CURRENT ROLE OF MINIMAL ACCESS SURGERY IN CHILDERN

Dr. M. A. Elgabroun :(consultant Pediatric surgeon Tripoli Medical Centre)
Prof. R. K. Mishra :(consultant laparoscopic surgeon Laparoscopy Hospital)

Abstract:

Since the introduction of minimal access surgery to general surgeons in the 1980s, pediatric surgeons have been employing this innovative technology to perform surgery on children.; in many cases multiple small incisions are the only access necessary to perform complicated procedures that would otherwise require a large wound. Improvements in techniques and tools have made minimal-access procedures increasingly available and can be applied to most of surgical procedures in children Additional benefits of minimal access surgery may include reduced postoperative analgesic requirements, shortened length of stay, and faster resumption of normal activities. Growing popularity of laparoscopy and thoracoscopy has resulted in greater numbers of patients benefiting from this approach. Disadvantage is increase in the operative costs, needs longer training period, Loss of tactile sensation, and some times major complication can occur The pediatric surgical community has embraced minimal access techniques for some operations; others remain controversial.

Keywords:

Minimal access surgery minimally invasive surgery laparoscopy thoracoscopy.

Materials and methods:

This is a review article the materials were obtained from google, emedicine, and high wire search 28 articles were selected out of 124.

Introduction:

Twenty years ago minimal access procedures largely consisted of diagnostic, endoscopy (eg, cystoscopy, esophagogastroscopy, colonoscopy), and gynecologic procedures. Gynecologists began to apply these techniques in tubal ligation than Prof Simm was the first to remove the appendix laparoscopically. General surgeons worldwide rapidly learned the technique started with cholecystectomy using several small openings rather than a large upper abdominal incision. Prof Muhe performed the first laparoscopic cholecystectomy in 1985, and now laparoscopic cholecystectomy is the standard of care. With increased interest Pioneering surgeons began to explore additional applications for minimal access surgery (MAS), came increased demand for the specialized instruments necessary to perform different procedures.

Historically, pediatric surgeons were slow to adapt to minimal access surgery MAS techniques compared with the adult surgical community, because of several reasons:

- Pediatric surgeons are used to perform surgery with a small incisions,
- Children recover from major procedures faster than adults, and analgesic requirement after surgery is less in children.
- The cost of laparoscopy was believed to be too high.
- Equipments were not small enough. to be used in pediatrics

- MAS was believed to be too difficult to perform in a small child and too difficult to learn.
- Children recover quickly from surgery.

Nonetheless, surgery in any patient is traumatic,
Pioneer surgeons such as, Rodgers, and Lobe showed that MAS was certainly applicable to the pediatric patient. Shortly after that several advantages of MAS was recognized:

- Laparoscopy offers a better visualization than open surgery, particularly deep structures in the pelvis and difficult area like the hiatus.
- Postoperative pain is less, with decreases in postoperative narcotic use
- Smaller wounds are associated with less wound infection and complications, less scarring, and better cosmesis.
- MAS results in reduction of postoperative adhesions.
- Shorter stay in the hospital and faster recovery than open surgery.
- Patients are able to return to their normal activities faster (eg. feeding, school, work).
- Video imaging allows all surgical assistants, anesthetist, and nurses to view what the surgeon is doing and to actively participate in the procedure in their respective roles.[1]

<u>However there are some disadvantages for MAS:</u>

- Initial capital cost is associated with laparoscopy because new equipment and training are necessary.
- Operating time is longer and the complication rate is higher during the learning curve of the procedure.
- Loss of tactile sensation occurs, which is perhaps the major disadvantage of minimal access surgery (MAS). Intraoperative ultrasonography is helping to overcome this deficiency.
- With current technology, the video camera can provide only a 2-dimensional image, although 3-dimensional views are becoming available.
- Controlling bleeding laparoscopically is difficult.
- The number of instruments and angles in which they can be applied are limited. Robotic applications using wrist technology is improving this problem.

<u>There are also some technical problems:</u>

- Complications can be related to placement of the primary trocar or at the creation of pneumoperitoneum. Underlying vessels or viscera can be injured. These injuries can be minimized by the use of open Hassan technique for the primary trocar insertion [1], [2], [3]
- Complications can also arise from dissection during the procedure. These include direct injuries to hollow and solid organs, as well as thermal injury. These can also be minimized by careful and precise technique.
- hypercarbia can occur as a result of absorption of carbon dioxide through the peritoneal surface. Elevation in carbon dioxide can lead to acidosis, which lead to further metabolic and hemodynamic changes.
- High intra abdominal pressure due to insufflation of carbon dioxide can lead to reduction of cardiac out as a result of decrease of venous return.

- Hypothermia can also ensue because of cold carbon dioxide insufflation, especially if there is a leak of gas from the abdominal.

Pathophysiological differences between adult and children:

Insufflations of the abdomen or chest cavities for minimal access surgery (MAS) procedures have important physiologic effects. Much of this physiology has been studied in adults, but very little work has been conducted on this subject in children.Pneumoperitoneum is required in most of the cases for successful laparoscopy. Some debate has occurred in terms of which medium is best. Most surgeons prefer carbon dioxide gas because it is easily absorbed, and, thus, the risk of embolism is reduced compared with other gases. In addition, it suppresses combustion. The pressure limit usually does not exceed 15 mm Hg in adults but it varies in infants and children, Care must be taken to start at low flow rate (eg, 0.5-1 L/min and pressures of 8-12 mm Hg) and use only the pressure that required obtaining visualization and being able to perform surgery. Increased intra-abdominal pressure interferes with infradiaphragmatic venous return and arterial blood flow to the kidneys. It may also push the diaphragm into the chest cavity, decreasing total lung capacity and functional residual capacity, adding to the acid-base disturbance caused by hypercarbia. An increase in intra-abdominal pressure effectively acts as a venous tourniquet. Blood flow from the lower limbs and abdomen is decreased while the arterial perfusion is intact. Cardiac output is decreased with increase in the ventricular stroke work and the heart rate. Pressure on the abdominal aorta casues increase pressure in the upper body. In children with preexisting decreased cardiac output, increased intra-abdominal pressure may lead to acute cardiac failure. Ventilatory and circulatory changes can be appreciated within 5 minutes of the onset of insufflation of gas. Pressures of more than 15 mm Hg are associated with significant pathophysiologic effects but are reversible over a 2-hour period. In infants and children, no hemodynamic effects are observed at a pressure of 10 mm Hg for less than 15 minutes. On the other hand, at insufflation pressures of 12 mm Hg, peak airway pressure increases by 40%, and compliance decreases by 47% with no change in dead space. Anesthetist has to increase minute ventilation (ie, increased rate, airway pressure, and/or tidal volume) to compensate for pulmonary mechanical restriction. Pulmonary arterial pressure and pulmonary wedge pressure both increase with pneumoperitoneum, improving ventilation-perfusion at intra-abdominal pressures of less than 12 mm Hg. This may help explain the lack of effect on pO2 under these conditions. The carbon dioxide is mostly absorbed across the peritoneal surface, and a rise in its partial pressure can be offset by increasing minute ventilation. Elevation in carbon dioxide may continue for 3 hours after an operation. This is important to recognize, especially if postoperative narcotic is used. Therefore continued monitoring of the cardiac, respiratory, and renal systems should be carried out in the immediate postoperative period. Increase in intra-abdominal pressure can also exacerbate gastroesophageal reflux, adding to perioperative risk of aspiration [1], [2], [3].

Application of Minimal access surgery in children:

Esophagus

- Open surgery on the esophagus is associated with significant morbidity which is directly related to the thoracotomy and/or laparotomy. Minimal access surgery (MAS) techniques offer a very good alternative to these morbid procedures.

- Thoracoscopic repair of esophageal atresia and tracheoesophageal fistula. Fine suturing of the esophageal anastomosis requires significant technical skills. Robotic surgery may play a role in this procedure in the future.
- Heller myotomy with fundoplication via a laparoscopic approach is ideal for patients with achalasia. Many surgeons are performing this procedure. When the diagnosis is made, some wait until recurrence occurs after a single pneumatic dilatation. An anterior myotomy is performed 4 cm above the gastroesophageal junction and extending onto the stomach for 2 cm. A Dor fundoplication is performed, suturing anterior fundic patch to both edges of the myotomized extramucosal incision. Simultaneous upper endoscopy is performed to ensure adequate myotomy.
- Heller myotomy can also be performed using the thoracoscopic technique.

Nissen fundoplication

- Laparoscopic fundoplication offers excellent visualization of the hiatus, and after the initial learning curve, it can be expeditiously performed.
- The morbidity of the surgical procedure, particularly complications, return of feeds, and hospital stays, is reduced with the laparoscopic approach.
- This procedure can also be combined with gastrostomy feeding tube if necessary.

Pyloromyotomy

- Laparoscopic pyloromyotomy can be performed with faster post operative recovery and batter cosmesis.
- The laparoscopic approach is not universally accepted because similar results can be achieved by Ramstedt pyloromyotomy via umbilical incision.
- The cosmetic results, when compared with the traditional right upper quadrant incisions, are superior [1].

Insertion of a gastrostomy tube

- Enteral access with a gastrostomy feeding tube is necessary in many children. Some are unable to swallow, and others take in inadequate calories because of neurologic impairment. Children with cystic fibrosis, malignancies, neurometabolic diseases, and cardiac malformations may also require exogenous enteral feeding.
- A MAS technique can be used for this procedure. A minilaparoscope (1.6 mm) with a single 5-mm trocar at the exit site for the gastrostomy button is used, and no special instrumentation or kits are needed. The operative time ranges from 15-30 minutes. [3]
- MAS-assisted percutaneous endoscopic gastrostomy tube placement assures proper location in the stomach and avoids injury especially if threr is previous laparotomy scar.

Cholecystectomy

- The first pediatric laparoscopic cholecystectomy was reported by Sigman et al in 1991. [5]
- This is one of the most common laparoscopic procedures performed in adults. However, it is less common in pediatric patients because of lower incidence of gallstones. Many of

the pediatric patients who require this procedure have blood dyscrasias and form pigment stones.
- Similar to its adult counterpart, pediatric laparoscopic cholecystectomy is performed with 4 ports, including the camera port. The size of these ports ranges from 2-10 mm.
- Laparoscopic cholecystectomy has been shown to be safe, even in an infant (<19 mo) [6]
- Biliary dyskinesia, which is less common than symptomatic biliary colic but is certainly encountered by pediatric surgeons, is aided by a laparoscopic cholecystectomy.

Biliary Diseases

Laparoscopic cholecystectomy is the standard of therapy in patients of all ages. Advances in laparoscopic suturing and stapling devices have made it possible to perform biliary anastomoses for such conditions as biliary atresia and choledochal cyst. Laparoscopy has also been used for guided liver biopsy as well as cholangiography.

Small bowel

- As with the feeding gastrostomy, a jejunostomy tube can be placed laparoscopically.
- Small bowel can be resected if necessary, with intra- or extra-abdominal anastomosis, using the miniature access technique.
- Laparoscopy has been used to treat intestinal malrotation [7] [8] intussusception, [9] adhesiolysis, [7] Meckel diverticulum [10] and small-bowel atresia.

Appendicectomy

- Laparoscopic appendectomy was developed in the early 1980s by the German gynecologists Semm and Schrieber. [11].
- In 1991, Valla et al reported the first series of pediatric laparoscopic appendectomies. [12]
- Laparoscopic appendectomy is being performed in increasing numbers throughout the Western world. It offers many of the same advantages as outlined above; however, a few studies show no major differences between open and laparoscopic techniques.[1]
- Laparoscopic appendectomy is even more useful if diagnosis of appendicitis is in question, especially in girls.
- The laparoscopic approach allows better allows better irrigation of the peritoneal cavity, and offers a lower wound infection rate.
- Three ports (2-5 mm) are typically used, although single-trocar appendectomy has also been described in the literature. [13]

Colon

- Laparoscopy has been used to treat diseases of the entire colon. Laparoscopy also takes advantage of the excellent collateral blood supply of the colon, which makes mobilizing large segments possible.
- As mentioned above, laparoscopy offers superb visualization of the pelvic structures, making working in the deep pelvis easier and safer.

- Once the colon is mobilized, it can be resected with intra- or extra-abdominal anastomosis. The specimen can also be removed via the anus, and anastomosis can be performed transanally from the outside.
- Laparoscopic pull-through for Hirschsprung disease is as follows:

    - Classically, Hirschsprung disease has been treated by staged procedures involving biopsy, colostomy, pull-through, and colostomy takedown over a period of 6-12 months.
    - In 1994, Curran et al performed the first laparoscopic pull-through in a canine. [14] It then was carried out in humans in 1994 by Smith et al.
    - Laparoscopic pull-through has been shown to be safe in infants as young as 1 week and as small as 2.3 kg. [16]
    - The procedure is carried out with 3-4 small (3.5-5 mm) ports in the mid abdomen. Seromuscular biopsies are taken to check for mature ganglion cells in the proximal colon. The blood supply (inferior mesenteric artery [IMA]) of the distal colon is ligated. The colon is then mobilized down to the levator musculature in girls and the prostate in boys.
    - The dissection is then begun transanally, and colon is removed to the level of biopsy-proven ganglionic cells, and if possible, a 2- to 5-cm margin is created. Anastomosis between the anus and neorectum is performed above the dentate line.[1]
    - Average operative time in this series was 147 minutes, and bowel function returned within 24 hours for more than 90% of patients. Patients stayed in the hospital for an average of 2 days postoperatively. [17]

Imperforate anus

- Most surgeons repair a perineal fistula primarily in the newborn period without a colostomy. For all other anorectal defects, most defer to the 3-step approach, consisting of diverting colostomy shortly after birth, the main repair at a later date, and finally, colostomy closure.
- More recently, a trend to repair congenital malformations earlier in life has developed, and an increasing trend to perform primary procedures without a protective colostomy has developed [18]
- The laparoscopic approach is even more attractive because it allows the repair of the defect without laparotomy, without colostomy, and with minimal pain.
- This procedure has particular application to patients with imperforate anus and recto–bladder neck fistula. The rectum can be mobilized off of the bladder with a laparoscopic approach. Long-term results from this approach are not yet available to determine patient's ability to achieve fecal continence.

Herniorrhaphy

- Assessment of the contralateral side can be a diagnostic dilemma in open surgery. Some authors have used laparoscopy to visualize the contralateral side.
- Laparoscopic repair has been reported via transabdominal approach. The peritoneal cavity is entered at the level of the umbilicus, and a trocar is placed. The peritoneal cavity is insufflated with carbon dioxide. Two 2-mm trocars are then placed under direct vision

slightly superior and medial to the anterior superior iliac spine. Both internal rings are inspected, and direct and indirect hernias are visualized easily. These hernias are repaired, and, if a contralateral hernia is visualized, it is also repaired.

- The repair consists of ligating the sac from the inside at the level of the internal ring. Injury to the gonadal vessels and vas deferens should be avoided during the closure of the hernia defect. This repair does not take care of a distal hydrocele.
- Laparoscopic hernia repair has a theoretical advantage with recurrent hernia because the surgical planes have not been previously violated. This avoids the risk of operating through scar tissue and injuring the testicular vessels or the vas deferens. It also has a theoretical advantage in girls because ovaries can be visualized adequately, especially if they are incarcerated.
- With a laparoscopic approach, minimal or no dissection of the cord structure occurs; therefore, the likelihood of injury to the testes is low.
- In females, the laparoscopic inversion ligation herniorrhaphy (LILH), using peritoneal inversion and high ligation, is a technique that is increasingly used.

Varicocele

- This procedure is usually performed with 1-3 trocars.
- In one study, the median operating time was approximately 30 minutes and the median hospital stay was 24 hours. Recurrence with the laparoscopic Palomo technique was low, and the rate of postoperative hydrocele formation was significant (6.6%) [19].

Nonpalpable testes

- MAS techniques must be used if the cryptorchid testis is not palpable in the inguinal canal after induction of anesthesia.
- The first report of abdominal testes identified by laparoscopy was in 1976 [20]and since then, laparoscopy has become the criterion standard for nonpalpable testes.
- Laparoscopy allows localization of intra-abdominal testes, identification of absence of testis and presence of canalicular testis. This localization is easily accomplished by following the course of vas and testicular vessels.
- Once located, intra-abdominal testes can be treated by MAS-assisted orchidopexy.
- The nonpalpable testes are usually found between the internal ring and the external iliac vessels. [20]

Ovarian pathology

- Laparoscopy has been used successfully to manage a wide variety of gynecologic problems, including tubal torsion, adnexal torsion, and oophorectomy.
- In teenaged girls with abdominal pain, diagnostic laparoscopy is invaluable.
- It can be performed easily with 2-3 ports and provides excellent operative view.
- Patients do extremely well and are able to return to their preoperative activity sooner.

Splenectomy

- The first MAS approach to splenectomy was successfully performed in 1990 in animals [21] since then; many accounts of laparoscopic splenectomy in humans have been

reported in the literature. The first laparoscopic splenectomy was performed in Buffalo, New York. It has now become the criterion standard for removal of the spleen.

- Indications for laparoscopic splenectomy are the same as they are for open procedure unless malignancy is suspected.
- Patients are usually placed in a in a 45° right lateral decubitus position. Typically, 4-5 trocars of varying sizes (5-12 mm) are used.
- Laparoscopic approach offers a much-improved view without an extensive incision. Most of the dissection has been facilitated by development of better energy modalities and improved stapling devices.
- The spleen is placed in a bag, which is exteriorized and removed after breaking it with a finger or sponge stick.
- Patients do extremely well postoperatively, and most are able to return home within 48 hours.
- Splenopexy has been performed for a wandering spleen in a 2-year-old girl [22]
- Partial splenectomy, splenopexy for wandering spleen, and splenic cyst excision all have been reported.

Nephrectomy

- Laparoscopic nephrectomy was first described in 1991 in adults.[23]
- Transperitoneal or retroperitoneal approaches have been used.
- Ehrlich et al reported the first series of laparoscopic renal surgery in children. [24]
- Ehrlich et al also reported the first laparoscopic partial nephrectomy in 1993.
- The retroperitoneal approach completely avoids the peritoneum, thereby decreasing the related complications. The incidence of postoperative ileus and postoperative adhesions are also avoided. It is also ideal in patients who have had previous abdominal surgeries.
- In 1992, Gaur performed the first successful retroperitoneal approach for renal surgery in India [25]
- This approach can be used for renal biopsy, nephrectomy, heminephrectomy, nephroureterectomies, nephropexy, adrenalectomy, and pyeloplasty [26]
- The retroperitoneum is dissected using balloon, saline, finger, or direct vision. Angled scopes provide a much better view because of the limited operational space. This approach is limited in small children.
- Laparoscopic donor nephrectomy has improved the operation for the donor and has increased the use of the living related renal transplantation.
- Other urologic procedures have also been performed laparoscopically, including pyeloplasty, bladder reconstruction, and transvesical ureteral reimplantation.

Adrenalectomy

- The MAS approach can be applied to adrenal tumors, such as pheochromocytoma, and incidentally found adrenal masses.
- The MAS approach can be transperitoneal or retroperitoneal. MAS offer an excellent view of the surgical anatomy and the vasculature.
- This approach is similar to the laparoscopic nephrectomy.

Thoracoscopy

- Thoracoscopy is safe and effective, even in infants without significant morbidity or mortality.
- Patients are placed in a lateral position with the operative side up, as in the open technique. Three trocars are used in most cases.
- Thoracoscopy can done in the following:
    - Assessment or resection of mediastinal or lung masses
    - Diaphragm placation [15].
    - Resection of subpleural blebs
    - Pleurodesis
    - Pericardial drainage
    - Lung biopsies
    - Drainage of empyema
    - Tumor biopsies

Obesity Surgery

Bariatric surgeons are interested in developing programs for obese adolescents. Both laparoscopic gastric bypass and laparoscopic adjustable gastric banding (LAGB) have proven to be effective procedures to help obese and superobese patients lose excess weight in numerous studies [27], [28].

Recent advances:

Over the past decades, robotic surgical systems have been used in laparoscopic surgery. This provides a batter ability to manipulate instruments at their distal end with great precision, increased freedom of movement, and excellent 3-dimensional depth perception. At the moment the size of the equipment can be a limiting factor with regard to the application and success in children we believe that further advances in device technology and a new generation of robotic equipment will facilitate precision in MAS in pediatrics.

Conclusions:

The field of MAS has grown remarkably over the past 2 decades. The imaginations and creativity of operating surgeons worldwide has led to a broad array of surgeries that can now be performed without large incisions. Instruments now available enable surgeons to perform most operations wielding scopes rather than scalpels. Most authors report results of MAS equal to or better than that of standard open surgery, with MAS showing shorter hospital stays, less analgesic requirement after surgery, more rapid return to work or school, and cosmetic satisfaction. MAS clearly has a steep learning curve, require certain skill and proper bimanual coordination, and some times major complications with MAS can occur. Often MAS procedures are more expensive in the operating room, but less costly for the hospital room.

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