

## Original Research Article

# Laparoscopic versus open appendectomy in children with complicated appendicitis in a tertiary teaching hospital

Pramod Sreekantamurthy<sup>1\*</sup>, Bhavana Chinmayee<sup>2</sup>, Sharath<sup>2</sup>

<sup>1</sup>Department of Paediatric Surgery, <sup>2</sup>Department of Surgery, Kempegowda Institute of Medical Sciences and Research Institute, Bangalore, Karnataka, India

**Received:** 30 March 2020

**Accepted:** 28 April 2020

### \*Correspondence:

Dr. Pramod Sreekantamurthy,  
E-mail: [pramodbmc76@gmail.com](mailto:pramodbmc76@gmail.com)

**Copyright:** © the author(s), publisher and licensee Medip Academy. This is an open-access article distributed under the terms of the Creative Commons Attribution Non-Commercial License, which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

## ABSTRACT

**Background:** Acute appendicitis in children is the most common surgical emergency. Good outcomes have been reported with laparoscopic appendectomy (LA) in children for uncomplicated appendicitis. But the use of laparoscopy for complicated appendicitis in children is more controversial. Higher incidences of postoperative abdominal and wound infections have been reported. The purpose of this study was to retrospectively compare LA and open appendectomy (OA) for complicated appendicitis in children.

**Methods:** The outcome of 73 patients with complicated appendicitis was retrospectively analyzed. There were 36 children in the LA group and 37 in the OA group. Data collection included demographics, duration of symptoms, type of complicated appendicitis, operative time, resumption of diet, early and late complication, length of hospitalization and duration of antibiotic use.

**Results:** No significant difference was found with respect to age, duration of symptoms and total leucocyte count between two groups. The operative time for LA ( $55.83 \pm 4.81$  minutes for LA versus  $67.16 \pm 4.27$  minutes for OA;  $p=0.0001$ ) was shorter. Patients in the LA group returned to oral intake earlier ( $2.83 \pm 0.31$  days for LA versus  $3.84 \pm 0.33$  days for OA;  $p=0.001$ ) and had a shorter length of hospital stay ( $5.11 \pm 0.55$  days for LA versus  $7.92 \pm 1.06$  days for OA;  $p=0.0001$ ). The incidence of wound infection in group LA was 5.5% compared to 18.9% in OA group.

**Conclusions:** The laparoscopic technique for complicated appendicitis in children is feasible, safe. Laparoscopic appendectomy should be the initial procedure of choice for most cases of complicated appendicitis in children.

**Keywords:** Complicated appendicitis, Laparoscopic appendectomy, Open appendectomy, Wound infection

## INTRODUCTION

Acute appendicitis in children is the most common surgical emergency. Its incidence peaks between the ages of 11 and 12 years, and it has a lifetime risk of 7-9%.<sup>1</sup> Children experience the greatest risk of disease, and incidence among children is 4 times greater than the overall population.

Appendicitis is often categorized as uncomplicated (early, inflamed, simple) or complicated (gangrenous, perforated appendicitis with abscess/phlegmon or

perforated appendicitis without abscess/phlegmon). Complicated appendicitis is found in up to 30% of patients treated operatively and represents a particularly resource-intensive condition.<sup>2</sup>

Children with complicated appendicitis have a longer length of stay (LOS), greater hospital cost, and higher risk of subsequent hospital visits compared with those with uncomplicated disease. Despite significant advancements in the diagnostic evaluation of children with suspected appendicitis during the past few decades, the rates of complicated appendicitis have remained unchanged.<sup>3</sup>

Since the first laparoscopic surgery for appendicitis in 1983, it has been established as the gold standard surgery for simple appendicitis. There are several hypothetical advantages for laparoscopic approach in complicated appendicitis. It facilitates evaluation of the entire abdominal space, diminishes the operative trauma and meticulous peritoneal lavage. The role of laparoscopic surgery in the treatment of complicated appendicitis has been more controversial.<sup>4</sup> Compared with open appendectomy (OA), laparoscopic appendectomy (LA) needs higher technical skills, longer operative time and is associated with a higher incidence of intra-abdominal collections. More recent studies have reported the safety and feasibility of this procedure in complicated appendicitis, with low incidence of infectious complications.<sup>5</sup>

The goal of this study was to review the results of laparoscopic versus open appendectomy in the treatment of complicated appendicitis in children in an attempt to assess the value of LA for paediatric patients, particularly in cases of gangrene and perforation.

**METHODS**

This was a retrospective observational study conducted by the department of Pediatric Surgery, Tertiary teaching hospital, Bangalore over a period of 48 months from January 2015 to January 2019.

**Inclusion criteria**

All children diagnosed with complicated appendicitis (perforated, gangrenous and mass) were included in the study.

**Exclusion criteria**

Children with simple appendicitis were excluded from the study.

The data of children with respect to sex, age, symptoms and their duration were tabulated. The clinical, biochemical and imaging findings were documented. In all the children blood counts and renal function test were done. Initially all children had an ultrasonography (USG) of the abdomen and pelvis. In children where ultrasonography was inconclusive computed tomography of the abdomen was done.

Children underwent surgery within 24 hours of admission after all the routine investigation. Informed consent about the procedure was taken. The children were divided into two groups: laparoscopic (group A) and open (group B) appendectomy groups. All the children received pre-operative antibiotics, combination of 1<sup>st</sup> generation cephalosporin, amikacin and metronidazole.

Open appendectomy was performed through a right infra umbilical transverse muscle splitting incision. The

appendix was identified, mobilized, ligated at the base and divided. In case of abscess/perforation the pus was drained, appendectomy done followed by a thorough peritoneal lavage.

Laparoscopic appendectomy was done by standard three port technique. Port sites were infraumbilical, left and right iliac fossa. Similar to open technique, pus was drained followed by appendectomy and lavage. In all the children a drain was placed which was subsequently removed in post-operative period.

Intraoperative findings in terms of type of complicated appendicitis, position of appendix, presence of appendicolith, were documented. Post-operative the duration of intravenous antibiotics, resumption of oral diet and the length of stay in each group was tabulated. The follow up period ranged from 6 months to 4 years. Immediate and late complications in each group were evaluated. All the data collected were entered into Microsoft Excel sheet and suitable analysis was carried out.

**Descriptive statistics**

Mean±SD and range for parametric numerical data. Frequency and percentage of non-numerical data.

**Analytical statistics**

Student’s T-test was used to assess the statistical significance of the difference between the mean of the two study groups.

Distribution of non-continuous variables in the groups were compared by 2×2 Fischer exact test. P value <0.05 was considered significant.

**RESULTS**

During the study period 73 children were operated for complicated appendicitis. Out of the 73 children 36 children underwent laparoscopic appendectomy (group LA) and 37 children underwent Open appendectomy (group OA). The Age and sex distribution of the children in each group is mentioned in Table 1. There was no statistical significance difference with respect to age between each group. More number of females underwent open appendectomy compared to laparoscopic appendectomy.

**Table 1: Demographic variables.**

	Group LA (n=36)	Group OA (n=37)	P value	Significance
Age (years)	10.11±0.86	10.54±0.94	0.51	NS
Sex	Male	31	22	
	Female	05	15	

Mean duration of pain at the time of presentation in group LA was 2.89 days and in group OA was 3.38 days. The mean total leucocyte count was 14,125.22 in group A and 14,033.24 in group B (Table 2).

**Table 2: Duration of pain, total leucocyte count.**

	Group LA (n=36)	Group OA (n=37)	P value	Significance
<b>Duration of pain (days)</b>	2.89±0.34	3.38±0.47	0.11	NS
<b>Total leucocyte count</b>	14,125.23 ±1,234.47	14,033.24 ±1,127.94	0.09	NS

### Operative findings

Each group was further subdivided into four sub groups according to the operative findings: subgroup 1- perforation with localized abscess, subgroup 2- perforation with generalized abscess, subgroup 3- appendicular mass and subgroup 4- gangrenous appendix. The distribution of operative findings among the groups and subgroups is presented in Table 3. The data with respect to position of appendix in each group is tabulated in Table 3.

**Table 3: Operative findings.**

Operative findings	Group LA (n=36)	Group OA (n=37)
<b>Perforation with localised abscess</b>	14 (38.9%)	12 (32.4%)
<b>Perforation with generalised abscess</b>	11 (30.5%)	20 (55.5%)
<b>Appendicular mass</b>	06 (16.7%)	03 (8.1%)
<b>Gangrenous appendix</b>	05 (13.9%)	02 (5.4%)
<b>Position of appendix</b>		
<b>Retrocaecal</b>	14 (38.9%)	17 (45.9%)
<b>Pelvic</b>	07 (19.4%)	13 (35.1%)
<b>Paraecaeal</b>	10 (27.8%)	04 (10.8%)
<b>Preileal</b>	05 (13.9%)	03 (8.1%)

### Operative time

The mean operative time for group LA was 55.83±4.81 minutes, whereas in group OA it was 67.16±4.27 minutes, with a p value of less than 0.001 by t-test, which was statistically significant (Table 4).

**Table 4: Operative time, duration of i.v. antibiotics, resumption of oral feed and length of stay.**

	Group LA (n=36)	Group OA (n=37)	P value	Significance
<b>Operative time (min)</b>	55.83±4.81	67.16±4.27	<0.05	S
<b>Duration of i.v. antibiotics (days)</b>	4.28±0.45	5.86±0.39	<0.05	S
<b>Resumption of oral feed (days)</b>	2.83 ±0.31	3.84 ±0.33	<0.05	S
<b>Length of stay (days)</b>	5.11 ±0.55	7.92 ±1.06	<0.05	S

### Rate of conversion

The rate of conversion from the laparoscopic approach to open approach was 8.3% (three cases). In two cases conversion was due to dense adhesions of small bowel loops forming a mass. In one case the appendix was retrocaecal and plastered to the lateral abdominal wall and the caecum. In view of chances of injuring the caecum decision to convert to open was taken.

### Duration of intravenous antibiotics, oral feeding, hospital stay

Table 4 shows in group LA, the mean time of duration of intravenous antibiotics was 4.23±0.45 days, whereas in group OA, it was 5.87±0.39 days, with a p value of 0.0001, which was statistically significant.

In group LA, the mean time for starting of oral feeding was 2.83±0.31 days, whereas in group OA, it was 3.84±0.33 days, with a p value of 0.001, which was statistically significant.

In group LA, the mean time for hospital stay was 5.11±0.54 days (range 3-10 days), whereas in group OA, it was 7.92±1.06 days (range 3-21 days), with a p value of 0.0001, which was statistically significant.

### Early and late complications

The incidence of early and late complications is shown in Table 5. In group LA, two (5.5%) patients had early postoperative complications in the form of wound infection. Both these patients were treated conservatively with regular dressing. In group OA, 7 (18.9%) patients had early postoperative complications in the form of wound infections and 6 (16.2%) patients had late postoperative complications in the form of adhesive obstruction. Out of the 6 patients with adhesive obstruction 3 were managed conservatively with nil per oral, antibiotics and intravenous fluids. Remaining three had to undergo re-laparotomy for adhesiolysis. We did not have any mortality in the study.

The overall incidence of postoperative complications was 2 (5.5%) patients in group LA and 10 (27%) patients in group OA. The p values for complications was 0.0242, which was statistically significant.

**Table 5: Comparison of complication in two groups.**

	No complication	Complication	Total	P value	Significance
<b>Group LA</b>	34	02	36	0.02	S
<b>Group OA</b>	27	10	37		

## DISCUSSION

Clinical presentation of paediatric appendicitis is rather typical: the pain is always present, initially located at the periumbilical area and afterwards at the right iliac fossa; in most of the cases vomit and lack of appetite follow the pain, associated to fever, which is also a very common find.

The examination of the abdomen, instead, can show different signs such as focal or diffuse tenderness, guarding, rebound, and mass, but these are better identified in older children. Given this presentation, a misdiagnosis can be frequent and the most common one is the gastroenteritis. Sometimes the actual diagnosis is delayed, and thus the severity of the condition increases, leading to a complicated appendicitis.

Laparoscopy is now demonstrated to be the optimal approach also to treat complicated appendicitis, but in very young children this standardized operation is not always easy to perform. Pneumoperitoneum in infants should be of low pressure for possible haemodynamic effects and so the working space could be very limited. Also the use of endoscopic mechanical staplers could be limited by the abdominal cavity dimensions.<sup>6</sup>

Some studies suggested a lack of good evidence supporting laparoscopic approach for complicated appendicitis.<sup>4,7-9</sup> However, others concluded that LA for complicated appendicitis is better than is open OA.<sup>10-13</sup> Hypothetically, in complicated appendicitis, especially in obese children, LA can benefit a patient compared with OA because it minimizes the tissues trauma, allows better visualization of abdominal spaces and meticulous peritoneal irrigation, avoids wound incision and extension, and is associated with less exposure of wound surface area to contaminated fluids. There is also reduced postoperative pain, early return to normal daily activity, and of course superior cosmetic results.

Taking in consideration the above-mentioned debate, the aim of our study was to evaluate the efficacy of LA in children with complicated appendicitis in our institution.

There was no statistically significant difference between the two groups with respect to the age, sex, duration of pain and total leukocyte counts.

The mean operative time for group LA was 55.83±4.81 min, whereas in group OA it was 67.16±4.27 minutes. This was very similar to Khirallah et al.<sup>14</sup> The mean operative time for LA in complicated cases was 56.41

min, whereas for OA it was 63.42 minutes.<sup>14</sup> This was very close to Li et al who reported a mean operative time of 55.8 minutes for LA and of 57.94 minutes for OA.<sup>15</sup>

Other studies have reported a longer or shorter operative time.<sup>13,16,17</sup> This difference could be attributed to the difference in the level of laparoscopist's skills.

In our study, the duration of time for which intravenous antibiotics were given to the patients was significantly lesser in the LA group (4.2 days) as compared to the OA group (5.8 days). In children undergoing Laparoscopic surgery oral antibiotics were started as soon as children were started orally. This significantly reduced the need for intravenous antibiotics.

Our patients, who underwent LA were able to start oral intake within 2.83±0.31 days, whereas in the OA group, feeds were started in 3.84±0.33 days. This is in agreement with Padankatti et al in which feeds were established in 2.5 days in the LA group and 3.7 days in the OA group.<sup>18</sup>

Our study also showed that the mean duration of hospital stay in the LA group (5.11±0.55) was significantly lesser than the OA group (7.92±1.06). Aziz et al showed that the length of hospital stay was significantly reduced in cases subjected to LA, either complicated or uncomplicated, and he assumed that these results may be related to the advantages of minimal invasive strategy of laparoscopic procedures, which included reduced postoperative pain and early mobilization leading to early discharge.<sup>19</sup>

Many studies found that LA markedly reduced the postoperative wound infection rate when compared with OA (1.3 versus 12.5%).<sup>10,12,20</sup> The overall incidence of postoperative complications in our study was 5.5% patients in group LA and 27% patients in group OA.

In children where diagnosis is in dilemma, laparoscopy has an added advantage of visualization of all the organs. The major drawback of the present study is the retrospective nature of the study and the possibility of bias in patient selection and randomization. Hence a prospective study is required to validate the findings of the present study.

## CONCLUSION

It was concluded that laparoscopic approach could be well used in cases of complicated appendicitis. Laparoscopic appendectomy for complicated appendicitis

in children is safe and feasible. It is associated with lesser mean operative time, early start of oral feeds, lower incidence of infectious complications and short duration of hospital stay. Therefore, it can be the first choice for cases of complicated appendicitis in children.

*Funding: No funding sources*

*Conflict of interest: None declared*

*Ethical approval: The study was approved by the Institutional Ethics Committee*

## REFERENCES

- Dunn JC, Grosfeld JI, O'Neil JA, Fonkalsrud JA, Coran AG. Appendicitis. In: Pediatric surgery. 6th ed. Philadelphia, PA: Mosby Elsevier; 2006: 1501.
- Ponsky TA, Huang ZJ, Kittle K, Eichelberger MR, Gilbert JC, Brody F, et al. Hospital-and patient-level characteristics and the risk of appendiceal rupture and negative appendectomy in children. JAMA. 2004;292(16):1977-82.
- Serres SK, Cameron DB, Glass CC, Graham DA, Zurakowski D, Karki M, et al. Time to Appendectomy and Risk of Complicated Appendicitis and Adverse Outcomes in Children. JAMA Pediatr. 2017;171(8):740-6.
- 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(11):1601-3
- Kassem R, Shreef K, Khalifa M. Effects and clinical outcomes of laparoscopic appendectomy in young children with complicated appendicitis: a case series. Egyptian J Surg. 2017;36:152-5.
- Guanà R, Lonati L, Garofalo S, Tommasoni N, Ferrero L, Cerrina A, et al. Laparoscopic versus open surgery in complicated appendicitis in children less than 5 years old: a six-year single-centre experience. Surg Res Pract. 2016;2016.
- Bonanni F, Reed J 3<sup>rd</sup>, Hartzell G, Trostle D, Boorse R, Gittleman M, et al. Laparoscopic versus conventional appendectomy. J Am Coll Surg. 1994;179:273-8.
- Martin LC, Puente I, Sosa JL, Bassin A, Breslaw R, McKenney MG, et al. Open versus laparoscopic appendectomy. A prospective randomized comparison. Ann Surg. 1995;222:256-61.
- Krisher SL, Browne A, Dibbins A, Tkacz N, Curci M. Intra-abdominal abscess after laparoscopic appendectomy for perforated appendicitis. Arch Surg. 2001;136:438-41.
- Wang X, Zhang W, Yang X, Shao J, Zhou X, Yuan J. Complicated appendicitis in children: is laparoscopic appendectomy appropriate? A comparative study with the open appendectomy- our experience. J Pediatr Surg. 2009;44:1924-7.
- Tashiro J, Einstein SA, Perez EA, Bronson SN, Lasko DS, Sola JE. Hospital preference of laparoscopic versus open appendectomy: effects on outcomes in simple and complicated appendicitis. J Pediatr Surg. 2016;52:804-9.
- Horvath P, Lange J, Bachmann R, Struller F, Königsrainer A, Zdichavsky M. Comparison of clinical outcome of laparoscopic versus open appendectomy for complicated appendicitis. Surg Endosc. 2016;31:199-205.
- Yau KK, Siu WT, Tang CN, Yang GP, Li MK. Laparoscopic versus open appendectomy for complicated appendicitis. J Am Coll Surg. 2007;205:60-5.
- Khirallah MG, Eldesouki NI, Elzanaty AA, Ismail KA, Arafa MA. Laparoscopic versus open appendectomy in children with complicated appendicitis. Ann Pediatr Surg. 2017;13(1):17-20.
- Li P, Xu Q, Ji Z, Gao Y, Zhang X, Duan Y, et al. Comparison of surgical stress between laparoscopic and open appendectomy in children. J Pediatr Surg. 2005; 40:1279-83.
- Mohajerzadeh LL, Rouzrokh M, Tabari AK. Laparoscopic appendectomy in complicated appendicitis of children. Ann Colorectal Res. 2014;2:e16599.
- Padankatti LR, Pramod RK, Gupta A, Ramachandran P. Laparoscopic versus open appendectomy for complicated appendicitis: A prospective study. J Indian Assoc Pediatr Surg. 2008;13(3):104-6.
- Marzouk M, Khater M, Elsadek M, Abdelmoghny A. Laparoscopic versus open appendectomy: a prospective comparative study of 227 patients. Surg Endosc. 2003;17:721-4.
- Aziz O, Athanasiou T, Tekkis PP, Purkayastha S, Haddow J, Malinovski V, et al. Laparoscopic versus open appendectomy in children: a meta-analysis. Ann Surg. 2006;243:17-27.
- Vahdad MR, Troebbs R, Nissen M, Burkhardt LB, Hardwig S, Cernaianu G. Laparoscopic appendectomy for perforated appendicitis in children has complication rates comparable with those of open appendectomy. J Pediatr Surg. 2013;48:555-61.

**Cite this article as:** Sreekantamurthy P, Chinmayee B, Sharath. Laparoscopic versus open appendectomy in children with complicated appendicitis in a tertiary teaching hospital. Int Surg J 2020;7:2213-7.