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Role of Open Partial Nephrectomy in Minimally Invasive Surgery Era

ABSTRACT

Introduction: With the aim of preserving maximum renal function, partial nephrectomy (PN) or nephron sparing surgery appears to be a logical choice for the management of renal cell carcinoma (RCC). We here in report our experience of Open PN (OPN) performed at our institution between January 2017 and June 2019. **Materials and Methods:** We included 33 patients who underwent OPN from January 2017 to June 2019 at our institution. Renal tumors were scored using the RENAL nephrometry score. Outcomes included patient demographic data, comorbidities, histological subtype, blood loss, ischemia time complication rate, and 5-year overall survival were analyzed and reported. **Results**: We report a case-cohort of 33 cases who underwent OPN. The average age of patients was 48 years (Range 29–74 years). The most common clinical presentation was incidentally detected renal mass (22 patients), followed by flank pain (6 patients). The median size of the tumor was 3.6 cm (1.1–7.4). The tumor's location was at the Lower pole in 14 patients, followed by the upper pole in 11 patients and the remaining were interpolar in eight patients. Clinical stage was T1a in 28 patients, T1b in three patients, and T2a and T2b in one patient each. Final Histopathological was - Clear cell RCC in 20 patients, type 1 papillary RCC in 5 patients, type 2 papillary RCC in 1 patient, chromophobe RCC in 2 patients, and oncocytoma in three patients and infective etiology in three patients. Perioperative complications as per Clavien-Dindo classification, Grade I in 7 (21.1%) patients, Grade II in 9 (27.2%) patients, and Grade IIIa or higher complications were in four patients. On frozen section analysis, three specimens were found to have microscopic positive margins, and hence margins were revised till new resected margins were negative. Final microscopic margin was positive in a single patient. In follow-ups ranging from 36 to 60 months, one patient had liver metastasis, started on targeted therapy and is alive. Death due to cardiac-related event in one patient and ARDS in one patient, unrelated to RCC. Thirty-one patients out of the total are alive and well, giving the 5-year overall survival rate of 93.9%. **Conclusion**: Our data demonstrate that OPN is still a viable option with excellent oncological and functional outcomes in simple as well as complex renal tumors in the minimally invasive surgery era.

Key words: Open Partial Nephrectomy(OPN), Minimally Invasive, Renal Cell Carcinoma(RCC)

INTRODUCTION

With the aim of preserving maximum renal function, partial nephrectomy (PN), or nephron sparing surgery (NSS) appears to be a logical choice in the management of renal cell carcinoma (RCC).[1] This surgery shifts the paradigm away from radical nephrectomy (RN) because it has acceptable surgical morbidity and a similar oncological result.[2] At present, PN/NSS is practiced in all patients with normally functioning contralateral kidney, depending on the size and location of the tumor.[3-5] We here in report our experience of 33 open PN (OPN) performed at our institution between January 2017 and June 2019.

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MATERIALS AND METHODS

Patient selection

This was a retrospective, single-institution study and included a cohort of 33 consecutive patients who underwent OPN from January 2017 to June 2019. The outcomes data included were patient demographic information, comorbidities, histological subtype, and operative details such as blood loss, ischemia time, complication rate, recurrence, and 5-year survival rate.

Preoperative evaluation of renal tumors

Most patients were found to have a lesion on an abdominal ultrasound done for various reasons. The final surgical decision was taken after renal tumors were assessed using cross-sectional imaging (three-dimensional computed tomography (CT) or

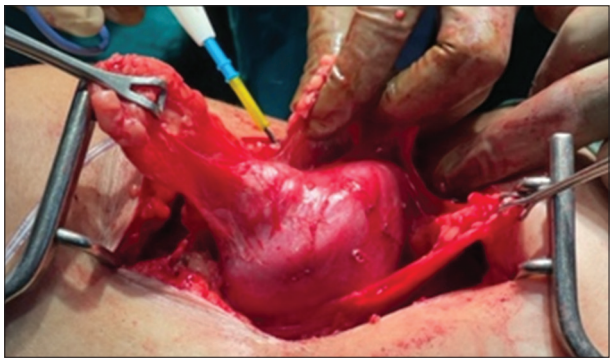


Figure 1: Tumor exposed with part of Gerota's attached

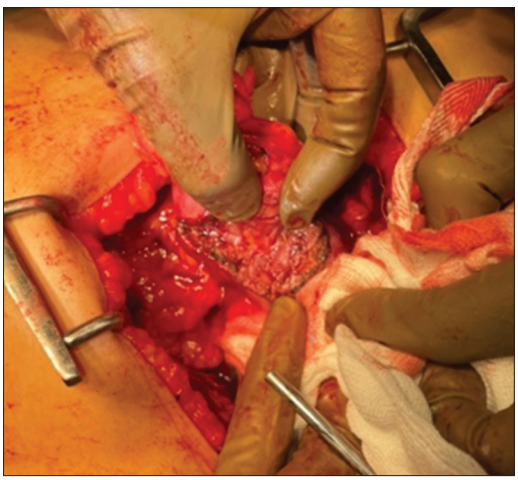


Figure 2: Resection of tumor

magnetic resonance imaging). Renal tumors were scored retrospectively using the R.E.N.A.L nephrometry score (NS).[6,8]

OPN procedure

The kidney and the tumor are localized using a flank incision technique that exposes Gerota's fascia [Figure 1]. For optimal planning of the excision, especially if the tumor is close to the hilum, a comprehensive visual evaluation is necessary. The renal pedicle is identified, and the main renal artery and vein are secured with vessel loops.

If the tumor is small <3 cm and polar in location and the indication is elective, resection of the tumor then commences, with safe margin of 1 cm of the healthy renal parenchyma [Figure 2]. If there is no major bleeding as the resection proceeds, total resection of the tumor is completed without recourse to any type of renal ischemia. If there is any doubt about the resection margins after removal of the tumor, an intraoperative biopsy of the bed is performed, and a frozen section is obtained, and we proceed according to the result. Then, hemostasis of the tumor bed is started rapidly with single stitches of 4/0 vicryl at the main bleeding points using spray-coagulation

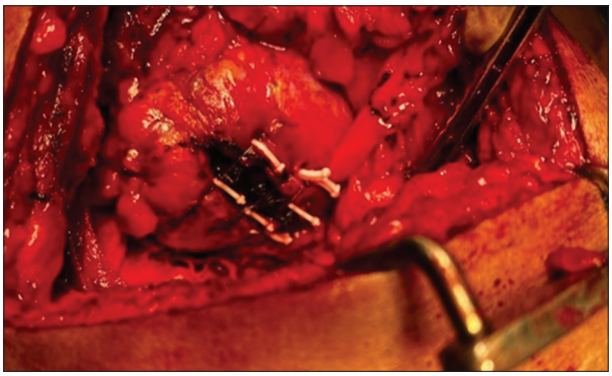
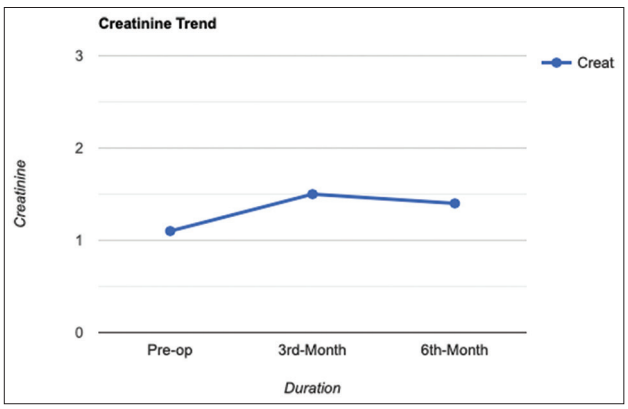
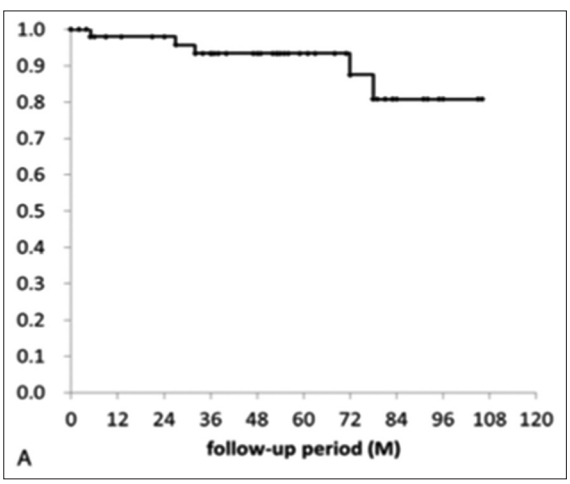


Figure 3: Completed renorrhaphy



Graph 1: Creatinine trend



Graph 2: Kaplan–Meier probability curves for OS

on secondary vessels with an electric scalpel, which takes considerable time.

When tumors are large >4 cm and complex or hilar, we prefer to clamp the renal artery to produce ischemia. In these cases, it is very useful to prepare the renal pedicle in advance, allowing ischemia to be produced within few seconds and minimizing blood loss.

After hemostasis is achieved, a thorough inspection is necessary to find any unintentional pelvicalyceal system openings to prevent postoperative leaks or fistulas. A resorbable suture is used to close any identified breaches. When an opening is suspected but cannot be seen, an intrapelvic injection of methylene blue is required; some authors previously insert a ureteral stent in patients with central-located tumors.[5] Renorrhaphy is completed in two layers at our institute, the inner layer with Vicryl 4-0. Gel foam bolsters of adequate size are used inside the crater over which renorrhaphy is done [Figure 3].

The outer layer is completed with Vicryl 2-0 with the help of hemoclips to avoid tearing of the edges. Resurface perirenal fat around the kidney and close the renal fascia. We keep drain to detect post-operative leaks or bleeding.

Post-operative and follow-up schedule

On the day following surgery, patients were permitted to walk and resume their normal diet (POD) 1. On POD 1–3, the urethral catheter, drainage tube, and epidural tube (if present) were all removed. Investigations were usually performed on POD 1 and on day 7 if required. During follow-up, blood investigations were performed at 3, 6, 12, and 24 months, and CT urography was performed at 6, 12, and 24 months.

RESULTS

Demographic data

Demographic data of cases are shown in Table 1. The average age of patients was 48 years (Range 29–74 years). Tumor was found more commonly in males (29 patients) than in females (four patients). The left side (19 patients) was affected more than the right side (14 patients). On clinical evaluation, the most common comorbidity was hypertension (61.7%), followed by diabetes mellitus (35.3%). The median baseline serum creatinine preoperatively was 1.1 mg/dl (0.7–2.6), and on follow-up after 3 months was found to be 1.5 mg/dl (9.0–3.4) [Graph 1]. The most common clinical presentation was incidentally detected renal mass in 22 patients, followed by flank pain in six patients. Ultrasound of the abdomen/kidney-ureter-bladder was the most commonly performed initial investigation. All patients underwent cross-sectional imaging (CT- Urography or MR- urography) to confirm the diagnosis and calculate the NS.

Table 1: Demographic data

Variable	Values	Mean/ Percentages
Age	29–74 years	Mean 48 years
Sex		
Male	29	84.8%
Female	4	12.1%
Side		
Right	14	42.4%
Left	19	57.5%
Comorbidity	Hypertension (1st), 61.7%	DM (2nd), 35.3%
Creat		
Pre-op	0.7–2.6	Mean 1.1
Post-op (3rd month)	0.9–3.4	Mean 1.5
Presenting symptom	Incidental–22 (Most common)	6- Flank pain/discomfort
Initial diagnosis	Ultrasound (31), 93.9%	CT–2, 6.1%
Final diagnosis	CT urography (32), 96.9%	100% patient showed lesion on CT Urography

Table 2: Tumor characteristics

Variable	Number	Percentage
Final stage		
T1a N0M0	28	84.8
T1b N0M0	3	9.0
T2a N0M0	1	3.0
T2b N0M0	1	3.0
Size	1.1–7.4 cm	Mean 3.6 cm
Location		
Upper pole	11	33.3
Mid pole	8	24.2
Lower pole	14	42.4
Pathologic type		
ccRCC	20	30.6
Papillary	5	15.1% (Type 1–4, type 2–1)
Chromophobe	2	6.0
Oncocytoma	3	9.0
Inflammatory/infective	3	9.0
Nephrometry score		
4–6	26	78.7
7–9	6	18.1
10–12	1	3.0
Margin positive (FzSx)	3	9.0
Final margin positive	1	3.0

Table 3: Surgery and related data

Variable	Value	Mean
Total operative time	124–188 min	Mean 150
Tumor resection time	17–32 min	Mean 22
Hilar clamping	28 cases	
Ischemia time	18–36	Mean 26 min
Estimated blood loss	40–300 ml	112 ml mean
Hospital stay	4–9 days	Mean 5 days

Tumor characteristics - radiological and pathological findings

CT-urography was performed in most cases to confirm the preoperative diagnosis, calculate the NS, and plan the surgery. The patients who could not undergo CT-urography were offered MR-urography, whenever possible CT renal angiography was performed [Table 2]. The median size of the tumor was 3.6 cm (1.1–7.4). The most common location of tumor was the lower pole in14 patients, followed by the upper pole in 11 patients and the remaining were interpolar in eight patients. R.E.N.A.L NS was calculated based on CT scan findings to anticipate the complexity of the procedure.[7] Grade 1 (score 4–6) was the most common score in 26 patients, Grade 2 (score 7–9) was observed in six patients, and Grade 3 (score 10–12) in one patient.

Final Stage was T1a (28 patients, 81.8%), T1b (3 patients, 9.0%), T1a (1 patient, 3%), and T2b (1 patient, 3%). All patients underwent Frozen Section Biopsy to confirm margin status before undergoing renorrhaphy and closure. On frozen section analysis, three specimens were found to have microscopic positive margins, and hence margins were revised till new resected margins were negative. The final microscopic margin was positive in a single case, which was a known case of hereditary papillary RCC.

Final Histopathological Diagnosis - Clear cell RCC was diagnosed in 20 patients, type 1 papillary RCC in four patients, type 2 papillary RCC in one patient, chromophobe RCC in two patients, oncocytoma in three patients, and other histological types in three patients.

Surgery and intra-operative parameters

Of the patients assessed in this study, eight had imperative indications for PN (e.g., history of surgery in two patients, based on tumor characteristics in three patients, compromised renal function in one patient, hereditary RCC syndromes in one patient, and simultaneous abdominal surgery in one patient). The other 25 patients had elective indications [Table 3].

Median total operative time was about 150 Min (124–188 min); renorrhaphy was not started till margins were negative on the frozen section report. The median resection time of the tumor since the kidney exposure was about 22 min. Hilar clamping was done in 28 patients, (five patients were operated without clamping), median ischemia (warm) time was 26 min, and no cooling of the kidney was done during the hilar clamping. The estimated average blood loss was 112 ml (40–300 ml), blood loss was more in complex cases with higher NSs and interpolar location of the tumor.

All patients during the post-operative period were managed by (enhanced recovery after surgery) protocol, and the average hospital stay was 5 days, with no readmissions within 1 month of discharge.

Complications

Perioperative complications are mentioned in Table 4. As per the Clavien-Dindo classification, total complications observed were in 20 patients (60.5%). Of these patients, Grade I complications were observed in 7 (21.1%) patients, Grade II complications were observed in 9 (27.2%) patients, and Grade IIIa or higher complications were observed in 4 cases (12.1%) with NS scores ranging from 7 to 10. Urinoma was observed in 3 cases, and treated with placement of an indwelling drainage catheter till resolution.

Table 4: Complications

Complications	Number	Percentage
Nil	13	39.3
Pyrexia	7	21.1
Wound infection	2	6.0
Urinary leak/urinoma	3	9.0
Blood transfusion	5	15.1
Uti requiring treatment	2	6.0
Clavien-Dindo classification of complications		
Grade I	7	21.1
Grade II	9	27.2
Grade III A OR Higher	4	12.1

Survival outcomes

During a median follow-up period of 36–60 months; one patient had liver metastasis on follow-up, started on targeted therapy and is alive [Graph 2]. Deaths during follow-up were due to cardiac-related event in one patient and acute respiratory distress syndrome in one patient. Finally remaining 31 patients are alive and well, giving a 5-year overall survival (OS) rate of 93.9%.

DISCUSSION

Conventionally, PN was reserved for single anatomical or functional kidney and bilateral renal masses, chronic renal impairment, and hereditary RCC syndromes. Advancements in surgical techniques have now allowed elective localized unilateral renal mass (healthy contralateral kidney) to undergo OPN.[2,3]

Since minimally invasive techniques are widely used for elective T1a and simple T1b lesions, cases being considered for OPN may have evolved to a more difficult case-cohort. Independent studies by Gill *et al*., Ghoneim *et al*., Ebbing *et al*., and Campbell *et al*. have reported rates of cases with imperative indications for OPN ranging from 23% to 54%.[9,10]

The last two decades have witnessed many changes in the techniques of OPN as well. Cold ischemia is no longer used routinely, but it is an invaluable technique to reduce the risk of renal injury and prolong the resection period without compromising post-operative renal function.[11] We did not use cold ischemia for any of the cases. Off-clamp PN and parenchymal compression are novel techniques that aim to

avoid hilar clamping entirely to reduce the warm ischemia time. Renorrhaphy has evolved to include internal and external renorrhaphy. Internal renorrhaphy includes identification of vessels on the cut surface of the kidney and oversewn with absorbable sutures as required.[12] Along with watertight closure of the pelvicalyceal system. In external renorrhaphy, with single 2–0 Vicryl sutures attached at both ends with a clip (such as Hem-o-lok) and Surgical bolsters, we execute a single layer rrhaphy,a comparable method has been reported by O'Connor *et al*. and others.

Stifelman *et al*. in their study found a lack of tactile sensation in minimally invasive surgeries. Tactile feedback is an important part of surgery and for many years has relied on it for demarcating diseased parts from normal on visual or imaging clues.[13] Despite being a more "invasive" approach, performing OPN might indeed provide distinct advantages for surgeons. Haptic feedback and tactile sensation helps the surgeon to demarcate subtle areas during resection. The ability to see the kidney/tumor in all directions confers a distinct advantage of planning and higher safety margin, better control of the tumor resection bed, quicker conversion to RN, safer management of serious intraoperative adverse events, or just increased assurance about the ability to execute PN (instead of RN).[14] OPN encompasses steps that are familiar to surgeons since the beginning of surgical training, making the surgeon learning curve easier, also knowledge of OPN is necessary before undertaking a minimally invasive approach.[15]

Compared to data on the minimally invasive approach described by Shibamori *et al*.,[12] OPN had a longer surgical time of 150 min (vs. 103 min). Estimated blood loss was less, 112 ml (vs. 193 ml), probably due to better tumor bed control. Average hospital stay was longer, 5 days (vs. 2 days), and had higher complication rates. The mean size of the tumor operated in our series was 3.6 cm (vs. 3.3 cm), with higher NS tumors. Cold ischemia was not employed, and the warm ischemia time ranged from 18 to 36 min. Oncological outcomes like OS were comparable with the minimally invasive approach, with 100% in both series at a follow-up of 3 years. However, the rate of positive surgical margins was 4% in the minimally invasive approach, compared to <1% in our series. All the resected tumors were sent for Frozen Section Biopsy analysis for margin status.

The 5-year OS was 94% and which was comparable with a previous report by Ghoneim and others.[4,16,17] Complication rates after OPN, defined as a Clavien-Dindo classification of Grade III or higher in studies by Ghoneim *et al*. and Ebbing *et al*., range from 10% to 16%.[4,10] Similarly, the observed complication rate was 12.2% in the present study.

Our study of OPN has highlighted the above points with data showing oncological safety and function preservation, and low complication rates. We would like to emphasize the role of haptic feedback to the surgeon is key to success.

CONCLUSION

Our data demonstrate that OPN is still a viable option with excellent oncological and functional outcomes in simple as well as complex renal tumors in the minimally invasive surgery era.

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