

Original Article

Laparoscopic Appendectomy for Complicated Appendicitis in Children: A Retrospective Study

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Abstract

Aim: The operation of appendectomy is being performed by both open and laparoscopic methods due to a lack of consensus on the selection of an appropriate method. This study aimed to compare the outcomes of two operations for complicated appendicitis in children. **Methods:** We collected and analysed the records of 1,008 children who were diagnosed complicated appendicitis and subsequently underwent either laparoscopic (LA) (472 cases in LA group) or open appendectomies (OA) (536 cases in OA group) from January 2010 to December 2016. The outcomes including operative time, wound infection, postoperative intra-abdominal abscess and surgical cost in two groups were compared. **Results:** There was no mortality recorded in all cases and 24 cases need the conversion from laparoscopic appendectomy to open appendectomies. Compared to OA group, laparoscopic appendectomy was associated with lower incidence of wound infection, higher postoperative intra-abdominal abscess formation, shorter hospital stay, but with similar operative time and similar cost of hospital stay. **Conclusions:** The laparoscopic appendectomy technique is a safe and effective operative procedure for the complicated appendicitis in children.

Key words

Appendectomy; Children; Complicated appendicitis; Laparoscopy

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Introduction

Open appendectomy (OA) has been conventionally performed for treating acute appendicitis, a common surgical emergency in children. Metastatic right lower abdominal pain is the most typical clinical manifestation of acute appendicitis. Obstruction of the appendix cavity is the main cause of perforated appendix. Laparoscopic appendectomy (LA) was first performed by Semm in 1983.¹ LA has become increasingly popular due to its better clinical outcomes, such as reduced length of hospital stay, lower incidence of wound infection, faster return to normal activities, shorter postoperative ileus, less postoperative pain and better cosmetic results.²⁻⁴ However, there is no

consensus on adopting LA to treat complicated appendicitis of children patients. Moreover, recent studies indicated several disadvantages of LA such as longer operating time, higher risk of intra-abdominal collection and more cost compared to OA.^{5,6} Therefore, in this study we collected a large scale of 1,008 children with complicated appendicitis between January 2010 and December 2016 and compared the outcomes of laparoscopic versus open appendectomy.

Subjects and Methods

Subjects

This study was approved by Institute Ethics Committee and all parents of the children provided written informed consent. Based on the operation records of pediatrics patients from January 2010 to December 2016 with clinical diagnosis of acute complicated appendicitis based on the criteria of perforation of the appendix, empyema or abscess formation, and finally faecal peritonitis, the patients selected in this study presented following symptoms: right lower quadrant pain with fever; imaging showed appendiceal wall thickening and luminal enlargement, with or without surrounding fluid; and the patients were confirmed by the operation and pathological diagnosis. Following patients were excluded, 1) older than 14 years old; 2) >1-week hospital stay; 3) previous history of open abdominal or pelvic operations; and 4) concurrent bowel resection in addition to appendectomy. Total 1,008 patients with complicated appendicitis were finally enrolled and their average age was 5.6 years old (range 15 months old to 14 years old). Among them, 472 underwent laparoscopic appendectomy and 536 had open appendectomy.

Operations

Open and laparoscopic appendectomies were performed by experienced surgeons. Under general anesthesia, OA was performed using standard techniques of operative surgery. LA was performed with a 3-trocar technique. Dissection and mobilisation of the appendix was performed with pretied suture loops, the retrieval of the resected appendix was performed through the umbilical port, the appendix was extracted using a disposable specimen retrieval bag through the largest port site, and the appendix was sent for histological examination. After operation, all patients received antibiotic therapy with antibiotic regimen as cephalosporin (dosage 50 mg/kg/die) and metronidazole (dosage 7.5 mg/kg/8 h) for 7 days. In case of cephalosporin allergy, ciprofloxacin (dosage 15 mg/kg/12 h) was used.

Statistical Analysis

The operative time, intraabdominal collection, Trocar wound infection, length of hospital stay and cost of hospital stay and the conversion from LA to OA were recorded for analysis. The statistical package for social sciences (SPSS version 13.0) was used to analyse the data. A two-tailed test with P value <0.05 was considered to be statistically significant.

Results

Table 1 summarised the general data of the patients in both LA and OP groups with regard to age, gender, weight, type of pathology and medical insurance. There were no significant differences between both groups.

Among the 1,008 children patients, there was no

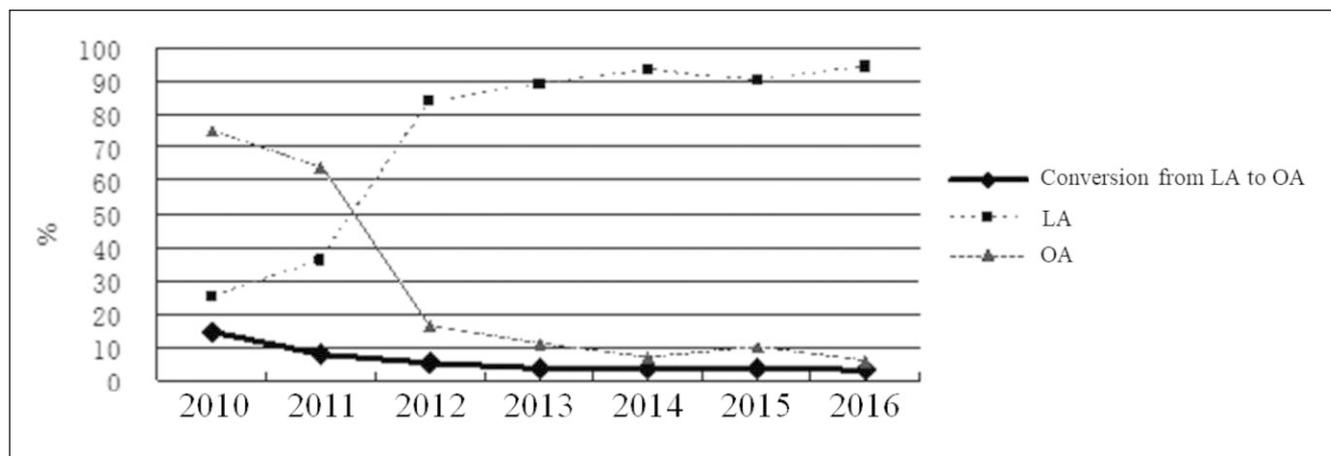


Figure 1 Patient profiles from 2010 to 2016. LA, laparoscopic appendectomy; OA, open appendectomy; conversion, from LA to OA.

mortality in either group. 472 underwent LA and 536 had OA with some conversions from LA group to OA group. As shown in Figure 1, LA was increasingly performed for patients since the medical insurance was employed in 2006. The percentage of conversions from LA to OA continuously decreased from the highest rate of 14.5% in 2010 to the lowest rate of 3.3% in 2016. There were 24 conversions in the LA group for technical difficulties including 11 cases of dense ileocecal adhesion, 6 cases of retrocecal appendix, 4 cases of gangrenous appendicitis, 2 cases of subcutaneous emphysema, and 1 case of iatrogenic appendicular artery injury.

Compared to OA group, laparoscopic appendectomy was associated with lower incidence of wound infection (6.1% vs. 11.9%, $P=0.001$), higher postoperative intra-abdominal abscess formation (7.4% vs. 3.7%, $P=0.011$), shorter hospital stay (4.6 ± 1.7 day vs. 8.1 ± 1.3 day, $P=0.002$), similar operative time (54 ± 12 min vs. 53 ± 14 min, $P=0.226$), and similar cost ($7,305\pm 426$ Chinese yuan vs. $7,255\pm 435$ Chinese yuan, $P=0.066$) (Table 2).

Discussion

LA operation has a number of advantages such as small wound, quick recovery, low incidence of postoperative wound infection and short length of hospital stay. However, several disadvantages of LA include longer operating time,

higher risk of intra-abdominal collection and more expensive hospital stay. In our study, we observed no significant difference in operation time between LA group and OA group, which is not consistent with the observation reported previously.^{5,6} We think that the operating time is highly determined by the surgeons' technical skills, experiences and the available surgery equipment. It takes some training procedure to keep up with LA operative skills. In our experience, the operating time is reduced with the improvement of LA techniques and the surgeons' technical skills.

Although the cost of hospital stay is slightly higher in LA group than in OA group, no significant difference was observed. LA has been increasingly adopted in treating complicated appendicitis and the cost has been decreasing because the frequency of postoperative wound infection decreases, the use of antibiotics is reduced, and the recovery of patients is quick. Especially, LA has a significant advantage in optimising the use of society resources and economics because the patients in LA group have shorter length of hospital stay to allow more treatments to be applied to other patients.⁶

There were two aspects causing 24 conversion cases in LA group, i.e. high complication of appendicitis and inadequate operating skills. It is very difficulty to reveal the appendix due to local dense ileocecal adhesion, appendix location and perforated appendix. To tackle such difficulties, we should remove the omentum and small

Table 1 Patient demographics

Group	No.	Age (year)	Gender (male)	Weight (kg)	Medical insurance	Type of pathology		
						Gangrene	Perforation	Abscess
LA	472	4.3±1.2	150	22±7	182	46	353	73
OA	536	4.5±1.3	212	23±7	215	55	409	72
T/ χ^2		-1.954	1.507	-1.584	2.543		2.223	
P		0.051	0.220	0.114	0.111		0.328	

Table 2 Comparison of the outcomes of LA and OA groups

Group	Intra-abdominal collection	Wound infection	Operative time (min)	Hospital stay (day)	Cost of hospital stay (RMB)
LA (n=472)	35	29	54±12	4.6±1.7	7,305±426
OA (n=536)	20	64	53±14	8.1±1.3	7,255±435
χ^2	6.518	10.200	1.211	8.322	1.841
P	0.011	0.001	0.226	0.002	0.066

intestine to expose the target region, precisely detach the adhesion with appropriate inclusion of ileocecal or side peritoneal and prevent unnecessary damage without touching the weak tissue. In addition, we may add one more Trocar for further assistance if necessary. With the improvement of operative techniques and skills the conversion rate would decrease largely from 14.5% at the early stage to 3.3% at present.

The intra-abdominal collection is a common postoperative complication which can severely delay the recovery of patients. It may extend the length of hospital stay and the use of antibiotics and, in serious cases, require re-admission in the hospital to receive additional operations. Billingham et al reported less intra-abdominal collection as postoperative complication in LA group than in OA group.⁷ However, other studies found no apparent difference in intra-abdominal collection as postoperative complication between LA and OA groups.^{8,9} Furthermore, LA enhanced the frequency of intra-abdominal collection compared to OA.¹⁰ In this study, we found that postoperative intra-abdominal abscess formation was 7.4% for LA and 3.7% for OA. Currently, the mechanism of intra-abdominal collection has not been fully understood. Bloechle et al induced gastric ulceration in rats by instillation of ethanol followed by gastrotomy to simulate perforation. Gas insufflation into the abdominal cavity increased the abdominal pressure and caused turbulence due to the constant gas flow.¹¹ Thus the extent and severity of peritonitis may be perpetuated by dissemination of contaminated risk for patients treated laparoscopically. Polat et al investigated the effect of different intra-abdominal pressure on bacterial translocation and suggested that patients should be closely monitored for septic complication risk following laparoscopic procedure in which the intra-abdominal pressure exceeded 20 mmHg.¹² Gupta et al showed that intra-abdominal abscess formation after LA may be affected by aggressive manipulation of the infected appendix and increased use of irrigation fluid.¹³ The formation of the intra-abdominal collection is also related to the surgeon's practice, cognitive skill and clinical techniques.¹⁴ Reid et al identified the risk factors for the development of post-appendectomy intra-abdominal abscess.¹⁵

The inflamed tissue inside the abdomen is the underlying pathology of intra-abdominal abscess. In our study, intra-abdominal abscess usually occurs near the infected area of the appendix and most commonly in the removed appendix and the bottom of the *cavitas pelvis*.

Therefore, the formation of the intra-abdominal collection is likely related to the inflamed tissue and flowing fluid from the free end of the appendix. To reduce the risk of the intra-abdominal abscess, we suggest: 1) to standardise the operation procedure of LA; 2) to improve clinical practices and training for the surgical residents and surgeons so as to reduce the impact of learning curves;¹⁶ 3) to reduce the abdominal pressure during the operation; 4) to drain completely the fluid accumulated in the abdomen to avoid same body posture for long time; 5) to optimise the timing of intervention and operative technique which includes four abdominal quadrants copious irrigation;¹⁷ 6) to extract the appendiceal faecalith in a whole without breaking them;¹⁸ 7) to effectively adopt antibiotic treatment.¹⁹

Compared to conventional technique, laparoscopic appendectomy may potentially provide better abdominal exploration to facilitate thorough irrigation of abdominal cavity. There is inconsistent literature evidence that LA may lead to higher risk of postoperative intra-abdominal abscess. Further improvement on LA surgery may decrease the incidence of intra-abdominal abscess formation and further studies are warranted.

Our study has several limitations. We could not exclude the bias and the preference of the surgeons since we only retrospectively reviewed the patients in a single institute in our hospital. Despite these limitations, our study suggests that laparoscopic appendectomy technique is a safe and effective operative procedure for complicated appendicitis in children.

Conflict of Interest

The authors declare no conflict of interest.

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