Retroperitoneal Robotic Partial Nephrectomy

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Introduction

Inception

Following Clayman et al.'s first description of transperitoneal (TP) laparoscopic nephrectomy in 1990 [1], the role of minimally invasive surgery in the retroperitoneum (RP) could not be realised till the introduction of the balloon dissector to create the retroperitoneal space. In 1994 the first complete RP laparoscopic lower pole partial nephrectomy was reported, with benefits noted in ambulation, discharge and recovery [2].

The first robot assisted RP partial nephrectomy was described in 2004 by Gettmann et al. in 2004, utilising the DaVinci robotic surgical system (Intuitive). Of 13 patients who underwent robot assisted partial nephrectomy (RAPN), 2 patients with posterior and lateral tumours underwent RP RAPN [3]. **The popularity and uptake of RP minimally invasive surgery has been slow, with a much steeper learning curve compared to TP surgery cited as a major factor**.

Current Myths and Misconceptions

The TP route is considered easier and allows the surgeon to perform in a familiar environment and a wider field (Table 1). The RP route has key advantages (Table 2) over the TP route in upper tract surgery and the aim of this chapter is to focus on the nuances of RP-RAPN and along the way dispel some of the commonly held myths and misconceptions of this approach within mainstream urology.

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Table 1 Summary of common advantages and disadvantages of TP-RAPN

Transperitoneal RAPN	
Advantages	Disadvantages
• More anatomic landmarks • Lager working space • Very anterior tumour • Anterior hilar tumour	• Manipulation of posterior tumour • Medial rotation of kidney • Bowel injury • Adhesions because of previous abdominal surgery

Table 2 Summary of common advantages and disadvantages of RP-RAPN

Retroperitoneal RAPN	
Advantages	Disadvantages
• Direct access to hilum • No peritoneal violation • Reduced risk of abdominal bowel injury • Earlier return of bowel habits • Conservation management of post-operative complications (urine leak, haemorrhage)	• Limited working space, reduced triangulation • Less familiar anatomical landmarks • Anterior tumour

Retroperitoneal Robotically Assisted Partial Nephrectomy: Technique and Tips

This section focuses on the technique and nuances in performing a successful RP RAPN. The fundamentals of our approach are as described by the team at the Vattikuti Urology Institute in Detroit, USA [4, 5].

Patient Positioning

The patient is placed in the lateral decubitus (or full flank) position. The hip, spine and shoulders of the patient are horizontally in line and positioned towards the edge of the table. The bottom leg is flexed, and the top leg may require a slight degree of flexion to avoid the risk of common peroneal nerve strain and footdrop. The location and degree of break varies across operating tables. The aim is to achieve a fully flexed table (approximately 230 °) providing maximal space between the 12th rib and the iliac crest. A general rule of thumb is to align the anterior superior iliac spine of the patient over the table break; however, this would require adjustment in patients with high BMI or those with prominent aprons. Patients with a prominent iliac crest also present a challenge, whereby positioning the hip below the level of the break often provides a better working space.

Creating the Retroperitoneal Space

The **surface landmarks required to find and create the retroperitoneal space are the iliac crest, tip of the 12th rib and the axillary lines.** The midaxillary line serves as a good reference point to adjust for patients who may have long/short 12th ribs and for those with absent 12th ribs. The placement of the ports differs subtly to the laparoscopic retroperitoneal approach, as if the camera port is too close to the 12th rib the instruments and camera tend to be too close to the kidney and result in external clashes. A 12–15 mm camera port incision is made approximately 2 cm above the iliac crest in line with the tip of 12th rib. This would broadly be in line with the mid axillary line and lateral to the triangle of petit. In the open approach the aponeurosis of the external oblique and the external oblique muscles are separated using retractors (e.g., a Kocher-Langenbeck), and the thoracolumbar fascia exposed. A curved forceps is used to penetrate this layer and enter the retroperitoneal space. One should be able to feel the 12th rib and posteriorly the belly of quadratus lumborum. The psoas muscle and the kidney may also be palpable. An alternative technique is to use a curved forceps following incision of the skin and subcutaneous tissue to penetrate both the aponeurosis of the external oblique and the thoracolumbar fascia. This provides two distinct 'pops' to suggest one is in the correct plane, and the space developed.

A balloon dilator is then inserted into the created space and, with the port facing the anterior abdomen. The obturator is removed, and the balloon can be expanded under direct vision using a laparoscope. Approximately 40 compressions are required to achieve an adequate space without compromising the peritoneum. This however will vary, with slimmer patients requiring fewer compressions and larger patients perhaps requiring up to 60 compressions. Once the appropriate space has been created the dilator is deflated and an 12 mm robotic camera port is placed.

Port Placement

Figure 1 illustrates optimal port placement for RP-RAPN. The camera port tends to be longer (120–130 mm) with a balloon and seal to secure its position. Pneumoretroperitoneum is established with CO_2 at 12–15 mmHg. The use of valveless pressure barrier insufflators such as Airseal can allow for use of lower pressures. The lateral port is inserted first, and a needle can be used to gauge angle of entry and position. This port is placed approximately 7–8 cm superolateral to the camera port in the superior lumbar triangle. The indentation found at the lateral edge of erector spinae and the inferior border of the 12th rib serve as external landmarks for this port. The medial robotic port is placed 7–8 cm often in line with the camera port. ***A consideration to make if expecting to work predominantly in the lower pole is to place the medial robotic port approximately 1–2 cm lower than the line of the camera port.*** A 12–15 mm assistant port is then placed equidistant to and 1 cm caudal to a line between the camera and the medial robotic port. This translates roughly to the anterior axillary line and should be cephalad to the anterior superior iliac spine. A fourth robotic arm can be utilised in some cases by inserting a port 2 cm inferiorly and 7–8 cm medial to the medial arm. The peritoneum overlying this area may need to be swept away using either laparoscopic instruments or blunt finger dissection. A fourth arm can be particularly useful in patients with

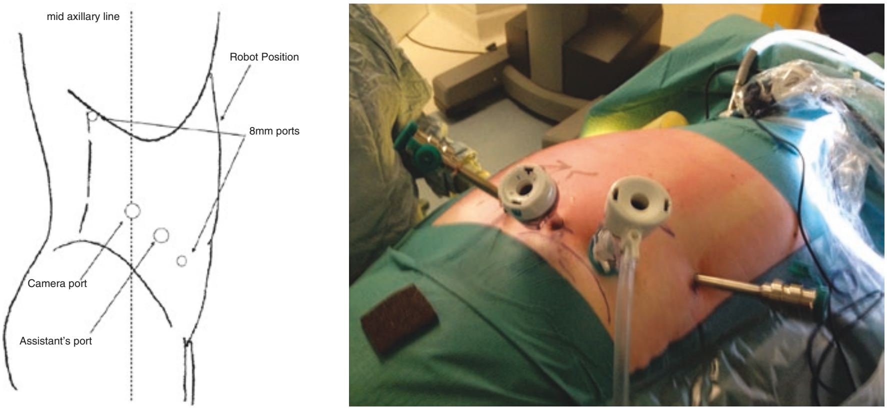

Fig. 1 Optimal port placement for RP-RAPN utilising the Da Vinci Si Surgical System (3 arm technique)

abundant perinephric fat or to allow for retraction during the warm ischaemic time to enable the assistant to concentrate all their efforts on assisting with tumour excision.

Docking

Robotic docking depends on the model that is utilised at a centre. With the Da Vinci Si the room layout should accommodate the entry of the patient side cart from over the patient's head and parallel to the patient's spine. With the Da Vinci Xi the patient side cart can be brought in perpendicular to the bed.

Initial Landmarks

Once instrument control has been gained by the surgeon on the console, orient oneself to the landmarks. **Superiorly the peritoneal fold and the transversus abdominus, inferiorly the psoas tendon and ureter, cranially the diaphragm and caudally the pelvis** (Fig. 2). An assessment of the paranephric fat should be made. **Fat management is an integral component of retroperitoneal surgery.** Where required the paranephric fat is dissected off Gerota's fascia and in some cases overhangs of fat from the peritoneal fold would also require management. When working superiorly it is important to take care so as not to breach the peritoneum.

Next Gerota's fascia is incised and entered parallel to and just above the psoas muscle. This is developed cranio-caudally in line with psoas. Dissection is then carried on cranially and caudally along the muscle to elevate the kidney and perinephric fat. Mobilising the upper and lower pole sufficiently will enable the assistant/the fourth arm to achieve optimal lift during identification of the hilum.

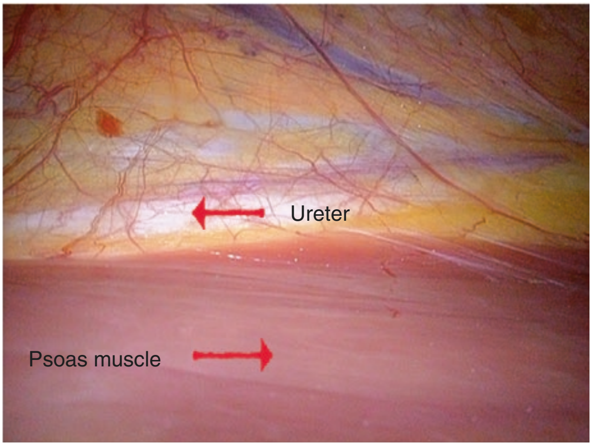

Fig. 2 Initial landmarks encountered during creation of the retroperitoneal space

Hilar Dissection

Adhering to systematic methods and similar principles to laparoscopic retroperitoneal surgery results in safe robotic retroperitoneal renal surgery. During dissection of the hilum the kidney should be placed on stretch to facilitate vessel identification and improve blunt dissection. We would recommend dissection to be parallel, in line with the direction of the vessels going from inferior to superior, to reveal the hilum. This minimises the risk of inadvertent vascular injury or bleeding from smaller vessels and tributaries. Retroperitoneally the renal artery is the first structure encountered and is mobilised to allow application of 2 vascular clamps (Fig. 3). We would recommend isolation of the artery with a vessel loop to facilitate easy location and retraction of the artery. The vein can similarly be identified and isolated, although this is not entirely necessary during retroperitoneal partial nephrectomy. As a result, ligation of the gonadal vein and any bleeding risk incurred from having to dissect or identify the renal vein (as is the case in transperitoneal surgery) is not frequently encountered.

Tumour Identification

Gerota's fascia can now be incised and mobilised off the capsular surface of the kidney to expose the tumour. There remains some debate and controversy as to the location of tumours that are accessible via the retroperitoneal route. In the experience of the authors, at high volume retroperitoneal robotic centres all tumours apart from anterior hilar tumours are accessible and manageable retroperitoneally. A key consideration in ensuring optimal access is managing the para, perinephric fat and peritoneal fold that could potentially obscure one's view. The position at which Gerota's fascia is incised to access the parenchyma is therefore quite important. For

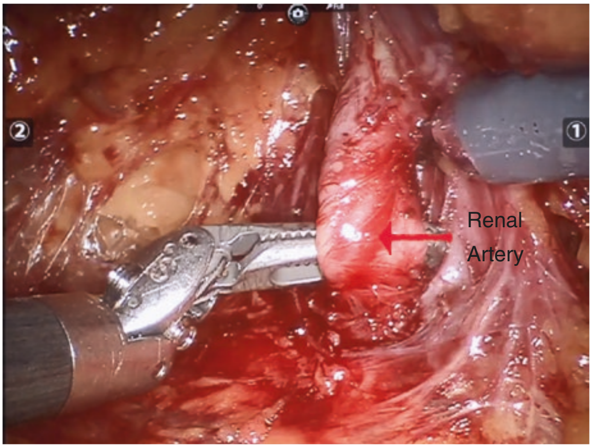

Fig. 3 Intraoperative demonstration of renal artery dissection in RP-RAPN

anterior and lateral tumours dropping the kidney from the peritoneal fold and coming onto the parenchyma at a more anterior location would mean that once the tumour has been identified and mobilised there is less overhanging fat during the warm ischaemia time. For more posterior tumours dropping the kidney this way could be counterproductive as the natural lift provided by the superior attachment to the peritoneal fold will help facilitate excision of the tumour. In these cases, one would tend to incise into Gerota's fascia 1–2 cm below the line of the peritoneal fold. Making these considerations on a case-by-case basis would result in most tumours being accessible retroperitoneally.

Intraoperative robotic ultrasound (US) can and is utilised retroperitoneally to identify the margins of the tumour and aid excision. It is particularly useful in identification of predominantly or completely endophytic tumours. The TilePro™ function displays the live US images on the console screen. Understandably the manipulation and space with which to perform intraoperative US can be restrictive and requires good co-ordination between surgeon and bed side assistant.

Hilar Clamping

All necessary material from sutures to instruments are confirmed to be present prior to hilar clamping. The ports are inspected to ensure they are within the retroperitoneal cavity, so as not to complicate instrument changes during the warm ischaemia time (WIT). The use of the osmotic diuretic Mannitol is controversial. It is thought to both improve renal blood flow and through free radical scavenging properties reduce the ischaemic insult post clamping. A 2018 prospective double-blind trial in patients with normal renal function undergoing RAPN found no statistically significant difference in renal function between mannitol and placebo [6]. Similarly using mannitol had no impact on renal function in patients with solitary kidney undergoing RAPN [7]. In our practice we had discontinued the use of intraoperative mannitol.

Clamping of the renal hilum can be performed with laparoscopically applied bulldog clamps (Fig. 4) or robotically applied bulldog (Klein/Scanlan) clamps. Although ex-vivo studies have claimed robotically applied clamps to provide less clamp force and allow more flow across a clamped segment compared to their laparoscopic counterparts [8], this does not translate into poorer haemostasis in-vivo. Their use has been shown to be safe, feasible and non-inferior to laparoscopic bulldog applicators [9].

The main renal artery is clamped first prior to clamping the renal vein. Not all centres / surgeons preferentially clamp the renal vein. Small exophytic tumours could also be tackled off clamp. Selective arterial clamping (SAC) remains controversial [10, 11]. The rationale is that the limitation of global ischaemia to the kidney reduces the ischaemic damage and improves the long-term functional outlook. SAC is often paired with Indocyanine Green (ICG) instillation and utilisation of Da Vinci's integrated fluorescence capability, FireFly ™, allowing visual assessment of perfusion to the tumour. Paulucci et al. conducted a multi-institution prospective study comparing main arterial clamping (MAC) to SAC in matched patients and found no statistically significant difference between the two [12].

Tumour Excision

Tumour excision is conventionally carried out using sharp dissection with a rim of normal parenchyma to minimise a positive surgical margin. In encapsulated tumours, enucleation can be carried out once onto the right plane, removing the tumour en-bloc with an intact capsule.

Renorrhaphy

Traditionally a 2-layer renorrhaphy is employed for closure. The monopolar scissors and if required the left robotic arm instrument are replaced for robotic needle drivers. Sutures are anchored with a knot and a Hem-O-Lok clip. A continuous

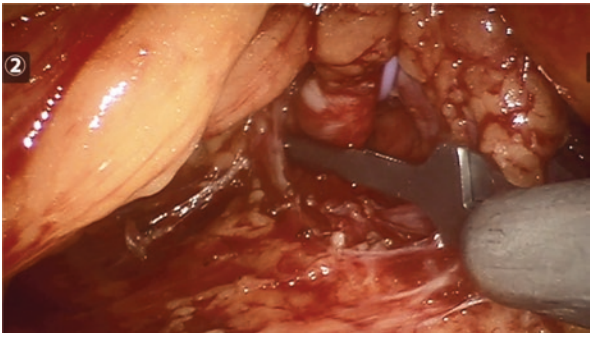

Fig. 4 Intraoperative demonstration of main artery clamping using laparoscopic bulldog applicators in RP-RAPN

inner/deep renorrhaphy is performed using either a braided suture (polyglactin) or a monofilament (poliglecaprone 25) in a continuous fashion. The sutures are secured with a Hem-O-Lok clip using the sliding clip technique [13]. We utilise a 2–0 poliglecaprone 25 in our practice. The advantage of a monofilament suture is the ability to tighten the renorrhaphy retrospectively if required. The outer renorrhaphy is similarly closed using either interrupted or continuous sutures. It is important to ensure the renal capsule is included in this layer to allow adequate tension of the sutures for haemostasis and closure of the defect. We utilise a 1–0 polyglactin suture for the outer layer.

Considerations to be made during retroperitoneal surgery include the direction of travel of the sutures. A general rule of thumb would be to suture from the far end of the defect towards you to prevent instrument clashes and a more awkward angle when progressing with the renorrhaphy. This way the left hand can utilise the previous suture to manipulate the kidney and the defect to an angle that would facilitate easier ergonomics when suturing.

In some centres barbed v-loc sutures have replaced traditional braided and monofilament sutures. The perceived benefit lies in maintaining the applied tension, and has been shown in studies to reduce mean WIT by a statistically significant 6.2 min [14].

Repair of any collecting system entry can be performed either individually or during the inner renorrhaphy. The sliding clip renorrhaphy has seen a steady elimination of the need for collecting system repair (Fig. 5). Omitting collecting system repair and utilising the sliding clip technique reduces the mean WIT with no difference in rate of post-operative complications and urine leak [15]. A contemporary review of factors influencing urine leak in 975 patients who underwent partial nephrectomy found open surgery, high estimated blood loss and not utilising a sliding clip renorrhaphy technique to increase this risk [16].

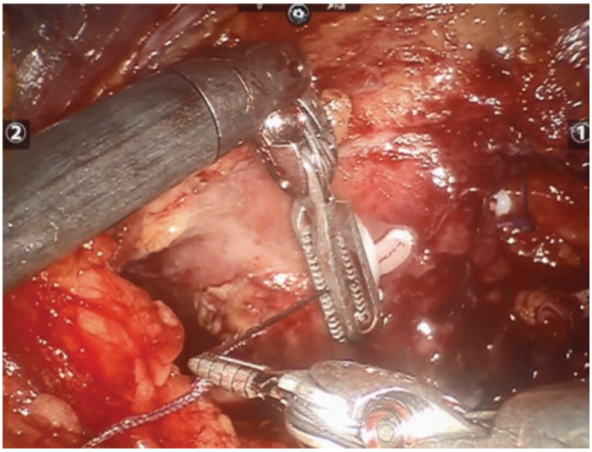

Fig. 5 Intraoperative demonstration of the sliding clip outer renorrhaphy in RP-RAPN

Hilar Unclamping and Tumour Retrieval

After completion of the renorrhaphy the hilar clamps are removed - the renal vein clamp should be removed first in cases where it is applied. Any persistent bleeding can be overcome by cinching the Hem-o-Lok clips to tighten the sutures. Further interrupted sutures can be added if required for haemostasis.

Early unclamping, after successful completion of the inner renorrhaphy, can be utilised to reduce the WIT. This method can also allow for supplementary re-enforcement of the inner layer if required.

The renorrhaphy bed can be further supplemented with haemostatic adjuncts. These are particularly useful in the case of oozing from the parenchymal edge. There are a wide range of absorbable haemostatic agents, haemostatic matrix, fibrin sealants and other adjuncts available for use. In our practice TISSEEL™, FLOSEAL™ (Baxter), VISTASEAL™ and SURGICEL SnOW™ (Ethicon) are the more commonly used agents.

A surgical drain can be left if required. In retroperitoneal surgery we tend not to do so. The tumour is placed in a specimen retrieval bag (Endo Catch™) and retrieved through the 15 mm assistant port. The overlying fascia and skin are closed.

Post-Operative Care

An enhanced recovery pathway (ERP) is utilised post-operatively centring on early mobilisation and return to a normal diet. Discharge criteria include tolerating a normal diet, mobilising and adequate oral analgesia. The median length of stay in our centre for RP-RAPN patients is 1 day.

Is RP-RAPN Safe, Efficacious and Affordable?

The choice of approach when tackling partial nephrectomy tends to be surgeon dependent. Naturally, higher volume centres are more likely to utilise and adopt RP-RAPN [17]. **There are no randomised trials comparing the safety and efficacy of RP and TP RAPN**. Most studies tend to be retrospective in design and are confounded by selection bias. The salient peri-operative, functional and oncological outcomes of the larger volume head-to-head studies are summaries in Table 3.

Perioperative Outcomes

A systematic review and meta-analysis of four eligible studies compared 229 TP-RAPN patients to 220 RP-RAPN patients who shared similar size, location and complexity characteristics. They found **RP-RAPN to be equivalent to TP in terms of complications (both Clavien < 3 and Clavien ≥ 3), conversion rate, warm**

Table 3 Summary of comparative literature of RP-RAPN vs TP-RAPN exploring peri-operative, functional and oncological outcome

Author	RP vs TP	Tumour Size (cm)	Nephrometry Score	Op Time (mins)	WIT (mins)	Complications (%)	Hospital Stay (days)	Positive Margins (%)	Drop in GFR
Hughes- Hallett, 2013 [18]	44 vs 59	2.8 vs 3.1	5.5 vs 5.5	149 vs195	22 vs 19	9 vs 10	2.5 vs 4.6	6.8 vs 5	–
Gin, 2014 [19]	75 vs 116	2.5 vs 3.2	8 vs 7	156 vs 191	24 vs 26	9 vs 17	1.5 vs 2	8 vs 6	2 vs 2 (gain)
Choo, 2014 [20]	43 vs 43	2.8 vs 2.7	6 vs 6.6	120 vs 153	23 vs 26	–	–	0 vs 2	11.4 vs 8.6
Kim, 2015 [21]	116 vs 97	2.5 vs 2.5	8 vs 8	152 vs 149	NR	7 vs 10	1 d 57% vs 10%	–	–
Sharma, 2016 [22]	25 vs 40	–	7 vs 7	224 vs 248	27 vs 30	16 vs 43	2.3 vs 3.0	4 vs 2	–
Maurice, 2017 [23]	74 vs 296	2.4 vs 2.5	8 vs 7	176 vs 176	21 vs 19	12 vs 14	2.2 vs 2.6	1.4 vs 1.7	Statistically insignificant
Stroup, 2017 [24]	141 vs 263	2.9 vs 3.1	7 vs 7	217 vs 232	23 vs 23	11 vs 14	2.2 vs 2.5	2.8 vs 4.2	6.2 vs 6.4
Laviana, 2018 [25]	78 vs 78	–	–	167 vs 191	21 vs 22	24 vs 36	1.8 vs 2.7	3.9 vs 2.6	4 vs 6
Arora, 2018 [26]	99 vs 394	3 vs 3.2	7 vs 7	160 vs 170	17 vs 17	–	1 vs 3	2.1 vs 2	6.8 vs 9.9
Harke, 2019 [27]	203 vs 551	2.6 vs 3.0	9 vs 9	120 vs 143	8 vs 11	14 vs 22	8 vs 9	4 vs 3	6.4 vs 11.5
Paulucci, 2019 [28]	157 vs 157	2.9 vs 3	–	157 vs 185	17 vs 17	12 vs 12	1 vs 2	3.9 vs 2.4	–
Abaza, 2020 [29]	30 vs 107	3.0 vs 3.5	7 vs 7	128 vs 141	11 vs 11	4 (overall)	0.7 vs 0.9	0 vs 0	16.3 vs 13.8
Mittakanti, 2020 [30]	166 vs 166	3.1 vs 3.3	6 vs 6	162 vs 191	18 vs 18	53 vs 47	1.7 vs 1.9	2.8 vs 1.9	4.1 vs 5.9
Frimley Renal Cancer Centre, 2020	**631**	**3.1**	**6.5**	**135**	**21**	**8**	**1**	**4**	**6**

ischaemic time (WIT) and estimated blood loss (EBL). A significant difference in operative time however was noted (p = 0.05), with a mean difference of 28.03 mins in favour of RP-RAPN [31]. Choo et al. demonstrated that this significant difference was present when both techniques were match-paired with nephrometry scores. Although no difference was noted in the WIT (p = 0.139), a **statistically significant (p = 0.028) mean 33 min reduction in operative time in favour of the RP group was noted even when match-paired for tumour complexity** [20]. These findings are corroborated by more contemporary larger volume multicentre series comparing RP and TP RAPN [17, 26, 27]. It has been argued that peri-operative outcome measures can be dependant on the expertise of the surgeon, as has been shown in a systematic review by McLean et al. looking at RP and TP RAPN in posterior tumours (considered a favourable location for RP surgery). They demonstrated no significant difference in the above outcome measures [32].

Where the message is certainly clearer is regarding patient length of stay (LOS) and convalescence. **LOS has been shown to be significantly shorter in RP-RAPN with a 1-day reduction in median LOS (p = <0.0001) in European collaborative data** [17], and **2-day reduction in LOS (p < 0.01) in International collaborations** [26]. This advantage in inpatient stay for RP-RAPN is also reflected in the McLean systematic review [32].

The obese patient presents additional challenges to both operative approaches. The **safety and advantages of RP-RAPN have also been demonstrated in patients with a BMI > 30 kg/m^2**. Median operative time of 130 mins, overall 3% post-operative complication rate, a 1% transfusion rate and a 1 day median length of stay have been established for RP-RAPN in this cohort [33].

Oncological and Functional Outcomes

Oncologically no significant difference in recurrence and disease progression is demonstrated in the literature. Similarly, **no significant difference in drop in eGFR in the immediate or longer term is recognized** (Table 3). Both approaches in the high-volume series display similar positive surgical margin (PSM) rates [18, 20, 26–30]. Low volume single centre experiences tend towards higher PSM rates for RP-RAPN patients and worse oncological outcomes, which highlights the need for centralisation and high volume to achieve equivalent safety and efficacy in an otherwise unfamiliar operative environment [34].

Cost Implications

Using time-driven activity-based costing (TDABC) model for small renal masses, Laviana et al. demonstrated **lower costs for RP-RAPN by $2337.16 per case**. This was predominantly driven by shorter statistically significant mean operative time

(167.0 vs 191.1 min, $P = 0.001$) and LOS [1.82 days vs 2.68 days, $P < 0.001$] in the RP-RAPN cohort. The slightly higher disposable instrument costs of RP-RAPN (approximately $207.66 more per case) were offset by the gains in operative time (approximately $37.63/min) and LOS ($1713/day). They deduced equivalent costs in the pre-operative and follow-up stages for both approaches, with **gains in cost variation attributed to intra and post-operative pathway differences** [25].

Challenging the Current Consensus

Based on the advantages and disadvantages of both approaches, as highlighted in Tables 1 and 2, there does seem to be a consensus in the literature about the optimal use of each approach as summarised in Table 4 [35].

Ultimately the **choice of approach should be based on the surgeon's experience and expertise**. Given the wider practice, familiarity and higher volume there is evidence in the literature that TP-RAPN can be utilised safely and effectively to manage patients with posterior and lateral masses and in the 'hostile' abdomen [23, 28, 32, 35]. As our experience and volume with RP-RAPN grows there is **emerging data to suggest similar safety and efficacy to RP-RAPN in cases where traditionally the TP route may have been favoured**. Technical challenges such as a prominent iliac crest can be overcome by utilising a longer assistant port to allow a more optimal fulcrum and less restricted range for the bed side assistant. Technological evolutions and the fourth generation of Intuitive's DaVinci better utilise space and further miniaturise ports allowing for anatomical variations to be less likely to hamper progress during RP surgery. The rotating boom of the Da Vinci Xi allows for much easier docking, resulting in suboptimal approach angles of the patient cart being more forgiving during surgery [30]. Malki et al. have demonstrated the non-inferiority of RP-RAPN in obese patients [33]. Contemporary multicentre studies have demonstrated feasibility and safety of RP-RAPN in anterior, medial and complex tumours, whilst maintaining their advantages of shorter operative times and quicker patient convalescence [17–34].

Table 4 Summary of current consensus when considering the surgical approach to RAPN

RP-RAPN	TP-RAPN
Posterior and lateral renal masses	Anterior and medial masses
Prior abdominal surgery	Highly complex Tumours
Prior intraperitoneal pathology (e.g., Crohn's disease, acute abdomen, ascites, malignancy)	Anatomical kidney variations (horseshoe, pelvic)
	Obese patients
	Prior retroperitoneal/percutaneous renal procedures
	Prominent iliac crest/lumbar spine pathology limiting flexion

Future Trends in RP-RAPN

The authors of this chapter are based at a tertiary upper tract robotic centre in Surrey, UK with a referral radius of over 50 miles spanning Surrey, Hampshire and Sussex. Currently we perform over 300 upper tract procedures per annum, with over 90% of these using the RP route. As technology improves and volume increases, we would expect a natural evolution with RP-RAPN to tackle increasingly complex tumours. **At our centre pT1b and pT2a tumours are managed via the RP route and we would expect this trend to continue to develop**. Meanwhile adapting to and utilising existing technology to hone technique will continue to evolve. Indocyanine Green (ICG) instillation and utilisation of Da Vinci's integrated fluorescence capability, FireFly ™, allows for visual assessment of perfusion to the tumour and aids in selective arterial clamping (SAC). This is already widely used in TP-RAPN [36] and with superior use of limited space offered by the Da Vinci Xi, this can become technically more feasible in RP-RAPN. IRIS™ is an anatomical visualization service using data from diagnostic imaging to construct 3D models of patient anatomy that can be integrated to the surgeon console using TilePro. This should pave the way for better surgical planning and help tackle more complex cases.

Currently various competitor robot assisted surgical (RAS) systems are in production or en-route to the market [37]. Of these CMR Surgical's Versius™ system is already established in clinical practice, whilst Medtronic's HUGO™ RAS is widely considered as the next viable competitor to enter the market. As RAS systems become widely available globally, the boundaries of what is achievable with these newer systems will also continue to be pushed with time, volume, experience and shared evolution between surgeon and surgical system. Although various upper tract procedures have been successfully completed using the Versius™ system, the RAPN procedure eludes this system for the time being. As the system evolves this milestone will no doubt be achieved, however with current system algorithms requiring a 5 cm intracorporeal clearance space for safe use of instruments, the retroperitoneal route will evade the current iteration of the Versius™ system.

Intuitive Surgical on the other hand have developed a Da Vinci SP system designed to drive laparoendoscopic single site surgery (LESS). Fang et al. recently presented their experience with single port RP-RAPN in 7 patients. Although safe and feasible this technique remains very much in the infancy of its journey. All patients were carefully selected to be performed off-clamp and the overall safety, cost effectiveness and perceived benefit to patients remains unanswered as yet [38].

Key Points

- Retroperitoneal robot assisted partial nephrectomy is increasingly establishing itself in the armamentarium of the management of small renal masses
- It displays advantages of the transperitoneal route with regard to shorter length of stay, quicker patient convalesence and being more affordable
- Retoperitoneal robot assisted partial nephrectomy is associated with a steep learning curve

- In experienced hands most small renal masses apart from anterior hilar masses can be managed successfully via the retroperitoneum
- Retroperitoneal surgery has been shown to be safe and efficacious in complex masses and patients with high BMI
- Intraoperatively management of the pre-renal and peri-renal fat are vital in optimising field of vision and space
- New generations and miniaturisation of robotic surgical systems should enable ongoing progress in the retroperitoneal RAPN
- Ultimately the choice of approach should be based on the surgeon's experience and expertise.

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