

Laparoscopic Nephrectomy For Benign and Inflammatory Conditions*

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ABSTRACT

Objectives: To evaluate the outcomes of laparoscopic nephrectomy for benign renal conditions associated with dense perinephric inflammation, such as xanthogranulomatous pyelonephritis (XGPN), pyonephrosis, tuberculous pyelonephritis, and calculus pyelonephritis, and compare outcomes with a matched group of patients undergoing open nephrectomy for similar indications. An additional objective was to evaluate factors predictive of complications and open conversions.

Patients and Methods: We retrospectively analyzed data from 84 patients with benign inflammatory diseases who underwent laparoscopic nephrectomy and compared the data with data from 94 matched patients undergoing open nephrectomy. Both groups were compared with regard to operative time, blood loss, intraoperative and postoperative complications, analgesia requirement, blood transfusion, and hospital stay. Univariate analysis assessed the predictive value of factors such as kidney size, presence of hilar lymphadenopathy, perinephric and perihilar adhesion, laterality and body mass index on complications and risk of open conversion.

Results: Mean operative time was 170 ± 59.8 and 148 ± 42.5 minutes, blood loss was 156.2 ± 6.8 and 154.6 ± 68.8 mL, analgesia requirement was 165 ± 71.2 and 284 ± 81 g diclofenac sodium, and average hospital stay was 4.34 ± 0.8 and 8.07 ± 1.8 days in the laparoscopic and open groups, respectively. Abnormal renal hilum (71%) and perihilar adhesions (86%) were common findings in patients with XGPN, whereas abnormal hilum and hilar lymphadenopathy (55%) were commonly seen in those with tuberculosis. The renal hilum was relatively unaffected in patients with pyonephrosis and calculus pyelonephritis.

Pleural entry was more common ($P < 0.0001$) in the open group, and visceral injury was more common in the laparoscopic group ($P = 0.04$). Blood transfusion was necessary in 7% and 11% of patients in the laparoscopic and open groups, respectively. Open conversion was required in 8 cases (autosomal dominant polycystic kidney disease-3, pyonephrosis, 2, XGPN and calculus pyelonephritis, 3). Intestinal obstruction that required laparotomy and adhesiolysis developed in one patient in the laparoscopic group.

Conclusion: Laparoscopic nephrectomy can be performed safely in most patients with benign inflammatory conditions that require surgical extirpation. Proper patient selection and technical modifications may help reduce morbidity. One should keep a low threshold for laparoscopic-assisted open conversion whenever necessary.

INTRODUCTION AND OBJECTIVES

LAPAROSCOPIC NEPHRECTOMY has become an established procedure for surgical management of most benign renal conditions that require removal of the kidney.¹⁻⁵ Laparoscopic nephrectomy has been performed effectively using transperi-

toneal, retroperitoneal, and hand-assisted approaches.⁵⁻⁸ Laparoscopy has been traditionally considered relatively contraindicated in benign conditions associated with severe inflammation and fibrosis, such as pyonephrosis, tuberculosis, and xanthogranulomatous pyelonephritis (XGPN).⁹⁻¹¹ In addition, laparoscopic nephrectomy may be technically challenging in patients with se-

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vere vertebral deformity and autosomal dominant polycystic kidney disease (ADPKD) because of space constraints.

After performing more than 250 laparoscopic renal procedures for more established indications, we cautiously extended our indications to include these more difficult procedures. In this study, we compare outcomes in 84 patients undergoing laparoscopic nephrectomy for benign diseases associated with severe inflammation or in patients with severe space constraints with a matched group of patients undergoing open surgery for similar indications. We also attempt to identify predictive factors for adverse outcomes for laparoscopic nephrectomy in this difficult surgical group.

PATIENTS AND METHODS

Data were analyzed from 84 patients with benign inflammatory diseases requiring laparoscopic nephrectomy and were retrospectively compared with data from 94 patients undergoing open nephrectomy for similar indications (Table 1). Patients with a perinephric abscess or previous open or laparoscopic renal surgery on the ipsilateral kidney were excluded from the study. The study was undertaken after obtaining approval from our institutional ethical committee.

All patients underwent preoperative clinical examination, appropriate imaging studies (ultrasonography and CT), and differential renal function assessment (diethyltriamine pentaacetic acid renal scan) before nephrectomy. Patients with active infection and obstruction (assessed by clinical, laboratory, and radiologic parameters) underwent percutaneous nephrostomy tube drainage before nephrectomy. All patients with renal tuberculosis received antituberculosis medication (four drug regimens) for at least 3 weeks before surgery.

Both groups were compared for operative time, blood loss, complications, analgesia requirement, transfusion rate, and hospital stay. In the laparoscopic group, intraoperative findings, such as abnormal hilum (defined as significant distortion of hilar anatomy by the inflammatory process as perceived by the surgeon), presence of hilar lymphadenopathy with or without caseation, and perihilar adhesions, were recorded. In addition, several factors, such as renal size >10 cm, laterality, body mass index (BMI), presence of hilar lymphadenopathy, and presence of perihilar adhesions, were assessed for their correlation with adverse outcomes, such as hemorrhage, visceral injury, or open conversion.

Statistical analysis

Two sample *t* tests were used for both equal and unequal variance. The Wilcoxon-Mann-Whitney test was used when the observations were abnormal, and the equality of proportion test was used to compare laparoscopic v open procedures when required. For all statistical tests, $P < 0.05$ was considered statistically significant.

Technique

All patients in the laparoscopic group underwent standard transperitoneal laparoscopic nephrectomy using 3 to 4 trocars. In this group, the inability to find an acceptable plane between the bowel and underlying kidney was considered an indication for elective open conversion. The subsequent procedure consisted of dissecting the ureter and periureteral tissues away from the ipsilateral great vessel to identify the psoas muscle. Every attempt was made to dissect hilar structures for individual clipping. In cases where there was nonprogression usually because of significant caseating lymph nodes, open conversion was preferred for the final dissection and transfixation of the vessels. The specimen was delivered via a small suprapubic incision or by enlarging the lowest trocar incision. All patients in the open group underwent nephrectomy via the retroperitoneal route through an 11th or 12th rib approach.

RESULTS

Indications for nephrectomy in the laparoscopic and open groups are summarized in Table 1. Pyonephrosis and calculus pyelonephritis accounted for most indications in the laparoscopic (29% and 30%, respectively) and open (21% and 21%, respectively) groups. Patients in the laparoscopic group tended to be younger (mean age, 42 v 54 years, $P < 0.0001$). However, laterality, BMI, and mean size were similar in both groups. Intraoperative data are summarized in Table 2. Overall operative time was shorter in the open group but was statistically significant only in the calculus pyelonephritis group. Hospital stay was shorter ($P < 0.0001$) and analgesia requirement was less ($P < 0.0001$) in the laparoscopic group compared with the open group. Transfusion rates were similar in the laparoscopic and open groups (7% v 11%, $P = 0.21$).

Complications occurred in 26 patients (31%) in the laparoscopic group and 46 patients (49%) in the open group (Fig. 1).

TABLE 1: INDICATIONS FOR NEPHRECTOMY

Indications/pathology	Laparoscopic	Open
Pyonephrosis	24	20
XGPN	07	20
Calculus pyelonephritis: total cases	25	20
Long standing stone diseases (> 5 years)	23	18
Renal dysmorphism	01	00
Kyphoscoliosis	01	02
Renal tuberculosis	09	20
ADPKD	19	14
Total	84	94

XGPN = xanthogranulomatous pyelonephritis; ADPKD = autosomal dominant polycystic kidney disease.

TABLE 2. DEMOGRAPHIC DATA

Overall	Laparoscopic group (84)	Open group (94)	P value
Age incidence (yrs)	42.11 ± 13.99	54.12 ± 19.05	<0.0001
Sex ratio (M:F)	54:30	56:38	NS
Right:Left	32:52	44:50	NS
BMI	26.9 ± 3.04	27 ± 2.07	NS
Average renal size (cm)	11.96 ± 2.10 (7.2–21.3)	12.03 ± 1.96 (9.3–24.6)	NS

BMI = body mass index; NS = not significant.

Pleural entry was more common in the open group (21% v 1%, $P < 0.0001$) compared with the laparoscopic group. The single pleural injury in the laparoscopic group, which occurred in a patient with ADPKD, was recognized intraoperatively and sutured laparoscopically without any untoward sequelae.

Three patients in the laparoscopic group had visceral injury (calculi pyelonephritis, 1, pyonephrosis, 1, and ADPKD, 1) compared with none in the open group. Postoperative paralytic ileus occurred with similar frequency in the laparoscopic and open groups. One patient in the laparoscopic group had intestinal obstruction that required open exploration and adhesiolysis.

Observed intraoperative findings in the laparoscopic group are reported in Table 3. Abnormal hilum (71%) and dense perihilar adhesions (86%) were common observations associated with XGPN. Abnormal hilum (78%) and hilar lymphadenopathy (55%) were commonly observed findings in patients with tuberculosis. In contrast, the renal hilum was relatively spared in patients with pyonephrosis and calculi pyelonephritis and ADPKD, wherein the dense adhesions were found predominantly on the surface of the renal parenchyma.

Assessment of various predictive factors for complications and open conversion in the laparoscopic group are summarized in Table 4. In the laparoscopic group, kidney size >10 cm and presence of hilar lymphadenopathy were predictors of a higher complication rate.

Open conversion occurred in 8 patients in the laparoscopic group (pyonephrosis, 2; XGPN, 2; ADPKD, 3; and calculi pyelonephritis, 1). Conversion was necessitated because of (2),

hemorrhage from venous injury (4) nonprogression (1), caseated lymph-node mass requiring open hilar vascular transfixation (1), and unexpected intraoperative detection of venous thrombus suspicion of malignancy.

DISCUSSION

Laparoscopic nephrectomy is increasingly performed for a variety of benign and malignant conditions affecting the kidney. While the safety and effectiveness of laparoscopic nephrectomy for many indications in patients with nonfunctioning noncancerous kidneys has been demonstrated,^{12,13} the role of laparoscopy in patients with benign conditions associated with dense inflammation and fibrosis, such as XGPN, tuberculosis, pyelonephritis, pyonephrosis, and long-standing calculi pyelonephritis, is still evolving.¹⁴

After gaining experience with laparoscopic nephrectomy for established indications, we extended our indications to include patients with dense inflammatory conditions (XGPN, tuberculosis, and calculi pyelonephritis), large renal size (ADPKD), and restricted anatomic factors (kyphoscoliosis).

Certain technical issues merit consideration while performing laparoscopic nephrectomy in this difficult group. Although the retroperitoneal approach has been performed by others,^{13,15–17} we prefer transperitoneal approach. The transperitoneal approach offers a larger working space and readily identifiable anatomic landmarks. This is especially important in patients with XGPN and tuberculosis where there is dense inflammation and scarring involving the hilum that often displaces hilar structures resulting in abnormal hilar orientation. Also, in patients with previous pyonephrosis and calculi pyelonephritis, there are often dense adhesions between the inflamed kidney and overlying bowel. In such situations, the transperitoneal approach facilitates separation of the colon and mesentery from the underlying kidney and Gerota's fascia. Exposing the peritoneal space to infective contents is a potential complication of the transperitoneal approach.

Securing the renal hilum may be challenging in conditions such as renal tuberculosis and XGPN. With these two conditions, we noticed dense scarring of perihilar tissues, making dissection of the renal hilum difficult. In addition, we found significant distortion of various hilar structures because of displacement by the enlarged hilar lymph nodes in tuberculosis and inflammatory tissue in XGPN. In contrast, with calculi pyelonephritis, pyonephrosis, and ADPKD, the renal hilum is relatively spared, and the main difficulty lies in mobilizing the kidney from adjacent viscera because of dense perinephric scar-

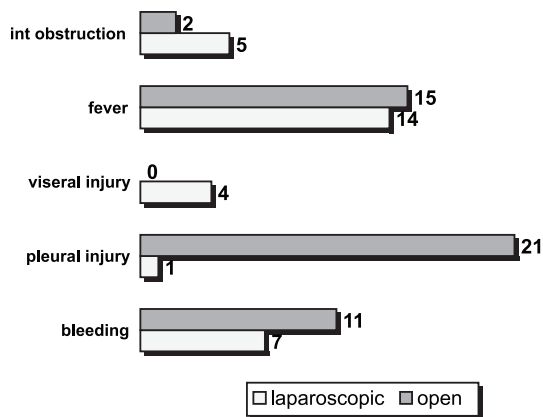


FIG. 1. Complications in the laparoscopic and open groups.

TABLE 3. INTRAOPERATIVE AND POSTOPERATIVE DATA

Indications	OR time (min), mean \pm SD	Blood loss (ml), mean \pm SD	Analgesia dosage (mg), mean \pm SD	Hospital stay (days), mean \pm SD
Calculus pyelonephritis				
Laparoscopic (25)	168 \pm 72	117 \pm 51	180 \pm 80	3.88 \pm 0.75
Open (20)	132 \pm 62	84 \pm 21	250 \pm 75	6.48 \pm 1.68
P value	0.04	0.005	0.002	< 0.0001
Tuberculosis				
Laparoscopic (09)	162 \pm 54	164 \pm 54	100 \pm 40	4 \pm 0.6
Open (20)	140 \pm 53	140 \pm 32	250 \pm 35	7.2 \pm 1.7
P value	0.28	0.10	< 0.0001	< 0.0001
Pyonephrosis				
Laparoscopic (24)	153 \pm 48	144 \pm 95	150 \pm 50	4.6 \pm 0.7
Open (20)	147 \pm 33	222 \pm 87	280 \pm 50	9 \pm 1.68
P value	0.32	0.004	< 0.0001	< 0.0001
XGPN				
Laparoscopic (07)	187 \pm 74	175 \pm 84	190 \pm 86	4.4 \pm 1.2
Open (20)	149 \pm 51	142 \pm 92	320 \pm 125	8.41 \pm 2.2
P value	0.09	0.21	0.01	< 0.0001
ADPKD				
Laparoscopic (19)	182 \pm 51	181 \pm 100	206 \pm 100	4.86 \pm 0.99
Open (14)	157 \pm 34	185 \pm 112	320 \pm 120	9.26 \pm 2.9
P value	0.06	0.46	0.003	< 0.0001

XGPN = xanthogranulomatous pyelonephritis; ADPKD = autosomal dominant polycystic kidney disease.

ring, which often obliterates the natural tissue planes. Although en bloc stapling of the renal hilum has been described in such situations,¹² we prefer to individually ligate the artery and vein as much as possible. In situations in which individual dissection of the artery and vein is not possible laparoscopically, we prefer to transfix the pedicle through a small incision after the remainder of the mobilization has been completed laparoscopically.

Laparoscopic nephrectomy for XGPN and tuberculosis has generally been associated with a high open conversion rate. In a large series (482 cases) by Rassweiler and associates⁵ the overall conversion rate was 9.4% for simple nephrectomy, but the renal tuberculosis group had a conversion rate of 80%. Hemal and colleagues,¹⁵ reported a 22% conversion rate in patients with renal tuberculosis, and Bijan et al¹² reported a 17% conversion rate for patients with benign inflammatory conditions undergoing laparoscopic nephrectomy.

In this present study, open conversion was required in 8 patients (9%). Although laterality did not correlate with the over-

all incidence of complications, most open conversions did occur on the right side (7 v 1, $P = 0.004$). The most common indication for conversion was failure to progress. In this regard, finding a suitable plane of dissection between the kidney and bowel is important. In situations in which this plane is obliterated by dense inflammatory adhesions, there may be a higher incidence of inadvertent bowel injury.

Associated incidental malignancy is an important consideration in patients with long-standing calculus pyelonephritis.^{18,19} Altered renal morphology from long-standing inflammation makes preoperative radiologic diagnosis of an associated subtle malignancy difficult. We detected cancer on postoperative pathologic examination in 3 patients (transitional-cell carcinoma, 2, renal-cell carcinoma 1); these patients had XGPN (2) or calculus pyelonephritis (1). We therefore prefer to perform as wide an excision as the individual case allows without unduly compromising safety, especially in patients with long-standing stone disease. Also, intact specimen extraction may be preferred in this group of patients.

TABLE 4. INTRAOPERATIVE FINDINGS IN THE LAPAROSCOPIC GROUP

Indications	Abnormal hilum		
	hilar vascular variation	Lymph nodes	Perihilar adhesion
Calculus pyelonephritis (25)	3 (12%)	4 (16%)	19 (76%)
Tuberculosis	7 (78%)	5 (55%)	7 (77%)
Pyonephrosis (24)	2 (8%)	3 (12%)	3 (12%)
XGPN (07)	5 (71%)	4 (57%)	6 (86%)
ADPKD (19)	—	0	9 (47%)

XGPN = xanthogranulomatous pyelonephritis; ADPKD = autosomal dominant polycystic kidney disease.

TABLE 5. COMPLICATIONS AND OPEN CONVERSION IN THE LAPAROSCOPIC GROUP

Parameter	Size (cm)		Perihilar adhesion		LN dissection		Side		BMI	
	>10 n = 48	<10 36	Present n = 44	Absent 40	Yes n = 16	No 68	Right n = 32	Left 52	<30 n = 70	>30 14
Blood transfusion n = 6 (7%)	06	00	03	02	04	01	02	03	03	02
Prolonged ileus ^a n = 4 (5%)	03	00	00	03	00	03	00	03	03	00
Visceral injury n = 4 (5%)	04	00	00	00	00	00	01	03	04	00
Open conversion n = 8 (9%)	06	02	05	03	03	05	07	01	05	03
P value	0.0001		0.41		0.009		0.11		0.15	

^aOne case of intestinal obstruction is included.

LN = lymph node; BMI = body mass index.

Although a few reports advocate progressive cyst aspiration and decortication at the time of nephrectomy for ADPKD,^{8,20} we have not used that approach. The cyst fluid contains toxic substances²¹ that may cause chemical peritonitis. Also, the raw area created after nephrectomy and extensive dissection may lead to significant postoperative ileus in these patients, as evidenced in our study. Laparoscopic removal of ADPKD is minimally invasive, helps faster recovery and convalescence, and facilitates early transplantation (9.06 days in our unpublished data) compared with open procedures (29.77 days).

We attempted to identify factors that could potentially predict the likelihood of adverse events and open conversion during laparoscopic nephrectomy for benign inflammatory conditions. In the present study, we found kidney size >10 cm ($P < 0.0001$) and presence of hilar lymphadenopathy ($P = 0.009$) to be significant for predicting adverse outcomes after laparoscopic nephrectomy in this difficult surgical environment.

In our opinion, the laparoscopic approach is contraindicated in patients with a perinephric abscess and fixed immobile kidneys.

CONCLUSION

Nephrectomy may be safely performed laparoscopically in patients with benign inflammatory conditions requiring surgical removal. Tuberculosis and XGPN are associated with significant hilar scarring and distortion of anatomy. Operating time in this difficult group of patients is longer with laparoscopy, but the blood loss, hospital stay, and analgesia requirements are lower compared with the open approach. Presence of renal size >10 cm and hilar lymphadenopathy are factors that predict an adverse outcome after laparoscopy.

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ABBREVIATIONS USED

ADPKD = autosomal dominant polycystic kidney disease;
 BMI = body mass index; XGPN = xanthogranulomatous
 pyelonephritis.