CHAPTER 122
Minimal Access Surgery in Paediatric Patients

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Introduction

It is difficult to credit any one person for the development of minimal access surgery (MAS) (also referred to as minimally invansive surgery, or MIS, by some), but diagnostic laparoscopy has been used in various medical specialties since early in the 20th century. Laparoscopy was commonly used by gynecologists throughout the 1960s and 1970s. Semm performed the first laparoscopic appendectomy in 1980, and Mouret performed the first laparoscopic cholecystectomy in 1987, leading to the widespread application of this technology to general surgery.[1,2] In Africa, diagnostic laparoscopy is sometimes the only method to make or confirm a diagnosis because other, less invasive modalities, such as ultrasound (US), computed tomography (CT), and magnetic resonance imaging (MRI), often are not available. However, advanced laparoscopic techniques are being utilised only in select regions; other areas basically perform almost no minimal access surgery.

Minimal access operations have been developed for most adult general surgical procedures; however, technical limitations, such as the size of the scopes and instruments, have made the application to paediatric surgery more guarded. As smaller and more delicate instruments have been developed and minimal access techniques have become standard teaching in general surgical training programmes, there has been a greater number of children treated with laparoscopic or thoracoscopic operations.[3] This chapter briefly discusses the general concepts of laparoscopy and thoracoscopy and reviews the current applications of MAS in the paediatric population, with an emphasis on those basic procedures that may be the most relevant in Africa.

Demographics

It is difficult to determine the exact proportional use of laparoscopy in any one region; however, it is clear that at major academic centres around the world, the use of minimal access techniques is increasing. One centre in the Netherlands reported that, in 1998, 60% of all intraabdominal operations in infants and children were performed laparoscopically, and by 2005, this number had risen to 81%.[3,4] More generally, a 2004 survey of North American paediatric surgeons investigating the preferred technique for appendectomy showed that 11% of the 344 respondents use laparoscopy in every case, whereas 10.8% of respondents never use it.[5] In a similar survey of 94 paediatric surgeons regarding pyloromyotomy in the United Kingdom and Ireland in 2008, it was found that 15% use laparoscopy only, with an additional 5% using laparoscopy depending on the case.[6]

Rationale

The rationale for MAS has been defined largely in the adult general surgery population and covers a broad range of procedures.[7–10] In general, the advantages of MAS are (1) better focal visualisation for the surgeon and associated staff members, (2) shorter length of hospital stay, (3) reduced postoperative ileus, (4) decreased requirements for postoperative pain medication, (5) fewer wound complications, and (6) improved cosmetic results. Recently, children have been shown to have the same benefits after laparoscopic surgery.[4,11] The advantages of the minimal access approach are outlined for specific procedures as they are mentioned throughout this chapter.

Physiological Changes

Laparoscopy

The physiological effects of carbon dioxide pneumoperitoneum can be divided into two categories: (1) gas-specific effects and (2) pressure-specific effects.[12] One of the most important gas-specific effects is due to carbon dioxide's rapid absorption across the peritoneal membrane into the circulation, potentially causing a respiratory acidosis by the generation of carbonic acid. The body's buffers absorb carbon dioxide to maintain a normal blood pH, minimising hypercarbia or respiratory acidosis during brief laparoscopic procedures. In fact, clinically significant acidosis is rare in procedures of less than 8 hours. Minimal access procedures of that duration are rare in children, with repair of large para-oesophageal hernias being a possible exception.[13]

In patients with normal respiratory function, the anaesthesiologist increases the ventilatory rate or vital capacity with the ventilator to compensate for any increase in end tidal carbon dioxide, although this is rarely needed in children.[14] In a situation where acidosis cannot be corrected by the anaesthesiologist, it is advisable to evacuate the pneumoperitoneum or reduce the intraabdominal pressure.[12] The preoperative assessment should include screening for cardiopulmonary dysfunction, which might increase the likelihood of developing a clinically significant acidosis; laparoscopy may be relatively contraindicated in patients with these conditions.[14] Mild respiratory acidosis probably is an insignificant problem, but more severe respiratory acidosis can lead to cardiac arrhythmias, which are rarely seen in children.[12]

Pressure-specific effects of pneumoperitoneum on cardiovascular physiology have also been documented.[12] In the hypovolaemic patient, excessive pneumoperitoneum may exert pressure on the inferior vena cava and cause decreased venous return and impaired cardiac output. Furthermore, increased pressure due to pneumoperitoneum is transmitted directly across the paralyzed diaphragm into the thoracic cavity, creating increased central venous pressure and increased filling pressures of the right and left sides of the heart. If the intraabdominal pressures are kept under 20 mm Hg, the cardiac output is usually well maintained; higher pressures, however, can impede venous return and decrease preload.[14] The direct effect of the pneumoperitoneum on increasing intrathoracic pressure is increased peak inspiratory pressure, pressure across the chest wall, and the potential for barotrauma.[12] Despite these concerns, disruption of blebs and consequent pneumothoraces are rare after uncomplicated laparoscopic surgery, and laparoscopic procedures in children usually do not result in significant hypotension or tachycardia.

Increased intraabdominal pressure may also decrease renal blood flow, glomerular filtration rate, and ultimately urine output.[12] These effects are likely mediated by direct pressure on the renal vein

and kidney. Relative oliguria is common during laparoscopy, but the urine output is not a reflection of intravascular volume status. During an uncomplicated laparoscopic procedure, intravenous fluid administration should not be linked to urine output, and one must be judicious with the total volume of fluid given. The requisite for supplemental fluids is decreased, especially as fluid losses through the open abdomen are eliminated.

Thoracoscopy

The physiology of thoracoscopy is different from that of laparoscopy due to the rigid nature of the chest. The bony confines of the thorax render it unnecessary to use a significant amount of positive pressure when working in this body cavity. The disadvantages of positive pressure in the chest include decreased venous return, mediastinal shift, and the need to keep a firm seal at all trocar sites. However, visualisation of structures is greatly enhanced with a small degree of insufflation. In older children a double-lumen endotracheal tube may be placed so that the ipsilateral lung can be deflated to obtain a working space within the thorax. In smaller children (weighing less than 30–40 kg), double lumen tubes are unavailable, so the chest is usually insufflated in order to compress the ipsilateral lung.[14] Pressures of 4–6 mm Hg are sufficient to maintain visualisation of the operative field.

Equipment

A video system for MAS must have the following properties: illumination, resolution, and color. Without the first two attributes, video surgery is unsafe.[12] Currently, most imaging for laparoscopy, thoracoscopy, and subcutaneous surgery uses a rigid metal telescope containing a series of quartz optical rods with differing optical characteristics that provide a specific character to each telescope. The standard adult scopes are usually 30 cm in length, with smaller lengths used in paediatric surgery. These metal telescopes vary in diameter from 1 to 10 mm.[12,15,16] Rigid telescopes may provide a straight or oblique view, with the scope angle ranging from 0° to 70°.[12,15] Angled scopes allow greater ability to view the entire operative field.

Illumination is delivered to the laparoscope through a fibre-optic cable.[12] Due to the inefficiency of these light cables, an extremely bright light source (300 watts) is necessary to provide optimal visualisation for video endosurgery. The quality of the videoendoscopic image is only as good as the weakest component in the imaging chain. It is therefore important to use a video monitor that has a resolution equal to or greater than the camera being used. This is particularly important for the smaller telescopes used for laparoscopy on infants, for which a state-of-the-art video setup is required.[12,15]

Instruments for MAS usually are adaptations of conventional surgical instruments made longer, thinner, and smaller at the tip.[12] It is important to realise that laparoscopic grasping instruments apply a greater force over a smaller surface area, thereby increasing the risk for perforation or injury to an infant. Standard instruments are 5 mm in diameter and 30 cm in length, but smaller and shorter instruments are now available for neonatal and infant surgery, with a diameter as small as 2 mm and a length as short as 20 cm.[12,16] Some instruments, such as linear staplers and specimen retrieval bags, are not available in the 5-mm diameter size. A unique laparoscopic instrument is the monopolar electrical hook,[12] which may be configured with a suction and irrigation apparatus to eliminate smoke and blood from the operative field. The monopolar hook allows tenting of tissue over a bare metal wire with subsequent coagulation and division of the tissue.

Common Applications of MAS

One of the more common applications for MAS in both children and adults is appendectomy. The use of laparoscopy for the treatment of appendicitis was first described more than 20 years ago, but its use remains controversial.[17,18] As previously stated, a survey of North American paediatric surgeons showed that 11% of respondents use laparoscopy for all appendectomies, and the same percentage of respondents never use it. In a large multicentre retrospective review from Europe, 1,506 laparoscopic appendectomies performed in children were compared to 826 open procedures.[19] Operative times and rates of complications were found to be similar, but the laparoscopic cohort had a shorter length of hospital stay for both acute and perforated appendicitis. In a review of 43 children with perforated appendicitis (Figure 122.1) who underwent laparoscopic appendectomy compared to 77 who underwent an open appendectomy, the infectious complication rate in the two groups was similar, but a lower overall complication rate was found in the laparoscopic group.[20] When interpreting these data, one must consider the learning curve required to master the laparoscopic approach. Statistically significant reductions in operative time, conversion rate, and presence of postoperative abscesses were observed when one group compared their experience between time periods before and after their learning curve.[21] The largest meta-analysis comparing laparoscopic (n=2789) versus open (n=3688) appendectomy in children revealed that there was a significantly decreased length of stay in the laparoscopic group, as well as lower rates of wound infection and postoperative ileus.[11] An advantage of a laparoscopic removal of a perforated appendicitis is also the ability to evacuate pus and fluid from the entire abdominal cavity (Figure 122.2). This might improve the outcome in African children who notoriously present late and with complicated appendicitis, although there are no hard data to support this contention.

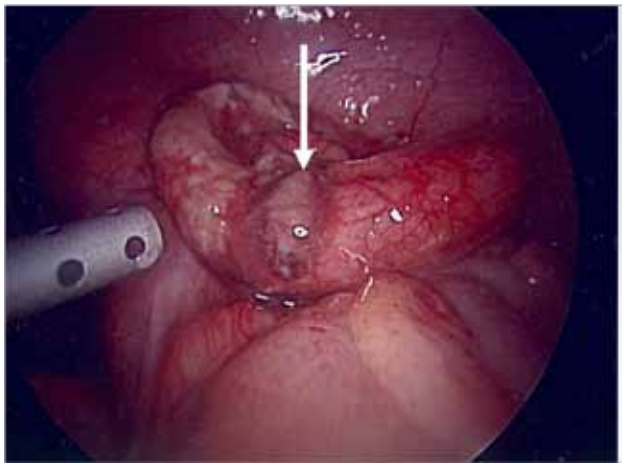

Figure 122.1: Laparoscopic view of perforation of the appendix. The arrow is pointing to pus extruding from the appendiceal lumen.

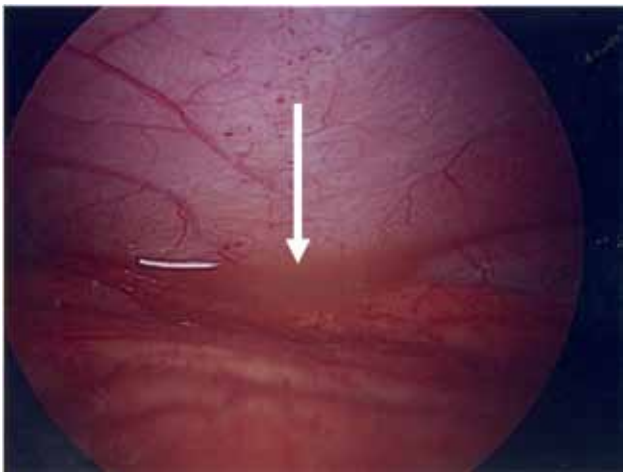

Figure 122.2: Laparoscopic view of pus (arrow) from a perforated appendix collecting in the left paracolic gutter.

Figure 122.3: Thoracoscopic view of the left lung in an immunocompromised patient with fungal pneumonia. Fibrinous debris (arrow) was removed and lung biopsy was performed to confirm the diagnosis.

The most common application of MAS in the thorax of paediatric patients is for debridement of empyemas (Figure 122.3). Pneumonia is one of the most common infections in the paediatric population, and parapneumonic effusions complicate 21–91% of cases.[22] When the pleural collections are simple (free flowing) the effusions often resolve with chest tube drainage and/or antibiotic therapy alone; however, a complicated effusion often requires pleural space drainage and sometimes decortication to facilitate recovery. Thoracoscopy has become the standard of care in North America for treating these conditions following the first report of its use in 1993.[23,24] Other options include thoracentesis, chest tube placement with instillation of fibrinolytics such as urokinase or tissue plasminogen activator, or antibiotics alone. Failure to treat these collections can lead to persistent pleural thickening and restrictive lung disease. This has led many to advocate for early surgery to treat complicated collections.[25–27] A number of small series have reported decreases in mean postoperative length when compared to thoracoscopy with the open technique.[2,28,29] A retrospective study comparing 54 children treated conservatively with 21 children treated with thoracoscopy found the mean length of stay was 15.4 days in the conservative group (chest tube and antibiotics alone) compared to 7.4 days in the thoracoscopy group, with no procedure-related complications in either case.[30] Clearly, these data show that using thoracoscopy can decrease hospital stay with significantly less morbidity. Although there is debate in the literature over the ideal timing of thoracoscopy and its efficacy compared to drainage with fibrinolysis, there is little doubt that thoracoscopy is the preferred surgical approach.[31–33]

Other Commonly Performed MAS Procedures

In addition to laparoscopic appendicitis and thoracoscopy, MAS has been applied to a large variety of procedures in both the abdomen and thorax (Table 122.1). As in the adult population, cholecystectomy is now routinely performed laparoscopically in children. In a retrospective review of 184 patients with a mean age of 14.1 years (range, 3–22 years) and a mean follow-up of 8.3 months, the only complications were one prolonged ileus and one wound infection.[34] Splenectomy is another operation performed frequently in children for a variety of haematological conditions, splenic cysts, complications of portal hypertension, and malignancies. For elective splenectomy, laparoscopy has become the standard, depending on the size of the spleen. In a retrospective study of 159 patients who underwent laparoscopic splenectomy at three centres,[35] eight cases were converted to open, one case required reoperation with laparoscopy for postoperative bleeding, and three generalised postoperative infections were noted.

Table 122.1: Commonly performed paediatric MIS procedures.

Laparoscopic surgery	Thoracoscopic surgery
Oesophagomyotomy for achalasia	Lung biopsy
Fundoplication	Blebectomy
Gastrostomy	Lung resection
Pyloromyotomy	Debridement of empyema
Pyloroplasty	Lobectomy
Ladd's procedure	Tracheo-oesophageal fistula repair
Duodeno-duodenostomy	Aortopexy
Small bowel atresias	Mediastinal biopsy
Reduction of intussusception	Thymectomy
Appendectomy	Resection of mediastinal mass
Ileocolectomy	Diaphragmatic hernia repair or plication
Partial colectomy	Complex central venous access
Total abdominal colectomy	Patent ductus arteriosus (PDA) ligation
Pull-through for Hirschsprung's disease and anorectal malformations	Pectus excavatum
Cholecystectomy	
Kasai procedure	
Choledochojejunostomy	
Oncological procedures	
Splenectomy	
Nephrectomy	
Adrenalectomy	

Pyloric stenosis is now frequently treated laparoscopically in the United States and Europe, although its advantages are mainly cosmetic. A retrospective comparison of 52 open pyloromyotomies and 65 laparoscopic pyloromyotomies from a single institution found that operating time, incidence and time to postoperative emesis, time to full feedings, total costs, length of stay, and complication rates were not significantly different between the two groups.[36] A prospective randomised trial comparing the techniques revealed less postoperative pain and emesis with laparoscopy when compared to the open approach, with no difference in complication rate.[37] However, a French randomised trial failed to show any difference in postoperative emesis.[38] This French study compared the laparoscopic approach with an open umbilical approach, and found that laparoscopic pyloromyotomy does not decrease the incidence of postoperative vomiting, has a similar complication rate compared with the open umbilical approach, but may expose patients to a risk of inadequate pyloromyotomy.. The umbilical approach may provide improved cosmesis and could constitute an attractive approach in the African setting, although no data detail the cosmetic outcomes for any of the approaches to pyloromyotomy. Thus, the laparoscopic approach is far from universally accepted.[6]

Ladd's procedure for malrotation has also been performed laparoscopically.[39] In a series of 10 patients without midgut volvulus, ranging in age from 10 weeks to 25 years, operated on laparoscopically,

the mean operative time was 111 minutes, mean length of stay was 3.6 days, and the only postoperative complication was an incisional hernia. One case was converted to open. This operation is also controversial because many believe that the laparoscopic approach will lead to fewer intraabdominal adhesions and perhaps a higher recurrence rate. However, no study directly comparing long-term outcomes for the laparoscopic and open Ladd's procedures has been published.

Laparoscopic Nissen fundoplication is routinely performed as an alternative to the open procedure in the United States. A retrospective study compared 150 open cases to 306 laparoscopic procedures.[40] Although reoperation was more common in the laparoscopic group (14% versus 8%), the laparoscopic group had significantly fewer complications, and mean length of stay was two days shorter. Another study comparing the hospital charges for 50 open fundoplications to 50 laparoscopic fundoplications found that the overall costs were similar between the two groups, with the shorter length of stay in the laparoscopic group offsetting higher costs in operating room time and equipment.[41] In fact, one study from South Africa has shown that select patients may be discharged on the day of surgery after laparoscopic Nissen fundoplication.[42] However, this practice has yet to be universally accepted.

A problem that is unique to developed nations but may be on the rise in other regions is morbid obesity. Laparoscopy is the preferred approach for bariatric procedures in adults; as adolescent obesity rates have risen in North America, similar procedures have been used in children.[43,44] These procedures should be reserved for only the most expert minimal access paediatric surgeons as part of a multidisciplinary weight-management team.

Minimal access techniques are now commonly used for colorectal surgery in the paediatric population. All three operations described for Hirschsprung's disease (Duhamel, Soave, and Swenson) have been successfully performed laparoscopically.[45] Laparoscopy allows for procurement of seromuscular biopsies to precisely identify the transition zone, and permits minimally invasive mobilisation of the colon, facilitating the pull-through procedures and ensuring a tension-free coloanal anastomosis. Similar techniques are used for colonic mobilisation when treating imperforate anus with mainly high rectourethral fistulas where a laparotomy might be needed in conjunction with the Pena posterior sagittal ano-rectoplasty.[46] A recent article compares laparoscopic-assisted and posterior sagittal anorectoplasty.[47] Laparoscopic-assisted proctocolectomy with J-pouch reconstruction has also been successfully performed in children with ulcerative colitis or familial adenopolyposis.[48]

Advanced thoracoscopic procedures are also being safely performed. In a review from six institutions of 104 patients with oesophageal atresia or tracheo-oesophageal fistula repaired thoracoscopically, the mean age at the time of surgery was 1.2 days and the mean operative time was 129.9 minutes.[49] Early leak or stricture developed in 11.5% of patients, at least one oesophageal dilatation was required in 31.7%, and 4.8% of the procedures were converted to thoracotomy. Three patients died, one related to oesophageal atresia/tracheo-oesophageal fistula (OA/TEF) on the 20th postoperative day. These complications were similar to the authors' experience with open repairs.

Thoracoscopy may also be used to treat pulmonary malignancies in children.[50] In a retrospective review of 55 thoracoscopy cases (31 pulmonary resections, 19 biopsies, 5 resections of mediastinal tumours), there were two cases of trocar site infections and no other complications. Congenital pulmonary malformations are also amenable to the thoracoscopic approach. A retrospective comparison of 12 patients with congenital cystic adenomatous malformations (CCAM) treated with thoracoscopy with 24 open resections found that the thoracoscopy group had a significantly shorter length of stay and that hospital costs were similar overall.[51]

Investigations and Management

Minimal access procedures rarely require a preoperative evaluation different than open procedures for the same conditions. Similarly, management is based on the disease being treated and can be derived from experience with the open approach. However, with MAS, the return of bowel function may be expedited and the duration and need for pain medication may be reduced.

Complications

Many of the known complications that may occur with open surgery also are common when using laparoscopic or thoracoscopic techniques. Some complications, however, such as trocar and Veress needle injuries, are unique to MAS, but these are rare in the hands of an experienced surgeon.[52] The most common injuries after placing trocars in the abdomen are injuries to the small bowel, colon, liver, and vascular structures. With the closed technique, a Veress needle is inserted into the abdomen blindly to deliver carbon dioxide, and subsequently, the umbilical trocar is placed. The placement of a needle blindly into the abdomen may result in injury to the intraabdominal viscera. It is due to this risk that many advocate an open technique. In the open, or Hasson, technique, an umbilical incision is made and the fascia is identified and incised. A blunt trocar is then placed through this incision, and the abdomen is insufflated. Although this approach may be safer, bowel and vascular injury may still occur.[53] In a large retrospective review comparing more than 400,000 closed laparoscopies and 12,000 open procedures, a statistically significantly higher rate of visceral and vascular injuries were found in the closed group. Hernias can develop at trocar sites. It is important that all subsequent trocar insertions and removals be watched under direct vision, to prevent iatrogenic injuries.[54]

Laparoscopy also increases the risk of electrothermal injuries. Monopolar, biploar, and ultrasonic instruments are all used routinely in MAS.[55–57] Overall, the incidence of electrothermal injuries is about 2–5 per 1,000 cases, with inadvertent perforation of the bowel occurring in 0.6–3 per 1,000 cases.[54,55] These numbers may be underreported, however. In addition to bowel perforation, electrosurgical injuries may lead to biliary, uretheral, and anal strictures; hydroureter; or fistula formation in the genitourinary tract.[56] Electrothermal injury can come from inadvertent direct application of the probe to tissue, a defect in the insulation of an instrument, direct coupling (unintended contact between the probe and a noninsulated instrument such as the scope or a grasper), or capacitive coupling (current passing from the probe through intact insulation to the tissue, which occurs when an active probe is in a trocar).[55,56] It is important to note that 75% of all electrothermal burns to the bowel go unrecognised at the time of initial surgery.[57] Thus, a high index of suspicion is paramount. In general, missed injuries present with signs and symptoms of peritonitis 4–10 days after the initial surgery and require emergent reoperation. Minimising electrothermal injuries is achieved via regular training of surgical staff and routine thorough equipment maintenance. The surgeon must ensure that the electrosurgical unit is activated only when the entire conducting component of the instrument is in view. Short bursts of the electrosurgical unit allow tissue to cool and may reduce the incidence and severity of electrothermal injuries as well. Thus, most units are designed to deliver short bursts of energy regardless of the intentions of the user.[55] In general, bipolar electrosurgical systems have a more limited area of thermal spread than monopolar systems, as well as a decreased risk of capacitive coupling.[55,56]

The ultrasonic coagulating shears (harmonic scalpel) work by converting electrical energy into mechanical vibrations (ultrasonic energy).[55] A lower temperature is reached in the jaws of this instrument than in traditional electrosurgical probes, resulting in less lateral tissue injury.[55,57] This device can safely seal vessels up to 3 mm in diameter, but comes in only 5- or 10-mm versions, and thus often is not used for MAS in infants. The electrothermal bipolar vessel sealer (LigaSure™)

can seal vessels up to 7 mm in size and also has a reduced thermal spread compared to traditional electrosurgical units.

Port-site metastases are another complication unique to laparoscopic or thoracoscopic techniques, but these are rare and occur when malignant cells implant on port sites during minimally invasive oncologic resections. This complication has been reported in children, but is not usually of major concern.[58] A survey of the Japanese Society of Paediatric Endosurgeons, designed specifically to identify the incidence of port-site metastasis, found no cases following 129 laparoscopic or thoracoscopic cancer operations.[59] Obviously, this relatively small sample size was unable to capture the true incidence of port-site recurrences, but suggests that port-site metastasis is not a common event. In general, the use of plastic bags for the removal of surgical specimens to decrease the contact between malignant cells and the port site and thus decrease the incidence of port-site metastasis is recommended.

Ethical Considerations

It is clear that minimal access techniques are becoming increasingly used for a variety of surgical diseases in children, but it is unclear which indications best warrant such technology in societies with limited resources. When basic health care needs cannot be met, it is difficult to justify the capital costs associated with purchasing the equipment necessary for MAS and training the surgical and ancillary staff to use it. However, there is no doubt that there are advantages to laparoscopic surgery with its smaller incisions, decreased pain, shorter hospital stay, and reduced complication rates. African children should have the same rights to these benefits as children from developed countries. Thus the chappenge is presented of finding new ways of collaboration where the strengths of both worlds could be integrated to help improve the service to all children.

This type of surgery has minimum basic requirements that should not be taken for granted within developing regions. An alternative approach should always be available in case of sudden loss of electricity. Furthermore, laparoscopic or thoracoscopic surgery should not be undertaken unless the surgeon is trained in the techniques and has ample experience with the open approach. We recommend that critical and honest data acquisition be a part of any program where MAS is to be used. Due to the lack of research infrastructure throughout many parts of Africa, however, this may be more difficult than it appears.

Quality control is not the sole responsibility of the operative surgeon—the hospital must also participate in this overall goal. It is of great importance that there be clearly designated responsibility for maintenance of the equipment, its safe storage, its postoperative cleaning, and its replacement and repair if broken. The surgical and nursing staff should attend ongoing training on handling the very sensitive equipment. We advise a clear and strict policy outlining the reuse of disposable equipment, taking note of all potential complications associated with such reuse. This policy is particularly important, considering the African context and the high prevalence of human immunodeficiency virus (HIV).

It may be that "minimally invasive" surgery as defined by laparoscopy and thoracoscopy may not be ideal in regions where resources are limited. Alternatives exist that apply the concept of MAS without utilising the highly sophisticated and expensive technology of videoscopic surgery. Suitable options for children in Africa include the transanal approach for Hirschsprung's disease, the Tan-Bianchi periumbilical incision and its variations[60] for hypertrophic pyloric stenosis, extended to other intraabdominal procedures such as for intestinal atresia repairs.[61] Surgery within the African context may be viewed as a challenge conducive for innovation and development.

Evidence-Based Research

No prospective randomised controlled trials compare open appendectomy to laparoscopic appendectomy or thoracoscopic debridement to thoracotomy for parapneumonic effusions in the paediatric population. Decisions therefore must be made by using retrospective studies as well as expert opinion and professional society guidelines. A retrospective study for laparoscopic appendectomy is presented in Table 122.2.

Several papers demonstrate the benefits of using thoracoscopy early in a child's course with complicated pneumonia. Table 122.3 presents a retrospective study for parapenumonic effusions or empyemas.

Table 122.2: Evidence-based research.

Title	Laparoscopic versus open appendectomy in children: a meta-analysis
Authors	Aziz O, Athanasiou T, Tekkis PP, et al.
Institution	Imperial College of Science, Technology and Medicine, Department of Surgical Oncology and Technology, St. Mary's Hospital, London, UK
Reference	Ann Surg 2006; 243(1):17-27
Problem	Surgical approach in treating appendicitis in children: laparoscopic versus open appendectomy.
Intervention	Laparoscopic versus open appendectomy.
Comparison/ control (quality of evidence)	Meta-analysis of 23 studies comparing a total of 2,789 laparoscopic appendectomies to 3,688 open appendectomies.
Outcome/ effect	The outcomes analysed were postoperative fever, ileus, wound infection, intraabdominal abscess formation, operative time, and postoperative hospital stay. Wound infection was significantly reduced with laparoscopic versus open appendectomy (1.5% versus 5%; OR = 0.45, 95% CI = 0.27–0.75), as was ileus (1.3% versus 2.8%; OR = 0.5, 95% CI = 0.29–0.86). Postoperative stay was significantly shorter in the laparoscopic group (weighted mean difference, 0.48; 95% CI = 0.65–0.31). Intraabdominal abscess formation was more common following laparoscopic surgery, although this was not statistically significant. There was no statistically significant difference in operative time or postoperative fever.
Historical significance/ comments	This large meta-analysis of 23 studies and almost 6,500 children represents the largest data set comparing laparoscopic and open appendectomy in the paediatric population. The results of this study demonstrate a lower incidence of wound infection and postoperative ileus and a shorter length of stay in the laparoscopic group. The finding of a decreased number of wound infections is seen in almost every procedure that is done laparoscopically when compared to its open counterpart. Regarding post-operative ileus, it is suggested that this may be reduced in laparoscopic surgery due to decreased handling of the bowel, reduced opiate requirements, and earlier mobilisation. Clearly, these same factors would affect postoperative length of stay. Additional benefits of laparoscopy are the ability to examine the entire abdomen prior to performing appendectomy, which is particularly useful when the diagnosis of appendicitis is in question. This study is a meta-analysis, which makes it imperfect in many ways. First, different studies may have had slightly different defining criteria for the outcome measures of interest, and this was not always clearly identified, according to the authors. The authors also point out the importance of nonpublication bias, as meta-analytic research is based only on published studies. Generally, meta-analyses are only as good as the studies included in the analysis. Thus, if the original studies are flawed, so is the meta-analysis. Despite these concerns, the conclusions drawn from this manuscript suggest a decreased length of stay, fewer wound infections, and a reduction in postoperative ileus in the laparoscopic group.

Table 122.3: Evidence-based research.

Title	Comparative analysis of chest tube thoracostomy and video-assisted thoracoscopic surgery in empyema and parapneumonic effusion associated with pneumonia in children
Authors	Aziz A, Healy JM, Qureshi F, Kane TD, Kurland G, Green M, Hackam DJ
Institution	Divisions of Pediatric Surgery, Pediatric Pulmonology, and Pediatric Infectious Disease, Children's Hospital of Pittsburgh and the University of Pittsburgh School of Medicine, Pittsburgh, Pennsylvania, USA.
Reference	Surg Infect 2008; 9(3):317–323
Problem	Conservative versus operative management of parapneumonic effusions and empyemas.
Intervention	Chest tube drainage versus thoracoscopic debridement.
Comparison/ control (quality of evidence)	Forty-nine paediatric patients with pneumonia complicated by parapneumonic effusion or empyema treated between 1997 and 2003 were divided into three groups: primary chest tube (n=21), chest tube followed by thoracoscopy (n=15), or primary thoracoscopy (n=13).
Outcome/ effect	The following data were obtained: Sex, age, presenting symptoms, duration of symptoms, comorbidities and history of empyema, vital signs on presentation, chest radiographic findings, antibiotic treatment, surgical procedure, pleural fluid content, intensive care unit stay, total days in hospital, and total hospital charges. All groups were similar with respect to demographics and initial antibiotic usage. Patients undergoing primary thoracoscopy had a higher initial temperature, whereas radiographic findings of mediastinal shift and air bronchograms were more likely to be found in patients who underwent primary chest tube placement. Patients undergoing primary thoracoscopy demonstrated a significantly shorter total hospital stay and lower hospital charges than the other groups. Forty percent of children started on chest tube therapy required subsequent thoracoscopy, necessitating a significantly longer hospital course (18±3 versus 11±0.8 days; $p<0.05$) and higher hospital charges ($50,000±$7,000 versus $29,000±$1,000) than those having primary thoracoscopy.
Historical significance/ comments	This study is certainly limited due to the fact that it is retrospective and has a relatively small sample size. However, the analysis performed was extensive and the results are striking for a significantly reduced length of stay and total hospital charges when primary thoracoscopy is the approach used. The fact that there were no significant differences across groups in regard to demographics, initial vital signs, or initial antibiotic course strengthens these results. The authors' conclusions advocate for this approach for all children presenting with parapneumonic effusions or empyemas. The authors suggest that one of the factors predisposing to failure of chest tube drainage is that the tubes placed by interventional radiology are smaller and may be more prone to obstruction compared to the larger caliber tubes placed in the operating room. Another factor that may increase the benefit of thoracoscopy is the improved visualisation, allowing for complete evacuation of debris and earlier expansion of the lung. Clearly, a prospective trial would be helpful in determining which patients are best treated surgically and which could be successfully managed with chest tube drainage alone.

Key Summary Points

1. Minimal access surgery for adults has been widely practiced by general surgeons for two decades; more recent technical advances have led to this technology being applied to the care of infants and children.
2. A large number of reports exist in the literature on minimal access techniques being successfully and safely applied to the care of infants and children for surgical disease in the abdomen and chest.
3. Laparoscopic appendectomy results in decreased incidence of wound infections and postoperative ileus as well as shorter length of hospital stay when compared to the open procedure.
4. Laparoscopic appendectomy can be performed safely for both acute and perforated appendicitis.
5. Thoracoscopic debridement of empyemas following complicated pneumonia has become standard in many centres. Early intervention has been shown to decrease hospital stay and total costs.
6. Thoracoscopic debridement for complicated pneumonia may be the most appropriate application of minimal access surgery to resource-limited African communities.
7. Complications unique to minimal access surgery include Veress needle and trocar injuries as well as electrothermal injuries. Early recognition and immediate treatment of vascular or visceral injuries improves outcome.
8. Controversy remains over the most appropriate applications of minimally invasive techniques in the paediatric population; these may differ, depending on the geographic location in question.
9. In resource-limited communities of Africa that are considering establishing a minimal access surgery program, attention must be paid not only to operative technique but also to equipment maintenance and storage, training of ancillary staff in equipment use, and critical acquisition of outcomes.

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