Chapter 1
Laparoscopy in Children: Basic Principles

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Abstract Minimal access surgery (MAS) in children is advancing, and the use of a video endoscope has entered all the surgical disciplines for children. Refinements of instrumentation have empowered surgeons, so that size and weight are no longer considered contraindications to an MAS approach. The pioneering era has passed, and virtually all procedures that could possibly be performed by an MAS technique in children have been accomplished. Further refinements will make the majority of these procedures the gold standard, but much work remains to be done and the evidence base needs consolidating. This chapter focuses on basic laparoscopic techniques.

Keywords Minimal access surgery • Laparoscopy

Introduction

Laparoscopy and laparoscopic techniques in children with urological problems have evolved over the last two decades, thereby allowing the urologist to offer this as an alternative to open surgery. Performing a safe laparoscopic urological procedure requires adequate training and experience with enough cases being performed to maintain skills. It is also important to be conversant with the basic skills pertaining to access and creation of working space and knowledge of physiological changes

The online version of this chapter (doi:10.1007/978-1-4471-5394-8_1) contains supplementary material, which is available to authorized users.

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P.P. Godbole et al. (eds.), *Pediatric Endourology Techniques*,
DOI 10.1007/978-1-4471-5394-8_1,

during laparoscopy to enable a safe and successful procedure. The first two aspects are covered in this chapter and will form the basis for the remaining chapters.

Preparation

In a minimally invasive procedure, the stomach and urinary bladder may need to be emptied following induction of anesthesia, but this is not routine. If the colon is loaded, administration of an enema might be considered preoperatively. Careful attention should be given to the preoperative preparation of the umbilicus, from which the cleaning of debris is important. Routine prophylactic antibiotics are unnecessary to cover the access component but may be indicated for the procedure.

Individual judgment should be applied to instances of preexisting coagulopathy or cardiorespiratory compromise that might be exacerbated by the pneumoperitoneum [1]. Previous extensive intra-abdominal surgery, anterior abdominal wall infection, and an intra-abdominal mass require caution but are not absolute contraindications.

Anesthesia

Nitrous oxide should be avoided as this may exacerbate gaseous intestinal distension.

Positioning

An electronic table that allows for a variety of positions is ideal. If the legs are to be supported, all forms of leg support are potentially hazardous, so a splitting table is preferred. For securing and placing patients in a variety of positions, a vacuum "beanbag" may be useful.

Access

Preinfiltration with long-acting local anesthetic and adrenaline of port sites is recommended. Furthermore, allowing the needle to penetrate the peritoneum or body wall helps to site secondary ports. Newer regional nerve block techniques such as transversus abdominis plane (TAP) block are being used but need further assessment and comparison. Access for instrumentation and telescope is usually via ports.

A port in its simplest form consists of a hollow tube or cannula with a cap that contains a valve to prevent gas leak but allows instruments to pass through. The solid trocar or obturator is often sharp but may be blunt. The primary port may be inserted either by a blind puncture after establishing a pneumoperitoneum with a Veress needle or by open insertion using a minimal cutdown technique. Either is acceptable but certain principles must be adhered to (see later).

Ports for children should be of the radially dilating or tissue-separating type; the use of bladed or sharp trocars should no longer be necessary. Cutting trocars are problematic even if shielded and are associated with greater incidence of visceral injury, port site herniation, and bleeding. Increasingly secondary access by stab incisions may be successful and can avoid many of the intraprocedural problems associated with ports, such as dislodgement, gas leak, or limitation of instrument movement [2]. Single port access has become an alternative to multiple ports with similar clinical outcomes but potentially better cosmesis.

Approach

Approaches to the genitourinary tract using rigid telescopes and a video camera include the endoluminal or laparoscopic routes via either the transperitoneal or retroperitoneal approach; the choice depends on the procedure involved and the experience of the surgeon. The retroperitoneal approach is advantageous in avoiding ileus or injury to intra-abdominal viscera, but skill is required to master the technique. Occasionally, approaches may be combined; this allows two images to be seen. Currently, most pediatric urologists with experience in laparoscopy would prefer a retroperitoneal approach, in which the patient may be in the prone, the lateral, or the supine position. Both the transperitoneal and retroperitoneal approaches are described below [3].

Transperitoneal Approach

Primary Port Insertion

Primary port insertion is done by one of two methods: the open or Hasson technique and the closed or Veress technique. Modifications of these techniques include a hybrid technique of limited open dissection with the use of the Veress needle. A newer method of direct visualization is now available using a disposable optical trocar and standard scope that is 5 or 10 mm in diameter or even a finer scope down an optical Veress needle. These may be most appropriate in the obese patient, but little experience of this method has been reported in children. Visual ports and smaller scopes via a modified Veress needles are also available, but again experience with children is limited [4].

No method has been shown to be superior, and each has its own proponents. The open insertion of the appropriately sized primary port by open placement is done under direct visualization of the fascia and peritoneum. Because the umbilicus is a natural scar and the approximate center of the abdomen, it is the usual site of the primary port for intraperitoneal procedures. Once the primary port is placed, the position should be checked with the scope before insufflation begins.

The least invasive method of open primary port insertion is the transumbilical method. In most children with a shallow umbilicus, this approach is quick, involves minimal dissection, and can easily be enlarged to accept 15 mm diameter ports without any obvious scar. Two pairs of hemostats are placed directly on the umbilical cicatrix to lift the abdominal wall gently. A no. 11 blade is used in a perpendicular plane in the longitudinal direction to create a vertical slit in the cicatrix and to enter the peritoneum. This can be confirmed by gently inserting a closed hemostat or blunt scissors.

For children with more than the average amount of subcutaneous fat or a deep umbilicus, the infraumbilical method is favored. A curved incision is made in the inferior umbilical fold and dissection carried down to the midline fascia. The linea alba is incised longitudinally at its junction with the umbilical tube. The underlying peritoneum may be cut with scissors or pierced with a hemostat. In the largest children, a pair of Littlewoods forceps is used to grasp the fascia before incising the fascia. Fascial stay sutures are sometimes placed to prevent outward displacement of the port. If used, these sutures can be secured to a Hasson port or around the tap of a simple port for insufflation. Sutures are usually unnecessary if with careful judgment the aperture is made just small enough to accept the port but still able to grip it, whether using the trans- or infraumbilical method. Inward displacement can be prevented by applying adhesive wound closure strips over the suture and around the port. Alternatively, a rubber catheter cut in small lengths can be pushed over the port; the rubber catheter is then sutured to the skin. A disposable port with an inflatable balloon and moveable cuff is an advanced way of securing the primary port, particularly if the port is to be removed and replaced during a procedure, such as when a large amount of tissue either free or within a bag needs to be retrieved. The inflated balloon prevents outward displacement, while a locking cuff prevents inward displacement, but the port diameter is greater than 10 mm. A port that has a blunt obturator or trocar tip is safest and may come as a bull-nosed or pencil-point type.

The closed method of primary port insertion depends on a Veress needle that is placed through a small incision of the infraumbilical fold just into the fascia with a no. 11 blade. A disposable needle is recommended. The Veress needle is held by the thumb and forefinger down the shaft, like a dart, to allow it to just penetrate the peritoneal cavity. The entry may be associated with a double click. Its position is then ensured by the following tests:

1. The needle movement test
2. Irrigation test
3. Aspiration test
4. Hanging drop test
5. Insufflation of gas or quadromanometric test

(a) Preset insufflation pressure
(b) Actual pressure
(c) Gas flow rate
(d) Total gas used

The pneumoperitoneum is established to a preset pressure for the procedure to the following suggested range:

Newborn infants: <1 year of age, 6–8 mmHg
Children: 1–12 years of age, 8–10 mmHg
Adolescents: 12–15 years of age, mmHg

The primary port is then inserted blind either through the same but enlarged incision or at another site. The only port that should really be used for such entry is a dilating type with Veress needle as the trocar; all other types of trocar are hazardous in the majority of children.

Once the primary port is placed, the position should be checked with the scope and continuation of the insufflation.

Insufflator systems are now available to provide humidified and warmed CO_2 with the possible benefits of reduced tissue desiccation, pain, and cooling. In addition, continuous CO_2 insufflators that recirculate the gas allow the maintenance of the pneumoperitoneum during suction and gas leak but also allow smoke and particle evacuation, are available, and represent the most modern solution.

Single ports are now manufactured with a range of sizes and allow for insufflation and smoke evacuation and are feasible for a range of procedures. These can be used with an incision as small as 2 cm and can be enlarged to 5 cm or more. While there may be some benefits for individual procedures, overwhelming benefits over and above conventional laparoscopy have not yet been fully determined. Reduced port approaches using fewer ports and/or narrower instruments are emerging at the same time.

Secondary Port Insertion

Secondary ports are carefully planned based on the proposed procedure and performed under direct visualization using the telescope. Manual elevation of the abdominal wall during trocar insertion facilitates placement and minimizes the risk of injury to the intra-abdominal organs. Raising the intra-abdominal pressure to as high as 30 mmHg transiently while siting secondary ports may improve safety.

Dilating ports based on a Veress needle are probably safest, and, certainly, those with a sharp cutting, if retractable blade (shielded trocars), should be used with extreme caution. Other “dilating” port trocars are based on a sharp or blunt conical shape or a pyramidal cutting point with dilating shoulders, but neither of these types offers the reliable protection of a Veress needle. The pediatric peritoneum is very elastic and penetrating the peritoneum with a less than sharp or blunt trocar is sometimes problematic and even hazardous.

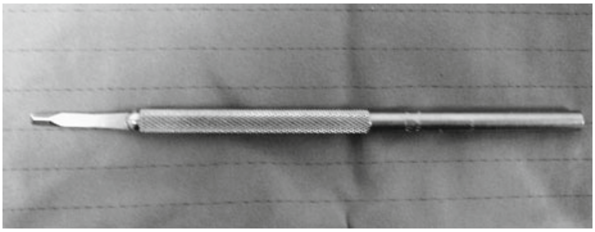

Fig. 1.1 Beaver handle with a no. 69 blade

For many procedures, however, secondary ports may be unnecessary, and access can be gained by carefully creating stab wounds with a scalpel blade. Many surgeons use a no. 11 blade, but this can cut wider than necessary and may therefore cause bleeding or gas leak. A no. 69 blade (Swann-Morton, Sheffield, UK) on a Beaver handle (Fig. 1.1) can be used to create a port hole for 2 or 3 mm instruments, or by inserting the blade further, it can be stretched gently to a 5 mm access hole without the need for a port. When the instrument is removed, gas leaks slowly. But then, as the abdominal wall begins to collapse, the layers of fascia and peritoneum begin to overlap to create a shutter valve that prevents complete deflation. This helpful phenomenon can be enhanced by placing a finger over the incision. This allows the pressure to rise, which then opens up the wound again. The light can be observed through the wound, and the instrument resited in the correct direction. Reducing the number of ports used helps to limit the invasion (e.g., single port nephrectomy).

Retroperitoneal Approach

This approach may be performed with the patient in either a prone, lateral, or even supine position. The approach with the patient in the prone position is described here, as it is the preferred method of the authors.

Anesthesia

General anesthesia should be used via endotracheal intubation; the muscles should be relaxed.

Patient Position

The patient is placed in a prone position. A bolster/sandbag is placed under the pelvis and lower chest so that the renal angle is opened out. This space is bordered inferiorly by the iliac crest, medially by the lateral border of the sacrospinalis, and

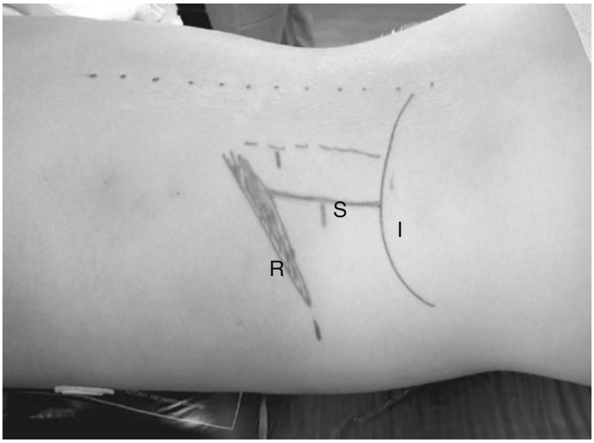

Fig. 1.2 Landmarks and boundaries of the renal space: ribs (*R*), sacrospinalis (*S*), and iliac crest (*I*)

superiorly by the 11th and 12th ribs (Fig. 1.2). Too much elevation will result in approximation of the ribs and the iliac crest, thereby reducing the working space. A useful way of ascertaining adequate support and elevation is by passing a hand below the elevated trunk. Easy passage of the upturned palm indicates adequate positioning. The renal angle may be further opened out by slightly abducting the entire pelvis away from the affected side. Finally the patient should be positioned as shown in Fig. 1.2 at the very edge of the table on the affected side to allow easy maneuverability of the instruments. The arms and legs should be well supported and padded (Fig. 1.3).

Access

The primary port is inserted at the lateral border of the sacrospinalis midway between the iliac crest and the 12th rib. A 5 mm/10 mm incision, depending on the size of port, is made in the skin. A blunt artery forceps, such as a Dunhill forceps, is "walked" off the lateral border of the sacrospinalis through the dorsolumbar fascia until the perinephric area is reached. This is evidenced by a sudden give through the muscle and free movement of the forceps. A ready-made balloon device or the middle finger of an 8.5 glove tied to a 12Fr Nelaton catheter with a three-way tap and 50 ml Luer-Lok syringe is inserted into the perinephric space (the authors' preference) (Fig. 1.4). The balloon is blown up gradually to approximately 200 ml. Too rapid inflation may result in rupture of the balloon. Alternatively, the port may be inserted and the space created using the telescope itself. Once the balloon is deflated, the balloon is removed and the port inserted. The working ports are placed just inferior to the tip of the 11th rib, and, if required, a second working port is placed under vision through the sacrospinalis muscle either in line with or superior to the primary port. The insufflation pressure is maintained at 10–12 mmHg at a flow rate of 1 l/min [5].

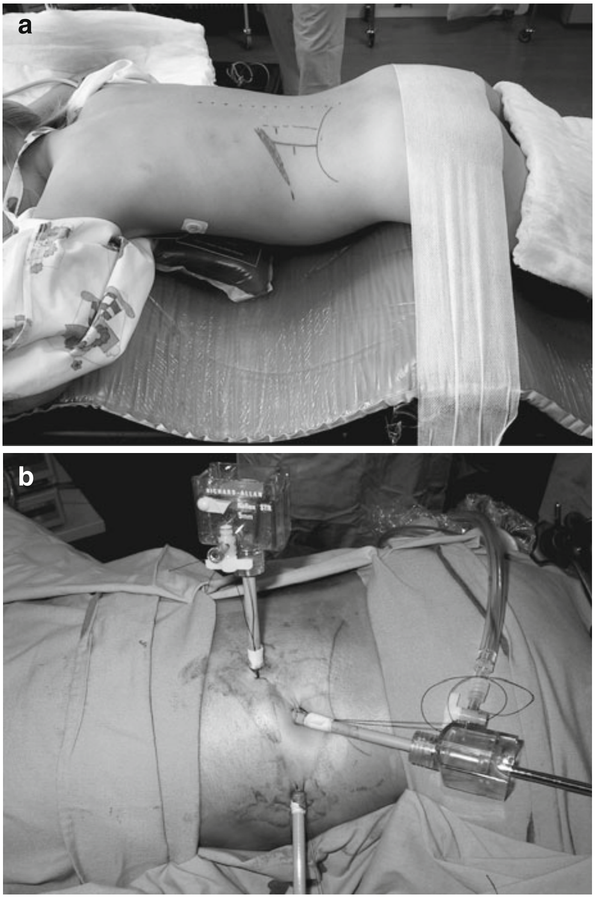

Fig. 1.3 (**a**) Patient position for prone retroperitoneoscopic nephrectomy and (**b**) the ports in situ

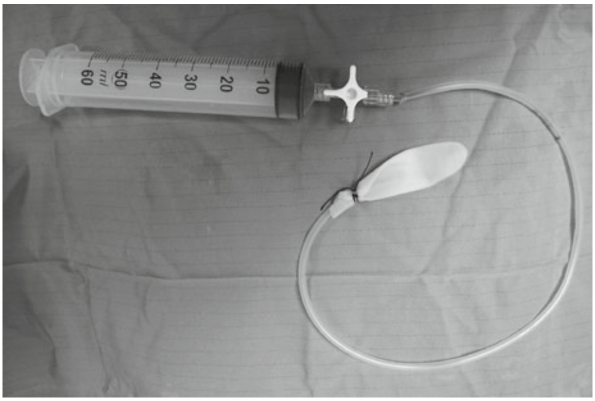

Fig. 1.4 Inexpensive balloon dissector made with the middle finger of an 8.5 glove tied to a 12 Fr Nelaton catheter, a three-way tap, and a 50 ml Luer-Lok syringe

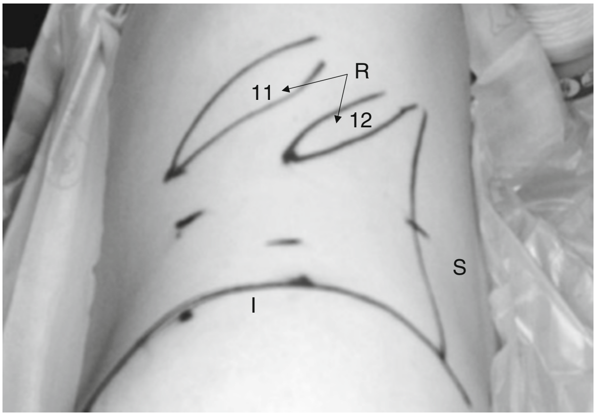

Fig. 1.5 The patient in the right lateral position for a left nephrectomy. The sacrospinalis (*S*), iliac crest (*I*), and ribs (*R*) are shown, as are the port sites

In the case of a lateral approach, the landmarks remain the same but the port position changes (Fig. 1.5). The primary port is inserted in a similar fashion to insertion in the prone approach.

Once the primary and working ports are inserted, the camera may be transferred to the port just above the iliac crest to get good triangulation.

Visualization

Visualization in MAS depends on the creation and maintenance of a working space within an existing or potential body cavity, for example, creating a pneumoperitoneum in laparoscopy or a retroperitoneal space in retroperitoneoscopy. Abdominal wall lifting has not found a place in pediatric MAS. Therefore, the potential retroperitoneal space is expanded initially with balloon devices and insufflation or pneumodissection performed in combination with a blunt or sharp instrument dissection. This will create an acceptable, if smaller, working space compared to the pneumoperitoneum. The initial maximum pressure limits chosen for the intraperitoneal insufflation can vary with the size of the child, but in essence the pressure should be limited to that required to achieve sufficient working space. Preparing a pneumovesicum for ureteric reimplantation will be discussed in another chapter.

Retracting adjacent organs within the working space may be desirable. If so, this is achieved by using retractor systems. Fan retractors are usually large and likely to cause injury. The most useful retractors are of the snake type, as they are flexible enough to allow insertion and then screwed tightly into a preconfigured shape. They may be used in association with a scope/instrument holding clamp that is adjustable or flexible. Suspension sutures and devices are increasingly used to percutaneously suspend any organ or tissue without need for a port. Magnetic systems are also on the horizon.

Instrumentation

In general, disposable equipment is not widely used in pediatric surgery. Note that 5 mm instruments may be useful but the length and the precision are not always ideal for the smallest patients. Disposable instruments smaller than 5 mm have not yet been developed. Instruments that are 3 and 2 mm are becoming more popular, but the shaft's loss of rigidity becomes a problem. But this can be enhanced by using longer ports to stiffen the shaft. Disposable attachments for energy sources make sense, but reusable instruments are generally the best given current developments. The ideal instrument would grasp, dissect, and seal vessels and cut tissue while offering an ergonomically comfortable grip and a wide range of movements or degree of freedom. Because such an instrument does not exist, the selection of instruments is often a matter of personal choice. Vessel sealing technology is technically possible at 3 mm size, but the market forces are holding back this development. Robotic assistance may offer advantages with complex suturing procedures, but this remains largely experimental.

Five mm scopes may be suitable for neonates to adolescents, but a 10 mm scope might be helpful when visualization is difficult because of bleeding. Smaller scopes that are 2 and 3 mm in diameter are rarely advantageous because of the consequent reduction in light. Angled telescopes of 30° or 45° are ideal, as they have a distinct advantage over 0° scopes. They help create a view that looks down onto the tips of instruments rather than along the shaft, avoiding tunnel vision. With practice, any disorientation from angled telescopes should diminish.

Tissue Retrieval

Specimen retrieval in pediatric cases is occasionally complicated by the small size of the trocars employed. A 10–12 mm port will, however, accommodate most specimens. Removal of the port to retrieve tissue may be necessary. The use of a smaller laparoscope at a secondary site while the tissue is withdrawn from the largest port is a useful trick. Simply extending the port wound to the appropriate size is a reasonable maneuver, but the use of a retrieval bag might make this unnecessary. Mechanical tissue morcellators are seldom used, although piecemeal removal from within a retrieval bag may be employed.

Wound Closure

Port site herniation can occur in even the smallest incisions, and therefore attention should be directed to closing the fascial wound with a suture if at all possible. The umbilical site fascia and the fascia of all trocar sites are closed with absorbable sutures. A 5/8 curved, round-bodied needle or a J-shaped needle on 3/0 or 2/0 sutures suffices for children of all sizes. Skin closure is usually achieved using cyanoacrylate-based glue for speed and simplicity; newer preparations are quicker drying and more flexible and create a covering that acts as a dressing. Approximation of skin edges with a subcuticular absorbable suture is still probably cheaper, but this can be tiresome to achieve. Any dressings are usually superfluous, unless there is persistent oozing, and simply cause discomfort on removal. Port site closure devices are available, but they are not widely used as the primary port can usually be closed under direct vision. Secondary ports of 2–5 mm may not require closure, although in small infants herniation of omentum has occurred in even 3 mm wounds.

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