Original Article

Perforated Appendicitis in Children: Benefits of Early Laparoscopic Surgery

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Abstract

Introduction: The aim of this study was to analyse the feasibility, safety and benefits of laparoscopic appendicectomy (LA) in comparison with open appendicectomy (OA) for perforated appendicitis (PA) in children. Materials and Methods: A retrospective analysis of all consecutive cases of PA who underwent OA or LA between July 2001 and April 2004 was done. The patient demographics, duration of symptoms and operative findings were noted and the feasibility, safety and benefits of LA were analysed with respect to postoperative recovery and complications. Results: One hundred and thirty-seven consecutive patients with PA underwent either OA (n = 46) or LA (n = 91). Both groups were comparable with respect to patient demographics, duration of symptoms and operative findings. The mean operative time was 106.5 min (95% CI, 100.2 - 112.8) in the LA group and 92.8 min (95% CI, 82.9-102.7) in the OA group (*P* = 0.02). The return to afebrile status after surgery was significantly faster in the LA group [mean, 45.4 hours (95% CI, 36.8-54)] than the OA group [mean, 77 hours (95% CI 56.7-97.3)] (*P* = 0.007). The mean duration for postoperative opioid analgesia was 2.5 days (95% CI, 2.2-2.7) for LA and 3.2 days (95% CI, 2.9- 3.6) for OA (*P* = 0.001). The resumption of oral feeds after surgery was at 3.1 days (95% CI, 2.8-3.3) for LA and 3.7 days (3.4-4.1) for OA (*P* = 0.005). The length of the hospital stay was shorter in the LA group [mean, 6.5 days (95% CI, 6.1-6.8)] as compared to that of the OA group [mean, 8.2 days (95% CI, 7.1-9.3)] (*P* = 0.006). Postoperative complications included wound infection, adhesive intestinal obstruction and pelvic abscess formation. The incidence of these complications was 5.6% in the LA group and 19.6% in the OA group (*P* = 0.01). Nine patients (9.8%) needed conversion to open surgery in the LA group. None of the LA patients had wound infection. Conclusion: LA is feasible, safe and beneficial in children with PA.

Ann Acad Med Singapore 2007;36:277-80

Key words: Appendicitis, Complications, Treatment

Introduction

Despite perforated appendicitis (PA) being a common surgical emergency in childhood, controversy still exists with regard to its management in this era of minimal access surgery. Open appendicectomy (OA) has been accepted as the standard procedure for PA. However, OA has been associated with prolonged hospitalisation and significant complications such as wound infection, intra-abdominal abscess and adhesive intestinal obstruction. With the advent of minimally invasive surgery, laparoscopic appendicectomy (LA) has been routine for simple appendicitis in many centers. However, the role of laparoscopic approach for PA in children is still debatable. We retrospectively reviewed our results in the application of LA and OA for PA and analysed the feasibility, safety and benefits of LA.

Materials and Methods

A retrospective analysis of consecutive cases of PA that were treated at our institute between June 2001 and April 2004 was performed. Patients with PA had been routinely offered early surgery as soon as their general condition had stabilised. PA was defined as appendiceal perforation with localised or generalised peritonitis or abscess formation. The diagnosis was confirmed intra-operatively and on histopathology. Patients with immunosuppressive disorders or age below 3 years were excluded from this review. The

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segregation of patients into LA and OA groups was according to the procedure performed. OA and LA were performed by trained as well as trainee paediatric general surgeons. The choice of the procedure was dependent on the familiarity with the procedure than the seniority of the surgeon. Patient demographics, operative findings, duration of surgery and operative techniques were recorded and the details of the postoperative recovery in terms of duration to attain afebrile status (axillary temperature ≤37.5ºC for 24 hours), resumption of oral feeds, duration of antibiotics, length of hospitalisation and postoperative complications were analysed.

OA was performed through right lower quadrant Lanz or gridiron incisions. It was our routine practice to perform thorough peritoneal lavage, walk-through of the bowel to release inter-loop adhesions and pus pockets and to place an intraperitoneal drain. LA was performed through 3 ports. 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 to12 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 cauterised 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. The small bowel was walked from the ileocecal junction proximally, with atraumatic graspers releasing all inter-loop adhesions and draining pus cavities. The peritoneal cavity was lavaged with warm normal saline and closed suction drain (Jackson Pratt) was placed in all patients with PA.

Intravenous antibiotics (ceftriaxone and metronidazole) were administered until the resolution of fever and converted to oral cephalexin and metronidazole for a total antibiotic duration of about 1 week. Analgesia was provided by intravenous morphine infusion and rectal or oral paracetamol. Oral feeds were started with resumption of bowel activity. The patients were discharged when afebrile and were able to tolerate regular diet. They were followed up in the outpatient clinic at least once after their discharge from the hospital.

Analyses were performed with the use of SPSS for Windows (version 14.0). Comparisons between the LA and OA groups were done with the use of Pearson Chi-square test for categorical variables and two-sample *t*-test for continuous variable. $P < 0.05$ was considered statistically significant.

Results

One hundred and thirty-seven consecutive children (81 males and 56 females) with a mean age of 9.3 years presented with PA. Ninety-one patients (52 males and 39 females) underwent LA while 46 (28 males and 18 females) underwent OA. The number of patients who underwent OA was less because with experience and familiarity with the laparoscopic techniques more surgeons opted to perform LA. Both groups were comparable in terms of patient demographics, duration of symptoms and operative findings (Table 1).

The operative duration was significantly longer for LA [mean, 106.5 min (95% CI, 100.2-112.8)] when compared with OA [mean, 92.8 min (95% CI, 82.9-102.7)] ($P = 0.02$). The return to afebrile status after surgery was significantly faster in the LA group [mean, 45.4 hours (95% CI, 36.7-54)] than that of the OA group [mean, 77 hours (95% CI, 56.7-97.3)] ($P = 0.007$). The mean duration for postoperative opioid analgesia was 2.5 days (95% CI, 2.2-2.7) for LA versus 3.2 days (95% CI, 2.9-3.6) for OA ($P = 0.001$). The

Table 1. Comparison of Demographic Data and Operative Findings

	LA (n = 91)	**OA (n = 46)**
Male:Female	52:39	28:18
Age (y) [mean, (95% CI)]	9.6 (9-10.3)	8.7 (7.9-9.4)
Duration of symptoms (days) [mean, (95% CI)]	2.4 (2.1-2.8)	3.7 (2.8-4.5)
Localised peritonitis	48 (52.7%)	29 (63%)
Generalised peritonitis	43 (47.3%)	17 (37%)
Inflamed small bowel	50 (54.9%)	15 (32.6%)

LA: laparoscopic appendicectomy; OA: open appendicectomy

Table 2. Comparison of Operative Time and Postoperative Course Between LA and OA

	LA (n = 91) [mean, (95% CI)]	**OA (n = 46) [mean, (95% CI)]**	***P***
Operative time (min)	106.5 (100.2-112.8)	92.8 (82.9-102.7)	0.02
Attainment of afebrile status (h)	45.4 (36.8-54)	77 (56.7-97.3)	0.007
Opioid analgesia (days)	2.5 (2.2-2.7)	3.2 (2.9-3.6)	0.001
Oral feeding (days)	3.1 (2.8-3.3)	3.7 (3.4-4.1)	0.005
Duration of antibiotics (days)	6.5 (6.2-6.8)	7.4 (6.7-8.1)	0.017
Length of hospital stay (days)	6.5 (6.1-6.8)	8.2 (7.1-9.3)	0.006
Complications [n (%)]	5 (5.6)	9 (19.6)	0.01
Wound infection	0	5 (10.8)	
Intra-abdominal abscess	2 (2.4)	2 (4.3)	
Intestinal obstruction	3 (3.2)	1 (2.2)	
Lung consolidation	0	1 (2.2)	

95% CI: 95% confidence interval; LA: laparoscopic appendicectomy; OA: open appendicectomy

resumption of oral feeds after surgery was at 3.1 days (95% CI, 2.8-3.3) for LA versus 3.7 days (95% CI, 3.4-4.1) for OA ($P = 0.005$). The length of the hospital stay was shorter in the LA group [mean, 6.5 days (95% CI, 6.1-6.8)] than in the OA [mean, 8.2 days (95% CI, 7.1-9.3)] ($P = 0.006$) (Table 2). The duration of postoperative antibiotic used was also noted to be shorter in the LA group [mean, 6.5 days (95% CI, 6.2-6.8)] than in the OA group [7.4 days (95%CI, 6.7-8.1)] ($P = 0.017$). Postoperative complications included wound infection, adhesive obstruction and pelvic abscess formation. The incidence of these complications was 5.6% in the LA group and 19.6% in the OA group ($P = 0.01$). Nine patients (9.8%) in the LA group needed conversion to open appendectomy. Two (4.3%) patients in the OA group had intra-abdominal abscesses and underwent laparotomy with drainage of abscesses on 10th and 11th postoperative days, respectively. One (2.2%) patient who underwent OA, developed adhesive intestinal obstruction and underwent laparotomy and adhesiolysis on the 8th postoperative day. In the LA group, 3 (3.2%) patients developed adhesive intestinal obstruction within the first week of their operations. All underwent successful laparoscopic adhesiolysis. Two (2.4%) patients had intra-abdominal abscesses and underwent CT-guided drainage of the abscess. Five patients (10.8%) of the OA group had postoperative wound infection while none were found in the LA group. There was no mortality in either group.

Discussion

LA has emerged as a safe alternative in the treatment of acute appendicitis in children. However, its application in PA is contentious.[1-18] LA in PA has been reported to offer increased safety, shorter duration of hospitalisation, less pain and quicker return to normal activity with fewer complications.[1-7] Conversely, no significant benefits of LA with respect to operative time, duration of recovery, complications and cost has been reported.[8-11] In fact, LA in PA has been reported to be associated with higher risks of postoperative intra-abdominal abscess formation, bleeding and visceral injuries.[12-14] As a result, some surgeons have encountered higher conversion rate with laparoscopic surgery for advanced appendicitis.[15] Besides these, increased postoperative complications following conversion from LA to OA have also been reported.[16] However, conversion to open surgery in some cases of PA is experience and circumstance dependent and it usually implies a sound surgical judgement than a complication.[17] In our series, the indications for conversion were varied and dependent on the surgeon's ability and experience, which improved over the course of the study period. In some cases, we made use of the panoramic benefits of the laparoscope to perform a thorough lavage before conversion and these should be better classified as laparoscopic-assisted rather than failed laparoscopic procedures. The small number of patients that were converted to OA from LA did not allow for a meaningful comparison in this study.

Our results have indicated the feasibility and efficacy of LA in PA. Although the operative time for LA was significantly higher than that for OA, the gap has shortened with familiarity of the procedure. The benefits of LA in PA were more obvious in the postoperative recovery. The duration of postoperative fever was significantly shorter in the LA group when compared to the OA group. This is an objective factor that reflects the benefit of LA over OA. The length of hospitalisation was significantly shorter in the LA group. We believe this is related to the faster resolution of postoperative fever, less pain, early resumption of oral feeds, quicker ambulation and fewer complications. The absence of wound infection in the LA group can be considered a major advantage, as they are prone to wound complications. When intra-abdominal abscesses and adhesive intestinal obstruction occurred, percutaneous drainage techniques and laparoscopic adhesiolysis were effective in managing these complications with quick recovery.

Limited space in the peritoneal cavity of children, accompanied by bowel distension, may pose challenges to the surgeon. In the hands of an experienced laparoscopic surgeon, the LA technique not only provides a panoramic view with increased magnification, it also has the ability to visualise hidden corners, therefore allowing better quantification of peritonitis and clearance of purulent material as compared to the open technique. We believe that the routine thorough irrigation with walking of bowel may have prevented the formation of inter-loop abscesses.

Our study has inherent limitations of a retrospective study, lack of randomisation and possible observer bias. Nevertheless, LA was found to be safe and effective with a steep learning curve among the trainee laparoscopic surgeons.[3] Our results indicate that early LA is beneficial in children with PA. In the presence of relevant expertise, we recommend early LA as an armamentarium for PA in children.

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