

# Experience With Laparoscopic Adrenalectomy in Pediatric Patients

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**Background:** Laparoscopic adrenalectomy (LA) is now being recognized as the standard in the management of benign adrenal pathology in adult patients. Few reports have described the use of this technique in pediatric patients. This study combines experience from 2 institutions with lateral transperitoneal LA in children to analyze our results and the clinical and biochemical response to laparoscopic adrenalectomy in patients with hormonally active adrenal tumors.

**Methods:** A bi-institutional retrospective review of all patients undergoing LA between January 1997 and January 2001 was performed. Clinical and biochemical data were obtained during routine follow-up.

**Results:** Seventeen laparoscopic adrenalectomies were performed during this period. The average operating time was 120 minutes, mean estimated blood loss was 25 mL, the

mean size of the adrenal lesion was 4.8 cm, and the mean length of hospitalization was 35 hours. Resolution of clinical and biochemical parameters of adrenal hyperfunction was accomplished in all patients with adrenocortical hyperplasia and pheochromocytoma in postoperative follow-up.

**Conclusions:** Laparoscopic adrenalectomy can be performed safely and effectively with a short hospital stay, minimal blood loss, and excellent functional outcome in this age group. The authors believe laparoscopic adrenalectomy is an excellent approach for the management of benign pediatric adrenal pathology.

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INDEX WORDS: Adrenalectomy, laparoscopic.

LAPAROSCOPIC ADRENALECTOMY (LA) was first performed in 1991.<sup>1</sup> As proficiency in laparoscopic skills grew, laparoscopic adrenalectomy rapidly replaced open adrenalectomy as standard management of benign adrenal pathology in adult patients.<sup>2-5</sup> Adrenalectomy is particularly well suited for the laparoscopic approach because of the relative small size of the adrenal gland, the low incidence of malignant tumors, and the associated morbidity of the open approach. The principal approaches laparoscopically are the transperitoneal or the retroperitoneal approach. Although both the transperitoneal and retroperitoneal routes have been associated with excellent results,<sup>6</sup> the lateral transperitoneal approach offers a more efficient working space and excellent exposure and has been advocated by many as the preferred approach.<sup>6-9</sup>

Despite multiple adult studies, few reports have described the outcome of this technique in pediatric patients.<sup>10-14</sup> Infrequent indications for adrenalectomy in children and concerns about small patient body habitus have contributed to a delay in the application of the laparoscopic approach in these patients. Also, the most common childhood adrenal pathology, neuroblastoma, is not readily amenable to laparoscopic excision because it is not a well encapsulated tumor but rather has an infiltrative and invasive nature. As laparoscopic skills have developed in the pediatric surgical community, more surgeons may be performing laparoscopic adrenalectomy for select pediatric patients. This study combines the experience from 2 institutions with LA in children to

analyze our operative results and the clinical and biochemical response to laparoscopic adrenalectomy in patients with hormonally active adrenal tumors.

## MATERIALS AND METHODS

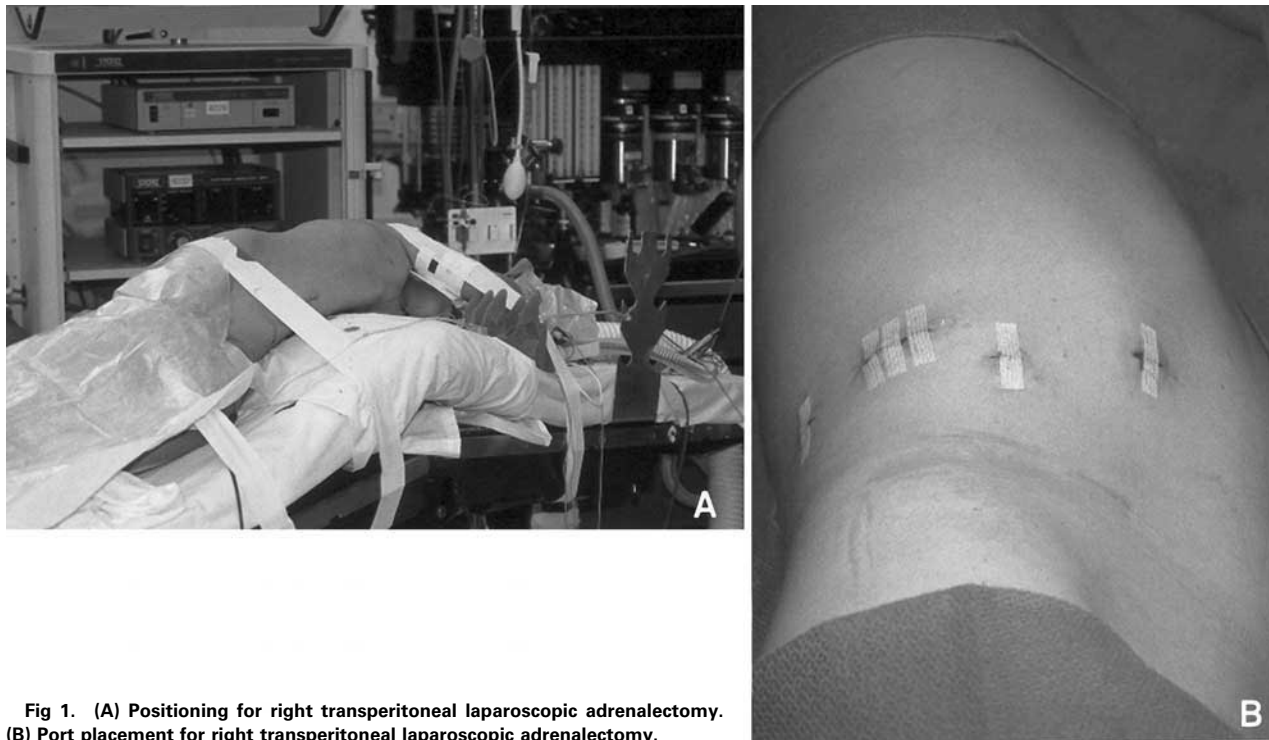
A bi-institutional retrospective chart review of all patients undergoing LA between January 1997 and January 2001 was performed at Children's Mercy Hospital (CMH), Kansas City, Missouri and the University of California, San Francisco Medical Center (UCSF). Institutional Review Board approval was obtained at UCSF. At CMH, this study began as a quality assurance (QA) monitor. Because the material was reviewed for QA purposes, IRB approval could not be granted. Surgeons at both institutions performed a thorough preoperative workup, including confirmation of the diagnosis by endocrine evaluation and radiographic localization of the pathology. During this study period, patients with known adrenal neuroblastomas were not considered candidates for laparoscopic adrenalectomy. The lateral transperitoneal laparoscopic approach was used in all cases. For LA, the patient is placed in the 90° lateral decubitus position with the operative side up. A kidney rest is raised and the table flexed maximally to create the largest possible distance between the costal margin and the iliac crest

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*Presented at the 53rd Annual Meeting of the Section on Surgery of the American Academy of Pediatrics, San Francisco, California, October 19-21, 2001.*

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0022-3468/02/3707-0007\$35.00/0  
doi:10.1053/jpsu.2002.33822*



**Fig 1. (A) Positioning for right transperitoneal laparoscopic adrenalectomy. (B) Port placement for right transperitoneal laparoscopic adrenalectomy.**

(Fig 1A). Four cannulas are inserted below the costal margins from the posterior axillary line to just medial to the anterior axillary line (Fig 1B). Dissection of the right triangular ligament for liver retraction in right-sided resections or the leinorenal ligament for splenic retraction for left-sided resections then is performed. Ligation of the adrenal vein with clips is attempted before manipulation of the mass, especially for pheochromocytomas. The remaining gland is freed by circumferential dissection. The specimen then is placed in a sterile bag and removed intact where possible or piecemeal if extremely large. Postoperative nasogastric tubes are not used. Clinical and biochemical data were obtained during routine follow-up.

## RESULTS

Seventeen laparoscopic adrenalectomies were performed during this period. Ten girls and 7 boys with a mean age of 9.8 years (range, 3 to 16) constituted the study group. Diagnoses included ganglioneuroma ( $n = 7$ ), nonfunctional adenoma ( $n = 5$ ), adrenocortical hyperplasia/Cushing's disease ( $n = 2$ ), pheochromocytoma ( $n = 2$ ) and adrenocortical carcinoma ( $n = 1$ ). There were 12 left and 5 right adrenalectomies (Table 1). The average duration of operation was 120 minutes, and the

estimated blood loss was less than 40 mL in all cases. The adrenal lesions ranged from 2 to 8.5 cm in greatest dimension with a mean size of 4.8 cm (Table 2). There were no intraoperative complications; however, the one patient with adrenal carcinoma had tumor thrombus in the adrenal vein, and the operation was converted to an open procedure for renal vein tumor thrombectomy. Both patients with pheochromocytoma were sporadic cases without familial or genetic syndromes. The average duration of operation for patients with pheochromocytoma was 221 minutes. Controllable hypertension occurred during removal of both pheochromocytomas despite preoperative pharmacologic blockade.

The mean length of postoperative hospitalization was 35 hours, including a 56-hour length of stay for the patient who required conversion to an open procedure. The average length of follow-up has been 29 months ( $\pm 15$ ). Resolution of clinical and biochemical signs of adrenal hyperfunction was accomplished in all patients with adrenocortical hyperplasia and pheochromocytoma in postoperative follow-up. No patient with pheochromocytoma currently requires antihypertensive medications. There have been no local or distant tumor recurrences.

**Table 1. Diagnoses and Locations of Lesions in Pediatric Laparoscopic Adrenalectomy Study Group**

|  | Number | Side |   |
|--|--------|------|---|
|  |        | L    | R |
| Ganglioneuromas                              | 7      | 3    | 4 |
| Nonfunctioning adrenal adenomas              | 5      | 4    | 1 |
| Adrenocortical hyperplasia/Cushing's disease | 2      | 2    |   |
| Pheochromocytoma                             | 2      | 2    |   |
| Adrenocortical carcinoma                     | 1      | 1    |   |

## DISCUSSION

Despite infrequent cases in the pediatric population, the wide application of laparoscopy to multiple pediatric surgical procedures has enabled pediatric surgeons with the necessary skills and equipment to perform laparo-

**Table 2. Short-Term Results for Laparoscopic Adrenalectomy in Children (n = 17)**

|                      | Mean | Range  | Standard Deviation |
|----------------------|------|--------|--------------------|
| Mass size (cm)       | 4.8  | 2-8.5  | 1.9                |
| Operative time (min) | 120  | 55-300 | 60                 |
| Blood loss (mL)      | 25   | 10-40  | 9.7                |
| Length of stay (d)   | 1.5  | 1-2.3  | 0.5                |

scopic adrenalectomies. Potential benefits of laparoscopic adrenalectomy are similar to those of other minimally invasive procedures, including decreased postoperative pain, shorter hospitalization, and faster return to normal activity. The transperitoneal laparoscopic approach is straightforward and can be performed safely and efficiently. Although absolute contraindications have not been identified in the adult patient, the open operation has been advocated for patients with known adrenal malignancies, particularly when magnetic resonance imaging or a metaiodobenzylguanidine nuclear scan documents metastatic lymph nodes in the periaortic chain or close to the bladder.<sup>8</sup> Other relative contraindications to endoscopic resection include uncorrectable coagulopathy or prior trauma in the area of the spleen or kidney.<sup>8</sup>

Current literature describing experience with large adrenal masses in adults also cautions against the laparoscopic approach for masses greater than 15 cm.<sup>8,15</sup> Difficulties with laparoscopic resection of these masses has been attributed to limited space availability and tedious dissection of unusual and numerous retroperitoneal feeding vessels. Rather than stating an absolute contraindicated mass size for pediatric patients, the size of the tumor may limit the laparoscopic approach when evaluated individually relative to the size of the patient. The surgeon's experience also should be considered in these cases.

The possibility of missing rare, synchronous, functional lesions exists regardless of technique used. Complete and thorough preoperative evaluation is essential for operative planning. The sensitivity of current imaging preoperative modalities will display most of the suspicious lesions and, therefore, is not reason to avoid the laparoscopic route.<sup>16</sup> Although not readily available to most pediatric surgeons, some institutions are performing intraoperative laparoscopic ultrasonography in the adult population to assist in the localization of these lesions.<sup>8,19</sup> Close postoperative endocrine evaluation al-

ways is necessary to evaluate for resolution of adrenal hyperfunction.

Although creation of a pneumoperitoneum for laparoscopy has been implicated as a possible surgical hypertensive stress in patients with pheochromocytomas, many studies have documented safe resection of pheochromocytomas with no difference in blood pressure and heart rate increments when compared with open operations.<sup>8-12,14,16-18</sup> Moderate but controllable hypertension did occur during the resection of the 2 pheochromocytomas in this study. We also have found laparoscopic adrenalectomy for patients with pheochromocytoma in our group to require more time for resection. Patients with familial pheochromocytomas are predisposed to multiple or bilateral adrenal tumors; therefore, preoperative localization is particularly important in this group. For patients with known bilateral pheochromocytomas, several institutions have described adrenocortical preserving partial laparoscopic adrenalectomies in adult patients.<sup>8,19</sup> Recurrent pheochromocytomas may develop in 20% to 33% of familial patients undergoing partial adrenalectomy; therefore, close follow-up is necessary in these patients.<sup>16</sup>

Only one conversion to an open procedure was required in our series and that involved the patient with adrenocortical carcinoma and renal vein tumor thrombosis. Evidence of enlarged veins on preoperative imaging or at the time of laparoscopic resection should prompt close evaluation of the renal vein. Although not performed in this series, laparoscopic nodal sampling has been performed when atypical or abnormal nodes have been identified during laparoscopic adrenalectomy in adults.<sup>8,20</sup>

Laparoscopic adrenalectomy can be performed safely and effectively with a short hospital stay and minimal blood loss in pediatric patients. In this small series, the clinical and biochemical outcome in pediatric patients with functional endocrine tumors has been excellent. Although there are no absolute contraindications, patients with adrenal malignancies with preoperative evidence of vein involvement or metastatic nodes may be better served with an open procedure. Pheochromocytomas may be removed safely in children; however, their resection may require a longer operating time compared with other adrenal pathologies. Whereas long-term evaluation is warranted, we believe laparoscopic adrenalectomy is an excellent approach for the management of most benign pediatric adrenal pathology.

## REFERENCES

1. Clayman RV, Kavoussi LR, Soper NJ, et al: Laparoscopic nephrectomy: Initial case report. *J Urol* 146:278-282, 1991.
2. Guazzoni G, Montorsi F, Bocciardi A, et al: Transperitoneal laparoscopic versus open adrenalectomy for benign hyperfunctioning adrenal tumors: A comparative study. *J Urol* 153:1597-1600, 1995.
3. Brunt LM, Doherty GM, Norton JA, et al: Laparoscopic adrenalectomy compared to open adrenalectomy for benign adrenal neoplasms. *J Am Coll Surg* 183:1-10, 1996.
4. Linos D, Stylopoulos N, Boukis M, et al: Anterior, posterior, or laparoscopic approach for the management of adrenal diseases? *Am J Surg* 173:120-125, 1997.

5. Jacobs JK, Goldstein RE, Geer RJ: Laparoscopic adrenalectomy: A new standard of care. *Ann Surg* 225:195-202, 1997
6. Sung GT, Gill IS, Hobart M, et al: Laparoscopic adrenalectomy: Prospective, randomized comparison of transperitoneal versus retroperitoneal approaches. *J Urol* 161:21, 1999 (suppl)
7. Suzuki K, Kageyama S, Hirano Y, et al: Comparison of 3 surgical approaches to laparoscopic adrenalectomy: A nonrandomized, background matched analysis. *J Urol* 166:437-443, 2001
8. Gagner M, Pomp A, Heniford BT, et al: Laparoscopic adrenalectomy: Lessons learned from 100 consecutive procedures. *Ann Surg* 226:238-247, 1997 comb@cmh.edu
9. Guazzoni G, Cestari A, Montorsi F, et al: Eight-year experience with transperitoneal laparoscopic adrenal surgery. *J Urol* 166:820-824, 2001
10. Yamamoto H, Yoshida M, Sera Y: Laparoscopic surgery for neuroblastoma identified by mass screening. *J Pediatr Surg* 31:385-388, 1996
11. Pretorius M, Rasmussen GE, Holcomb GW III: Hemodynamic and catecholamine responses to a laparoscopic adrenalectomy for pheochromocytoma in a pediatric patient. *Anesth Analg* 87:1268-1270, 1998
12. Reddy VS, O'Neill JA Jr, Holcomb GW III, et al: Twenty-five-year surgical experience with pheochromocytoma in children. *Am Surg* 66:1085-1091, 2001
13. Mirallie E, Leclair MD, de Lagausie P, et al: Laparoscopic adrenalectomy in children. *Surg Endosc* 15:156-160, 2001
14. Clements RH, Goldstein RE, Holcomb GW III: Laparoscopic left adrenalectomy for pheochromocytoma in a child. *J Pediatr Surg* 34:1408-1409, 1999
15. Kazaryan AM, Mala T, Eswin B: Does tumor size influence the outcome of laparoscopic adrenalectomy? *J Lap Adv Surg Tech* 11:1-4, 2001
16. Pacak K, Linehan WM, Eisenhofer G, et al: Recent advances in genetics, diagnosis, localization, and treatment of pheochromocytoma. *Ann Intern Med* 134:315-329, 2001
17. Gagner M, Lacroix A, Bolte E: Laparoscopic adrenalectomy in Cushing's syndrome and pheochromocytoma. *N Engl J Med* 327:1033, 1992 (letter)
18. Gagner M, Breton G, Pharand D, et al: Is laparoscopic adrenalectomy indicated for pheochromocytomas? *Surgery* 120:1076-1080, 1996
19. Walther MM, Herring J, Choyke PL, et al: Laparoscopic partial adrenalectomy in patients with hereditary forms of pheochromocytoma. *J Urol* 164:14-17, 2000
20. Heniford, BT, Area MJ, Walsh RM, et al: Laparoscopic adrenalectomy for cancer. *Semin Surg Oncol* 16:293-306, 1999

## Discussion

*M. Chalsky (Columbus, OH):* The same question per 2 different aspects of your population, because you have identified 2 subsets that have some controversy. Those would be patients with pheochromocytoma and those patients with a carcinoma. Can you comment on the applicability for those 2 subpopulations?

*K.A. Miller (response):* Yes. While there are no complete contraindications to laparoscopic adrenalectomy, I do believe the adult literature supports the thinking that malignancies are not approached this way, especially if, by preoperative evaluation, there is evidence of significant lymphadenopathy or renal vein involvement.

As far as pheochromocytoma, there has been good support in the literature for this technique. However, it also is clear that patients with familiar forms of pheochromocytoma have more chance of bilaterality and multicentricity, and preoperative evaluation really needs to be done to try to evaluate these possibilities. I think that this would be a complicated potential study but there have been patients in the adult population, who have undergone laparoscopic ultrasonography during the procedure, and although it is not widely used in the pediatric age group, it might be indicated for those patients with familial pheochromocytoma.