Original Article

Robotic-assisted laparoscopic partial nephrectomy: A single centre Indian experience

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Abstract

BACKGROUND: We summarise our experience with RPN emphasising on learning curve, techniques and outcomes. **PATIENTS AND METHODS:** A retrospective chart review of 57 patients was done. The preoperative workup included a triple phase CT angiography. The parameters analyzed were demographics, tumor characteristics, operative details, postoperative outcome, histopathology and follow-up. The data were compared with historical cohort of the laparoscopic partial nephrectomy (LPN). **RESULTS:** 58 renal units in 57 patients (45 males and 12 females) underwent RPN. The mean age was 53.08 ± 13.6 (30-71) years. The mean tumor size was 4.96 ± 2.33 (2-15.5) cm. Average operative time was 129.4 ± 29.9 (70-200) min.; mean warm ischemia time was 20.9 ± 7.34 (9-39) min. 8 renal units in 7 patients were operated with the zero ischemia technique. The average follow-up was 5.15 months (1-18). There was no recurrence. 15 patients underwent LPN. The mean tumor size was 4.3 ± 1.6 (1.6-8) cm. operative time was 230.7 ± 114.8 (150-300) min.; mean warm ischemia time was 31.8 ± 9 min. The nephromerty score in the LPN group was 7.1 ± 0.89, in the RPN group was 8.75 ± 1.21. **CONCLUSION:** Our results suggest that prior experience of LPN shortens the learning curve for RPN as seen by shorter warm ischemia time and operative time in our series. The nephrometry score in RPN were higher suggesting that complex tumour can be managed with robotic approach.

Access this article online	
Quick Response Code:	Website: www.journalofmas.com
	DOI: 10.4103/0972-9941.147701

Key words: Disease free survival, laparoscopic partial nephrectomy, robotic partial nephrectomy, warm ischemia, zero ischemia

INTRODUCTION

The management of renal masses has changed radically over the past few years. Small renal masses are treated either with open, laparoscopic and robotic approach. Open radical nephrectomy was the traditional treatment for management of renal malignancies in the past, nephron sparing surgery has become the standard of care for T1a renal masses.[1] The choice of approach still remains a matter of surgeon preference and is dictated by the complexity of the lesion. Laparoscopic partial nephrectomy (LPN) has been performed at a number of centres of excellence with good results. The obvious advantages of minimally invasive surgery are evident in laparoscopic approach, however, the downside of LPN is that it is technically challenging with a longer learning curve.

Robotic surgical assistance has been used to perform this complex reconstructive procedure in a minimally invasive approach. Robotic partial nephrectomy (RPN) has been the prime example in which a complex open procedure may be reproduced with robotic assistance in a minimally invasive fashion. The robot allows easy intra-corporeal dissection and suturing because of its wristed and articulating instrumentation. In this article, we have summarised our initial experience with RPN emphasising on learning curve, techniques and outcomes.

MATERIAL AND METHODS

A retrospective chart review of 57 patients who had undergone RPN from September 2010 to April 2013 was performed. The pre-operative workup included a haemogram,

urine examination and a triple phase computed tomography (CT) angiography. The CT angiography helped in ascertaining the location of the tumour in relation to the pelvicalyceal system and in assessing the tumour in relation to the vascular anatomy. In addition, it also helped to prime the surgeon regarding the possible approach. The patient was counselled regarding the various approaches. All locations, including hilar [Figure 1] and posterior underwent the procedure. The parameters analysed were patient demographics, pre-operative tumour characteristics, operative details, post-operative outcome, histopathology and follow-up. A renal nephrometryscore was calculated for all the patients.

Surgical Technique

Transperitoneal approach was used in all cases. A three-arm approach was used. The da Vinci 'si' system was used in allcases. The port placement configuration included a 12 mm port for robotic camera, two 8 mm ports for robotic retracting and cutting instruments. A 12 mm assistant laparoscopic port was used for inserting hem-o-lok clips; the same port was used for suction, which was done by the assistant [Figure 2]. In the initial 32 cases, a 12 mm port was used for introduction of laparoscopic Satinsky clamp, since then we have been using the robotic bull dog clamp, in effect decreasing the need for an additional port. The four arm approach was used in select cases, particularly in those cases in which zero ischaemia RPN was done with micro vascular dissection.

The procedure in brief was as follows, a ureteric catheter was placed in all cases prior to positioning the patient on the table. The renal hilum was dissected so that a Satinsky clamp could be applied to include enbloc for the hilar tissues, if a zero ischaemia approach was not contemplated, the vessels were not bared. Thereafter the renal tumour was scored; the intra-operative ultrasound was a useful tool for this purpose. The tumour was excised with bipolar scissor and the collecting system was over sewn with 2-0 Vicryl (Ethicon Inc, Cincinnati, USA) suture. The renal parenchyma was sutured with 0-vicrylCT1 (Ethicon Inc) suture in two layers [Figure 3]. In all patients'closure was confirmed by injecting methylene blue from the preplaced 6Fr ureteric catheters to ensure that the collecting system was closed.

Post-operative management included analgesia with tramadol. A renal Doppler was done on first or second post-operative day in all patients. Patients were discharged when they started tolerating a regular diet and the bowel function returned.

We were mentored in our initial cases by MMD. The proctored mentoring programme included review of videos and attending fellowship/training programmes.

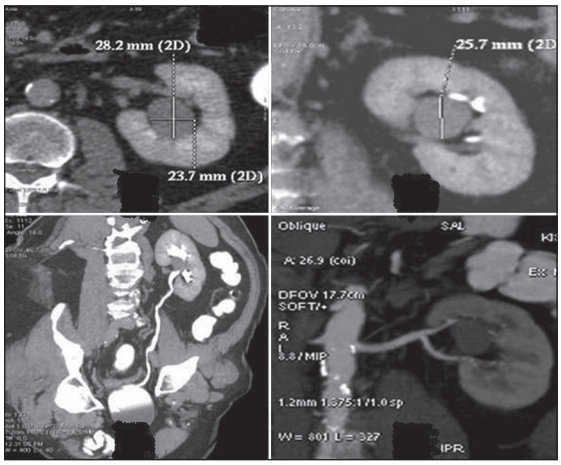

Figure 1: CT angiography helps in assessing the feasibility and approach to the mass

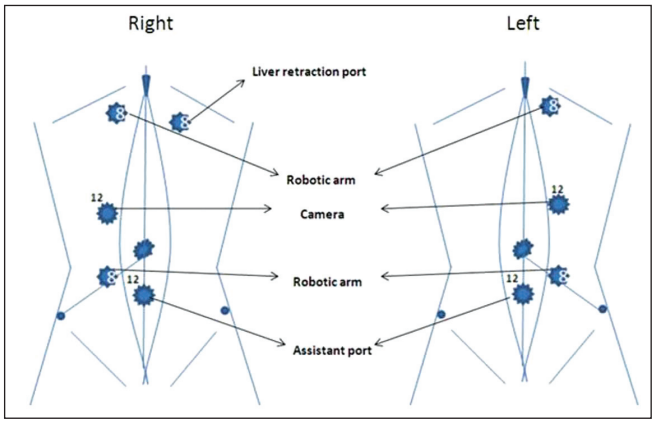

Figure 2: Port positioning on right and left side

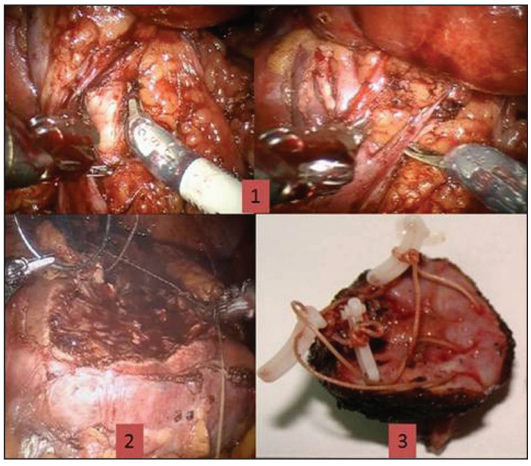

Figure 3: Robotic assistance helps in dissecting tertiary and quaternary branches

RESULTS

A total of 58 renal units in 57 patients (45 males and 12 females) underwent RPN. The mean age of the patients was 53.08 ± 13.6 (30-71) years. A total of 23 patients had tumours

on right, 31 patients had tumours on the left and 3 patients had bilateral renal mass. Location wise the distribution was as follows: Upper pole (n = 21), midpole (n = 19), lower pole (n = 17) and 1 had hilar mass. The mean tumour size was 4.96 ± 2.33 (2–15.5) cm. We operated on two patients with a solitary kidney.

Average operative time was 129.4 ± 29.9 (70-200) min. During resection of the tumour mean warm ischaemia time was 20.9 ± 7.34 (9-39) min. Eight renal units in seven patients were operated with the zero ischaemia technique. No major intra-operative event occurred in any patient. The distribution of location of tumours that underwent zero ischaemia partial nephrectomy was as follows: Three upper pole, one hilar, two mid polar and two lower polar.

The mean haemoglobin drop was 1.8 ± 1.12 (0-4.6) mg/dl. Average analgesic requirement was 137.7 ± 42.55 mg of Tramdol. Among the six patients who had post-operative urine leak from the drain site, three patients were managed with a DJ stent and rest responded to conservative treatment. One patient developed an upper ureteric stricture. He presented with flank pain and subsequent imaging and work up showed an upper ureteric stricture, he required an ureteroureterostomy. One patient had pulmonary embolism and was managed conservatively. Average hospital stay was 6.4 ± 1.8 (4-13) days. Fifty-five masses were renal cell carcinoma and three were benign (2 angiomyolipoma and 1 oncocytoma). Of the renal cell carcinomas, 33 were clear cell, 17 were papillary, 3 were chromophobe, 1 was cystic and 1 was tubulocystic. In pathological staging, 36 specimens were T1a, 16 were T1b and 3 were T2a with negative margin in all the patients.

The average follow-up period was 5.15 months (1-18). There was no local recurrence or distant metastasis in any patient and disease free survival was 100%.

The Impact of Learning Curve and Comparison with Laparoscopic Approach

On analysing the case records for the first 23 cases and then for the later 24 cases, we found that during the initial 23 cases, average operative time was 137.17 ± 28.11 min, which reduced to 124.08 ± 30.25 min in the subsequent 24 cases. During resection of the tumour, mean warm ischaemia time in initial 23 cases was 25.5 ±8.09 min, which was reduced to 18.73 ± 5.93 min in the last 24 cases. The mean haemoglobin drop was 2.1 mg/dl in first 23 cases and 1.6 mg/dl in next 24 cases. Average analgesic requirement was 128.26 ± 39.39 mg of Tramdol in the first 23 cases and 144.11 ± 43.97 in the next 24 cases. During the initial 23 cases, 2 patients had fever, 1 patient had Ileus, 3 patients had post-operative urine leak, 1 patient had upper ureteric stricture and required an ureteroureterostomy. During the subsequent 24 cases, 1 patienthad Ileus, 3 patients had urine leak, 1 patient had pulmonary embolism and was managed conservatively.

On comparison with a historic cohort of LPN series done by the same surgeon, we found the warm ischaemia time, operating time was significantly less in the robotic group [Table 1]. The nephromerty score in the LPN group was 7.1 ± 0.89, while in the RPN group it was 8.75 ± 1.21.

DISCUSSION

RPN has emerged as a minimally invasive alternative to nephron-sparing surgery. Studies have shown that the transition from LPN to RALPN can be undertaken without an additional learning curve. Few studies further confirm that the transition from LPN to RPN is rapid in an experienced laparoscopic surgeon;[2] our results confirm these findings.

Unlike open approach, the robotic or laparoscopic approach lacks the tactile feedback and visual cues required for accurate localisation and excision of the tumour. In minimally invasive approach (laparoscopic or robotic) intra-operative laparoscopic ultrasonography is useful for tumour localisation [Figure 3c], the ultrasound probe is controlled by the bedside

Table 1: Comparison between laparoscopic and robotic assisted laparoscopic partial nephrectomy

Parameters	LPN	RALPN
Total	15	58
Nephrometry score	7.1±0.89	8.75±1.21
Operative time (min)	230.7±114.8 (150-300) min	129.4±29.9 (70-200) min
Warm ischaemia time (min)	31.8±9 min	20.9±7.34 (9-39) min
Zero iscahemia	0	08
Mean haemoglobin drop (mg/dl)	2.35±1.09 mg/dl	1.8±1.12 (0-4.6) mg/dl
Benign pathology	05	03
Malignant pathology	09	55
Clear cell	05	33
Papillary	03	17
Chromophobe	01	03
Cystic	00	01
Tubulocystic	00	01
Pathological stage		
pT1aNx	06	36
pT1bNx	04	16
pT2aNx	00	03
Margin status		
Free	15	55
Positive	00	00
Avg. hospital stay (days)	7.4±2 days	6.4±1.8 (4-13) days
Recurrence	02	00

assistant and the console surgeon does not have control over this probe. In every case, we used intra-operative ultrasound to get a "roadmap" of the tumour. The technique of intra-operative ultrasound changed as we ascended our learning curve. Initially we used an intra-operative ultrasound probe introduced through a 12 mm port; the disadvantage of this technique was that the console surgeon had to remain dependent on the bedside assistant for delineating the margin. The recent addition in the armamentarium is a 'drop down' probe for assessing the margins. The probe can be manipulated by the console surgeon himself with the help of grasper or a prograsp forceps. The advantage of the drop down probe is the ability of this probe to scan the tumour surface along the contours of the tumour. In a recent study, the authors have described their experience and efficacy with robotic ultrasound probe tumour localisation and scoring. They conclude that the use of a robotic ultrasound probe during partialnephrectomy allows the surgeon to optimise tumour identification with maximal autonomy.[3] We always use intra-operative ultrasonography to score the tumour and excise the tumour with margin of normal renal parenchyma. As a routine, we do not send frozen sections; however, in select cases such as large tumours and if the surgeon has an intra-operative doubt regarding the margins we send frozen section.

We performed zero ischaemia RPN in hilar tumours, solitary kidney with endophytic tumours and cases with bilateral tumours. The principle steps included pre-operative assessment of anatomy with 3D reconstructed CT scan [Figure 1d], hilar dissection of quaternary and tertiary arteries [Figure 3a and b], use of intra-operative ultrasound (drop down or standard probe)and selective clamping of vessels. Leslie *et al*., compared outcomes of 22 patients undergoing zero-ischaemia RPN/LPN with anatomic vascular micro dissection. This study demonstrated that anatomic vascular microdissection and control of tumour-specific renal arterial branch(es) enabled zero-ischaemia RPN even for challenging medial or hilar tumours without hilar clamping.[4]

There is a paucity of randomised studies comparing the outcome of laparoscopic approach with the robotic approach. Benway *et al*.,[5] Wang *et al*.,[6] and Kural *et al*.,[7] in their series noted a significantly less blood loss, warm ischaemia time and hospital stay in the RPN cohort as compared with the LPN cohort.

Although the choice of approach is a matter of surgeon preferences the approach can be decided by applying the renal nephrometry score.[8] Renal nephrometry scores helps in deciding the approach of small renal masses. Robotic approach had a higher score in our study suggesting that robot helps in dealing with difficult tumours such as hilar tumours, relatively large posterior tumours.[9] We had six patients who had post-operative urine leak. We usually avoid placing stents to avoid leaks as far as possible, however, if a significant amount of pelvicalyceal system (PCS) is opened up and we are dealing with special situations such as tumours encroaching the PCS in solitary kidney or tumours in both the kidneys, we place stents. From a technical standpoint, we close the PCS after confirmation by instillation of methylene blue with absorbable sutures in all cases. We also had a patient with post-operative upper ureteric stricture, which is a rare complication. This was a 63-year-old male patientwho had right lower pole posterior and left mid pole exophytic tumour. We planned for zero ischaemia RPN. During the procedure on the right side, there was a cautery injury to the ureter and this may be the probable cause for upper ureteric stricture. The strategy to prevent such a complication would be to identify the ureter particularly while operating on lower polar tumours.

RPN requires the presence of a skilled bedside assistant who preferably should be an expert in laparoscopy. The assistant helps in applying clips, suctions and keeps the surgical field clean. In addition, the assistant also helps in trouble shooting at the bedside. Anteriorly located mid or lower polar exophytic tumours should be selected during the initial learning curve. Posterior location, upper polar and hilar tumours (high nephrometry score) require advanced skill set and experienced proctors. We feel prior experience with laparoscopy will definitely help in blunting the learning curve on the robotic platform. The high capital cost and the maintenance cost can be overcome with increased volume of cases.

CONCLUSION

Our results suggest that prior experience of LPN shortens the learning curve for RAPN as seen by shorter warm ischaemia time and operative time in our series. The nephrometry score in RAPN were higher suggesting that complex tumour can be managed with robotic approach. Robotic assistance allows urologists to perform RPN with improved precision and dexterity.

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Cite this article as: Ganpule AP, Goti AG, Mishra SK, Sabnis RB, Desai MM, Desai MR. Robotic-assisted laparoscopic partial nephrectomy: A single centre Indian experience. J Min Access Surg 2015;11:78-82.

Date of submission: 10/07/2013, **Date of acceptance:** 10/09/2013

Source of Support: Nil, **Conflict of Interest**: None declared.