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ORIGINAL ARTICLE

LAPAROSCOPIC PARTIAL NEPHRECTOMY: INTEGRATION OF AN ADVANCED LAPAROSCOPIC TECHNIQUE

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Background: Laparoscopic radical nephrectomy and open partial nephrectomy are now established methods of treatment for appropriate renal lesions suspicious for malignancy, Laparoscopic partial nephrectomy has undergone progressive evolution. The aim of this paper is to; (i) evaluate the current status of laparoscopic partial nephrectomy, and (ii) to place it in the Australian and New Zealand context by evaluating the necessary skill acquisition for advanced laparoscopic urology.

Methods: The National Library of Medicine database (PubMed) was used to specifically search the available literature on laparoscopic partial nephrectomy, renal failure and nephrectomy, modular surgical training and laparoscopic training. Of the articles identified, selection was based on their contribution to the development of techniques, progressive clinical outcomes, as well as comparisons with current management.

Results: The technique and outcomes of laparoscopic partial nephrectomy are now secure enough to treat anatomically complex tumours in laparoscopically experienced hands. For the appropriate patient with a small renal mass, the impact of radical nephrectomy and long-term renal dysfunction needs to be considered, even in the presence of a normal contra-lateral kidney. Robotic assisted laparoscopic surgery is expensive and may impair the acquisition of advanced iaparoscopic skills.

Conclusion: Over the past 5 years, laparoscopic partial nephrectomy has developed to the stage where, with the necessary laparoscopic skill, it is now a standard of care at tertiary referral institutions. Widespread dissemination of advanced laparoscopic skills remains the next challenge.

Key words: laparoscopic partial nephrectomy, laparoscopic training, nephrectomy, renal failure, renal tumour.

Abbreviations: ANZ, Australia and New Zealand; LPN, laparoscopic partial nephrectomy; LRN, laparoscopic radical nephrectomy; MINSS, minimally invasive nephron-sparing surgery; OPN, open partial nephrectomy; ORN, open radical nephrectomy; PN, partial nephrectomy; RCC, renal cell carcinoma; RN, radical nephrectomy; SRM, small renal mass.

INTRODUCTION

Open radical nephrectomy (ORN) and laparoscopic radical nephrectomy (LRN) are established procedures for the management of solid renal tumours suspicious for malignancy.[1] ORN was established more than 35 years ago as the definitive surgical management for renal lesions suspicious for malignancy.[2] At that time, however, renal tumours presented as large, often symptomatic masses.[3] Now, more commonly, incidental-type tumours are discovered on imaging for an unrelated medical issue.[4] The decision to consider partial nephrectomy (PN) would be based on tumour size and location as well as the state of the contralateral kidney and overall renal function. Laparoscopic skill on the part of the urologist is a significant factor in this decision process.

Until recently, ORN has been the procedure of choice as it maintains oncological principles and can be carried out by most community urologists. However, its disadvantages relate to the morbidity from the muscle-cutting incision, with 49% complaining of a flank bulge and 24% with long-term pain (of which 3% graded the pain as severe).[5] This is in addition to the short-term and intermediate-term issues of wound pain, longer hospitalization and prolonged convalescence, which can significantly influence quality of life.[5] As such, currently, in many centres worldwide, LRN has become an equivalent option as ORN with superior patient recovery profile and equivalent oncological outcomes.[6,7]

The aim of this review is to assess the emerging evidence for laparoscopic partial nephrectomy (LPN) and address the challenges in gaining advanced laparoscopic skill.

PARTIAL NEPHRECTOMY

Partial nephrectomy (PN) is being increasingly indicated in the treatment of small renal masses (SRM) (up to 4 cm) in the presence of a normal contralateral kidney.[1] It is absolutely indicated when radical nephrectomy (RN) would render the patient anephric, for example, solitary kidney or bilateral tumours, such as seen in Von Hippel–Lindau disease.[2] This is relatively indicated where renal function may be jeopardized in the future, for example, calculus disease or renal vascular disease[3] and electively indicated for a SRM, in the presence of a normal contralateral kidney, in an effort to maximize long-term renal function.[1] Over the last decade, there has been no obvious increase in open partial nephrectomy (OPN) in Australia and New Zealand (ANZ) practice

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Table 1. Indications of partial nephrectomy or laparoscopic partial nephrectomy

Absolute indications
Bilateral RCC
Tumour in a solitary kidney
Unilateral tumour with poorly/non-functioning contralateral kidney
Relative indications (contralateral kidney at risk for future compromise)
Hereditary RCC
Genetic diseases with risk of metachronous kidney cancer
Diabetes mellitus and/or hypertension
Ipsilateral or contralateral urolithiasis, chronic pyelonephritis, renal artery stenosis or ureteric reflux
Renal dysfunction (or potential for future dysfunction)
Elective indications (normal contralateral kidney)
Renal tumour ≤ 4 cm (T_1), otherwise healthy
Indeterminate cyst with malignant potential

RCC, renal cell carcinoma.

despite the increased detection rate of small, incidental renal masses. This may have something to do with the perception of the technical complexity of OPN. Compared with LRN, OPN provides similar oncological outcomes and superior renal functional outcomes.[8] This raises an issue of overall quality of care, which may be based on incorrect assumptions.[9] Despite a 30–65% increase in volume of OPN at tertiary referral centres in the USA, the rate of OPN was low overall in the USA (1988–2002) at 7.5% and in the UK (2002) at 4%.[9–14]

Another existing perception has been that either ORN or LRN are acceptable for any small primary renal tumour in the presence of a normal contralateral kidney, with no clinically appreciable effect on long-term renal function. This is no longer considered correct. PN is increasingly recommended to optimize renal functional outcomes such that the 2007 European Association of Urology Guidelines on Renal Cell Carcinoma state that 'Radical nephrectomy according to Robson is no longer the gold standard treatment for small renal tumors…' and '…Nephron-sparing surgery is an established curative approach for the treatment of patients with RCC'.[15]

There appears to be a graded independent association between reduced glomerular filtration rate and the risk of death, cardiovascular events and hospitalization in community-based populations.[16] RN may be a more significant risk for chronic renal dysfunction than was previously appreciated. As such, it may be preferable to recommend PN over RN in the setting of an organ-confined T_1 renal mass (unless renal preservation is technically not feasible).[15,17]

Depending on the level of surgical expertise available, relative contraindications for PN include prior open kidney surgery, deep-seated central location and concomitant renal vein thrombus. Morbid obesity, more than two tumours, coagulopathy and renovascular disease with renal artery stenting pose specific problems as well.[18] Indications for PN can be elective, relative or absolute (Table 1).

Along with LPN, minimally invasive nephron-sparing surgery (MINSS) continues to progress with a variety of evolving ablative technologies, including cryotherapy, radio-frequency ablation, microwave, interstitial laser, high-frequency ultrasound and extracorporeal radiosurgery. With all non-extirpative probe ablative or extracorporeal techniques, there remain serious limitations with regard to the histological documentation of completeness of tumour ablation, necessitating careful and long-term radiological follow up. These technologies have yet to equal PN.[19] The objectives of *excisional* and *probe ablative* MINSS must be minimization of damage to residual renal parenchyma and oncological outcomes equivalent to OPN (Table 2). In general, excisional MINSS (or LPN) is preferable to establish the histological nature of the lesion and tumour margin clearance.[23]

OPEN PARTIAL NEPHRECTOMY VERSUS LPN

Open partial nephrectomy has been the preferred treatment option in the appropriately selected patient. It is a safe procedure with 5-year and 10-year cancer-specific survivals of 81 and 64% and local recurrence-free survival of 89 and 80%, respectively.[24] It does, however, carry with it the morbidity associated with a large, muscle-cutting, often rib-resecting, open flank incision.[5] LPN patients require less analgesia, shorter hospitalization and have a quicker convalescence.[25]

Laparoscopic partial nephrectomy appears to offer similar renal functional and oncological outcomes to OPN.[26] Five-year data on 50 LPN patients are now available, in addition to larger patient numbers in 3-year follow-up series that confirm equivalent intermediate-term oncological control.[18,20,25] Postoperative complication rates have been somewhat higher in LPN; however, results continue to improve (Table 3). Warm ischaemia time is now 30 min or less, on average.[18,29] Historically, the sequelae of warm ischaemia when limited to 30 min appear to be negligible with the loss of function commensurate with the amount of parenchyma excised.[30]

Although LPN is being routinely carried out at tertiary centres, for increasingly challenging tumours (Figs 1,2), there is little doubt that the main impediment to widespread adoption of LPN appears to be its technical complexity.[31]

ROBOTIC LPN

It is apparent that robotic assisted laparoscopic surgery, which has been popularized for prostatectomy, does allow laparoscopically

Table 2. Oncological outcomes after laparoscopic partial nephrectomy

Authors (reference)	No. patients	Mean size (cm)	Positive surgical margin	Mean follow up (months)	Local recurrence	Port site recurrence	Cancer-specific survival
Moinzadeh *et al.*[20]	100	2.9 (1–10.3)	2%	42.6	0	0	100%
Lane and Gill[7]	50	3.0 (1.4–7)	2%	62	0	0	100%
Weld *et al.*[21]	60	2.4 (0.7–5.1)	0	25.3	0	0	ND
Wille *et al.*[22]	44	2.8 (1–5)	0	15	0	0	ND

ND, no data.

Table 3. Perioperative outcomes after laparoscopic partial nephrectomy

Authors (reference)	No. patients	Warm ischaemia time (min)	Estimated blood loss	Tumour size (cm)	Select complications
Abukora *et al*.[27]	78	33.8 (warm ischaemia, n = 25; cold ischaemia, n = 24; no clamping n = 29)	Without clamping: 254 mL; with clamping: 212 mL	2.27 (0.6–3.5)	Bleeding 1.3%; urine leak 3.8%
Weld *et al*.[21]	60	39	225 mL	2.4 (0.7–5.1)	Bleeding 8%; urine leak 8%
Wille *et al*.[22]	44	21 (warm ischaemia, n = 25; unclamped n = 19)	ND	2.8 (1–5)	Bleeding 4.5%; urine leak 4.5%
Simmons and Gill[28]	200	35 (8–60)	150 mL (25–2500 mL)	3.0 (0.9–10.3)	Bleeding 4.5%; urine leak 2%

ND, no data.

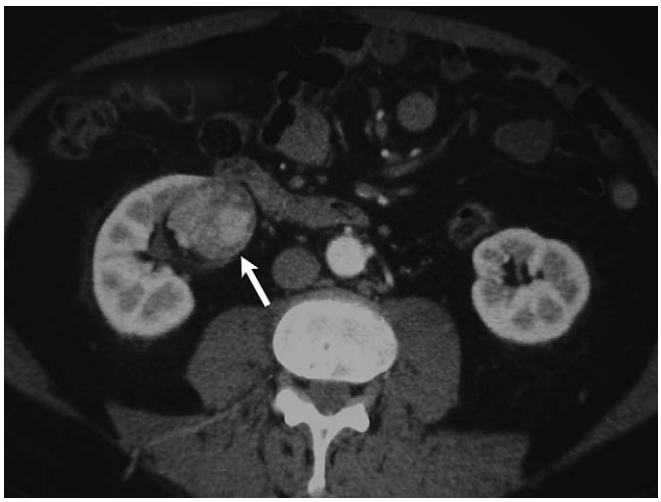

Fig. 1. Computed tomography showing a right-sided 4 cm enhancing, infiltrating mid-pole hilar tumour (arrow) abutting the renal vessels as well as the renal pelvis.

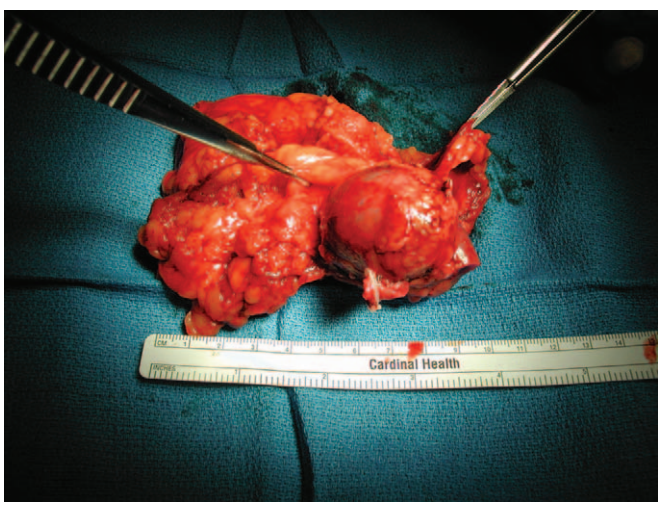

Fig. 2. Laparoscopic partial nephrectomy pathology specimen of lesion shown in Figure 1.

inexperienced surgeons to carry out complex suturing. There does not, however, appear to be an advantage to current robotic usage for LPN in laparoscopically experienced hands.[32] We believe that the current and practical reality is that it would probably be more effective, cheaper and widely applicable to train and upskill laparoscopic surgeons to minimize recurring disposable instrument and maintenance costs.[33] The overall cost to the health-care system may not be sustainable if robotic systems are purchased widely.[34] Because robot skills do not transfer directly to the laparoscopic arena, robotic usage may interfere with the broader issue of acquisition and dissemination of laparoscopic technical skills. Robot use also limits the geographical patient access, which is an issue that ANZ urologists as a group need to address. Furthermore, Eden *et al.* have suggested that robot use does confer an undeniable marketing advantage in clinical practice.[35]

TRAINING ISSUES IN LPN

Laparoscopic partial nephrectomy is clearly not a procedure for the novice laparoscopic urologist and the potential for major catastrophic complications, such as the vascular complications seen with LRN or the common bile duct injuries seen with the initial introduction of laparoscopic cholecystectomy, should not be understated.[29] The safe introduction of LPN to the Australia and New Zealand community should initially commence with established, appropriately trained, experienced, high-volume laparoscopic urological surgeons in centres with the appropriate level of medical, surgical and radiological support. Beyond this, the challenge is to establish advanced laparoscopic training with appropriate mentoring to allow the broader dissemination of the technique. In this way, LPN could be introduced into the ANZ arena in a stepwise, controlled fashion. Despite the potential of low numbers of LPN in the Australia and New Zealand context, any learning curve influences can possibly be minimized if LPN is carried out by experienced laparoscopic surgeons already well versed in advanced urological laparoscopic procedures, such as radical prostatectomy, cystectomy, pyeloplasty and donor nephrectomy. However, the overall numbers involved may ultimately limit LPN to tertiary referral centres.

Attendance at basic and intermediate laparoscopic skills labs are a prerequisite for laparoscopic training. These labs would include principles of laparoscopic access and insufflation as well as operative strategy and problem solving. Dry labs can be used with a variety of working models to establish instrument handling, gaining an intracorporeal perspective, access issues, needle manipulation, intracorporeal suturing, stapling and a variety of clip applications. These skills can then be translated to animal models where the same skills are refined and practised in a somewhat more realistic setting. Following competency in these lab-based modules, progress can be made with assisting at LRN with

an experienced mentor. Once competency is established, then the mentor can take the role of assistant. Experience needs to be established with transperitoneal and/or retroperitoneal access. Laparoscopic pyeloplasty would be a logical extension to improve intracorporeal suturing skills. Progression to laparoscopic prostatectomy before LPN is probably appropriate as LPN requires a higher degree of laparoscopic skills.[29] Prospective audit and honest self-critique are an essential part of this process.

Attendance at a tertiary referral centre to further evaluate specific skills is beneficial. Some have already developed stepwise protocols in teaching urological laparoscopy.[36] This could also take the form of a specific or multi-institutional fellowship or preceptorship in advanced laparoscopy.[37] These could deal with issues related to specific manoeuvres to secure clamping of the vessels, use of haemostatic agents, suturing techniques and access for tumours in specific locations.[18,38]

Finally, there remains a critical need for ANZ urologists to address the issue of limited availability of Fellowships in advanced laparoscopy (www.usanz.org.au). Clinical positions are becoming increasingly scarce overseas for our recently qualified Fellows in urology. It is imperative that we become self-sufficient by continuing to further develop our own advanced laparoscopic (and robotic) centres to address this issue.

The development of advanced laparoscopic skills remains the next challenge. There needs to be an established training method to progressively acquire increasing laparoscopic skill to competently carry out LPN. It may be time to expand ANZ-based Advanced Laparoscopic Centres where training and research take place to continue the expansion of minimally invasive skills.

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