Chapter 11
Laparoscopic Adrenalectomy

Imran Mushtaq and Francisca Yankovic

Abstract Laparoscopic adrenalectomy is considered to be the standard of care for the surgical excision of the adrenal gland. Transperitoneal and retroperitoneoscopic approaches are the two principal laparoscopic routes to the adrenal gland. Both are safe and effective as open adrenalectomy, but offer the benefits of decreased blood loss, less postoperative pain, shorter hospital stay, rapid convalescence, and improved cosmetic outcome. This technique can safely be used in patients with pheochromocytoma, adrenal adenoma, adrenal adenocarcinoma, Cushing's syndrome, neuroblastoma, and incidentaloma. Relative contraindications include previous surgery of the liver or kidney, large tumors (>8–10 cm in diameter), or coagulation disorders.

Although the transperitoneal route is used more widely, the retroperitoneal approach provides a more direct exposure of the adrenal gland and a better visualization of the adrenal vein. It avoids also colonic mobilization, minimizes the risk of injury to hollow viscera, and the potential risk of adhesion formation. However, the reversed orientation of the kidney and hilum, combined with a significantly smaller working space, may make this approach difficult to master. Familiarity with this approach for renal surgery has made this the preferred approach for adrenal surgery in our institution.

Keywords Laparoscopic adrenalectomy • Retroperitoneoscopic adrenalectomy • Pediatric adrenalectomy • Minimally invasive surgery • Adrenal masses

---

The online version of this chapter (doi:10.1007/978-1-4471-5394-8_11) contains supplementary material, which is available to authorized users.

I. Mushtaq, MBchB, MD, FRCS(Glasg), FRCS(Paed) (✉)
Great Ormond Street Hospital for Children, London, UK
e-mail: mushti@gosh.nhs.uk

F. Yankovic, MD
Department of Pediatric Urology, Great Ormond Street Hospital NHS Trust, London, UK

P.P. Godbole et al. (eds.), *Pediatric Endourology Techniques*,
DOI 10.1007/978-1-4471-5394-8_11,

Introduction

Laparoscopic adrenalectomy is considered the standard of care for the surgical excision of the adrenal gland. Recent guidelines published in 2010 by the International Pediatric Endosurgery Group (IPEG) have validated the minimally invasive treatment for adrenal masses in children [1].

Since the initial report of laparoscopic adrenalectomy in 1992 [2], it has evolved into a feasible and reproducible minimally invasive procedure for benign adrenal tumors [3]. Treatment of suspected malignant lesions such as adrenocortical carcinoma is recommended only for experienced surgeons and localized tumors less than 6 cm in diameter [4].

Transperitoneal and retroperitoneal approaches are the two principal laparoscopic routes to the adrenal gland [5, 6]. Both approaches are safe and effective as open adrenalectomy, but offer the additional benefits of decreased blood loss, less postoperative pain, shorter hospital stay, rapid convalescence, and improved cosmetic outcome [7]. Whether the laparoscopic approach confers benefit in terms of greater hemodynamic stability in patients with catecholamine excess is undefined. There is a paucity of literature in the available in pediatric population, but the number of case series reported in the last 5 years has increased substantially.

Although the transperitoneal route is used more widely, the retroperitoneal approach offers distinct advantages that make it a valuable alternative route to the adrenal gland. It avoids colonic mobilization, minimizes the risk of injury to hollow viscera, and the potential risk of adhesion formation. The exposure of the adrenal gland is direct, and the visualization of the adrenal vein is more precise. These observations have been made by Waltz in an experience of more than 500 prone retroperitoneal adrenalectomies [8]. With the patient in a prone position, the reversed orientation of the kidney and hilum, combined with a significantly smaller working space, may make this approach difficult to master. Familiarity with this approach for renal surgery has made this the preferred approach for adrenal surgery in our institution.

Anatomy

Left Adrenal Gland

The left adrenal gland is smaller than the right and lies in the renal fossa at the medial aspect of the upper pole of the left kidney. The arterial supply is derived from the left superior (left inferior phrenic artery), middle (aorta), and inferior (left renal artery) adrenal arteries. The main left adrenal vein joins with the left inferior phrenic vein to drain into the left renal vein.

Right Adrenal Gland

The right adrenal gland is larger than the left and is of variable shape. It is located at the medial aspect of the upper pole of the right kidney, behind the vena cava in a very deep and high position. The arterial supply derives from the right superior (inferior phrenic artery), middle (aorta), and inferior (right renal artery) adrenal arteries. The main right adrenal vein drains into the posterior lateral aspect of the vena cava after a short horizontal course. Approximately 10 % of individuals have an accessory adrenal vein, which drains into the right hepatic vein.

Indications

1. Pheochromocytoma
2. Adrenal adenoma
3. ACTH-dependant Cushing's syndrome
4. Neuroblastoma (<8 cm without involvement of adjacent organs)
5. Adrenocortical tumor (<8 cm without involvement of adjacent organs)
6. Incidentaloma

Relative Contraindications

1. Previous surgery of the liver or kidney
2. Large tumors (>8–10 cm in diameter)
3. Coagulation disorders

Preoperative Work-Up

Imaging

A detailed ultrasound of the kidneys and adrenal glands is an essential investigation in all children suspected of having an adrenal lesion. The ultrasound provides information regarding the presence of a distinct lesion, including its size and whether it is cystic or solid. In some cases, there will be bilateral diffuse enlargement of the adrenal glands without a focal lesion, such as in central Cushing's syndrome. It is also essential to determine if there is intravascular extension of a lesion into the

adrenal vein and inferior vena cava. This information will serve as a guide to the suitability of the laparoscopic approach and also for deciding the technique for specimen removal. The information gained from an ultrasound must be supplemented with a CT scan and/or an MRI scan.

Blood Tests

All patients should have routine blood test, which should include serum creatinine, hemoglobin level, and a group/save of serum. Clotting parameters do not need to be checked routinely, unless there is a history of bleeding disorders.

Pheochromocytoma

Hypertensive patients with a pheochromocytoma secrete excessive quantities of catecholamines, and the measurement of urinary catecholamines is diagnostic in 95 % of patients. Preoperative preparation in such cases requires the administration of phenoxybenzamine for 7 days prior to surgery. In addition, the administration of beta-blockers (propranolol) can decrease the risk of tachyarrhythmias, but should not be given without prior alpha-blockade. These patients require a multidisciplinary team comprising a nephrologist, endocrinologist, and anesthetist to prepare and stabilize the patient for surgery.

Antibiotics

All children receive a single dose of an appropriate intravenous antibiotic, either prior to leaving the ward or at the induction of anesthesia. The authors prefer an aminoglycoside such as amikacin or gentamicin.

Specific Instrumentation

1. Primary camera port – 6 mm Hasson
2. 2 secondary 5 mm ports (the author prefers 5 mm Endopath Xcel® trocars)
3. 30-degree 5 mm telescope
4. Kelly forceps (×2) for dissection
5. Metzenbaum scissors
6. LigaSure® for coagulation/division of vessels or 5 mm endoclips
7. Endopouch® for specimen retrieval

Position and Key Landmarks

The patient (P) is positioned fully prone for the operation. The monitor and stack system (AV) should be placed on the side opposite to the adrenal gland/mass to be removed, towards the head of the table, with the screen pointing towards the pelvis. The scrub nurse (N) should be positioned adjacent to the laparoscopic stack, with the operating surgeon (S) and assistant (A) both on the side of the lesion (Fig. 11.1). The patient is positioned at the edge of the table to allow free movement of the laparoscopic instruments. Two small supports are placed under the hips and chest of the patient, allowing the abdomen to be suspended. This reduces the contact of the intraperitoneal organs with the retroperitoneum. Once position is ready, the patient should not be moved and before skin preparation the landmarks are drawn as shown (Fig. 11.2).

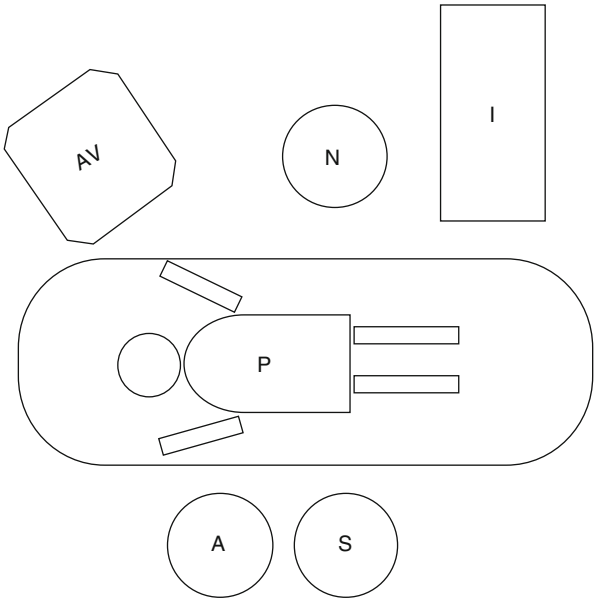

Fig. 11.1 Schematic representation of the room setup. *P* patient, *AV* audiovisual equipment, *N* scrub nurse, *I* instrument trolley, *S* surgeon, *A* camera holder

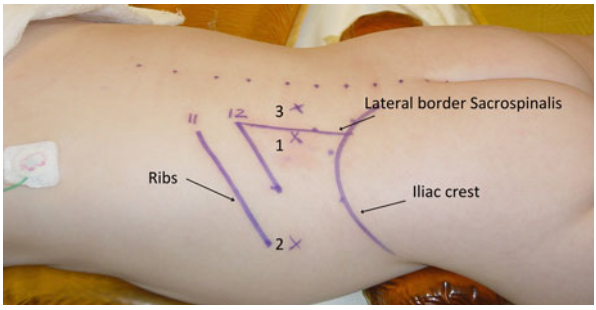

Fig. 11.2 Schematic representation of port position. *1* Camera port, *2* First instrument port, *3* Second instrument port

Anesthesia

Endotracheal intubation is required in all cases using either a cuffed or reinforced endotracheal tube that is securely fastened to prevent tube dislodgement when the child is positioned prone for the surgery. Preoperative and postoperative analgesia is provided by preemptive local infiltration of the planned incisions with 0.25 % bupivacaine.

Operative Technique

General Principles

The operative strategy is based on complete dissection of the adrenal gland outside the surrounding adipose tissue. This minimizes bleeding, which can occur with dissection on the surface of the gland. A left adrenalectomy is more difficult than a right adrenalectomy because of the absence of clear landmarks, such as the vena cava, the smaller size of the gland, and adrenal vein. The key to success is to begin dissection on the medial aspect to identify and ligate the vessels from an early stage in the operation.

Retroperitoneoscopic Adrenalectomy (Videos 11.1, 11.2)

1. The patient is positioned fully prone under general anesthesia. The exposed dorsal and lateral aspects of the trunk are prepared and draped in a sterile manner. Topographic landmarks and anticipated port sites are marked as shown (Fig. 11.2).
2. The retroperitoneal space is created outside Gerota's fascia using the technique described by Gaur [9]. Several balloons are available for creation of the retroperitoneal space. However, the authors prefer a simple and inexpensive balloon made by securing the finger of a sterile surgical glove to the end of a 12 Fr Jacques catheter with a silk tie. The catheter is connected to a three-way tap and a 50 ml Luer lock syringe. Depending on the size of the patient, 100–250 ml of air is injected slowly to develop the retroperitoneal space. The system is left inflated for 2 min to promote hemostasis and is then deflated and withdrawn.
3. Insertion of primary and secondary ports: A 6 mm Hasson cannula is inserted into the port site, followed by insufflation of the retroperitoneum with CO_2 to pressure of 10–12 mmHg. A suture to the skin secures the Hasson port. A 5 mm instrument port is placed under direct vision below the tip of the 11th rib and above the iliac crest. If necessary, a second working port (5 mm) can be placed through the paravertebral muscles.
4. Exposure of the kidney: Gerota's fascia is incised longitudinally adjacent to the posterior abdominal wall using scissors. The adventitious tissue is divided to gain adequate exposure and working space for the procedure.

5. Exposure of the posterior surface of the kidney: the kidney is dissected commencing at the apex and along the medial aspect. Using blunt dissection and gentle pressure, the kidney is reflected anteromedially to expose the posterolateral aspect of the kidney. The lateral and inferior attachments are not divided at this stage as they anchor the kidney in position and aid in exposure of the upper pole. The inferior margin of the adrenal gland can then be visualized at the superomedial border of the kidney.
6. Division of the adrenal vessels: The vessels are divided between hemoclips or with a LigaSure® when the vessels are less than 8 mm in diameter. A minimum of three clips should be applied on all vessels, with at least two clips remaining on the proximal stump of the divided vessel.
7. Removal of the gland: Once the vascular supply to the adrenal gland is completely divided, the gland is fully mobilized and freed of all attachments using either monopolar diathermy or a LigaSure®. The gland is then placed within an endobag and removed through the camera port incision, which can be slightly enlarged to facilitate removal.

Postoperative Management

1. Patient can start fluids and diet on return to the ward.
2. Frequent blood pressure monitoring in a specialized unit (nephrology ward/intensive care unit) under the supervision of a nephrologist and endocrinologist.
3. The patient is discharged when the blood pressure control has been stabilized.

Complications

Peritoneal Tear

The posterior prone approach minimizes the risk of a peritoneal tear when compared with other approaches for retroperitoneoscopic surgery. It can occur if the balloon is inflated too rapidly, when the balloon is too small for the size of the patient and in adolescents.

Balloon Rupture

Rupture of the dissecting balloon can occur when the balloon is inflated too rapidly, with over inflation of the balloon or when excessive external pressure is applied over the balloon. When it occurs the ruptured balloon must be carefully examined for lost fragments, which should be sought and removed from the patient.

Intraoperative Bleeding

Intraoperative bleeding is most likely the result of the slipping of hemoclips from an adrenal vein or because of inadvertent damage to an adrenal vein or vena cava by a laparoscopic instrument. In most cases, hemorrhage can be controlled by the prompt application of hemoclips to the affected vessel. Uncontrollable hemorrhage will require conversion to an open approach to ligate the bleeding vessel.

Author's Experience

At our institution, we have performed 14 retroperitoneoscopic adrenalectomies in 12 patients, including 2 bilateral synchronous adrenalectomies. Our patients comprised 7 boys and 5 girls, with a mean age at the time of surgery of 6 years (range, 2 months–15 years). Presentation was with hypertension ($n=4$), Cushing's syndrome ($n=3$), abdominal pain ($n=2$), virilization ($n=2$), and incidental finding on imaging ($n=1$). Our mean operative time is 124 min (range, 70–186 min). A single instrument port adrenalectomy technique was performed in four children. Histopathological diagnoses included adrenal cyst, pheochromocytoma, adrenal cortical tumor, ACTH-dependant Cushing disease, and neuroblastoma. In these children, all lesions were completely excised, and all patients have remained symptom free with a mean follow-up of 20 months.

These cases represent our experience with retroperitoneoscopic adrenalectomy. The general learning curve for laparoscopy has been long since surmounted for the senior reporting surgeon, and this experience has proved vital to expand our repertoire as a result of such encouraging results. The technique confers excellent intraoperative hemodynamic stability, and we consider the retroperitoneoscopic approach the technique of choice for adrenal surgery.

References

1. International Pediatric Endosurgery Group. IPEG guidelines for the surgical treatment of adrenal masses in children. J Laparoendosc Adv Surg Tech A. 2010;20(2):vii–ix.
2. Higashihara E, Tanaka Y, Horie S, Aruga S, Nutahara K, Homma Y, et al. A case report of a laparoscopic adrenalectomy. Nihon Hinvokika Gakkai Zasshi. 1992;83(7):1130–3.
3. Romano P, Avolio L, Martucciello G, Steyaert H, Valla JS. Adrenal masses in children: the role of minimally invasive surgery. Surg Laparosc Endosc Percutan Tech. 2007;17(6):504–7.
4. Heloury Y, Muthucumaru M, Panabokke G, Cheng W, Kimber C, Leclair MD. Minimally invasive adrenalectomy in children. J Pediatr Surg. 2012;47(2):415–21.
5. St Peter SD, Valusek PA, Hill S, Wulkan ML, Shah SS, Martinez Ferro M, et al. Laparoscopic adrenalectomy in children: a multicenter experience. J Laparoendosc Adv Surg Tech A. 2011; 21(7):647–9.
6. Nassrallah RA, Valla JS, Van Hoorde E, Steyaert H. Retroperitoneal minimally invasive endoscopic adrenalectomy in children. Saudi Med J. 2003;24(5 Suppl):S11–4.

7. Nigri G, Rosman AS, Petrucciani N, Fancellu A, Pisano M, Zorcolo L, et al. Meta-analysis of trials comparing laparoscopic transperitoneal and retroperitoneal adrenalectomy. Surgery. 2013;153(1):111–9.
8. Walz MK, Alesina PF, Wenger FA, Deligiannis A, Szuczik E, Petersenn S, et al. Posterior retroperitoneoscopic adrenalectomy–results of 560 procedures in 520 patients. Surgery. 2006; 140(6):943–8.
9. Gaur DD. Retroperitoneoscopy: the balloon technique. Ann R Coll Surg Engl. 1994; 76(4):259–63.