

Case Report

Re-visiting laparoscopic radical nephrectomy- the past, present and future: case report and review of literature

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ABSTRACT

Laparoscopic radical nephrectomy (LRN) has since long proven its therapeutic credentials in the field of renal cancer. Since the first reported case of LRN thirty years ago, it has stood the test of time. With the development of newer energy sources, better optics and ergonomically superior instruments, it has further established itself as the milestone or the landmark with which all future variations in the field of renal cancer surgery would be compared. Newer procedures such as retroperitoneoscopic radical nephrectomy, laparoscopic partial nephrectomy, robotic radical nephrectomy and partial nephrectomy and few other more conservative procedures such as radio-frequency ablation, cryo-ablation etc. are examples of these variations. In this paper, we present a case report on laparoscopic radical nephrectomy, review literature on the subject and delve into comparisons with newer procedures vis-à-vis their individual pros and cons. Through this study we are portraying the past, present and future of laparoscopic radical nephrectomy.

Keywords: Laparoscopic radical nephrectomy, Retroperitoneoscopic, Robotic, Partial nephrectomy, Cryoablation, Radiofrequency ablation

INTRODUCTION

The first laparoscopic nephrectomy was performed in 1990. This was rapidly accepted world-wide and became a viable alternative for the surgical management of T1 renal tumors. LRN is considered as the gold standard for management of patients with T1 renal cell carcinoma (RCC) who cannot be considered for nephron-sparing surgery (NSS). Over time, minimally invasive approaches have been also used for excision of larger lesions. The standard advantages of laparoscopy over open surgical approaches are well known. Intra-operative blood loss, time of hospital stay, analgesia used, and time of convalescence have all been shown to be shorter in laparoscopic surgery, without compromising on oncological outcomes. For these reasons, laparoscopic

radical nephrectomy has now been even for renal masses more than seven centimetres in size.

CASE REPORT

We hereby present a case of a 75-year-old female who presented to the OPD with chief complaint of painless haematuria on and off, for 1 month. She had no other complaints. She was a known case of diabetes with no history of any previous surgeries. Her lab reports were as follows: Hb- 9.7 g/dl, tlc- 8,500 /mm³, creatinine 1.2 mg/dl, urine routine examination showed plenty RBCs and urine culture showed no growth. She was planned for Contrast Enhanced Computed Tomography (CECT) of the abdomen which showed a growth in the upper pole of the left kidney which measured approximately 4×3×2.5 cm

with no local invasion or lymph node involvement (Figure 1).

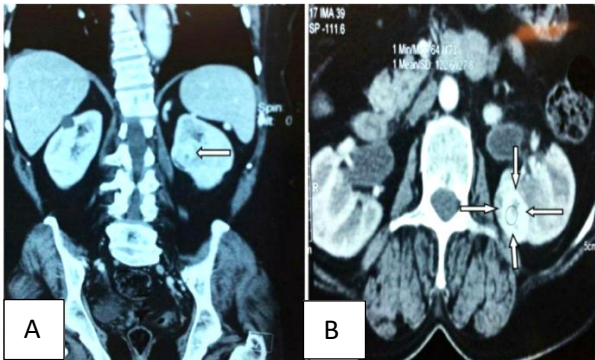


Figure 1: (A) CECT Axial view; (B) coronal view showing a left renal mass.

The patient along with her family were advised laparoscopic partial nephrectomy and were counselled that if the resection margins were to come positive, then in view of close proximity of her tumor to the renal hilum, she would need another surgery that is LRN. In view of the fact that they stayed in a remote interior town far away from the hospital, they decided to opt directly for LRN instead of NSS, presumably for the sake of logistic convenience and possibility of increasing costs. At laparoscopy there was no local invasion and the entire specimen was extracted in toto in a plastic bag after clipping and dividing the gonadal vein, ureter, renal artery and renal vein (Figure 2).

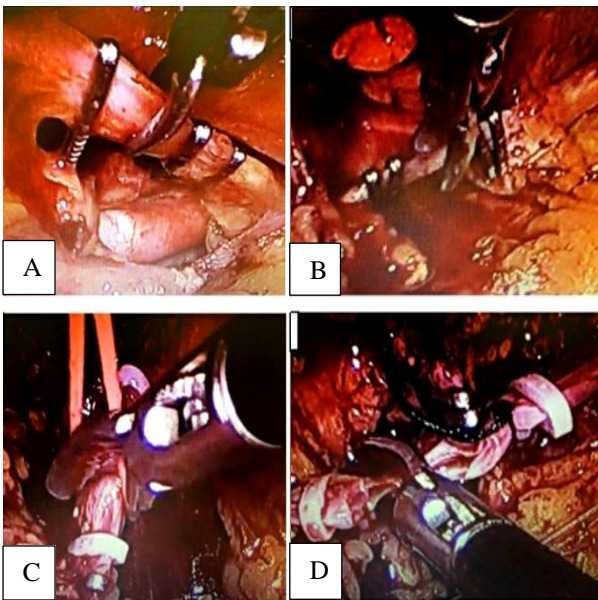


Figure 2: Intraoperative images of LRN (A) showing ligation and division of gonadal vein; (B) showing division of ureter; (C) showing ligation and division of left renal artery; (D) showing ligation and division of left renal vein.

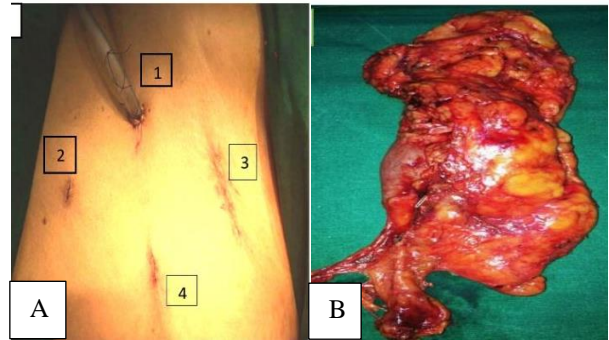


Figure 3: (A) Patient in right lateral position (1-shows rt.hand working port on site; 2-lt. hand working port site; 3- assistants 5mm port extended for specimen retrieval; 4-optic port of 10 mm); (B) Shows left radical nephrectomy specimen retrieved in toto in a bag.

The specimen was removed by extending assistant's 5 mm port site. By post-operative day (POD) 3, the drain output was 20 cc serous fluid and was removed. She was discharged on POD 4. The histopathology report stated a 5×2×1.5 cm growth and was graded according to Fuhrman's nuclear grading as grade 2 and according to TNM staging it was a T1AN0M0 (Figure 4). The patient had an uneventful post-operative recovery and did not require any further interventions. On her OPD follow up on POD 10, she was stable with no complaints. A telephonic interview was conducted with her at the time of writing this paper. Three years after her surgery, she continued to be asymptomatic.

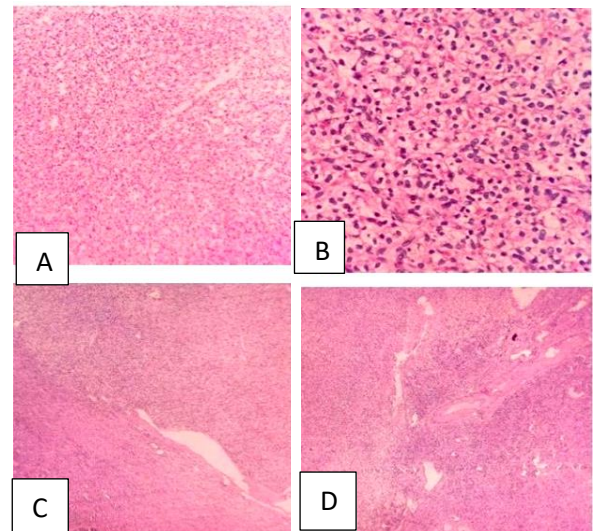


Figure 4: (A) View of nests of clear tumor cells under 10X; (B) view of clear tumor cells with very few of them revealing inconspicuous nuclei; (C and D) Low power view of fairly circumscribed tumor with adjacent normal renal parenchyma.

Table 1: Summary of review of recent literature on renal cancer surgery.

Authors (ref. no.)	Journal (year of publication)	Type of Study	No. of pts.	Mode of surgery	Conclusions/observations
Burgess et al¹⁹	Journal of Endourology (2007)	Randomized control trial	45	Lap vs Open (loin incision)	LRN is associated with lesser postoperative pain and a faster return to normal activities
Colombo Jr et al²⁰	Urology Journal (2008)	Comparative study	116	Lap vs Open	Comparable long term oncologic and renal function outcomes
Hemal et al²¹	Journal of Urology (2007)	Comparative study-only T2N0M0 pts.	112	Lap vs Open	Similar long-term results
Dunn et al²²	Journal of Urology (2000)	Comparative study	94	Lap vs Open	Similar efficacy at 2 yr. follows up for patients with T1 and T2 tumors
Park et al²³	World Journal of Urology (2015)	Randomised controlled trial (localised RCC)	35	Lap vs LESS	Equivalent surgical outcomes & improved postop. quality of recovery in LESS
DeLong et al²⁴	Canadian Journal of Urology (2010)	Review study	28	Lap vs Robotic surgery	Decreased warm ischemia time but total operating time increased in the robotic group
Cwach et al²⁵	Investigative and Clinical Urology (2016)	Review study		Lap	Overview of advances in minimal invasive renal surgery
Fan et al¹⁰	British Journal of Urology International (2013)	Meta-analysis	18 studie-s(12 RCT's & 6 retro-spect-ive obser-vatio--nal studie-s)	Lap vs Retro-perit-oneoscopi-c radical and partial nephrecto-my	Retroperitoneal laparoscopic approach is faster & equally safe as compared to transperitoneal approach in selected pts.especially those with posteriorly located tumors
Ghani et al²⁶	British Journal of Urology International (2010)	Review study		Lap & Robotic surgery	Outline of pros and cons of robotic surgery.
Venkatramani et al²⁷	Indian Journal of Surgical Oncology (2017)	Review study		NSS	NSS is a standard of care for T1 renal masses, whenever technically feasible

DISCUSSION

LRN has come a long way since its first performance 30 years ago. Well known and well published benefits such as minimal blood loss, early mobilization, minimal post-operative pain, early discharge and early resumption of normal activities; established it as the preferred procedure over open radical nephrectomy, in eligible cases. The history of its evolution is equally fascinating.

In 1990 after multiple trials on pigs, Clayman et al successfully completed the world's first laparoscopic nephrectomy in humans at Washington university in 1990.¹ The kidney was successfully dissected and removed by morcellation. The operation lasted seven hours in total and the patient was discharged on post-operative day 6.²

In 1995 Winfield and colleagues published the first case series on laparoscopic partial nephrectomy of 4 patients.³ At the same time, the first laparoscopic live donor nephrectomy was performed by Kavoussi et al at Johns Hopkins university in 1995.⁴ In 2004, Gettman et al performed the world's first robot assisted partial nephrectomy. In 2008, Mahesh Desai and colleagues

performed the first SILS (single incision laparoscopic surgery) nephrectomy. As technology and techniques improved, the average operating time and length of stay reduced significantly. Like most new procedures, initially laparoscopic nephrectomy was slow to be adopted widely, due to increased operating time and a significant learning curve. A comparative review in 1998 concluded that 5-year survival was equivalent among open and laparoscopic nephrectomy groups.¹ LRN significantly reduced postoperative analgesia requirements (by 9 folds) and intra-operative blood loss.¹ Eventually with more widespread adoption and the increasing benefits, LRN became the gold standard for renal tumors not amenable to partial nephrectomy.¹ A large retrospective study of over 14,000 patients undergoing open versus laparoscopic total or partial nephrectomy found that patients undergoing laparoscopic surgery had decreased rates of surgical site infection, sepsis, pneumonia, return to the operating room, need for blood transfusion and shorter length of stay.^{1,5} But laparoscopic approach is used only if tumors involve only the kidney with no lymph node involvement or spread to the adrenals.

With increasing recognition of the advantages NSS in terms of oncologic and superior renal function outcomes, there is an increased acceptance to perform laparoscopic partial nephrectomy.⁶ At first reserved only for bilateral renal masses or solitary kidney with a mass, partial nephrectomy has now become the preferred procedure, whenever feasible.⁶ NSS is contraindicated for tumors more than 4 cm in diameter or if there is a nodal involvement.⁷

Gill et al in their seminal paper on retroperitoneoscopic renal surgery conclude that retroperitoneoscopy allows excellent, easy access to the hilum while avoiding breach of the peritoneal cavity, and is their preferred approach for performing most laparoscopic renal surgeries, including radical nephrectomy for cancer. A meta-analysis by Fan et al concludes that in appropriately selected patients, especially those with posteriorly located renal tumours, the retroperitoneal approach may be faster and equally safe compared with the transperitoneal approach.⁸ The steep learning curve due to the relatively restricted working space and getting used to the relatively lesser accessed retroperitoneal anatomy are potential challenges to the beginners.

In 2005, robotic radical nephrectomy was described and reported by Klingler et al for the first time.⁹ The robotic assistance was not associated with increased risk of any major complication. Its only disadvantage as compared to LRN was the prolonged operating time which also increased the hospital stay and costs.¹⁰ Initial docking of the robot for accurate positioning of the camera and the two working arms is time consuming. A limitation of the earlier generation robots was the lack of haptic feedback. As a result, sutures could be torn due to over tightening. However, the lack of haptic feedback is compensated by three-dimensional vision. The later generation robotic systems have overcome this lacuna by incorporating tensile feedback technology. The robotic surgical system has a large capital and maintenance cost. In robotic-assisted renal surgery the bedside surgeon has more responsibilities and has to be a skilled laparoscopic surgeon. The assistant might have to perform tasks such as counter-traction, irrigation, suction, insertion of sutures, application of clips, placement of clamps for hilar control, and entrapment and removal of the dissected organ. The console surgeon must be able to adjust with this sharing of the workload. In the event of a major vascular complication that requires immediate open control, the bedside surgeon should be able to perform the initial steps till the console surgeon gets scrubbed. Multiple studies of robotic versus laparoscopic partial nephrectomy have demonstrated equivalent perioperative outcomes with regards to average operative time, hospital length of stay, complications, and positive margins.¹¹ One of the biggest differences between the 2 techniques appears to be the associated cost.

A 2012 study by Yu et al found robotic partial nephrectomy to cost an average of \$1,600 more per person or an additional 6% per case compared to laparoscopic partial nephrectomy.¹² As newer generation robotic

systems iron out the pitfalls and shortcomings of the older ones, the benefits of robotic surgery, especially for challenging cases, are only too obvious.

The robotic instruments have a significantly increased range of movements than the human wrist. Also, the three-dimensional vision is a definite plus point. Even if one discounts the console surgeon's comfort factor as an obvious advantage, the above-mentioned other advantages have unquestionably cemented the role of robotic surgical systems in modern day practice of renal cancer surgery.

As life expectancy increases, the number of small incidental renal masses found on CECT scan increases and the role of observation versus intervention becomes increasingly uncertain and blurred. First, thermal or cryoablation techniques were used for small renal masses in poor surgical candidates. In the outcomes studies, it was realized that local recurrence rates of cryotherapy or radiofrequency ablation were found to be similar to partial nephrectomy, thus questioning the role of partial nephrectomy.¹³ Most recently, studies have examined the combined zero ischemia laparoscopic radio frequency ablation assisted enucleation versus laparoscopic partial nephrectomy and have found a decrease in operative blood loss, operating time and length of stay.¹⁴

Goals for the future of renal cancer management include improving outcomes, decreasing morbidity and mortality and decreasing length of recovery while trying to be cost effective and as less invasive as possible.

As technology evolves and newer instruments are designed, so will the capabilities of laparo-endoscopic single-site surgery (LESS) and natural orifice transluminal endoscopic surgery (NOTES). As robotic technology improves, new and future robots hope to include better ways to operate and complete difficult operations and also decrease the learning curve in an effort to improve and standardize patient outcomes.¹⁵

An emerging branch of surgery is computer-assisted surgery, which is the integration of computer technology for pre-surgical planning and guiding for surgery. Future robotic applications include image-guided robots that through use of CECT, magnetic resonance imaging or ultrasound would help in reducing inadvertent organ injury such as obtaining percutaneous access for nephrolithotomy. The future of progress in laparoscopic renal surgery consists of improving and standardizing training in an effort to reduce adverse surgical events and improve outcomes. Multiple studies have attempted to investigate the best method for introducing new trainees to laparoscopy by introducing simulation techniques to reduce the learning curve.¹⁶

CONCLUSION

LRN is the surgery of choice for those renal tumors where NSS is not technically feasible. In the three decades since the first reported case of laparoscopic nephrectomy, renal cancer surgery has seen many advancements in technology and technique. With the introduction of robotics and newer

modalities, interventions for renal cancer are becoming increasingly less invasive with progressively better operative outcomes.

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