Original Article

Laparoscopic Nephrectomy: New Standard of Care?

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OBJECTIVE: The pace of implementation of a laparoscopic nephrectomy programme is affected by factors including surgical expertise, case load, learning curves and outcome audits. We report our experience in introducing a laparoscopic nephrectomy programme over a 3-year period.
METHODS: From January 2001 to December 2003, 187 nephrectomies were performed (105 by conventional surgery, 82 by laparoscopy). Hand-assisted laparoscopy was used predominantly. The indications for surgery, factors affecting the approach and outcome parameters were studied. A cost comparison was made between patients with similar-sized renal tumours undergoing laparoscopic versus open surgery.
RESULTS: Most operations were performed for malignancy in both the open (70%) and laparoscopic (67%) surgery groups. The laparoscopic approach was most commonly used in upper tract transitional cell cancers (TCCs; 70% of 30 patients) and benign pathologies (49% of 35 patients), followed by radical nephrectomies (34% of 99 patients) and donor nephrectomies (44% of 23 patients). There was a rapid rise in laparoscopic surgeries, from 30% in 2001 to 58% in 2002. The median hospital stay was 5.8 days in the laparoscopic group and 8.1 days in the open surgery group. The procedure cost for laparoscopic surgery was S$4,943 compared with S$4,479 for open surgery. However, due to a shorter hospital stay, the total hospital cost was slightly lower in the laparoscopic group (S$7,500 versus S$7,907).
CONCLUSION: The laparoscopic approach for various renal pathologies was quickly established with a rapid increase in the number of laparoscopic procedures. [*Asian J Surg* 2005;28(4):277–81]

Key Words: kidney neoplasm, laparoscopy, outcome, renal cell carcinoma

This paper won the best scientific video at the 2004 Singapore Urological Association Annual Scientific Meeting held on 20–22 February 2004 in Singapore.

Introduction

Laparoscopic nephrectomy is increasingly performed as a viable alternative to traditional open approaches. The advantages of minimally invasive surgery include reduction in morbidity and shorter convalescence. However, numerous factors interplay to affect the implementation of such programmes. These include the availability of surgical expertise, case load, learning curve and outcome audit as well as costs. Of these, an anticipated steep learning curve is a major consideration. The Department of Urology at Singapore General Hospital has a laparoscopic programme in adrenal pathologies. We have previously reported our results with transperitoneal adrenalectomy, which compare favourably with those of its open counterpart.[1,2] We extended our programme to encompass renal pathologies in late 2000, using hand-assisted laparoscopy (HAL). We started with upper tract transitional cell carcinoma (TCC), where conventionally two separate incisions are used to perform a total nephroureterectomy.[3] Our initial success prompted us to extend HAL to benign

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pathologies, followed by renal cell carcinoma (RCC)[4] and, recently, donor nephrectomies. Here, we report our experience over 3 years in the introduction of laparoscopic nephrectomy.

Materials and methods

Surgical techniques

HAL via the transperitoneal route was predominantly used. Essentially, the patient was put in the full lateral position and bridge elevated at the level of the loin. For right-side pathology, a gridiron incision measuring 7 cm was made using a standard open surgical technique. A HAL device was inserted using a Gelport™ (Applied Medical Inc, Rancho Santa Margarita, CA, USA) or Lapdisc™ (Ethicon Endosurgery Inc, Cincinnati, OH, USA). Pneumoperitoneum was created to 20 mmHg, and additional ports were inserted for a 30° laparoscope and dissecting instruments. A slight modification was made for left-side pathology where the HAL port was made using the lower midline below the umbilicus. Pneumoperitoneum was then reduced to 12–15 mmHg. The procedure commenced with reflection of the colon followed by exposure of the renal vascular pedicle. The renal vessels were typically controlled using Hem-o-Lok devices (Weck Closure System, Research Triangle Park, NC, USA), as previously reported.[5] The specimen (including any transplant graft) was delivered through the hand port incision. In the case of nephroureterectomies, the lower incision allowed for control and ligation of the ureter together with a cuff of the urinary bladder in the standard open surgery fashion. For patients with carcinoma of the ureter, open control of the lower segment of the ureter preceded the HAL nephrectomy. Laparoscopic donor nephrectomy was performed using HAL exclusively.

The standard laparoscopic technique was used selectively for small renal tumours (intact specimen retrieval) or other benign pathologies in the absence of previous renal surgery and gross infection.

Study parameters

The surgical approach in relation to underlying pathology, including size of tumour, hospital stay and surgical outcome, was studied. A subgroup of 53 consecutive patients with RCC (size matched, without concurrent additional surgery) was compared for hospital stay and hospitalization costs.

Results

Of the 187 nephrectomies performed over the 3-year study period, 82 (44%) were laparoscopic and 105 (56%) were open. The distribution of cases and their underlying pathologies are shown in Table 1.

Among the 34 RCCs that were treated using laparoscopic nephrectomy, the average tumour size was 5.0 cm (range, 2–11.5 cm). Regarding pathology, 24 were T1 tumours, two were T2, seven were T3a and one was T3b. All cases were node negative and all had tumour-free resection margins, except one where a tumour embolus was found in the vascular resection margin. Among the 65 RCCs treated with open nephrectomy, the average size of the tumour was 8.2 cm (range, 2.5–21 cm). From pathology, 16 tumours were T1, 17 were T2, 15 were T3a, 15 were T3b and two were T4. Three cases were node positive (two were N1, one was N2). Four of the 65 cases had involved margins.

Of the 21 patients undergoing laparoscopic nephroureterectomy for upper tract TCC, 11 had ureteric TCC, nine had renal pelvic tumours and one had synchronous ureteric and renal pelvic tumours. Pathology showed that five tumours were Ta, two were T1, five were T2 and seven were T3, and that there were two carcinoma *in situ* (Tis) without any invasive lesion. All cases except two had clear resection margins. Of the nine patients with upper tract TCC undergoing open nephroureterectomy, four had ureteric and five had renal pelvic tumours. Three were Ta tumours, two were T1 and four were T3. All cases had tumour-free resection margins.

Table 1. Surgical approach in relation to underlying pathology

Pathology	Total (*n*)	Open (*n*)	Lap (*n*)	HAL (*n*)	Percentage of total done as Lap and/or HAL
RCC	99	65	14	20	34
TCC	30	9	3	18	70
Benign	35	18	2	15	49
Donor	23	13	0	10	44
Total	187	105	19	63	44

Lap = standard laparoscopic surgery; HAL = hand-assisted laparoscopy; RCC = renal cell carcinoma; TCC = transitional cell carcinoma.

Table 2. Size-matched cost comparisons between pT1–2 open and laparoscopic radical nephrectomy without other additional procedures

	Laparoscopic (n = 24)	Open (n = 29)	p*
Mean postoperative stay (d)	3.9 (2–8)	6.9 (3–41)	0.038
Mean duration of surgery (min)	197 (115–355)	138 (70–330)	< 0.001
Mean cost of postoperative hospital stay (S$)	2,558 (1,574–8,708)	3,427 (1,757–6,551)	0.028
Mean cost of surgery (S$)	3,602 (2,960–4,070)	4,040 (2,060–7,780)	0.048
Mean cost of consumables (S$)	1,341 (605–2,796)	439 (180–2,115)	< 0.001
Mean total cost (S$)	7,500 (5,787–13,328)	7,907 (5,952–12,064)	0.401

*Paired sample t test. Range shown in parentheses. Calculations based on Singapore dollars (S$).

The benign pathologies that were removed laparoscopically included non-functioning kidneys secondary to pelvi-ureteric junction obstruction (4), cystic kidneys from end-stage renal failure (3), staghorn stones (2), chronic pyelonephritis (5), angiomyolipoma (1), oncocytoma (1) and chronic tuberculous pyelonephritis (1). There were 18 open nephrectomies for benign pathologies, mostly for huge and severely hydronephrotic kidneys or infective aetiology.

A laparoscopic donor nephrectomy programme was introduced much later in 2002. Ten laparoscopic live-donor nephrectomies were performed compared with 13 open donor nephrectomies.

There was no perioperative or 30-day mortality. The transfusion rate was 3.7% (n = 3). Major complications occurred in two patients (2.4%). One patient who had end-stage renal failure preoperatively and underwent HAL nephrectomy for a renal tumour (final histology, lipoma) developed retroperitoneal haemorrhage, deep vein thrombosis and pulmonary emboli postoperatively. Another patient developed an intra-abdominal abscess that necessitated open drainage. Two patients had conversion to open surgery: one patient had chronic liver disease and laparoscopic haemostasis was difficult, while in the other patient, a vascular clip slipped from the renal artery during donor nephrectomy. The former patient subsequently developed the intra-abdominal abscess.

Length of stay was calculated from the day of surgery to the day of discharge. The average length of stay in the laparoscopic group was 5.8 ± 2.8 days (range, 2–22 days). In the open group, the average length of stay was 8.1 ± 10.8 days (range 2–80 days). The upper limit of hospitalization was skewed by the two patients with complications.

The open surgery group included six patients who underwent concomitant surgical procedures. Three patients underwent cholecystectomy, one underwent cystectomy, one underwent colonic resection and another underwent liver resection.

The result of the subgroup cost analysis is shown in Table 2. Essentially, the laparoscopic group had a higher procedure cost (which included use of consumable single-use items) but a lower hospital inpatient facilities cost due to a shorter hospital stay. The overall cost was very similar in the two groups.

Of the laparoscopic cases, 54% (13/24) were HAL and were the main determinant of the higher cost of laparoscopic surgery because of the use of the HAL device. The upper limit of the cost of open surgery was skewed by patients who required other concomitant surgeries and the two open conversion cases which used HAL ports prior to conversion. The prolonged hospital stay also contributed to the higher maximum hospitalization costs. On the other hand, the first six cases of HAL nephrectomy were performed with hand-assisted devices provided free of charge by the companies, contributing to the lower limit of consumable costs in the laparoscopic group.

Discussion

Since Clayman et al performed the first laparoscopic nephrectomy in 1991,[6] laparoscopic nephrectomy has gained wide acceptance in many centres around the world.[7–10] Conventional "pure" laparoscopic nephrectomy is significantly less morbid, with shorter hospital stay and earlier return to work. It also appears to be oncologically sound with oncological clearance and long-term survival rates comparable with those after traditional open nephrectomy.[11–13] HAL, which was the method used in nearly 80% of nephrectomies performed in this series, is a modified technique that has gained wide acceptance around the world.[14,15] It has the advantage of having a significantly shorter learning curve and reduced operating time compared with the "standard" laparoscopic technique. Despite a slightly larger wound than its standard laparoscopic counterparts, it is still significantly less morbid than the

Table 3. Internal recommendations for laparoscopic nephrectomy in relation to pathology

Surgical condition	Recommendation
Renal cell carcinoma	
≤ 5 cm	Standard lap
5–8 cm	HAL
> 8 cm	Open surgery
Indeterminate lesion requiring exploration before decision on nephrectomy	Open surgery
Transitional cell carcinoma	
Renal pelvis	HAL, followed by lower ureterectomy
Ureter	Lower ureterectomy followed by HAL
Benign pathology	
Small to moderately enlarged kidneys	Standard lap
Grossly enlarged kidneys/mild to moderate inflammation	HAL
Anticipated gross inflamed, infected system	Open surgery
Live donor	
Left kidney with single artery	HAL nephrectomy
Any other vascular management	Open surgery

lap = laparoscopic surgery; HAL = hand-assisted laparoscopy.

traditional open method.[14,15] In addition, HAL is arguably emerging as the technique of choice for laparoscopic donor nephrectomy.[16,17]

Laparoscopic nephrectomy has quickly established itself in the surgical repertoire of the department, with 42% of all nephrectomies being performed laparoscopically over the 3-year period. Currently, laparoscopic nephrectomies are performed for a wide range of indications, including both benign and malignant disease, as well as for organ donation.

We adopted the HAL technique early in the programme in radical nephroureterectomy in view of the need for an open procedure to control the lower ureter, which had been our standard practice. The use of the same wound for HAL nephrectomy became a natural extension. A relatively normal upper tract anatomy was another attraction when we first introduced the programme. Laparoscopic nephroureterectomy has almost completely replaced open nephroureterectomy even in this early period of the department's laparoscopic experience.

On the other hand, the number of open nephrectomies for RCC still exceeded that of laparoscopic nephrectomy. That was due to our cautious approach to laparoscopic surgery, where only patients with smaller, less advanced lesions were offered HAL nephrectomy. Those with clinical stage T3a disease or worse were typically excluded.

As a general guideline, we only offered laparoscopic/HAL nephrectomy for lesions of 8 cm or less. In addition to the technical consideration in cases of big tumours, we also strongly believe in intact specimen retrieval. Thus, should the delivery of specimen require an extension of wound well beyond the original 7-cm hand port incision, the benefit becomes marginal. Our internal recommendation regarding laparoscopic surgery is shown in Table 3. We feel that a tumour size of 8 cm is a reasonable upper limit for a newly established laparoscopic urology team starting a laparoscopic nephrectomy programme. Embarking on much larger lesions at this juncture will lead to more complications, which may curtail the programme. When more experience has been accumulated, it would then be appropriate to embark on technically more challenging renal lesions, including those that are larger than 8 cm. In fact, the largest renal tumour we removed laparoscopically via HAL was 11.5 cm, but this was performed at a later phase of our programme. It is also important to recognize that preoperative factors other than tumour size, including amount of perinephric fat, extent of collateral vasculature and aberrant arterial or venous anatomy, can significantly influence the decision to proceed with laparoscopic nephrectomy.

For benign pathologies, the choice between open and laparoscopic nephrectomy was largely technical. A significant number of open nephrectomies were still being performed for benign pathologies, especially when much adhesion or dense inflammation from previous surgery or infection was anticipated.

Laparoscopic donor nephrectomy has gained acceptance world wide. We embarked on a laparoscopic programme only after reasonable experience was obtained from ablative HAL procedures. The potential benefits are obvious: by being able to offer kidney donors a less morbid procedure, more people may be willing to consider kidney donation.

Our overall conversion rate was kept very low, partly due to tight selection criteria. The HAL approach could have contributed to this low conversion rate as vascular control rarely poses a problem using HAL. On the other hand, we were aware that a standard laparoscopic technique might have some marginal benefits in terms of shortened hospital stay. Currently, we largely reserve the standard laparoscopic technique for benign pathologies, where the specimen is delivered via a 3-cm incision after crushing, and small RCCs where the specimen is delivered intact using a Pfannenstiel incision.

The relatively long hospital stay in our laparoscopic group could be attributed to a very cautious approach early in our experience. In addition, this figure may be skewed slightly as relatively more TCC underwent laparoscopic than open nephrectomy, for which a urinary catheter was typically left *in situ* for 5–7 days. Our subgroup cost analysis demonstrated that as long as the hospital stay for patients undergoing laparoscopic surgery is reduced, the overall cost would still be in the same range as that for open surgery.

Our approach to offering laparoscopic surgery evolved slowly over a 3-year period, and has struck a balance between moving into new areas of medical advance and quality assurance.

Conclusion

The laparoscopic nephrectomy programme has been introduced successfully and with a reasonable learning curve. We anticipate that even more nephrectomies will be performed laparoscopically in the near future, as it has quickly established itself as the standard of care that we offer to our patients.

Acknowledgements

The authors want to acknowledge the tremendous support from the Department of Experimental Surgery, Singapore General Hospital, in the training and development of laparoscopic nephrectomy.

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