Current status of pediatric minimal access surgery at Sultan Qaboos University Hospital: a 3-year experience

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Objective **The objective of this study was to determine the current practices of pediatric minimal access surgery (MAS) in our institute over a period of 3 years.**

Background data **Pediatric MAS has received recognition among pediatric surgeons and is currently being practiced in most centers worldwide. However, studies in our region are limited.**

Materials and methods **This study was carried out in Sultan Qaboos university Hospital (Muscat, Oman). Medical records of all the children (0–12 years) who required abdominal, groin, or thoracic surgery between July 2009 and August 2012 were reviewed. Data analysis was carried out using SPSS v16.**

Results **A total of 904 abdominal, groin, and thoracic procedures were performed in 790 children. In 257 (28.4%) procedures [emergency = 164 (64%), elective = 93 (36%)] minimal access was utilized. In total, 152 (60%) patients were males, whereas 102 (40%) were female. The age of the patients ranged from 0 to 12 years, with an average of 7.02 ± 3.93 years (SD). Weight ranged from 2.8 to 61 kg [mean = 23.74 ± 12.16 (SD)]. The MAS modality included 251 (97.6%) laparoscopic and six (2.4%) thoracoscopic procedures. Conversion to open and complication rates were 3.5 and 5.05%, respectively. Follow-up period ranged from 3 to 40 months, with an average of 18.05 ± 8.96 (SD).**

Conclusion **At Sultan Qaboos University Hospital, pediatric MAS is evolving as we are performing a number of diverse procedures at a comparable conversion and complication rate.** ***Ann Pediatr Surg*** **9:140–143 © 2013 Annals of Pediatric Surgery.**

Annals of Pediatric Surgery 2013, **9**:140–143

Keywords: current status, laparoscopy, minimal access surgery, thoracoscopy

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Received 31 January 2013 **accepted** 24 August 2013

Introduction

Minimal access surgery (MAS) has a long history, starting even before Palmer's first article on abdominal endoscopy in 1947 [1]. The transition from diagnostic to operative MAS in humans took more than three decades till Semm performed the first laparoscopic appendectomy in 1981 [2]. The first ever account on pediatric diagnostic MAS 'Peritoneoscopy in infants and children' was published in 1973 [3]. Although it was diagnostic in nature, it provided a new horizon. Overall, the idea of MAS was more readily adopted by the general surgeons and the first successful laparoscopic cholecystectomy was actually performed in adults in 1985 [4]. Initially, the pediatric surgeons were reluctant to adopt MAS with a view that MAS was not required in children because of already existing smaller incisions, lesser pain, and shorter hospital stays. However, eventually, its significance was recognized by pediatric surgeons after a delay of almost two decades. Starting from pediatric laparoscopic cholecystectomy in 1991 [5], over the next 20 years, a wide variety of procedures have been added. Currently, any pediatric surgical procedure can be performed by MAS.

In Oman, Sultan Qaboos University was established in 1986 whereas the department of surgery became operational in 1990. Most of the pediatric surgery cases were operated by general surgeons until 2009, when a separate department was established for pediatric surgery. MAS surgery was started in July 2009 once consultant surgeons experienced in MAS and necessary equipment were available. Although considerable western literature is available on the experience of MAS, there is no such study in our region. In this paper, we have evaluated the current practices of MAS in our institute over a period of 3 years.

Materials and methods

This retrospective study was carried out in Sultan Qaboos University Hospital (Muscat, Oman). Medical records of all the children (0–12 years of age) who required abdominal, groin, or thoracic surgery between July 2009 and August 2012 were reviewed after receiving approval from the concerned ethical committee. Demographic data such as age, weight, and sex were collected from the electronic patient database. Other variables recorded were diagnosis, anatomical region, name of the procedure, modality of MAS used, type (emergency/elective) and complexity class (simple, difficult, demanding) of the procedure, conversion to open, reason for conversion, and complication of procedure.

MAS was defined as any surgical procedure that was attempted ± completed by either of two modalities, that is, laparoscopy or thoracoscopy. By current status, we meant the total number of abdominal, groin, and thoracic

1687-4137 © 2013 Annals of Pediatric Surgery DOI: 10.1097/01.XPS.0000434487.93877.be

surgeries, number, breadth, and complexity class of cases done by MAS, trends over a period of 3 years, and conversion and complication rates. Procedure was labeled as emergency when it was performed within 12 h after diagnosis. Complexity classification was first described by Costi *et al.* [6]. He developed this scoring system by asking the operating surgeons in his series to attribute a score of mean complexity to each of the procedures in a standard situation. On the basis of the median of the scores collected, he classified the MAS procedures into three classes of complexity. For the pediatric population, this classification was modified by Metzelder *et al.* [7]. Complexity class in our series was based on classification described by these two authors [6,7]. In laparoscopic procedures, the open technique was used for the creation of pneumoperitoneum. A blend of disposable and reusable instruments was used. Pressure and flow rates were adjusted according to the age of the individual child (8–10 mmHg/at 5–7 l/min in older children, 5–7 mmHg, and 2–3 l/min in infants). The number of additional ports varied depending on the laparoscopic procedure. Three ports were used for isolated splenectomy, whereas five ports were used for combined cholecystectomy/splenectomy. In case of a combined procedure, cholecystectomy was performed before splenectomy. Inguinal herniotomy was performed only in females using inversion and endoloops ligation technique as described by Zallen and Glick [8] Most of the emergency surgeries were performed by specialists or senior specialist surgeons. However, most of the elective procedures were either performed or directly supervised by a consultant.

Proforma was used for the collection of data. Data analysis was performed using the Statistical Package for the Social Sciences (SPSS), Version 16 (IBM, Chicago, Illinois, USA). Descriptive statistics were used for numerical variables whereas frequencies were determined for qualitative variables.

Results

A total of 904 abdominal, groin, and thoracic procedures were performed in 790 children (males: 596, females: 194). These included 451 (50%) abdominal, 430 (48%) groin, and 23 (2%) thoracic procedures. The age of the patients ranged from 0 to 12 years, with an average of 3.61 ± 3.96 years (SD). Weight ranged from 0.8 to 77 kg [mean = 14.52 ± 10.87 (SD)].

In 257 procedures [emergency = 164 (64%), elective = 93 (36%)], minimal access was utilized. Of 240 patients, 100 (42%) patients were males whereas 140 (58%) patients were females. The age of the patients ranged from 0 to 12 years, with an average of 7.02 ± 3.93 years (SD). The youngest child was a 7-day-old girl with Morgagni hernia in whom laparoscopic repair was attempted but was converted into open because of desaturation. Weight ranged from 2.8 to 61 kg [mean = 23.74 ± 12.16 (SD)].

The MAS modality included 251 (97.6%) laparoscopic and six (2.4%) thoracoscopic procedures. Depending on the complexity level, 188 (73%) cases were easy, 53 (21%) were difficult, and 16 (6%) were demanding. The most common emergency procedure was laparoscopic appendectomy (142). The other common elective cases included orchiopexy for nonpalpable undescended testis (one stage, Stephen Fowler I/II), Splenectomy and cholecystectomy (isolated/combined), and female inguinal herniotomy (unilateral/bilateral). The rest of the laparoscopic procedures are shown in Table 1 and thoracoscopic procedures are shown in Table 2. In terms of trends, the number of MAS procedures increased from 26 in the first year to 105 in the second year and 126 in the third year. Similarly, the number of difficult and demanding cases increased over this period (Fig. 1). Moreover, the variety of cases increased from eight in the first year to 22 in the third year (Table 3).

Table 1 Laparoscopic procedures

Name of procedure	MAS	Open	Conversion	Complication
Appendectomy	142	4	1	5
Orchiopexy (nonpalpable UDT)	23	7	–	–
Splenectomy	18	8	–	–
Inguinal herniotomy (female)	17	24	–	1
Cholecystectomy	16	2	1	–
Combined cholecystectomy and splenectomy	5	–	–	2
Morgagni hernia repair	5	–	1	–
Nissen fundoplication ± gastrostomy	5	1	–	–
Oophorectomy	3	–	–	–
Liver biopsy	3	2	–	–
Nephrectomy/heminephrectomy	3	3	1	–
Diagnostic	2	–	2	–
Intestinal resection (RA/SF)	2	15	–	2
Drainage of abscess	1	1	–	–
Reduction of intussusception	1	–	–	–
Repair of urinary bladder injury	1	–	–	–
Colonic pull through (ARM)	1	13	–	1
Adhesiolysis	1	15	1	–
Excision of bladder diverticulum	1	–	1	–
Detorsion of ovary	1	–	–	–
Miscellaneous	–	535	–	–
Total	251	592	8	11

MAS, minimal access surgery; RA/SF, resection anastomosis/stoma formation; UDT, undescended testis.

Table 2 Thoracoscopic procedures

Name of procedure	MAS	Open	Conversion	Complication
Decortication	4	0	1	2
Excision of mediastinal mass	2	0	–	–
Miscellaneous	0	17	–	–
Total	6	17	1	2

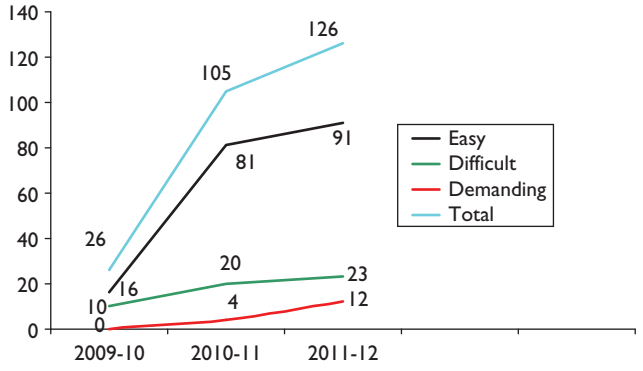
MAS, minimal access surgery.

The conversion rate was 3.5% (Table 1). The most common reason to convert was difficulty in proceeding. The complication rate was 5.0% (Table 1). Two patients had intraoperative complications (CBD injury, $n = 1$; urinary bladder injury, $n = 1$) and one female patient operated for bilateral inguinal herniotomy had recurrence of the inguinal hernia on one side. Minor postoperative complications ($n = 10$) included fever ($n = 4$), chest infection ($n = 3$), wound infection ($n = 2$), and postoperative diarrhea ($n = 1$).

Discussion

Development of pediatric surgery as a specialty in itself took almost a century. Progress in pediatric MAS was

Fig. 1



Trends in minimal access surgery.

Table 3 Yearly analysis of minimal access surgery procedures

2009–10	2010–11	2011–12
Appendectomy	Adhesiolysis	Drainage of intra-abdominal abscess
Cholecystectomy	Decortication	Excision of bladder diverticulum
Combined cholecystectomy/ splenectomy	Detorsion of ovary	Excision of mediastinal mass
Intestinal resection (RA/SF)	Inguinal herniotomy	Morgagni hernia repair
Liver biopsy	Nissen fundoplication	Oophorectomy
Orchiopexy	Repair of urinary bladder	Reduction of intestinal intussusception
Splenectomy	Pull through for ARM	Total/heminephrectomy
Stephen Fowler stage I	–	–

RA/SF, resection anastomosis/stoma formation.

further delayed because of reasons such as unavailability of good-quality and smaller sized instruments, relatively higher cost of procedures, and lack of evidence that it was beneficial in children. Only in the early 1990s were the advantages of MAS realized by pediatric surgeons. However, once this reality was acknowledged, it evolved considerably. Pediatric laparoscopic cholecystectomy was started in 1991 [5], followed by appendectomy in 1992 [9] and splenectomy in 1993 [10]. Currently, almost all the pediatric surgical procedures are amenable to MAS. Nissen fundoplication, pyloromyotomy, cholecystectomy, splenectomy, nephrectomy, adrenalectomy, resection anastomosis/stoma formation of small or large gut, herniotomy, orchiopexy, surgery on female adnexa, and large gut biopsies for Hirschsprung disease are few of the examples of the procedures that can be performed by laparoscopy. Thoracoscopic applications include drainage of empyema, diagnosis, and resection of mediastinal or lung mass and repair of tracheoesophageal fistula and congenital diaphragmatic hernia.

In our setup, pediatric MAS is also evolving at a good pace. Only 3% of the appendectomies were performed by an open technique in the last 3 years. Emergency procedures outnumbered the elective procedures because appendectomy was the most common procedure and most of those were performed by laparoscopy. We started with eight types of surgical procedures in the first year and added seven more subsequently each year. Most of the cases added in the subsequent years were difficult and demanding in nature such as Nissen fundoplication, Morgagni hernia repair, total and heminephrectomy and thoracoscopic decortication, and excision of mediastinal masses. Among the groin procedures, we performed laparoscopy only for nonpalpable undescended testis (UDT) in males and inguinal herniotomy in females. To start with, female inguinal herniotomy was performed by an open technique but in the last year all the female inguinal hernia cases were performed by laparoscopy using the sac inversion endoloop application technique [8]. Similarly, none of the orchiopexy procedures for nonpalpable UDT was performed by an open technique in the last year. Laparoscopic splenectomy and cholecystectomy, alone or combined, were among the common procedures because of sickle cell disease, which is common in our community. Seventy-four percent of the splenectomies and 90% of the cholecystectomies were performed by MAS. Morgagni hernia repair and female adnexal procedures were performed exclusively by the MAS technique. For thoracoscopic procedures, all the decortications and excision of the diagnostic masses were performed by this technique. Experience of neonatal MAS surgery was limited because of the lack of instruments, experienced anesthetists, and perioperative care. The only procedure that was attempted in a neonate was repair of Morgagni hernia in a 7-day-old girl, who required conversion because the baby started to desaturate.

The safety of the MAS procedures in our setup is evident by the 3.5% conversion and 5.05% complication rates, which are comparable to those reported in the literature [11,12]. The conversion was required because of difficulty in proceeding in most of the cases. These cases included appendectomy ($n = 1$), cholecystectomy ($n = 1$), Morgagni hernia repair ($n = 1$), nephrectomy ($n = 1$), adhesionolysis [($n = 1$), the only attempted case], excision of bladder diverticulum ($n = 1$), diagnostic ($n = 2$), and decortication ($n = 1$). No conversion was required for orchiopexy (nonpalpable UDT), splenectomy, inguinal herniotomy (female), combined cholecystectomy and splenectomy, and Nissen fundoplication ± gastrostomy. Higher conversion rate of adhesionolysis has been reported by Szomstein *et al.* [13]. In our series, there were two intraoperative (CBD injury and urinary bladder injury) and 11 postoperative complications. Recurrence of the inguinal hernia on one side developed in a female child who underwent bilateral inguinal herniotomy. The rest of the postoperative complications were minor and not related to the procedure itself.

Although a wide variety of pediatric surgical procedures can be performed by MAS, evidence that MAS for every procedure is superior to its open counterpart is still lacking. On the basis of this, MAS procedures can be classified broadly into two categories, that is, MAS procedures that are clearly superior and those that lack evidence. Li *et al.* [14] published a meta-analysis of randomized-controlled trials on laparoscopic versus conventional appendectomy that concluded that laparoscopic appendectomy

had considerable benefits over open appendectomy in terms of a shorter length of hospital stay, less postoperative pain, earlier postoperative recovery, and a lower complication rate. Another study by Chowdhary and Kandpal [15] documented the superiority of laparoscopic cholecystectomy, appendectomy, nephrectomy, splenectomy, and surgery for intra-abdominal testis to open surgery. The safety and superiority of the congenital Morgagni hernia repair has also been established [16]. However, the area of major challenge is repair of neonatal Bochdalek hernia and tracheoesophageal fistulae by MAS. Shah *et al.* [17], in a recent article, have reported the success of neonatal Bochdalek hernia repair by thoracoscopy but the number was small. In 11 cases (of 90), MAS was attempted and was completed successfully only in nine. Repair of esophageal atresia and tracheoesophageal fistula has been reported by Rothenberg *et al.* [18]. It is technically challenging and more data are required to evaluate this approach, especially in long-gap defects. Another area of controversy is application of MAS for repair of male inguinal hernia [19]. Longer operative time and chances of injury to spermatic cord do not make it an ideal approach. In contrast, in females, it is applicable because of minimal chances of injury to vital structures and higher incidence of contra lateral subclinical hernia, which can be dealt with simultaneously. Moreover, sac inversion endoloop application is feasible and has a low recurrence rate. Data on laparoscopic-assisted procedures for duodenal atresia, intestinal malrotation, Hirschsprung disease, and anorectal malformations are insufficient to make any conclusions [20–23].

Conclusion

MAS is applicable in a wide variety of pediatric surgical conditions. In the majority of the cases, safety is well established. However, in other conditions, large randomized multicenter trials are required to ascertain its superiority to the open counterpart.

Acknowledgements

Conflicts of interest

There are no conflicts of interest.

References

1 Palmer R. Instrumentation and technical gynecological laparoscopy. *Gynecol Obstet* 1947; **46**:420–431.
2 Semm K. Endoscopic appendectomy. *Endoscopy* 1983; **15**:59–64.
3 Gans SL, Berci G. Peritoneoscopy in infants and children [abstract]. *J Pediatr Surg* 1973; **8**:399–405.
4 Reynolds W. The first laparoscopic cholecystectomy. *JSLS* 2001; **5**:89–94.
5 Sigman HH, Laberge JM, Croitoru D, Hong A, Sigman K, Nguyen LT, Guttman FM. Laparoscopic cholecystectomy: a treatment option for gallbladder disease in children. *J Pediatr Surg* 1991; **26**:1184–1185.
6 Costi R, Denet C, Sarli L, Perniceni T, Roncoroni L, Gayet B. Laparoscopy in the last decade of the millennium: have we really improved? *Surg Endosc* 2003; **17**:791–797.
7 Metzelder ML, Jesch N, Dick A, Kuebler J, Petersen C, Ure BM. Impact of prior surgery on the feasibility of laparoscopic surgery for children: a prospective study. *Surg Endosc* 2006; **20**:1733–1737.
8 Zallen G, Glick PL. Laparoscopic inversion and ligation inguinal hernia repair in girls. *J Laparoendosc Adv Surg Tech A* 2007; **17**:143–145.
9 Gilchrist BF, Lobe TE, Schropp KP, Kay GA, Hixson SD, Wrenn EL Jr, *et al.* Is there a role for laparoscopic appendectomy in pediatric surgery? *J Pediatr Surg* 1992; **27**:209–214.
10 Tulman S, Holcomb GW, Karamanoukian HL, Reynhout J. Pediatric laparoscopic splenectomy. *J Pediatr Surg* 1993; **28**:689–692.
11 Saravanan K, Kumaran V, Rajamani G, Kannan S, Mohan NV, Nataraj M, Rangarajan R. Minimally invasive pediatric surgery: our experience. *J Indian Assoc Pediatr Surg* 2008; **13**:101–103.
12 Te Velde EA, Bax NM, Tytgat SH, de Jong JR, Travassos DV, Kramer WL, van der Zee DC. Minimally invasive pediatric surgery: increasing implementation in daily practice and residents' training. *Surg Endosc* 2008; **22**:163–166.
13 Szomstein S, Lo Menzo E, Simpfendorfer C, Zundel N, Rosenthal RJ. Laparoscopic lysis of adhesions. *World J Surg* 2006; **30**:535–540.
14 Li X, Zhang J, Sang L, Zhang W, Chu Z, Li X, Liu Y. Laparoscopic versus conventional appendectomy – a meta-analysis of randomized controlled trials. *BMC Gastroenterol* 2010; **10**:129.
15 Chowdhary SK, Kandpal D. Minimal access surgery in children: a 5 year study. *Indian Pediatr* 2012; **49**:971–974.
16 Alqahtani A, Al-Salem AH. Laparoscopic-assisted versus open repair of Morgagni hernia in infants and children. *Surg Laparosc Endosc Percutan Tech* 2011; **21**:46–49.
17 Shah SR, Wishnew J, Barsness K, Gaines BA, Potoka DA, Gittes GK, Kane TD. Minimally invasive congenital diaphragmatic hernia repair: a 7-year review of one institution's experience. *Surg Endosc* 2009; **23**:1265–1271.
18 Rothenberg SS, Bealer JF, Chang JH. Primary laparoscopic placement of gastrostomy buttons for feeding tubes. A safer and simpler technique. *Surg Endosc* 1999; **13**:995–997.
19 Yang C, Zhang H, Pu J, Mei H, Zheng L, Tong Q. Laparoscopic vs open herniorrhaphy in the management of pediatric inguinal hernia: a systemic review and meta-analysis. *J Pediatr Surg* 2011; **46**:1824–1834.
20 Van der Zee DC. Laparoscopic repair of duodenal atresia: revisited. *World J Surg* 2011; **35**:1781–1784.
21 Hagendoorn J, Vieira-Travassos D, van der Zee D. Laparoscopic treatment of intestinal malrotation in neonates and infants: retrospective study. *Surg Endosc* 2011; **25**:217–220.
22 Georgeson KE, Robertson DJ. Laparoscopic-assisted approaches for the definitive surgery for Hirschsprung's disease. *Semin Pediatr Surg* 2004; **13**:256–262.
23 Bischoff A, Levitt MA, Peña A. Laparoscopy and its use in the repair of anorectal malformations. *J Pediatr Surg* 2011; **46**:1609–1617.