Stepwise Approach to Laparoscopic Appendicectomy in Children

Anisha Sarkar · Joselito Tantoco · Chris Kimber ·
Yves Heloury · Peter Ferguson · Wei Cheng

Received: 31 July 2012 / Accepted: 17 January 2013 / Published online: 31 January 2013
© Association of Surgeons of India 2013

Abstract Traditionally, three ports are used in laparoscopic appendicectomy. However to reduce surgical incision and cost, it is feasible to remove the appendix using fewer ports. In this study, we compared the efficacy of stepwise and standard approach in laparoscopic appendicectomies in children. Between August 2008 and September 2010, 378 children with appendicitis were allotted to either the stepwise or standard laparoscopy group depending on the operating surgeon's preference. In the former group, an operating telescope was inserted first. The number of ports used was based on the pathology (stepwise approach). In the latter group, three ports were inserted in all patients (standard approach). The two groups were similar. In the stepwise group, we performed 95 single port (utilising a scope with an instrument channel), 37 two ports and 13 three ports appendicectomies. In the stepwise group, operating time was shorter (not yet statistically significant) and it reduced the port numbers by more than 50 %. The stepwise approach provides an evidence-based management of appendicitis with comparable outcomes. This procedure further reduces incision trauma, operating times and the cost of operation. However, the reduction of post-operative analgesic requirement needs further study.

Keywords Stepwise · Children · Appendicectomy · Standard · Laparoscopy

A. Sarkar
Southern Health, Melbourne, Australia

J. Tantoco · C. Kimber · Y. Heloury · P. Ferguson · W. Cheng
Department of Paediatric Surgery, Monash Medical Centre,
Melbourne, VIC, Australia

A. Sarkar (✉)
Level 5, Block E, 246 Clayton Road, Clayton,
Melbourne, VIC 3168, Australia
e-mail: keethi101@gmail.com

Introduction

Acute appendicitis is the most common intra-abdominal condition requiring emergency surgery in children [1]. Open appendicectomy has been the standard treatment for more than a century. In 1983, Kurt Semm introduced laparoscopic appendicectomy [2]. Valla and colleagues [3] reported the first series in children in 1991. The procedure has now become the preferred technique in many paediatric surgical centres. Laparoscopic appendicectomy using three ports is the standard approach; however, there are variations to this technique. Several reports advocate using fewer ports to further reduce the invasiveness of the procedure, improve cosmesis and reduce the cost [4–8].

We have adopted an evidence-based stepwise approach, whereby the number of ports used is determined by the location, mobility and pathology of the appendix. The result of the stepwise approach to laparoscopic appendicectomy is herewith compared with that of the standard approach within a given timeframe.

Materials and Methods

Appendicectomies performed between August 2008 and September 2010 at the Monash Medical Centre, Clayton, were reviewed. Ethics Committee approval had been obtained for the chart review. Informed written consents were also obtained from parents for all procedures. The study population included all children who underwent laparoscopic surgery with a diagnosis of appendicitis or suspected appendicitis. The diagnosis of appendicitis was based on a history of abdominal pain and persistent right lower quadrant tenderness. Equivocal cases underwent either serial physical examination or ultrasound examination of the abdomen. Patients were allotted to either the stepwise or

standard laparoscopic appendectomy group depending on the operating surgeon's preference. Children with significant abdominal distension, those requiring an open approach and those with contraindication to pneumoperitoneum were excluded from the study.

Standard general anaesthesia with endotracheal intubation was used. Intravenous antibiotics were given post-induction of anaesthesia. A combination of ampicillin, gentamicin and metronidazole or cephazolin and metronidazole were the antibiotics administered with its duration dependent on the operative findings. Twelve paediatric surgery consultants and registrars performed an average of 34 operations each (both stepwise and standard approach) for the purposes of this study. Each of them had previously performed at least 30 laparoscopic appendectomies in children and ensured that a standard operative technique and perioperative care was followed.

Open umbilical access and insertion of 10-mm port by Hasson technique was carried out. A '0' polysorb suture on a 3/4 needle was used to purse-string the fascia and anchor the port. A telescope was inserted to determine the positioning of the port placement. Once confirmed, pneumoperitoneum was created with a pressure limit set at 10–12 mmHg with a rate of 1–3 l/min.

In the stepwise group, an operating telescope was used. The instrument contained a 0° scope and a 5-mm instrument channel (Fig. 1). The decision to insert a second or third 5-mm disposable port was made after assessment of the location, mobility and integrity of the appendix. One-port technique was feasible for a non-friable appendix that could be mobilised to the umbilical port site. After assessing the pathology, the tip of the appendix was grasped and exteriorised through the umbilical orifice. Appendectomy was then performed as in an open procedure (Fig. 1). Additional ports were inserted when there were extensive adhesions, collections and difficulty in exposure of the pathology. Appendectomies were performed either intra- or extracorporeally.

In the standard approach, three ports were employed prior to any formal assessment of the pathology. Port

placement was determined by the position of the appendix following the principle of triangulation. Appendectomy was then performed entirely intracorporeally.

At the end of the procedure, 0.5 % Marcaine with adrenaline was infiltrated along the port sites. All appendices removed were sent for histopathology. Postoperatively, early mobilisation was encouraged. Antibiotics were given for 24 h for non-perforated appendicitis and 5 days for perforated appendicitis. The patients were discharged once tolerating normal oral diet, afebrile for 24 h and mobilising comfortably. Patients were followed up 4 weeks postoperatively.

Descriptive analysis, Student's *t* test and analysis of variance analysis were performed on the outcome criteria. $P < 0.05$ was considered to be statistically significant.

Results

A total of 404 children underwent appendectomy during the study period. Nineteen patients underwent an open procedure and were excluded from the study. Seven children who were initiated with the standard procedure were later converted to open and were also excluded from this study. Overall, there were 35 complications. There was no mortality in either group.

Complications were recorded in eight patients of the stepwise group and in 23 cases following the standard approach. Collectively, these included five port site infections, ten post-operative intra-abdominal collections, three early adhesive bowel obstructions, four cases of prolonged post-operative ileus, four intra-abdominal abscesses, one stump appendicitis requiring an open surgical approach and one sepsis case of unknown aetiology requiring intensive care treatment (Table 1). The two groups were comparable in age, sex, perforation rate, normal appendix rate, hospital stay and complication rates (Table 2).

Of the stepwise group, 95 underwent one-port, 37 underwent two-port and 13 underwent three-port appendectomy.

Fig. 1 One-port technique

Table 1 Complications

Complications	Stepwise N=8	Standard N=23
Port site infection	2	3
Post-operative intra-abdominal collection	3	7
Adhesive bowel obstruction	1	2
Prolonged post-operative ileus	1	3
Intraabdominal abscess	1	2
Other	0	5 ^a

^a Stump appendicitis requiring open approach=1, post-operative ICU admission due to unknown sepsis=1, readmission for post-operative pain=3

Table 2 Stepwise versus standard group

	Stepwise N=145	Standard N=233	Student's <i>t</i> test Stepwise versus standard
Age (years)	7.67	12.00	ns
Sex (M/F) ratio	1.50	1.26	ns
Perforation rate	27.6 %	28.3 %	ns
Negative appendicectomy rate	9.7 %	4.7 %	ns
Operating time (min)	50.80	64.79	ns
Complications	5.5 %	10.3 %	ns
Hospital stay (days)	3.00	2.97	ns
Number of ports/patient	1.4	3.0	<i>P</i> =0.03

ns not statistically significant

Subgroup analysis in the stepwise group showed 16.8 % of the one-port subgroup, 48.6 % of the two-port subgroup and 76.9 % of the three-port subgroup had appendicitis with perforation and soiling. The overall operating time for the stepwise and the standard groups showed minimal difference (50.80 and 64.79 min, respectively).

Subgroup analysis of the operating time for the stepwise group showed that it took 42.02 min to complete a one-port procedure, 61.50 min for a two-port procedure and 68.92 min for a three-port procedure.

The stepwise approach used 208 ports/145 patients. In the standard group, 699 ports/233 patients were used. If the stepwise group of patients undergo laparoscopic appendectomy using the standard approach, i.e. three ports per patient, a total of 435 ports/145 patients would have been used. Instead, the 145 patients successfully used 227 less ports as a result of this new technique, resulting in *P*=0.03 (Table 2).

Discussion

This study demonstrates a modified approach to laparoscopic appendectomy. The number of ports used depends on the complexity of the surgery. Our data indicate that the results of conventional three-port approach and the stepwise approach to appendicectomy were comparable.

The only statistically significant difference between the two groups was the number of ports used. Stepwise approach provides equitable treatment of appendicitis without compromising the safety of patients [9]. The decision of additional port placement was determined by perceived difficulty of the procedure [10, 11]. In those who underwent appendicectomy with one or two ports, there was theoretically less surgical trauma and less scarring, although a larger cohort is required to demonstrate the benefits. Last, but not least, stepwise approach reduces the number of ports used by more than 50 %. Given that appendicectomy is one of the

most frequently performed surgical procedures, this can translate into a sizeable saving on the national base. Admittedly, it requires an initial investment of an operating scope [12].

Based on our initial experience, we have developed an algorithm of decision making (Fig. 2). One-port technique is feasible for a mobile and non-friable appendix that can reach the umbilical port site. To assess for mobility, the tip of the appendix is grasped and pulled towards the gallbladder. If this is possible, most of the appendix can then be exteriorised through the umbilical orifice. Appendicectomy is then performed as in an open procedure. A second port is inserted when there are adhesions limiting the mobility of the appendix [10]. Often, this port is inserted on the left iliac fossa, medial and inferior to the anterior superior iliac spine. Using this technique, the appendix can either be exteriorised through the umbilical port site and removed as in open procedure or intracorporeally as in the standard laparoscopic approach. A third port (second 5-mm disposable) is inserted in advanced cases of appendicitis when exposure, dissection and peritoneal wash are anticipated to be a challenge after laparoscopic confirmation of the pathology. The procedure is then performed as in standard laparoscopic appendicectomy.

Admittedly, our pilot study was not randomised. The patient selection was based on the surgeons' preferences and level of experience. This does not exclude bias and we acknowledge this. The sample size was small. The time required to return to normal activities and post-operative analgesic requirements warrant further studies. The stepwise technique is relatively easy to adopt and poses little technical difficulty to those who are used to three-port approach.

Conclusion

Stepwise approach of laparoscopic appendicectomy provides evidence-based management of appendicitis. It

Fig. 2 Stepwise approach. The number of ports used depended on perceived difficulty of the operation. Additional ports were inserted when the surgeon encounters difficulty in mobilising the appendix

optimises the use of resources, offers flexibility and minimises trauma without compromising the safety of the patients. There is a potential for significant cost savings, shorter operating times and use of fewer ports.

References

1. Addiss DG, Shaffer N, Fowler BS, Tauxe RV (1990) The epidemiology of appendicitis and appendectomy in the United States. *Am J Epidemiol* 132:910–925
2. Semm K (1983) Endoscopic appendectomy. *Endoscopy* 15:59–64
3. Valla JS, Limonne B, Valla V, Montupet P, Daoud N, Grinda A et al (1991) Laparoscopic appendectomy in children: report of 465 cases. *Surg Laparosc Endosc* 1:166–172
4. Roberts KE (2009) True single port appendectomy: first experience with the “puppeteer technique”. *Surg Endosc* 23:1825–1830
5. Hong TH, Kim HL, Lee YS, Kim JJ, Lee KH, You YK et al (2009) Transumbilical single port laparoscopic appendectomy (TUSPLA): scarless intracorporeal appendectomy. *J Laparoendosc Adv Surg Tech A* 19:75–78
6. Nguyen NT, Reavis KM, Hinojosa MW, Smith BR, Stamos MJ (2009) A single port technique for laparoscopic extended stapled appendectomy. *Surg Innov* 16:78–81
7. Merchant AM, Cook MW, White BC, Davis SS, Sweeney JF, Lin E (2009) Transumbilical Gelport access technique for performing single incision laparoscopic surgery (SILS). *J Gastrointest Surg* 13:159–162
8. Schier F (1998) Laparoscopic appendectomy with 1.7 mm instruments. *Pediatr Surg Int* 14:142–143
9. Stanfill AB, Matilsky DK, Kalvakuri K, Pearl RH, Wallace LJ, Vegunta RK (2010) Transumbilical laparoscopically assisted appendectomy: an alternative minimally invasive technique in paediatric patients. *J Laproendosc Adv Surg Tech A* 20:873–876
10. Sesia SB, Frech M, Hacker FM, Mayr J (2011) Laparoscopic “single-port” appendectomy in children. *Zentralbl Chir* 136:50–55
11. Gauderer MW (2007) An individualized approach to appendectomy in children based on anatomico-laparoscopic findings. *Am Surg* 73:814–817
12. Lee YS, Kim JH, Moon EJ, Kim JJ, Lee KH, Oh SJ et al (2009) Comparative study on surgical outcomes and operative costs of transumbilical single-port laparoscopic appendectomy versus conventional laparoscopic appendectomy in adult patients. *Surg Laprosc Endosc Percutan Tech* 19:493–496