Perioperative Complications and Surgical Outcomes in Partial Nephrectomy for Renal Mass

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ABSTRACT

Background

Partial nephrectomy (PN) is considered the standard treatment for small renal masses, providing superior oncological and functional outcomes compared with radical nephrectomy. While both open partial nephrectomy (OPN) and laparoscopic partial nephrectomy (LPN) are effective, minimally invasive techniques are gaining preference.

Objective

To analyze the perioperative complications and surgical outcomes of partial nephrectomy, with emphasis on its safety and efficacy.

Method

This retrospective study reviewed data from 26 patients who underwent partial nephrectomy for renal masses between January 2021 and December 2024, including 8 open partial nephrectomy and 18 laparoscopic partial nephrectomy. Collected data included tumor size, surgical margins, histopathological findings, ischemia time, and complications.

Result

The mean age was 53.7 years in the open partial nephrectomy group and 48.2 years in the laparoscopic partial nephrectomy group. Most tumors were detected incidentally, with clear cell renal cell carcinoma (ccRCC) being the most common histology (87.5% in open partial nephrectomy and 83.3% in laparoscopic partial nephrectomy). The mean tumor size was 29.5 mm in the open partial nephrectomy group and 32.9 mm in the laparoscopic partial nephrectomy group. Negative surgical margins were achieved in all cases. The mean operative time was 1.6 hours for open partial nephrectomy and 2.1 hours for laparoscopic partial nephrectomy, with mean warm ischemia times of 18.25 minutes and 20.6 minutes, respectively. The laparoscopic partial nephrectomy group had a shorter hospital stay (mean 4.7 days versus 5.3 days). Complications were minimal: one patient developed a renal artery pseudoaneurysm after laparoscopic partial nephrectomy, which was successfully managed with angioembolization.

Conclusion

In this small single-center series, partial nephrectomy, performed either laparoscopically or through an open approach, showed good surgical outcomes and perioperative safety in the management of small renal masses.

KEY WORDS

Laparoscopic surgery, Open surgery, Partial nephrectomy, Perioperative complications, Renal masses, Surgical outcomes

INTRODUCTION

Partial nephrectomy (PN) has become the preferred treatment for small renal tumors, classified as clinical T1a–b, because of its evidence-based superior oncological and functional outcomes compared with radical nephrectomy (RN).[1] While the role of open partial nephrectomy (OPN) remains debated in the era of minimally invasive surgery (MIS), current international guidelines emphasize renal preservation as the primary goal, regardless of the surgical approach. Initially, PN was limited to cases with contraindications to RN, such as solitary kidney, chronic kidney disease (CKD), or multifocal or bilateral tumors. However, it is now considered the gold standard for managing small renal tumors when technically feasible. Both the American Urological Association (AUA) and the European Association of Urology (EAU) recommend PN for T1 renal masses where technically feasible.[2,3]

Indications for PN can be classified as absolute, relative, or elective:[4]

Absolute

• Solitary kidney

• Bilateral renal masses

• Severe renal insufficiency

Relative

• Contralateral kidney with pre-existing renal disease (e.g., nephrolithiasis, recurrent pyelonephritis, ureteropelvic junction obstruction, reflux)

• Medical diseases predisposing to renal insufficiency (e.g., diabetes, hypertension)

• Known multifocality (e.g., genetic syndromes)

Elective

• Small lesions (less than 4 cm)

• Peripheral lesions

• Young, healthy patients

OPN has traditionally been preferred for patients with higher tumor complexity, although LPN has shown outcomes comparable to OPN in selected patients, with possible advantages in some operative and postoperative parameters.[5] Recent reports found no difference in perioperative complications between the two approaches.[6]

This retrospective study provides perspective on the safety and efficacy of PN for renal masses in the context of a tertiary care center in Nepal.

METHODS

This retrospective study was conducted at Nepal Mediciti Hospital to evaluate perioperative complications and surgical outcomes of PN for renal masses. Patient data were reviewed retrospectively from the hospital's electronic records. Data were collected for all patients who underwent either LPN or OPN for renal masses from January 2021 to December 2024.

Patient records were retrieved from the hospital database and included:

• Demographics: age, sex, and comorbidities.

• Tumor characteristics: size, location, and complexity.

• Surgical details: type of PN (open or laparoscopic), operative time, blood loss, and ischemia time.

• Perioperative outcomes: complications, length of hospital stay, and recovery details.

• Oncological outcomes: tumor histopathology, surgical margins, and follow-up outcomes.

Inclusion criteria: patients who underwent PN for renal masses at Nepal Mediciti Hospital during the study period.

Exclusion criteria: patients with incomplete medical records.

RESULTS

Patient characteristics

Eight patients underwent OPN. Their mean age was 53.7 years (standard deviation [SD] 17.9; range 25–86 years). Five patients (62.5%) were male and three (37.5%) were female. Three patients (37.5%) were smokers and five (62.5%) were non-smokers. Comorbidities were common: diabetes mellitus (DM) in three patients (37.5%), hypertension (HTN) in two (25%), and chronic liver disease (CLD) in one (12.5%), while three patients (37.5%) had no comorbidities (Table 1).

Eighteen patients underwent LPN. Their mean age was 48.2 years (SD 13.5; range 25–77 years). Eleven patients (61.1%) were male and seven (38.9%) were female. Only one patient (5.6%) was a smoker, and 17 (94.4%) were non-smokers. Comorbidities included DM in three patients (16.7%), HTN in five (27.8%), hyperuricemia in one (5.6%), and nephrotic syndrome in one (5.6%), while nine patients (50%) had no reported comorbidities (Table 1).

Tumor characteristics

In the OPN group, seven tumors (87.5%) were incidental findings and one patient (12.5%) presented with hematuria. Laterality was evenly distributed (four left, four right). Six tumors (75%) were clinical stage T1a and two (25%) were T1b. The mean maximum tumor diameter was 29.5 ± 11.5 mm (range 16–50 mm). Two tumors (25%) were in the upper pole, two (25%) in the mid pole, and four (50%) in the lower pole. All tumors were classified as low complexity by the RENAL nephrometry score. Histologically, seven tumors (87.5%) were ccRCC and one (12.5%) was an oncocytoma. Six tumors (75%) were International Society of Urological

Table 1. Demographic and Clinical Characteristics

Surgery	Age (Years)	Sex	Comorbidities	Smoking
OPN= 8	Mean ± SD: 53.7 ± 17.9 Range: 25 – 86	Male: 62.5% (5/8) Female: 37.5% (3/8)	Diabetes Mellitus: 37.5% (3/8) Hypertension: 25% (2/8) Chronic Liver Disease: 12.5% (1/8) No Comorbidities: 37.5% (3/8)	Smokers: 37.5% (3/8) Non-Smokers: 62.5% (5/8)
LPN=18	Mean ± SD: 48.2 ± 13.5 Range: 25 – 77	Male: 61.1% (11/18) Female: 38.9% (7/18)	Diabetes Mellitus: 16.7% (3/18) Hypertension: 27.8% (5/18) Hyperuricemia: 5.6% (1/18) Nephrotic Syndrome: 5.6% (1/18) No Comorbidities: 50% (9/18)	Smokers: 5.6% (1/18) Non-Smokers: 94.4% (17/18)

Pathology (ISUP) grade 1, one (12.5%) was grade 2, and the oncocytoma was ungraded (12.5%). All cases had negative surgical margins (Table 2).

In the LPN group, 16 tumors (88.9%) were incidental findings and two patients (11.1%) presented with hematuria. Seven tumors (38.9%) were on the left and 11 (61.1%) on the right. Fourteen (77.8%) were stage T1a and four (22.2%) were T1b. The mean maximum tumor diameter was 32.9 ± 11.8 mm (range 15–65 mm). Seven tumors (38.9%) were in the upper pole, six (33.3%) in the mid pole, and five (27.8%) in the lower pole. By RENAL nephrometry score, 16 tumors (88.9%) were low complexity and two (11.1%) were intermediate complexity. Histopathology showed ccRCC in 15 cases (83.3%), while oncocytoma, angiomyolipoma, and benign mesenchymal tumor accounted for one case (5.6%) each. Twelve tumors (66.7%) were ISUP grade 1 and three (16.7%) were grade 2; three (16.7%), all non-ccRCC, were ungraded. All surgical margins were negative (Table 2).

Table 2. Tumor Character

Tumor Character	OPN (n=8)	LPN (n=18)
Complain	Hematuria: 1 Incidental : 7	Hematuria: 2 Incidental : 16
Laterality	Left: 4 Right: 4	Left: 7 Right: 11
Clinical Stage	T1a: 6 T1b: 2	T1a: 14 T1b: 4
Maximum Diameter	Mean ± SD: 29.5 ± 11.5 Range: 16 – 50 mm	Mean ± SD: 32.9 ± 11.8 Range: 15 – 65 mm
Location	Upper pole: 2 Mid Pole: 2 Lower Pole: 4	Upper pole: 7 Mid Pole: 6 Lower Pole: 5
RENAL Nephrometry Score	Low: 8	Low: 16 Intermediate: 2
Histopathology	ccRCC: 7 Oncocytoma: 1	ccRCC: 15 Oncocytoma: 1 Angiomyolipoma: 1 Benign Mesanchymal Tumor: 1
ISUP grade	Grade 1: 6 Grade 2: 1	Grade 1: 12 Grade 2: 3
Surgical margin	Positive: 0 Negative: 8	Positive: 0 Negative: 18

Surgical outcomes

In the OPN group, the mean operative time was 1.6 hours (SD 0.2; range 1.5–2 hours), the mean warm ischemia time (WIT) was 18.25 minutes (SD 2.04; range 15–20 minutes), and the mean hospital stay was 5.3 days (SD 0.48; range 5–6 days). In the LPN group, the mean operative time was 2.1 hours (SD 0.3; range 2–3 hours), the mean WIT was 20.6 minutes (SD 2.4; range 15–25 minutes), and the mean hospital stay was 4.7 days (SD 0.4; range 4–5 days) (Table 3).

No patient in either group had significant intraoperative or postoperative bleeding requiring blood transfusion. One patient in the LPN group developed a renal artery pseudoaneurysm two weeks after surgery, which was managed by angioembolization (Table 3).

Table 3. Surgical Outcome

Surgery outcome	Surgery Time (hrs)	Warm Ischemic Time (min)	Hospital Stay (days)	Blood Transfusion	Renal artery pseudo-aneurysms
OPN	Mean ± SD: 1.6 ± 0.2 Range: 1.5 - 2	Mean ± SD: 18.25 ± 2.04 Range: 15 - 20	Mean ± SD: 5.3 ± 0.48 Range: 5 - 6	None	NO
LPN	Mean ± SD: 2.1 ± 0.3 Range: 2 - 3	Mean ± SD: 20.6 ± 2.4 Range: 15 - 25	Mean ± SD: 4.7 ± 0.4 Range: 4 - 5	None	1

DISCUSSIONS

The history of renal surgery began on an unfortunate note when entire kidneys (Walcott, 1861) and portions of kidneys (Spiegelberg, 1867) were mistakenly removed during surgeries intended for liver cysts, resulting in the deaths of both patients. In 1869, Simon achieved a milestone by performing the first planned nephrectomy to successfully treat a urinary fistula. OPN was first performed by Spencer Wells in 1884, when Wells unintentionally removed one-third of a kidney while performing an enucleation of a perirenal fibrolipoma. In 1887, Czerny became the first surgeon to intentionally perform a partial resection of a renal tumor, successfully treating a case of angiosarcoma.[7]

In 1991, Ralph Clayman performed the first laparoscopic radical nephrectomy on an 85-year-old woman with an incidentally discovered 3 cm renal mass in the right mid pole, which was later identified as a grade I oncocytoma. In 1992, Howard Winfield performed the first LPN (transperitoneal approach) in a 35-year-old woman with recurrent urinary tract infections due to a lower pole renal calculus in a caliceal diverticulum. In 1994, Inderbir Gill conducted the first laparoscopic retroperitoneal PN.[8]

PN, whether open or laparoscopic, is the preferred treatment for small renal masses (T1a and selected T1b), with excellent oncological outcomes and preservation of renal function reported in the literature. This study provides insight into the perioperative outcomes of OPN and LPN in managing renal masses at a single tertiary center.

Mean age and comorbidity profiles differed slightly between the OPN and LPN groups; the mean age of OPN patients was higher (53.7 years) than that of LPN patients (48.2 years). The male predominance and the prevalence of comorbidities such as diabetes and hypertension align with known risk factors for renal tumors, underscoring the importance of comprehensive preoperative assessment in this population. Diabetes is considered an independent risk factor for the development of kidney cancer.[9] RCC is strongly linked to male sex, obesity, smoking, hypertension, a history of renal disease, and a history of viral hepatitis.[10]

In both cohorts, the majority of tumors were incidental findings, highlighting the increasing role of advanced imaging in detecting renal masses. The incidence of renal cell carcinoma has increased in recent years, largely attributed to the incidental detection of small renal lesions during abdominal examinations conducted for other reasons.[11] Tumor size, laterality, and RENAL nephrometry scores were broadly comparable between the groups, although the only two intermediate-complexity tumors were in the LPN group. The predominance of ccRCC in both groups mirrors global trends: approximately 75% of RCCs are clear cell. Papillary RCC accounts for around 15% of kidney cancers and is divided into type 1 (basophilic) and type 2 (eosinophilic), while chromophobe RCC represents approximately 5% of kidney tumors.[12]

Operative time was longer in the LPN group (mean 2.1 hours) than in the OPN group (mean 1.6 hours). This is consistent with the technical demands of laparoscopic surgery and, possibly, with the learning curve.[13] The WIT in LPN averaged 20.6 minutes, slightly exceeding the 18.25-minute average in OPN. Although both durations remain within limits generally considered acceptable to prevent renal injury, the marginally longer WIT in LPN may reflect the technical difficulty of laparoscopic tumor resection and renal reconstruction.[13,14]

Hospital stay was shorter for LPN (mean 4.7 days) than for OPN (mean 5.3 days), which may suggest faster recovery with the minimally invasive approach, although the ranges were close (4–5 versus 5–6 days) and no statistical comparison was performed. The low complication rate in this study is encouraging, as shown by the absence of major bleeding and of any need for transfusion in either group. These findings are in line with other studies suggesting that LPN offers reduced perioperative morbidity and quicker recovery without compromising oncological outcomes.[15]

One patient developed a renal artery pseudoaneurysm after LPN, which was successfully managed with angioembolization. This highlights the importance of vigilant postoperative surveillance. Renal artery pseudoaneurysm is a known but infrequent complication of PN, including laparoscopic techniques. A systematic review reported an incidence of around 1% after OPN and 1.96% after minimally invasive PN. Selective arterial embolization (SAE) is regarded as an effective treatment for these vascular complications.[16]

The absence of positive surgical margins in both groups and the predominance of low-grade tumors suggest that both approaches achieved complete tumor removal in this series. These findings are consistent with the role of PN in treating small renal masses while preserving renal function and achieving good cancer control.[17] In their meta-analysis, You et al. concluded that LPN is a viable and safe alternative to OPN, offering comparable surgical, oncological, and functional outcomes.[18]

This study has several limitations. The sample size is small, particularly in the OPN group (n = 8), which limits the generalizability of the findings and precluded formal statistical comparison between groups. The retrospective design carries a risk of selection and information bias. As a single-center study conducted in a tertiary care hospital, its applicability to other healthcare settings or regions may be limited. Follow-up and functional outcomes (e.g., renal function) were not reported. Future research with larger samples, multicenter collaboration, and extended follow-up is needed to validate these findings and to assess oncological and functional outcomes more comprehensively.

CONCLUSION

In this small single-center series, PN, whether performed laparoscopically or through an open approach, showed good surgical outcomes and perioperative safety in the management of small renal masses. LPN appeared to be a safe and feasible alternative to OPN, with comparable surgical and oncological findings. Larger studies with longer follow-up are needed to confirm these results.

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