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Case Series

Surgery Section

Partial Nephrectomy for Renal Cancer- A Phoenix Risen from the Ashes: A Case Series on Totally Laparoscopic Partial Nephrectomy with Review of Literature

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ABSTRACT

Partial Nephrectomy (PN), also called Kidney-sparing Surgery (KSS) or Nephron-sparing Surgery (NSS), is an operation wherein, only a cancerous renal tumour or diseased renal tissue is surgically removed; leaving behind as much healthy renal tissue as possible. Understandably, it was initially preferred in patients with solitary kidney and those, with concurrent bilateral tumours. Over the first two decades of the 21st century, PN has become the standard procedure for many renal tumours; even in unilateral disease. This is because of early pick up due to significant developments in imaging modalities and also, due to better understanding of the biology of renal tumours. With advances in minimal access surgery, partial nephrectomy too has come under its ambit. In the present case series, it's fascinating journey has been discussed- its exciting rise, subsequent downfall and then its unique rise again; as the preferred surgical therapy for many renal tumours, around the world. The purpose of reporting the present case series on Laparoscopic Partial Nephrectomy (LPN) performed for renal cancer, was to share the authors' early experience and results on the topic and to compare them with the world literature. Also, the aim was to underscore the fact that, in an advanced laparoscopy set up, with optimum patient selection and availability of advanced laparoscopic skills, it is an effective and feasible operation. Herein, the authors have described three cases of totally LPN and review of literature on the same. Over an average follow-up period of 23 months, all three patients continue to be asymptomatic and disease free.

Keywords: Laparoscopy, Nephron-sparing surgery, Renal carcinoma

INTRODUCTION

A little before the dawn of the new millenium, partial nephrectomy or NSS started off again, with a limited role only in solitary kidney with cancer and in bilateral renal cancers. However, comparable oncologic outcomes vis-à-vis recurrence rate and long term disease free survival have further expanded its indications even to patients with localised unilateral cancer, who have normal contralateral kidneys [1]. The advent of minimal access surgery at about the same time has seen LPN emerge, as the standard surgical therapy for carefully selected patients with renal cancer, all over the world.

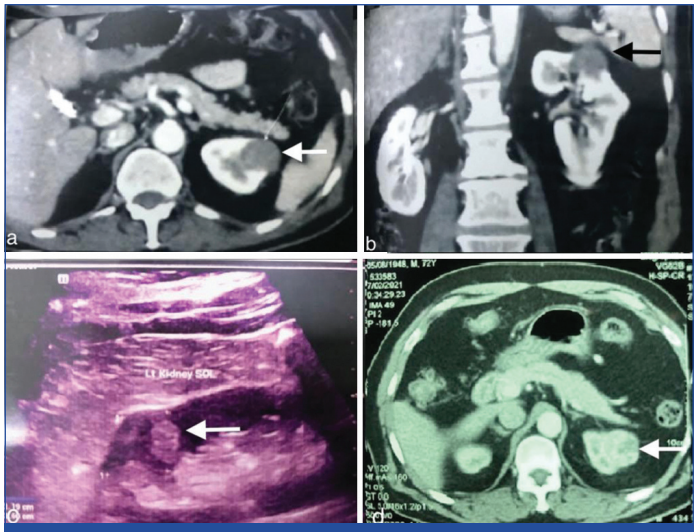
CASE SERIES

The present case series includes three patients, who presented to the Department of Urology. The patients' demographic and preoperative clinical details including investigations, operative details, histopathology reports and postoperative follow-up information of all the three patients are shown in [Table/Fig-1]. Preoperative imaging investigations of patients 1 and 2 are shown in [Table/Fig-2]. A contralateral position was the preferred patient position for this surgery. A transperitoneal approach was preferred for all the three cases, given the anterior location of the tumours and the absence of any scars of previous surgery on the abdomen. The harmonic scalpel was the preferred energy source for these surgeries. A standard four trocar technique was used for both the cases. Bulldog vascular clamps [Table/Fig-3-5] were used to clamp the renal artery and vein. The anaesthesiologist was entrusted with the responsibility of measurement and monitoring of the Warm Ischaemia Time (WIT).

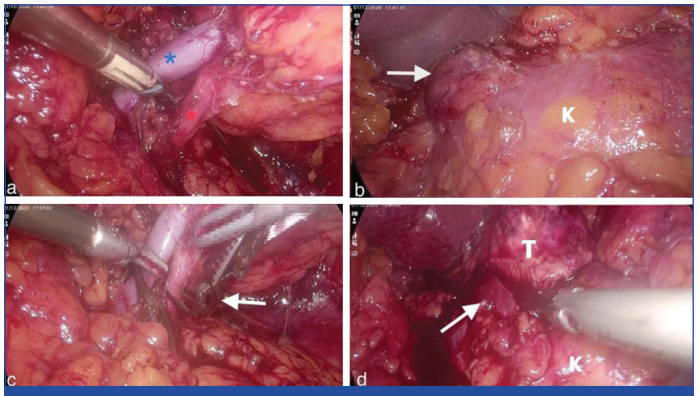
The WIT, in the present context, is a period which begins at the point of clamping of the renal pedicle and ends at the point of it's unclamping. For the kidney, it is said to be 30 minutes [2]. Prolongation of the WIT can cause long term renal dysfunction. So, the challenge in this surgery was to complete the resection of the tumour, along with the renorrhaphy within 30 minutes. Once, the renal pedicle was skeletonised [Table/Fig-3a,5a], the kidney surface over and around the tumour was bared [Table/Fig-3b] by incising

Operative details	Case 1	Case 2	Case 3
Age/Sex	70/M	72/M	59/M
Preoperative relevant signs and symptoms	None, incidental diagnosis	None, incidental diagnosis	Vague unrelated pain in abdomen, incidental diagnosis
History of present illness/past medical history	Non significant	Non significant	Non significant
CECT abdomen finding	Exophytic lesion, upper pole of left kidney	Exophytic, hyperechoic lesion, upper pole of left kidney	Irregular, thick walled, hypodense lesion in midpole left kidney
Size of tumour (mm)	28×19	32×26×29	16×21×20
Intraoperative WIT (in minutes)	30	29	30
Intra/postoperative complication	None	None	None
Histopathology report	Papillary renal cell carcinoma, WHO/ISUP grade 1, tumour free margins	Clear cell renal cell carcinoma, Fuhrman's grade 2, tumour free margins	Clear cell renal cell carcinoma- pT1, Fuhrman's grade 3, tumour free margins
Length of stay (in days)	4	4	4
Duration of surgery (in minutes)	175	165	160
Follow-up period (in months)	26	23	21

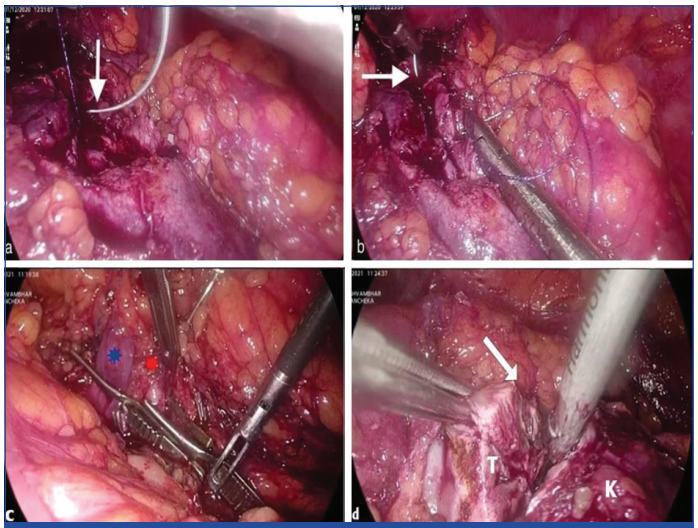
[Table/Fig-1]: Patient demographic, pre and perioperative details, follow-up.
CECT: Contrast enhanced computed tomography; WHO: World health organisation; ISUP: International society of urological pathology



[Table/Fig-2]: Patient 1: a) Shows tumour (white arrow) in axial cut of Computed Tomography (CT) scan; b) Coronal section showing left-sided tumour (black arrow) in CT scan. Patient 2: c) Ultrasonography (USG) scan showing left tumour (white arrow); d) Contrast enhancing left-sided tumour shown in CT scan axial view.

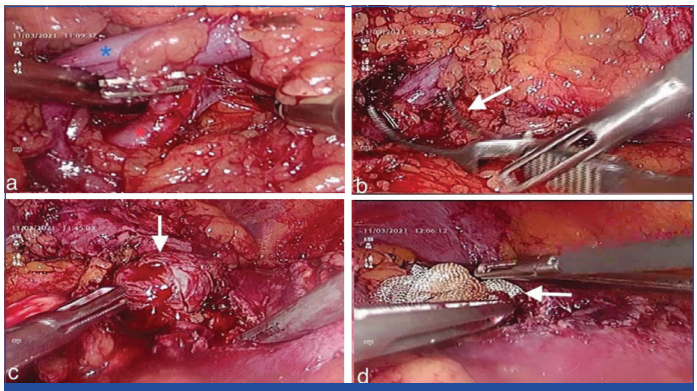


[Table/Fig-3]: Patient 1: a) Skeletonised renal vein (blue asterisk) and renal artery (red asterisk); b) Tumour (white arrow) arising from upper pole of left kidney (white 'K') after initial dissection; c) Application of bulldog clamp; d) Resection of tumour (white 'T') from upper pole of kidney (white 'K') using harmonic scalpel (white arrow).

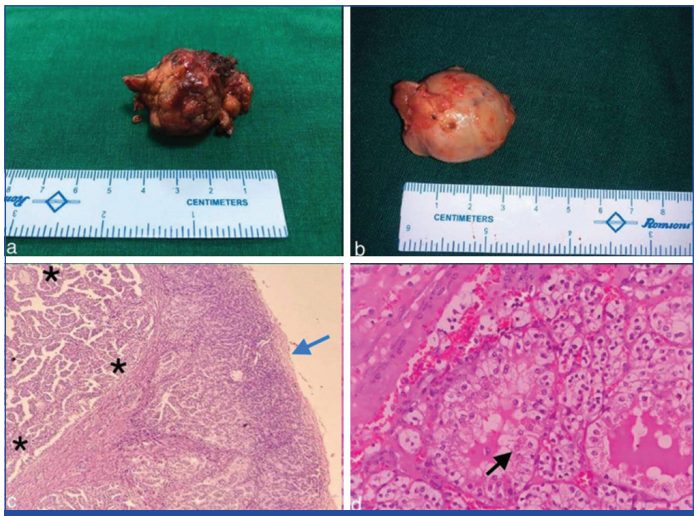


[Table/Fig-4]: Patient 3: a) and b) Shows inner layer (renorrhaphy) reconstruction with V-loc® barbed suture; c,d) c) Clamping of the renal pedicle (blue and red asterisks), d) Resection (white arrow) of tumour (white 'T') from kidney (white 'K').

the Gerota's fascia, prior to application of the vascular clamps. Injection Mannitol (20 gm, intravenous) was administered by the anaesthesiologist, just before applying the vascular clamps over the renal pedicle. Once, the tumour was excised [Table/Fig-6], it was sent immediately to the laboratory for a frozen section analysis of the resection margins. The resected margins were free of tumour invasion, in all the cases. The renorrhaphy [Table/Fig-4a,b] was performed using 3-0 V-Loc® barbed suture in two running layers. Hem-o-lok clips were used to secure the exiting suture at the end of the running suture line. Haemostasis [Table/Fig-5d] was confirmed, after releasing the vascular clamps applied over the renal pedicle.



[Table/Fig-5]: Patient 2: a) Renal vein (blue asterisk) and renal artery (red asterisk) after hilar dissection; b) Application of bulldog clamp; c) Dissection around the tumour; d) Achieving haemostasis.



[Table/Fig-6]: a) Specimen of patient 1; b) Specimen of patient 2; c,d) Histopathological evaluation slides- stain: Haematoxylin & Eosin; c) Patient 1 (low power)-Circumscribed tumour (black asterisks) with prominent pseudocapsule (blue arrow); d) Patient 2 (high power)- Clear cells with distinct cell membrane, tiny nucleoli and irregular nuclear membrane (black arrow).

The specimen was retrieved from the widened lowermost (assistant's) trocar site. A 32 French (Fr) Romsons tube drain was kept in-situ and brought out through the surgeon's right hand working trocar site. There was no urinary leak or haemorrhage and the drain was removed on Postoperative Day (POD) 3, in all the cases. The per-urethral catheter was removed on POD 2. On their respective POD 10, outpatient department visits, all their operative wounds had healed well. At the time of writing the present case series, a telephonic interview was conducted with all three patients. Over an average follow-up period of 23 months, till date; all three patients continue to be disease free.

DISCUSSION

Although, the first partial nephrectomy for cancer was performed over 130 years ago (Czerny, 1887, for renal angiosarcoma), it rapidly went off the radar as a therapeutic option, due to complications like haemorrhage (both primary and secondary) and urinary leaks/fistula formation. Due to lack of preoperative diagnostic imaging tools in that era, most renal cancers were detected and operated upon, at an advanced stage. This changed in the second half of the 20th century. With the invention of cutting edge diagnostic tools such as, Computed Tomography (CT) (Hounsfield & Cormack, 1972) and Magnetic Resonance Imaging (MRI) (Damadian, 1977), more renal cancers started getting detected incidentally at a very early stage (from the 1980s onwards). In addition, around 1950, it was discovered that, clear cell renal carcinomas arise from the cortex, are localised and encapsulated and rarely invade surrounding

structures [3]. Also, a study showed that, comparatively a very small percentage of the smaller (<5 cm) renal tumours metastasized as against the larger (>10 cm) ones [1]. An elegant microscopic study by Vermooten V proved that, many tumours could be excised with only a 1 cm margin, without fear of local recurrence [4]. The 1960's saw significant improvement in the surgical technique of PN, due to a better understanding of the segmental renal blood supply. Introduction of renal hypothermia around the same time prevented ischaemic damage and allowed longer, complicated reconstructions in relatively bloodless fields. Additionally, use of the argon beam coagulator and intraoperative ultrasound afforded lesser haemorrhage and more precise surgery, respectively. Thus, it was a serendipitous combination of discoveries and inventions (starting from around 1950), which led to better imaging, better understanding of tumour biology and better haemostatic techniques, which in effect led to a resurgence of PN towards the end of the 20th century; as ably validated by many objective outcomes studies (Herr HW, Lict MR et al.,) [1,5]. The minimal access surgical revolution which kicked off in Europe in the late 1980s further enthroned LPN as the standard surgical therapy in many select cases. Robot Assisted Partial Nephrectomy (RAPN) took off in the new millennium [5]. A distinct technical advantage of RAPN over LPN seems to be Three Dimensional (3D) vision and easier suturing. However, most comparative outcomes studies have shown the two to be at par. The concept of zero ischaemia or minimum ischaemia has helped surgeons perform PN without clamping the pedicle (by using hypothermia and/or compression) or selective clamping of the feeding segmental vessel. This has further helped alleviate ischaemic damage to the remnant kidney, as measured objectively by Glomerular Filtration Rate (GFR) at different times in the postoperative period [6].

The future holds further refinements in imaging technology as 3D reconstruction of helical CT and MRI images have already arrived. Also, augmented reality systems give side by side images of live intraoperative USG pictures and their corresponding CT slice images, in the operating room while the surgery is on. Predictive surgical navigation systems, which can potentially guide the safe dissection line for an accurate tumour excision in PN are being developed and refined. Akin to Global Positioning System (GPS) systems in motor vehicles, predictive surgical navigational systems utilise the combination of preoperative 3D imaging with intraoperative ultrasound to guide the tip of surgical instrument to the target (i.e., tumour) and may assist in determining the surgical anatomy beyond what is directly visible to the surgeon. This will revolutionise reconstructive surgeries like PN. Image guided robots are extensions of the same. The Holmium: Neodymium-doped Yttrium Aluminum Garnet (Nd: YAG) laser has shown promising results in the porcine model for PN vis-a-vis bloodless dissection. Various nephrometry scoring systems have evolved like the RENAL Nephrometry Score (RNS), Padua Predication Score (PPS) and the Concordance-index (C-index). The RENAL and PPS scores are identical and involve assigning points based on various tumour characteristics. The C-index considers tumour size and proximity to the renal hilum. These have shown good correlation with WIT, peri-operative complications and postoperative GFR. Thereby, objectively predicting difficulty levels and permitting precise comparisons of individual surgical variations with outcomes [7]. A review of recent literature on LPN is summarised [Table/Fig-7] [7-12].

Authors	Journal (Year)	Type	Methods	Conclusion(s)	Miscellaneous
Pietzak A et al., [7]	Advances in Urology (2012)	Review article	Review of latest LPN literature to enlist steps to widen its horizon	*3D recons of helical CT scans and MR angiography give excellent relation of tumours with collecting system and renal vasculature *Augmented reality navigation systems fuse preoperative imaging with intraoperative real time USG images-very helpful in understanding anatomy	*Strategies to reduce ischaemia: a) No clamp; b) Use of focal radiofrequency coagulation; c) Induced hypotension, d) Induced hypothermia; e) Compression of renal parenchyma near tumour; f) i.v. Mannitol/Furosemide. *For better haemostasis a) Fibrin sealants; b) Floseal; c) PEG based sealants; d) Albumin-glutaraldehyde based sealants. *For objective positive prediction regarding feasibility of PN:RENAL, PPS scores, C-index etc.
Gurram S et al., [8]	Journal of Endourology (2020)	Review article	Comparison of outcomes study of various series between OPN and LPN	*WIT more in LPN *Duration of surgery, length of hospital stay shorter with LPN *Blood loss lesser with LPN *Larger tumour sizes treated with OPN	*Absolute indications: solitary kidney, B/L tumours. *Relative indications: a) Hereditary cancers like VH-Hereditary papillary RCC etc., b) CKD; c) Pre-existing predisposing conditions-uncontrolled HT,DM; d) Recurrent urolithiasis, e)Morbid obesity. *Relative contraindications: a) Tumour invasion in renal vein, IVC, b) Uncorrectable coagulopathy.
Zhao PT et al., [9]	International Journal of Surgery (2016)	Review article	All aspects of LPN were discussed	*Intraoperative CT/MRI useful in confirming laterality and for decision making *Intraoperative USG very useful to assess margin, depth of larger endophytic tumours	*Off clamp approach for smaller peripheral tumours to minimise ischaemic damage. *Selective clamping of segmental artery in cases with central hilar tumours and multiple extrarenal arteries, again to minimise/negate ischaemic damage. *No known threshold for WIT-3 Q's: quality, quantity and quickness.
Dominguez-Escrig J L et al., [10]	J Min Access Surg (2011)	Review article	Surgical outcomes, patient demographics, complications between OPN and LPN were compared	For T1 tumours in a solitary kidney, outcomes of OPN superior to LPN such as GFR decrease, postoperative dialysis requirement and complications	Predictors of poor postoperative renal functional outcomes in LPN: a) Pre-existing renal disease, b) Age >70 years, c) WIT >30 minutes, d) Reclamping of renal artery, e) WIT >60 minutes.
Li M et al., [11]	Urologia Internationalis (2020)	Review article	Comparison of outcomes of LPN vs RAPN and TP vs RP approaches	*Outcomes similar between LPN vs RAPN *RAPN costlier *WIT longer for tumours >4 cm	*TP better for anterior tumours, also give wide operative area, not good for posterior tumours. *RP better for posterior tumours and multiple scars of previous surgery-shorter hospital stay, faster return of bowel function. *Problems with RP are limited space and suboptimal visualisation.
Tsivian M et al., [12]	Int Braz J Urol (2017)	Review article	Retrospective review of outcomes of LPN done in localised T2 tumours	LPN for tumours >7 cm is feasible	Perioperative outcomes were favourable vis-a-vis WIT, EBL and operative time.

[Table/Fig-7]: Review of recent literature on LPN.
OPN: Open partial nephrectomy; LPN: Lap partial nephrectomy; CT: Computed tomography; MR: Magnetic resonance; USG: Ultrasonography; WIT: Warm ischaemia time, EBL: Estimated blood loss; VH-L: VonHippel-Lindau; HT: Hypertension, DM: Diabetes mellitus; IVC: Inferior vena cava; i.v.: Intravenous; GFR: Glomerular filtration rate; RAPN: Robot assisted partial nephrectomy; B/L: Bilateral; RCC: Renal cell carcinoma; TP: Transperitoneal; RP: Retroperitoneal; PEG: Polyethylene glycol; CKD: Chronic kidney disease

CONCLUSION(S)

As seen in the present study, PN is the treatment of choice in selected cases of renal cancer. Also, as is seen here, LPN is feasible in an advanced setup, when coupled with requisite laparoscopic surgical skills and optimum patient selection. Also, it is clear from the present case series that, even in one's early experience, it is possible to adhere to the tight operating time restrictions imposed by the WIT, for this operation. We stand today at very exciting crossroads of progress as laparoscopic and percutaneous energy ablation procedures promise to treat renal tumours with much lesser morbidity. Truly, the phoenix of less and less surgical tissue invasion has risen and is soaring higher and higher!

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