV, Ehrlich R, Evans R, Fuchs G, *et al*. Complications of laparoscopic nephrectomy in 185 patients: A multi-institutional review. J Urol 1995;154:479-83.
9. Rassweiler J, Fornara P, Weber M, Janetschek G, Fahlenkamp D, Henkel T, *et al*. Laparoscopic nephrectomy: The experience of the laparoscopy working group of the German Urologic Association. J Urol 1998;160:18-21.
10. Keeley FX, Tolley DA. A review of our first 100 cases of laparoscopic nephrectomy: Defining risk factors for complications. Br J Urol 1998;82:615-8.
11. Kanno T, Shichiri Y, Oida T, Kanamaru H, Takao N, Shimizu Y. Complications and the learning curve for a laparoscopic nephrectomy at a single institution. Int J Urol 2006;13:101-4.
12. Simon SD, Castle EP, Ferrigni RG, Lamm DL, Swanson SK, Novicki DE, *et al*. Complications of laparoscopic nephrectomy: The Mayo clinic experience. J Urol 2004;171:1447-50.
13. Siqueira TM Jr, Kuo RL, Gardner TA, Paterson RF, Stevens LH, Lingeman JE, *et al*. Major complications in 213 laparoscopic nephrectomy cases: The Indianapolis experience. J Urol 2002;168:1361-5.
14. Sammon J, Trinh QD, Sun M, Bianchi M, Schmitges J, Shariat SF, *et al*. The effect of gender on nephrectomy perioperative outcomes: A national survey. Can J Urol 2012;19:6337-44.
15. Aguilera A, Pérez S, Díez J, Polo C, Cisneros J, de la Peña J. Laparoscopy in elderly patients. Arch Esp Urol 2012;65:550-5.
16. Parsons JK, Jarrett TJ, Chow GK, Kavoussi LR. The effect of previous abdominal surgery on urological laparoscopy. J Urol 2002;168:2387-90.
17. Lipke MC, Bargman V, Milgrom M, Sundaram CP. Limitations of laparoscopy for bilateral nephrectomy for autosomal dominant polycystic kidney disease. J Urol 2007;177:627-31.
18. Lafranca JA, Hagen SM, Dols LF, Arends LR, Weimar W, Ijzermans JN, *et al*. Systematic review and meta-analysis of the relation between body mass index and short-term donor outcome of laparoscopic donor nephrectomy.

Kidney Int 2013;83:931-9.

19. Kumazawa T, Tsuchiya N, Inoue T, Obara T, Tsuruta H, Saito M, *et al*. Association between various indices of obesity and intraoperative factors in laparoscopic donor nephrectomy. J Laparoendosc Adv Surg Tech A 2012;22:567-71.

20. Shoma AM, Erkay I, El-Kappany H. Laparoscopic nephrectomy: Prediction of outcome in relation to the preoperative risk factors in two approaches. J Endourol 2001;15:517-22.

21. Thornton E, Mendiratta-Lala M, Siewert B, Eisenberg RL. Patterns of fat stranding. AJR Am J Roentgenol 2011;197:W1-14.

22. Bylund JR, Qiong H, Crispen PL, Venkatesh R, Strup SE. Association of clinical and radiographic features with perinephric "sticky" fat. J Endourol 2013;27:370-3.