

## Laparoscopic Appendicectomy in Children: A Trainee's Perspective

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### Abstract

**Introduction:** The emergence of operative laparoscopy has brought a great demand for training surgical residents, but there are no clear guidelines regarding choice of procedure for training, proficiency assessment and accreditation. We aim to examine from a trainee's point of view, the safety and efficacy of laparoscopic appendicectomy (LA) as a laparoscopic training procedure. **Materials and Methods:** A retrospective analysis of all the consecutive cases of LA done by a trainee in paediatric laparoscopic surgery from September 2003 to February 2005 was done. **Results:** A total of 70 consecutive patients (37 males and 33 females) aged 3 to 15 years (mean,  $10.5 \pm 2.5$ ) with suspected appendicitis underwent LA. Twelve (17.1%) patients had acute appendicitis, 25 (35.7%) had acute suppurative appendicitis adherent to the caecum with localised and/or pelvic pus pocketing, 29 (41.4%) had perforated appendicitis with generalised peritonitis and 4 (5.7%) had normal appendix [mesenteric adenitis (1), omental infarct (1), torted Meckel's diverticulum (1) and primary peritonitis (1)]. There were no operative complications and none required conversion to open surgery. The operative duration ranged from 25 to 110 minutes (mean,  $55.6 \pm 23.4$ ). There were two complications; one had adhesive intestinal obstruction and underwent successful laparoscopic adhesiolysis and one had umbilical wound infection. **Conclusions:** LA is a safe and effective laparoscopic training procedure, in addition to being effective for all stages of appendicitis, as well as concurrent lesions encountered in children with suspected appendicitis.

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**Key words:** Appendicitis, Laparoscopy, Training

### Introduction

The advent of laparoendoscopic surgery in children has opened new avenues of treatment with added benefits but at the same time demands adequate training for its safe execution. Laparoscopic techniques can be safely incorporated into surgical residency training using graded and supervised clinical programmes.<sup>1-3</sup> Laparoscopic appendicectomy (LA) provides enough case material for the training of surgical residents, as appendicitis is a common surgical condition in children. However, since its inception in 1983 by Kurt Semm,<sup>4</sup> LA has not been fully accepted as the standard technique for the treatment of acute appendicitis. Despite individual reports favouring open appendectomies, various meta-analysis give LA a reluctant edge, concluding that it is either better than or at least as effective as open appendectomy.<sup>5-14</sup> We aimed to examine, from a trainee's point of view, the application of laparoscopic approach for suspected appendicitis in children

through a retrospective analysis of results of LA performed by a trainee laparoscopic surgeon, with an emphasis on laparoscopic training and the safety and efficacy of the procedure.

### Materials and Methods

All the consecutive cases of LA performed independently by a trainee in paediatric laparoscopic surgery, after a period of supervised training, over a period of 18 months, were retrospectively reviewed. There was no selection bias and all patients with suspected appendicitis admitted during the trainee's on-call duty days, underwent LA by the same surgeon, and open appendicectomy was not performed after September 2003. The operative findings, operative duration, conversion to open surgery, complications, hospital stay and follow-up were noted. The efficacy and safety of the procedure were analysed with respect to the operative duration, conversion rate, management of

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concurrent or incidental lesions, length of hospital stay, readmissions and complications.

At our institute, minimal access surgery is introduced in the first year of residency training. This is compounded with theoretical exercises regarding instrumentation, troubleshooting, video presentations and also training with simulators and performance on porcine animal models. Appendectomy is the most common laparoscopic procedure performed at our institute. Assistance in 10 laparoscopic appendectomy procedures and performing 10 laparoscopic appendectomies under supervision is considered as an adequate training experience. Meanwhile, residents concurrently assist and train in other minimal access procedures like laparoscopic pyloromyotomy, fundoplication, endo-rectal pull through, reduction of intussusception, varicocele, orchiopexy, oophorectomy, ovarian cystectomy and thoracoscopic procedures like decortication and pleurodesis. Dedicated consultant time for emergencies has facilitated teaching of laparoscopic appendectomy. A subjective assessment by the supervising consultant with regard to trainee's proficiency and safety, endowed the trainee with the privilege to perform independently, after in-house sequential hospital accreditation.

The LA procedure was performed under general anaesthesia with endotracheal intubation and using reusable instruments. Urinary catheter was placed in cases of suspected perforated appendicitis, and a nasogastric tube was inserted by the anaesthetist and removed after the procedure if the aspirates were non-bilious. Intravenous antibiotics (ceftriaxone and metronidazole, or gentamicin and metronidazole) were administered at induction. The patient was placed supine and the surgeon stood on the left of the patient and the lone assistant (Medical Officer) stood opposite to the surgeon till the ports were inserted and later shifted to the surgeon's right, to drive the camera. The video monitor for the surgeon was placed to the right of the patient at the level of the patient's shoulder and the scrub nurse was stationed near the foot end of the patient's right. A 10-mm umbilical camera port was inserted by the open Hasson's technique. Pneumoperitoneum with carbon dioxide was achieved to a pressure of 10 to 12 mm Hg. Two 5-mm working ports were inserted under vision in the left iliac fossa and the suprapubic region. The appendix was dissected out and the mesoappendix was diathermised with bipolar or monopolar hook diathermy and divided. The appendicular base was ligated with pre-tied absorbable loop suture (vicryl endoloop, Ethicon) and divided. The appendix was retrieved through the umbilical port or the umbilical incision, in cases of swollen appendix. The ileum was walked from the ileocaecal junction proximally, with atraumatic graspers releasing all inter-loop adhesions and draining pus cavities. The peritoneal cavity was lavaged

with warm normal saline in cases of peritonitis and closed suction drain (Jackson Pratt) was placed in the pelvis in patients with perforation peritonitis. The umbilical fascia was closed with 3-0 absorbable suture (vicryl, Ethicon). The port incisions were approximated with sterile adhesive strips.

Patients were either grouped as simple acute appendicitis (AA) or complicated/perforated appendicitis (APA), as per the hospital clinical pathway for management of acute appendicitis. Since there was ambiguity in the differentiation of acute suppurative appendicitis (ASA) with localised and/or pelvic pus pocketing, including appendicular mass from APA with peritonitis, we are at present prospectively studying these 3 groups (AA, ASA, APA) regarding the outcome of laparoscopic management.

Intravenous gentamicin and metronidazole was administered for AA for 24 hours or till afebrile, and intravenous ceftriaxone and metronidazole was given for APA/ASA till afebrile and continued on oral cephalexin and metronidazole later for a total antibiotic duration of 7 days. Analgesia was achieved with oral/rectal paracetamol for AA and intravenous morphine for APA/ASA for the first and second postoperative days overlapped with oral/rectal paracetamol. Oral feeds were started soon after the procedure for AA and after return of bowel activity for ASA/APA. The patients were discharged when afebrile and able to tolerate oral feeds.

## Results

Between September 2003 and February 2005, a total of 70 consecutive patients (37 males and 33 females) aged 3 to 15 years (mean,  $10.5 \pm 2.5$ ) with suspected appendicitis underwent LA. Twelve (17.1%) patients had AA, 25 (35.7%) had ASA adherent to the caecum with localised and/or pelvic pus pocketing including appendicular mass, 29 (41.4%) had APA with peritonitis and 4 (5.7%) had normal appendix [mesenteric adenitis (1), omental infarct (1), tortured Meckel's diverticulum (MD) (1) and primary peritonitis (1)]. There were no operative complications and none required conversion to open surgery (Table 1). Four patients underwent simultaneous laparoscopic assisted trans-umbilical Meckel's diverticulectomy (LATUM); 1 with perforated MD and secondary appendicitis, 1 with tortured MD and 2 with incidental narrow-based MD (Table 2). The operative duration ranged from 25 to 110 mins (mean,  $55.6 \pm 23.4$ ); 25 to 60 mins (mean,  $38 \pm 12$ ) for AA, 25 to 95 mins (mean,  $48 \pm 16.2$ ) for ASA and 35 to 110 mins (mean,  $74.5 \pm 20.8$ ) for APA. The hospital stay ranged from 1 to 14 days; 1 to 4 days (mean,  $2.1 \pm 0.9$ ) for AA, 2 to 7 days (mean,  $3.7 \pm 1.2$ ) for ASA and 3 to 14 days (mean,  $5.6 \pm 2.3$ ) for APA (Table 1). There were 2 complications; 1 had adhesive intestinal obstruction and underwent successful

Table 1. Laparoscopic Appendicectomy: Outcome at Different Stages

	AA	ASA	APA
No of patients (n = 70)	12 (17.1%)	25 (35.7%)	29 (41.4%)
Operative duration (min)	25-60 (38 ± 12)	25-95 (48 ± 16.2)	35-110 (74.5 ± 20.8)
Operative complications	Nil	Nil	Nil
Conversion to open surgery	Nil	Nil	Nil
Postoperative complications	Nil	Nil	2 (adhesive IO and umbilical wound infection)
Length of hospital stay (days)	1-4 (2.1 ± 0.9)	2-7 (3.7 ± 1.2)	3-14 (5.6 ± 2.3)

AA: acute appendicitis; ASA: acute suppurative appendicitis; APA: acute perforated appendicitis; IO: intestinal obstruction

laparoscopic adhesiolysis on the 7th postoperative day through the previous port incisions, and 1 had umbilical wound infection. There were no other complications during the follow-up period of 5 to 22 months (mean, 12.9 ± 5.2).

## Discussion

The unprecedented expansion of minimal access surgery in the 1990s has been described as the biggest unaudited free-for-all in the history of surgery.<sup>15</sup> Training and accreditation of surgeons are the key issues for the safe and ethical introduction of the new procedures.<sup>16</sup> Tests of knowledge, aptitude and psychomotor skills have been used to assess and select surgical trainees but none of these correlate well with the technical ability and the related aptitudes of spatial resolution and dexterity.<sup>17</sup> Surgeons trained in laparoscopic surgery are granted privileges by the accrediting professional bodies or the surgeon's own institution, according to the designated guidelines. The Society of American Gastrointestinal Endoscopic Surgeons<sup>18</sup> and the European Association of Endoscopic Surgeons<sup>19</sup> have published guidelines but do not specify numerical requirements for any procedure. Among institutions, there is a great variation in the number of procedures to be performed to achieve proficiency. It varies from 8 to 200 for cholecystectomy and 20 to 60 for fundoplication.<sup>20</sup> It is obvious that there are no clear guidelines regarding the definition of proficiency and this should be acknowledged with respect to the medico-legal issues.<sup>20</sup> Also, numerical achievement may cause logistic problems in low-volume specialties like paediatric surgery.

There is also considerable debate regarding the choice of surgery in which to train the residents in minimal access surgery. Laparoscopic cholecystectomy has emerged as the procedure of choice for symptomatic cholelithiasis and

Table 2. Operative Findings and Procedures Performed

Diagnosis	No. of cases (n = 70)	Procedure
AA/ASA/APA	66 (94.2%)	LA
Meckel's diverticulitis and secondary appendicitis	1	LATUM and LA
Torted Meckel's diverticulum	1	LATUM and LA
Incidental MD	2	LA and LATUM
Omental infarct	1	Partial omentectomy and LA
Primary peritonitis	1	Peritoneal lavage and LA
Mesenteric adenitis	1	LA
Postoperative adhesive IO	1	Laparoscopic adhesiolysis

AA: acute appendicitis; ASA: acute suppurative appendicitis; APA: acute perforated appendicitis; MD: Meckel's diverticulum; IO: intestinal obstruction; LA: laparoscopic appendicectomy; LATUM: laparoscopic assisted trans-umbilical Meckel's diverticulectomy

a model procedure for laparoscopic training for adult surgeons. LA represents a challenge for residency training and its impact on the residency environment has not been examined in detail.<sup>21,22</sup> It is presently at the efficacy stage of development, as most of the data on feasibility and safety originate from centres with special interest in minimal-access surgery. It is not yet considered a gold standard for acute appendicitis.<sup>16,21</sup> A wrongly perceived notion of longer learning curve, longer operative times, need for additional equipment and possibly, its performance as an emergency procedure during odd hours, have contributed towards the reluctance to accept LA as an ideal procedure for acute appendicitis. However, appendicitis, being one of the most common paediatric surgical entities, provides enough case material for a novice in laparoscopy to learn laparoscopic skills such as port insertions, camera manoeuvres, dissection, and handling of sutures.<sup>3</sup>

The surgical technique and selection of patients for LA varies among the centres. At our institute, laparoscopy is performed for all stages of appendicitis. We practice and advocate open Hasson's technique for umbilical port insertion and have not experienced any complications associated with the technique. The appendicular mesentery is routinely fulgurated with bipolar diathermy, but we have found that monopolar hook diathermy is useful especially in cases of retrocaecal appendicitis as well as appendicular mass. However, there is controversy regarding the application of laparoscopy for complicated appendicitis.<sup>5-14</sup> Our experience suggests that even under a trainee's hands, laparoscopy is quite safe for all stages of acute appendicitis. We lay more importance on thorough peritoneal lavage

and bowel walking from the ileocecal junction proximally to release inter-loop adhesions and drain the pus cavities. Closed suction drain is placed only in cases of appendicular perforation, although its efficacy is debatable. The only major complication we had was adhesive intestinal obstruction in a girl with perforated appendicitis, who underwent successful laparoscopic adhesiolysis. A salient and striking feature was that none of our patients needed conversion to open surgery.<sup>23</sup> However, it is also vital for surgeons and patients to appreciate that converting to an open operation is not a complication but instead, usually implies sound surgical judgment. In our experience, appendicular mass walled off by omentum and intestinal loops, along with fibrotic adhesions without pus collection, is the most technically demanding scenario, requiring more skills and patience.

Laparoscopy also provides a good four-quadrant view and detection of other causes of acute abdomen during exploration for suspected appendicitis.<sup>24,25</sup> This would aid in ascertaining the diagnosis and simultaneous management of those inciting lesions, and also planning incisions if conversion to open procedure is required.<sup>24,25</sup> Laparoscopic trans-umbilical Meckel's diverticulectomy with extra corporeal resection and hand-sewn anastomosis and partial omentectomy was performed successfully for concurrent lesions in our patients.

Our experience suggests that acute appendicitis provides enough case material for the laparoscopic training of surgical residents. Although techniques like intracorporeal knotting are not learnt, they can be mastered with time, with other procedures. However, laparoscopy in cases of suspected appendicitis is anytime challenging, as a myriad of conditions mimic appendicitis. The procedure is usually done as an emergency in odd hours, assisted by medical officers and lacks expert supervision. Also, the skills of the surgeon are frequently put to test, demanding innovation, as it is not a straightforward, well-described procedure due to the varied locations of the appendix along with the different stages of inflammation and associated complications. Nevertheless, LA is amenable for safe and effective resident training and has proven to be safe and effective for all stages of appendicitis. Our experience also proves that with considerable practice, other concurrent lesions encountered in cases of suspected appendicitis in children can be successfully treated with laparoscopic techniques.

#### REFERENCES

- Baker A. Laparoscopic appendectomy – a trainee's experience. *N Z Med J* 1999;112:208-11.
- Sefr R, Penka I, Olivero R, Jagos F, Munteanu A. The impact of laparoendoscopic surgery on the training of surgical residents. *Int Surg* 1995;80:358-60.
- Scott-Conner CE, Hall TJ, Anglin BL, Muakkassa FF. Laparoscopic appendectomy. Initial experience in a teaching program. *Ann Surg* 1992;215:660-8.
- Semm K. Endoscopic appendectomy. *Endoscopy* 1983;15:59-64.
- Horwitz JR, Custer MD, May BH, Mehall JR, Lally KP. Should laparoscopic appendectomy be avoided for complicated appendicitis in children? *J Pediatr Surg* 1997;32:1601-3.
- Alvarez C, Voitk AJ. The road to ambulatory laparoscopic management of perforated appendicitis. *Am J Surg* 2000;179:63-6.
- Katkhoua N, Friedlander MH, Grant SW, Achanta KK, Essani R, Paik P, et al. Intraabdominal abscess rate after laparoscopic appendectomy. *Am J Surg* 2000;180:456-61.
- Lintula H, Kokki H, Vanamo K, Antila P, Eskelinen M. Laparoscopy in children with complicated appendicitis. *J Pediatr Surg* 2002;37:1317-20.
- Little DC, Custer MD, May BH, Blalock SE, Cooney DR. Laparoscopic appendectomy: An unnecessary and expensive procedure in children? *J Pediatr Surg* 2002;37:310-7.
- Golub R, Siddiqui F, Pohl D. Laparoscopic versus open appendectomy: a metaanalysis. *J Am Coll Surg* 1998;186:545-53.
- Vegunta RK, Ali A, Wallace LJ, Switzer DM, Pearl RH. Laparoscopic appendectomy in children: technically feasible and safe in all stages of acute appendicitis. *Am Surg* 2004;70:198-202.
- Canty TG Sr, Collins D, Losasso B, Lynch F, Brown C. Laparoscopic appendectomy for simple and perforated appendicitis in children: the procedure of choice? *J Pediatr Surg* 2000;35:1582-5.
- Piskun G, Kozik D, Rajpal S, Shaftan G, Fogler R. Comparison of laparoscopic, open, and converted appendectomy for perforated appendicitis. *Surg Endosc* 2001;15:660-2.
- Ikeda H, Ishimaru Y, Takayasu H, Okamura K, Kisaki Y, Fujino J. Laparoscopic versus open appendectomy in children with uncomplicated and complicated appendicitis. *J Pediatr Surg* 2004;39:1680-5.
- Cuschieri A. Whither minimal access surgery: tribulations and expectations. *Am J Surg* 1995;169:9-19.
- Neugebauer E, Troidl H, Kum CK, Eypasch E, Miserez M, Paul A. The E.A.E.S. Consensus Development Conferences on laparoscopic cholecystectomy, appendectomy, and hernia repair. Consensus statements – September 1994. The Educational Committee of the European Association for Endoscopic Surgery. *Surg Endosc* 1995;9:550-63.
- Van Rij AM, McDonald JR, Pettigrew RA, Putterill MJ, Reddy CK, Wright JJ. Cusum as an aid to early assessment of the surgical trainee. *Br J Surg* 1995;82:1500-3.
- The Society of American Gastrointestinal Endoscopic Surgeons. Framework for post-residency training surgical education and training. *Surg Endosc* 1994;8:1137-42.
- Training and assessment of competence. *Surg Endosc* 1994;8:721-2.
- Dagash H, Chowdhury M, Pierro A. When can I be proficient in laparoscopic surgery? A systematic review of the evidence. *J Pediatr Surg* 2003;38:720-4.
- Duff SE, Dixon AR. Laparoscopic appendectomy: safe and useful for training. *Ann R Coll Surg Engl* 2000;82:388-91.
- Neal GE, McClintic EC, Williams JS. Experience with laparoscopic and open appendectomies in a surgical residency program. *Surg Laparosc Endosc* 1994;4:272-6.
- Palesty JA, Wang XJ, Rutland RC, Leighton J, Dudrick SJ, Benbrahim A. Fifty-five consecutive laparoscopic appendectomy procedures without conversion. *JLS* 2004;8:141-5.
- Prasad TR, Chui CH, Jacobsen AS. Laparoscopic resection of an axially torted Meckel's diverticulum in a 13-year-old. *J Laparoendosc Adv Surg Tech A* 2006;16:425-7.
- Prasad TR, Chui CH, Jacobsen AS. Laparoscopic-assisted resection of Meckel's diverticulum in children. *JLS* 2006;10:310-6.