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Oncology

Feasibility of laparoscopic tumour nephrectomy in children

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ABSTRACT

Aims: The laparoscopic approach to tumour nephrectomy in children is controversial. We therefore reviewed our institution's cases of tumour nephrectomy (laparoscopic, open, and converted) to better understand which is suitable for this approach, what factors prevent it, and whether one can excise tumours greater than the CCLG recommendation of 300 ml.
Methods: All tumour nephrectomies performed between 2002 and 2016 were identified using our surgical database. Further data were gathered from radiology and pathology databases. Those with nonrenal tumours or having a partial nephrectomy were excluded. Tumour maximum diameters, volumes, and ratios to contralateral kidneys were calculated. A Mann–Whitney U was used to compare the groups.
Results: Forty-three cases were included. Fifteen procedures were completed laparoscopically (35%), and a further 3 converted. The median age at surgery was 2.5 years (range 0–10) in the laparoscopic group and 2 years (range 0–15) in the open group. There was a significant difference ($P < 0.05$) between the laparoscopic and open groups for: median maximum diameter (10cm vs 12.25cm), median volume (155 ml vs 459 ml), maximum diameter ratio (1.22 vs 1.75), and volume ratio (3.8 vs 11.2).
Conclusion: Tumours in the laparoscopic group were significantly smaller, but it was possible to excise tumours more than 300 ml. Difficulties in excision related to tumour size relative to the abdomen. Therefore, a ratio of tumour to contralateral kidney may be a better guide to safe excision than an overall volume cutoff. From our series, the laparoscopic approach is likely to be achievable if the volume ratio is ≤ 8.1.
Level of evidence: Level 3.

Minimally invasive surgery (MIS) has become commonplace in paediatric surgical practice and it is standard to perform nephrectomy for nononcological reasons laparoscopically. However, the MIS approach to tumour nephrectomy in children is not routine and was first described in the literature as recently as 2004 [1]. Since this time, several groups have shown that it is possible to perform MIS tumour nephrectomy safely [2–5] and that it can lead to reduced analgesia requirements and decreased length of stay [4] as well as equivalent outcomes to open tumour nephrectomy [4,5]. In adults, the European Association of Urologists recommends laparoscopic nephrectomy for renal tumours unless nephron sparing surgery is indicated [6].

In the paediatric population, the research to date has involved small numbers of patients and it has been difficult to elucidate what factors contribute to or prevent successful laparoscopic tumour nephrectomy. This is important as complete tumour resection is a key prognostic indicator [7,8]. Additionally, numbers of lymph nodes sampled may be insufficient [2–5] according to the current recommendations [7,9].

In the series published, maximum diameter, volume and weight have been variably measured and it is unclear whether these pertain to just the tumour or to the specimen in its entirety. It is also uncertain which of these measurements and its upper limit should be used to guide the surgeon on whether to adopt a MIS or open approach.

The Children's Cancer and Leukaemia Group (CCLG) suggest tumours amenable to MIS are those that are central with an unaffected rim of tissue and less than 300 ml volume. This series aims to develop our understanding of which patients are suitable for an MIS approach to paediatric renal tumours, what factors make it difficult to perform and whether it is possible to remove renal tumours more than a volume of 300 ml.

1. Methodology

1.1. Study design

All tumour nephrectomies performed in our centre over the 15 year period from January 2002 to December 2016 were identified using our prospectively collected surgical database. Further data were gathered from electronic patient records and local radiology and pathology

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databases. Partial nephrectomies and nephrectomies for nonrenal tumours were excluded from the series. Patients with malignant or presumed malignant tumours received neoadjuvant chemotherapy apart from one patient in the open group who required upfront nephrectomy for uncontrolled hypertension. Tumour volumes were calculated using the formula for an ellipsoid ($4/3 \times \pi \times$ radius of height $\times$ radius of width $\times$ radius of depth) from both the cross sectional imaging performed closest to surgery (only available from 2008) and pathology specimens. Tumour to contralateral kidney volume and maximum diameter ratios were also calculated on those with radiological imaging available. A Fisher's Exact test or Mann–Whitney U was used to compare the groups as appropriate. Data are quoted as median (range) unless otherwise indicated. $P \leq 0.05$ was accepted as significant.

1.2. MIS operative technique

A transperitoneal approach is performed for all MIS tumour nephrectomies in this centre. An initial 5 mm infraumbilical port is placed using an open cut down technique. Two further 5 mm ports are placed under direct vision in the epigastrium and at the lower end of the tumour. A 4th incision may be made if a liver retractor is required. Any overlying structures are mobilised off the tumour and the renal pedicle identified and vessels dissected out. A vessel sealing device is used to divide them. The kidney and tumour are mobilised and the ureter divided. A Pfannenstiel incision is made only when the specimen is completely free. The specimen is placed in a retrieval bag and removed through the Pfannenstiel incision so that it remains intact. Any lymph nodes identified are removed.

2. Results

Forty-three tumour nephrectomies were performed over the 15 year period; the majority being for Wilms' tumours. Fifteen (35%) procedures were completed laparoscopically and a further three converted to open. Patients were grouped according to whether the nephrectomy had been completed laparoscopically or not. The median age at surgery was 2.5 (range 0–10) years in the laparoscopic group and 2 (0–15) years in the open group ($P = 0.8$).

Tables 1 and 2 show the demographics for the two groups. There was no difference in gender or nature of tumour (Wilms' vs. Non-Wilms).

One patient in the laparoscopic group had a preoperative tumour rupture and two others were known to have lung metastases (one had thoracoscopic metastectomy at the same operation whilst the metastases had resolved with chemotherapy in the other). One further patient in this group was found to have tumour extending into the perirenal fat at surgery. In the open group, four patients were known to have preoperative tumour rupture or invasion into local structures with a further three patients known to have distant metastases.

The maximum diameter and volumes between radiology and pathology measurements, where both were available, correlated well ($P = 0.96$). Median maximum diameter was smaller in the laparoscopic group compared to open [10 (6–13) cm vs. 12.25 (7.5–35) cm; $P < 0.05$] (pathology measurements, $n = 43$). The median volume of the pathology specimen was also smaller in the laparoscopic group [155 (42–599) ml vs. 459 (52–6435) ml; $P < 0.05$]. Median maximum diameter was smaller in the laparoscopic group [8.5 (7.3–12.2) cm vs. 13.6 (7.3–24.9) cm; $P < 0.05$] (radiology measurements, $n = 26$).

Table 1
Demographics by group (gender, type of tumour).

Attribute	N	P value	
Male	Laparoscopic	9	1.00
	Open	16	
Female	Laparoscopic	6	
	Open	12	
Wilms' tumours	Laparoscopic	11	1.00
	Open	19	
Non-Wilms' tumours	Laparoscopic	3	
	Open	5	

Table 2
Demographics by group (age, length of stay, follow-up).

Attribute	Median (range)	P value	
Age at operation	Laparoscopic	2.5 (0–10)	0.8
	Open	2 (0–15)	
Length of hospital stay	Laparoscopic	3 (2–15)	0.0009
	Open	5 (3–15)	
Length of follow-up	Laparoscopic	98 (10–165)	0.4
	Open	49 (8–186)	

Calculated (radiological) median volume was much lower in the laparoscopic group [163 (50–671) ml vs. 658 (109–5581) ml; $P < 0.05$]. The median volume ratio in the laparoscopic group was 3.8 (range 1.4–10.8; upper quartile 8.1) and in the open group was 11.2 (range 1.3–41.9) ($P < 0.05$) and the median maximum diameter ratio was 1.22 (range 1.05–1.58; upper quartile 1.35) in the laparoscopic group and 1.75 (range 1.11–2.93) in the open group ($P < 0.05$).

Fig. 1 shows radiological tumour volume by age for each group. In children <2 years all tumours were <250 ml volume, but in older patients, volumes up to 670 ml were successfully removed. Fig. 2 shows the difference in volume ratio between the groups.

The median number of lymph nodes sampled in malignant tumours was reduced in the laparoscopic group [0.5 (0–5) vs. 3 (0–16); $P < 0.05$]. For the patients where it was available, the median laparoscopic operative time was 180 min and there was no learning curve over time. The median length of stay was shorter for the laparoscopic group [3 (2–15) days vs. 5 (3–15) days; $P = 0.009$)] (Table 1).

The three operations that were converted to open were because of inability to adequately visualise the renal pedicle. The decision not to attempt laparoscopic resection was taken preoperatively in some patients when there was felt to be insufficient intraabdominal space to safely access the tumour or deploy a suitable specimen extraction bag.

One patient in the laparoscopic group had a breach of the tumour pseudocapsule during dissection but no gross spillage and one in the open group had an intraoperative rupture, but both these patients already had a preoperative rupture, so no patients were upstaged by surgery in either group. There was one significant complication in the laparoscopic group (see Table 3) where a patient returned to theatre with an acute abdomen secondary to ischaemia to the ascending colon requiring a hemicolectomy. This occurred as there was abnormal vasculature to the colon from the lateral peritoneal attachments which were divided in order to reflect the colon. This is likely to have occurred whether the operation was performed laparoscopically or open as the bowel needed to be mobilised regardless. There was one surgical related mortality in the open group which occurred on table in a premature neonate with respiratory compromise secondary to a massive congenital mesoblastic nephroma that was excised as an emergency.

Follow-up for both laparoscopic and open groups was equivalent [95 (7–161) months vs. 46 (8–183) months; $P = 0.4$].

Of the patients who died from malignancy, those in the open group had histologically high risk tumours and the patient from the laparoscopic group had a renal cell carcinoma with a recurrence in the original biopsy tract.

3. Discussion

This series, in line with the previous literature, shows that a minimally invasive approach to tumour nephrectomy is safe. There was also a significantly shorter hospital stay associated with the laparoscopic group and whilst this may be because of the tumours in the laparoscopic group being smaller, we feel that it is more likely to be because of the MIS techniques used as is associated with other operations [