

## Two Year Experience with Minimal Access Surgery at Schneider Children's Medical Center of Israel

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### Abstract

**Background:** The minimal access surgery revolution has only just begun to impact on pediatric surgery, thanks mainly to technologic advances and evidence of the benefits of minimally invasive procedures in this population.

**Objectives:** To review the current status of MAS in a pediatric tertiary care center in Israel, in terms of feasibility, safety, and effect on standard practices.

**Methods:** We reviewed the files of all children who underwent a MAS procedure in our department during the period April 2002 to July 2004, and compared the findings with those of children treated by standard practices.

**Results:** A total of 301 procedures were performed in 271 patients: 107 thoracoscopic and 194 laparoscopic. There were no major intraoperative complications. The total conversion rate was 3.65%: 0 for thoracoscopy and 5.6% for laparoscopy (11/194). Twenty-four types of procedures were performed during the study period. The thorascopies accounted for 92.24% of all thoracic procedures in the department (107/116), and routine abdominal laparoscopic procedures replaced open surgery in 30–100% of cases (total 44.8%, 194/433).

**Conclusions:** MAS procedures appear to be safe for a wide range of indications in children. In our center they currently account for a significant percentage of pediatric surgeries. We suggest that the integration of MAS training in the residency programs of pediatric surgeons be made a major long-term goal. The creation of a pediatric MAS study group that would allow for multi-institutional studies is especially important in Israel where a relatively large number of pediatric surgery departments handle a small annual number of patients.

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The minimal access surgery revolution has had little initial impact on the practice of pediatric surgery, for several reasons. First, the rapid development of laparoscopic surgery in adults was prompted mainly by laparoscopic cholecystectomy, an uncommon procedure in children. Second, postoperative pain and surgical stress are underappreciated in young children, who cannot adequately verbalize their feelings [1]. Third, the advantages of smaller incisions were underestimated by pediatric surgeons, because they already used "small" incisions. However, when considered relative to body size, the incision length for open procedures in children is the same as for adults. Furthermore,

because most manufacturers produced only instruments that were unsuitable for pediatric patients, the applicability of MAS to this population was limited. This factor also made it harder for physicians to justify the high initial set-up costs of MAS procedures to skeptical chief executive officers at children's hospitals [2,3]. Finally, the methodologies developed for teaching thoracoscopic and laparoscopic procedures were not well suited to the advanced techniques required by pediatric surgeons. The learning curve for pediatric MAS procedures is quite long, and many senior pediatric surgeons were reluctant to acquire these skills when they were already highly proficient in open surgery.

It is therefore only recently that progress in minimal invasive pediatric surgery has accelerated, thanks mainly to the growing involvement of pediatric surgeons, combined with technologic advances that make it possible to apply the principle of minimal access to highly sophisticated pediatric surgery. The significant benefits of MAS in children, including reduced physical and emotional trauma, fewer wound complications, fewer hospital days, improved cosmetic results, and a less hostile hospital milieu [4–7], are fueling the drive to change practice paradigms.

The aim of the present study was to review the current status of MAS at a tertiary care university-affiliated referral center in Israel. Specifically, the safety and performance of MAS were assessed, in addition to its effect on conventional surgical practices.

### Patients and Methods

The Schneider Children's Medical Center of Israel is a pediatric tertiary care facility for patients from the neonatal period to late adolescence. In our center, MAS procedures were introduced in 1995 and have since become a routine tool in daily surgical practice. The number of eligible patients and range of procedures have increased considerably with time, significantly improving the quality of care. The selection of patients and procedures in this series was highly individual; many important factors were considered: patient/parent preference, surgeon's experience, complexity of the procedure, and the patient's medical condition. Contraindications for MAS included hemodynamic instability, severe cardiac disease, pulmonary insufficiency, bleeding disorders, previous repeated surgical procedures, and malignancies.

The study group for the present analysis included all 271

MAS = minimal access surgery

children who underwent MAS procedures, 107 thoracoscopic and 194 laparoscopic, in our Department of Pediatric Surgery during the period April 2002 to July 2004. Patient characteristics and operative and postoperative data were derived from the computerized files and recorded in standardized forms. The findings were compared to those for conventional operations performed during the same period.

At our center, laparoscopy and thoracoscopy in infants and children are performed under general anesthesia with endotracheal intubation, using instruments of 3–10 mm in diameter, with lens configurations of 0–30°. The “open” technique [8] for introducing the first trocar through the inferior umbilical fold is widely used by us in small infants to establish pneumoperitoneum. The Veress needle technique is used only in adolescents. We have not noted any complications with this technique. Maximum intraabdominal pressure is kept at 6–8 mmHg in infants, 8–10 mmHg in small children, and 10–12 mmHg in older children and adolescents. Most of the instruments are reusable. Bipolar electrocautery, endoscopic ligature, the Harmonic Scalpel®, and endoscopic vascular staplers are applied selectively in different types of procedures. Most of the trocars are 3–5 mm in diameter, though in some procedures, in order to evacuate resected tissue or to obtain enough tissue for pathologic examination, we use a single 10–12 mm trocar. At completion of the procedure, an attempt to expel the insufflated gas is made, and the port sites are reapproximated at the skin site. A separate fascia layer is closed for ports larger than 5 mm to lower the likelihood of herniation at the port side.

## Results

Twenty-four types of MAS procedures were performed during the 2 year study, as shown in Tables 1 and 2.

Of the 116 thoracic procedures performed in our department, 107 (92.24%) were done endoscopically. Sympathectomy was the most common type of thoracoscopic procedure (24 bilateral cases) with zero conversions. Thoracoscopic-assisted repair of pectus excavatum (Nuss operation), which is gaining popularity with very promising results, was used in 40 children with good cosmetic outcome and no conversions.

Among the elective routine abdominal procedures, laparoscopy replaced open surgery in 194 of 433 cases (44.80%). Laparoscopic procedures accounted for all the cholecystectomies done during this period, in addition to 14 of 32 funduplications (43.7%), and 11 of 19 splenectomies (57.89%), with 4 open evacuations of large spleens. Of the 435 appendectomies, 89 were done by laparoscopy (20.45%), with conversion in 4 cases (4.49%). A perforated appendicitis (n=8) was not found to be a contraindication for laparoscopic resection. Elective Meckel diverticulectomy was done by laparoscopy in 3 of 5 cases (66.66%) using vascular staplers. Laparoscopic adrenalectomy was performed in two cases after imaging and laboratory tests excluded malignancy and in one case of residual neuroblastoma. Of the five bowel resections performed for Crohn's disease, four were laparoscopically assisted with extracorporeal anastomosis. Laparoscopic repair of Morgagny-Larrey hernia was

**Table 1.** Types of thoracic minimally invasive procedures performed, and comparison with open surgery

Type of procedure	Thoracoscopy		Open surgery
	No.	Conversions	
Lung biopsy	6	0	4
Mediastinal mass biopsy	7	0	1
Excision of mediastinal mass/cyst			4
Blebectomy for recurrent pneumothorax	8	0	0
Sympathectomy	48	0	0
Nuss operation	38	0	0
Total	107		

**Table 2.** Types of abdominal minimally invasive procedures performed, and comparison with open surgery

Type of procedure	Laparoscopy		Open surgery
	No.	Conversions	
Adrenalectomy	3	0	4
Appendectomy	89	4 (4.49%)	346
Cholecystectomy	19	0	0
Splenectomy	11	4 (36.35%)	8
Fundoplication	14	1 (16.66%)	18
Heller myotomy	2	0	1
Meckel's diverticulotomy	3	0	2
Adhesiolysis	5	2 (40.00%)	6
Gastrostomy	6	0	15
Tumor biopsy	1	0	0
Excision of mesenteric mass	1	0	1
High ligation for varicocele	8	0	0
Fowler-Stephens operation, stage I	9	0	0
Bowel resection for Crohn's disease	4		3
Repair of Morgagny-Larrey hernia	2	0	0
Ovarian cyst resection	6		0
Ovarian detorsion	1		0
Ovarian biopsy	7		0
Gonadectomy	8		1
Total	194		

performed in two cases. This modality may be safe and effective for primary diagnostic evaluation of suspected diaphragmatic hernias in infants and children.

The Fowler-Stephens procedure for undescended testis (first stage) was performed in nine patients. All eight high ligations for varicocele performed during this period were done by laparoscopy (100%). In addition, all “gynecologic” procedures were done by laparoscopy, except for excision of a huge yolk sac tumor. These included six ovarian cyst excisions, seven ovarian biopsies, one ovarian detorsion, and four bilateral gonadectomies in patients with testicular feminization syndrome (XY reverse).

There were no intraoperative complications in the entire series. The total conversion rate was 3.65%: 0 for the 107 thoracoscopic procedures and 5.67% (11/194) for the laparoscopic procedures.

## Discussion

The incorporation of minimal access procedures as an integral part of pediatric surgery seems inevitable. Examples of

MAS can be found in nearly every specialty in pediatrics, from ventriculotomy in neurosurgery to arthroscopy in orthopedics. Most practicing physicians are well versed in the applications of bronchoscopy, cystoscopy, and gastrointestinal endoscopy as diagnostic procedures. However, the application of the innovative instrumentation for intracavitary therapeutic procedures in the abdomen and chest is relatively new in the pediatric population. The present study was intended to acquaint pediatric surgeons with the capabilities of endoscopic surgery in children. Nevertheless, it should be stressed that the technical possibility of performing a MAS procedure does not necessarily mean that it is better for the patient. It must be at least as safe and effective as the standard procedure it purports to replace. Furthermore, surgeons must be skilled also in conventional surgical methods for situations in which rapid conversion to an open operation is necessary.

In our facility, as in many other centers, pediatric surgeons adopt the MAS procedures used in adults and use them for children. Initially we performed MAS only in older children because the instruments were adult size. Technically, operating in infants was unfeasible until manufacturers began to produce smaller and shorter tools. Gradually, surgeons began to use a laparoscopic approach for more and more procedures traditionally performed by an open technique, thereby considerably broadening the range of MAS in children. In 1999, the pediatric surgery training program in Israel was modified to match the North American concept, resulting in a new generation of general surgeons who practice and promote pediatric MAS. The more complicated procedures still require that the surgeons train in a laboratory setting in order to identify and correct weaknesses and pitfalls.

MAS is especially well suited for learning by observation. Much experience can be gained by spending time in the operating room with a physician who has mastered these procedures. Although many retrospective studies on individual procedures in children have been published [9,10], there are as yet no randomized prospective trials, probably owing to an insufficient volume of procedures at individual institutions. The creation of a pediatric MAS study group would allow for multicenter studies. This is particularly important for small countries such as Israel where a relatively large number of pediatric surgery departments handle a relatively small number of patients annually.

The promising advantages of MAS over open surgery in children are reflected by the large number of applications that have become routine practice in many pediatric medical centers worldwide. In general, the classification of potential indications for MAS into good, equivocal or poor is highly individual. It is also likely to change with time because the scene is advancing rapidly and younger general surgeons well trained in laparoscopic techniques early in their careers are moving to establish recognized criteria in the pediatric population. What is now classified as an equivocal indication or non-indication for laparoscopic surgery could become a good indication in the future.

Laparoscopic cholecystectomy, splenectomy, fundoplication,

and thoracoscopic sympathectomy have all become "gold standard" methods by evidence-based medicine. It is just a matter of time until the other minimally invasive procedures join the list. Ure et al. [11] reported that 60% of all abdominal operations in the pediatric population are now performed endoscopically. The lack of correlation between the rate of conversion and body weight observed in their study indicates that laparoscopy and thoracoscopy are as feasible in young children (body weight above 5 kg) as in older ones. Complications are few, with an overall reported rate of 5.3% for minor complications and 1.2% for major complications [12]. In our study, however, the conversion rates for splenectomy and adhesiolysis were relatively high. The main reason for conversion in splenectomy was spleen size. In four converted cases, spleen weight was more than 1,000 g, and it was technically impossible to evacuate the already dissected and mobilized spleen, even with the largest endo bag (15 x 15 cm). This factor must be considered during patient selection for laparoscopic splenectomy. Nevertheless, even "giant" spleens resected laparoscopically can be evacuated through a relatively small, low abdominal or suprapubic transverse excision.

Adhesiolysis, performed as an elective procedure in five patients with chronic abdominal pain and a few episodes of partial small bowel obstruction, had a fairly high conversion rate (2 patients, 40%). Conversion was necessary because of an enteroenteric fistula in one patient and inadequate exposure in the other.

Laparoscopy may soon be the procedure of choice for Nissen fundoplication in our department. In this series, conversion was necessary in one case because of difficulties in controlling bleeding. With experience, we are gradually decreasing the age and weight limits. Laparoscopic cholecystectomy was performed in 19 children with symptomatic cholelithiasis, with no conversions. The youngest patient was 2 years old. Laparoscopic appendectomy remains controversial [13,14]. We believe it is especially suitable for specific patient groups, namely obese patients, female adolescents and diabetic patients. Uncertain diagnosis in cases of right lower quadrant pain is probably the most common reason for diagnostic laparoscopy and appendectomy.

In conclusion, recent improvements in pediatric instrumentation and technique have made these procedures safer, decreasing complications, conversion rates and operative time. More reports documenting the safety, efficacy and cost-effectiveness of pediatric MAS are needed. It is the pediatric patient who has the most to gain from these improvements in surgical care.

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