Does laparoscopic appendectomy confer advantages over open appendectomy for pediatric complicated appendicitis? A single institute experience

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ABSTRACT

Introduction: Laparoscopic appendectomy (LA) for complicated appendicitis appears to be controversial due to the difficulty in dissection and clearing off the peritoneal contamination, prolonged operating times, higher incidence of post-operative abdominal abscess, and wound infections. **Objectives:** The objective of the study was to compare laparoscopic and open appendectomy (OA) and evaluate the outcome of LA in children with complicated appendicitis. **Materials and Methods:** A retrospective analysis of 182 patients' records with complicated appendicitis was done. Data collected included demographics, operative time, resumption of oral intake, and infectious complications such as wound infection and intra-abdominal abscess, need for redo surgery, length of hospitalization, and duration of antibiotic use. Patients were followed up for 6 months in the post-operative period to assess delayed complications. **Results:** LA was performed in 102 patients and 80 patients underwent an OA. The two groups did not differ significantly in mean age, duration of antibiotic use, resumption of oral intake, and length of the hospital stay. The duration of surgery was significantly longer for LA ($p<0.0001$). However, the wound infection was significantly more common in the OA group than the laparoscopy group ($p=0.0058$). None of the patients in the LA group developed delayed complications. A total of four patients in the open group had to undergo surgery for late-onset complications. **Conclusion:** LA for complicated appendicitis is more advantageous than OA as there is reduced surgical site infection. However, the operative time is prolonged with an increased incidence of immediate post-operative intestinal obstruction. Nevertheless, it avoids the late complications of OA.

Key words: *Complicated appendicitis, Intra-abdominal abscess, Laparoscopic appendectomy, Open appendectomy*

Complicated appendicitis may be defined as preoperatively, intraoperatively, or histologically diagnosed appendicitis with an abscess or mass formation, perforated appendicitis or gangrenous appendicitis [1]. Laparoscopic appendectomy (LA) is routinely used in children for uncomplicated appendicitis but for complicated appendicitis an open appendectomy (OA) is preferred. This could be due to difficult dissection, risk of injury to adjacent viscera, longer operative times, difficulty in clearing the inter-loop collection, higher incidence of post-operative intra-abdominal abscess (IAA), and increased costs [2].

However, proponents of laparoscopy cite fewer wound infections, shorter hospital stay, and less morbidity compared to OA in complicated appendicitis [3]. Pediatric literature related to the laparoscopic approach for complicated appendicitis appears to have conflicting results as compared with the adult counterpart [4,5]. This could be due to the possible differences in patient characteristics, surgical practice, and severity of appendicitis in these studies. Hence, this study was done to compare LA and OA and evaluate the efficacy of LA in children with complicated appendicitis.

MATERIALS AND METHODS

This was a retrospective study carried out at a tertiary care pediatric surgical center. We analyzed the medical records of all the patients undergoing surgery for acute appendicitis between January 2014 and April 2019. Children with complicated appendicitis diagnosed either preoperatively on imaging or based on intraoperative findings were included in the study. Complicated appendicitis was defined as acute appendicitis in which the features present were abscess formation/mass formation diagnosed on abdominal ultrasonogram or contrast-enhanced computed tomography (CECT) scan obtained before surgery appendix with perforation or a free lying fecalith in the abdomen observed during the surgery. Children with uncomplicated appendicitis were excluded from the study.

Data collected from the medical records included demographics, radiological findings, operative time, resumption to diet, duration of antibiotic use, and post-operative complications including wound infections and the length of hospital stay. Follow-up records up to 6 months were also retrieved. Institutional ethical committee approval was obtained for the study.

Operative Technique

All the patients were operated under general anesthesia with endotracheal intubation. Three trocars were employed for LA, with a 10 mm subumbilical trocar for the laparoscope. After pneumoperitoneum was established, a laparoscope was inserted to assess the disease. A 5 mm trocar was inserted at the outer border of the left rectus muscle just below the level of the umbilicus and a similar trocar was placed in the midline in the lower abdomen just above the pubic symphysis. After noting the findings, dissection was started with drainage of pus and when present, fecalith was retrieved (Figs. 1 and 2).

Mesoappendix was divided using diathermy and the appendicular stump was secured with a 2-0 catgut or silk loop. The appendix was removed from the 10 mm port. OA was accomplished using either a McBurney's or Lanz incision. Irrigation was done in both techniques with normal saline only when gross contamination was evident. Intravenous ceftriaxone (100 mg/kg) and metronidazole (30 mg/kg) were used in post-operative period (100 mg/kg and 30 mg/kg) until the child remained afebrile for at least 24 h. As soon as the bowel function was evident, oral feeds were started.

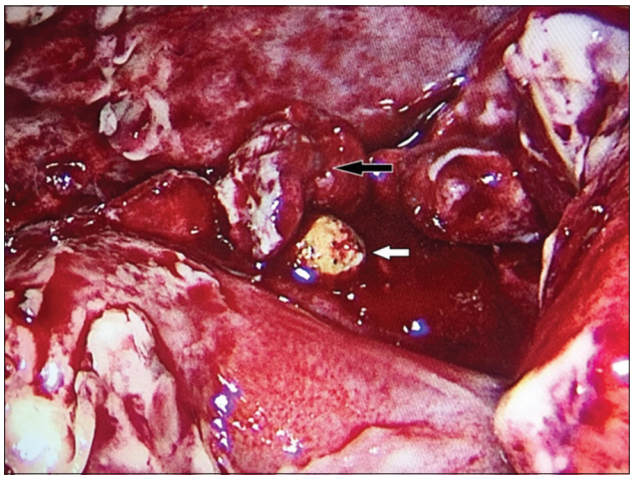

Figure 1: Perforated appendix (black arrow) with fecalith (white arrow)

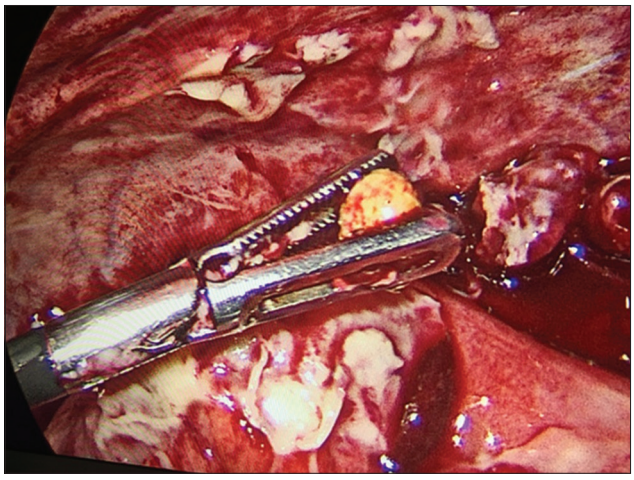

Figure 2: Retrieval of fecalith

Statistical analysis was performed with SPSS (IBM SPSS Statistics for Windows, Version 21.0. Armonk, NY: IBM Corp.). Continuous variables were expressed as mean±standard deviation and range. The unpaired t-test was used to analyze continuous variables. Categorical variables were analyzed using the Chi-square test and Fisher exact test and $p<0.05$ was considered statistically significant.

RESULTS

A total of 377 appendectomies were performed for acute appendicitis during the study period, of which 190 children had undergone appendectomy for complicated appendicitis. Of these 80 underwent OA. LA was attempted in 110 patients but could be completed in 102 patients. A total of eight patients required conversion to open surgery with a conversion rate of 7.27%. These patients were excluded from the final analysis.

The comparison between the two groups is summarized in Table 1. There were no statistically significant differences between the two groups in terms of mean age, resumption of oral diet, duration of antibiotic use, and the length of hospital stay. However, a statistically significant difference was noted among the two groups in the duration of surgery, with the operative time being shorter in the OA group by 13 min.

Infectious complications were seen in 19 children. Children in the OA group had a higher rate of superficial surgical site infection (14 in OA group vs. 5 in LA group) and this difference was statistically significant ($p=0.0058$) (Table 2). All these patients had adhesive intestinal obstruction either due to bowel adhesions or omental adhesions or both.

The follow-up data for 6 months were available in the post-operative period. While none of the patients in the LA group developed any complications, there were four patients in the OA group who developed intestinal obstruction (two patients) and incisional hernia (two patients) and this was statistically significant. There was no mortality in the study population.

DISCUSSION

Meta-analysis in both adults and children has supported the fact that LA has better outcomes than OA in terms of reduced post-operative wound infections, shorter length of hospital stay, less post-operative pain, earlier post-operative recovery, and a lower complication rate [4-7]. However, these studies did not analyze complicated appendicitis exclusively.

Appendicitis in children can be quite severe in presentation with complicated appendicitis accounting for a significant portion of the cases. Although it accounts for approximately 28% of cases [8], in our cohort it constituted 50% of the total cases. Our cohort included patients with appendicular mass, perforation, and abscess formation. We did not consider mass formation as a contraindication for surgery. Young children have specific anatomic and pathophysiologic elements for developing more often complicated appendicitis and it has been seen that children <6 years old have a diagnostic delay as analyzed by Marzuillo *et al*. [5].

Table 1: Comparison of demographics and operative results

Result parameter	LA group (n=102)	OA group (n=80)	p-value
Mean age (years)	9.69±3.25	8.71±3.50	0.053
Gender			
Male (n=116)	63	53	
Female (n=66)	39	27	
Duration of symptoms	3.5±0.88	3.44±0.92	0.6551
Duration of surgery (min)	85.44±7.80	72.37±9.41	<0.0001
Resumption of oral diet (days)	1.73±1.25	1.91±1.44	0.3684
Duration of antibiotic use (days)	3.94±2.44	4.11±2.51	0.6456
Length of hospital stay (days)	5.72±4.01	5.98±3.93	0.6534

Table 2: Post-operative complications

Result parameter	LA group (n=102)	OA group (n=80)	p-value
Surgical site infection	5 (4.9%)	14 (17.5%)	0.0058
Superficial	1	12	0.00027
Post-operative abscess	4	2	0.5939
Ileus	12	15	0.1882
Intestinal obstruction	5 (4.9%)	1 (1.25%)	0.1708
Need for reoperation	5 (4.9%)	5 (6.25%)	0.6920
Laparotomy/laparoscopy	4/01	1	0.1708
Wound suturing	-	4	-
Delayed complications	-	4 (5.0%)	0.0358

Studies by Krisher *et al.* [9] and Zhang *et al*. [10] have shown that complicated appendicitis can be associated with an increased risk of post-operative complications, particularly IAA, which makes the role of laparoscopy controversial. The presence of free air on pre-operative CECT in patients with acute appendicitis appears to be an independent predictor for the development of IAA and surgeons should be scrupulous in the post-operative period of those patients with this finding [11]. A study by Schlottmann *et al*. [12] analyzed the risk factors for the development of IAA following LA. They found that obese patients, with leukocytosis count >20,000/mm^3, perforated appendicitis, and surgical time longer than 90 min had a higher chance of developing post-operative IAA.

In our study, the duration of surgery in the laparoscopic group was longer than compared to the open group and this finding was statistically significant. The same has been supported by other studies [13-17]; however, studies by Horwitz *et al*. [2] and Li *et al.* [18] did not find any difference between the time taken for LA and OA. Although Khirallah *et al*. [19] found prolonged operative time in OA, increased experience with laparoscopy might see a reduction in the operative time.

We noticed a higher incidence of immediate post-operative intestinal obstruction in the LA group (4.9% in LA group vs. 1.25% in OA group) with all the patients requiring reoperation and this did not resolve with conservative management. This finding was not statistically significant. Although most studies did not support this finding [4,8,10], a similar clinical outcome was seen in the study by Michailidou *et al*. [13].

More patients in the OA group in our study had ileus but this finding did not have statistical significance. Studies by Low *et al*. [8] and Ikeda *et al*. [14] supported this finding. Prolonged ileus in OA is mainly due to bowel handling which is minimized in LA. Other factors affecting ileus could be the degree of peritoneal contamination and the occurrence of post-operative IAA. We started oral feeds in our patients once bowel sounds were heard and the two groups did not differ in the duration to start oral intake. However, many studies have found a significant difference between LA and OA groups in resumption of oral intake with the duration being shorter in the former [3,8,13,15,18].

Antibiotic usage was prolonged in our patients with post-operative IAA until the patients showed signs of clinical improvement. This was not in accordance with the previous studies by Rai *et al*. [17] and Li *et al*. [18]. The incidence of post-operative surgical site infection was found to be significantly higher in patients undergoing OA in the present study and this was in accordance with previous studies [3,4,8,10,16-20]. This was probably due to the direct exposure of the wound to the infected contents at surgery which was minimized with laparoscopy.

Even though we found a higher incidence of IAA in the laparoscopic group, this finding was not statistically significant. While studies have shown a higher incidence of IAA in the LA group [2,4,9,10], a few others have described reduced incidence [3,16,19]. There are studies that reported the absence of a significant difference in the incidence of IAA between LA and OA groups [8,14,17,18,20]. The occurrence of post-operative IAA was of prime concern since this was a major cause of morbidity in terms of prolonged antibiotic use, need for intervention or reoperation, and overall a prolonged hospital stay. Laparoscopy provided the advantage of exploring the entire abdomen and clearing the contaminated peritoneal cavity in generalized peritonitis due to appendicitis as described by Ikeda *et al*. [14]. A recent meta-analysis by Siotos *et al*. [21] did not find any advantage of irrigation in reducing the occurrence of IAA. This parameter was not evaluated in our study as we did not find adequate documentation in the records regarding the same.

The duration of hospital stays increased as the severity of appendicitis increased, irrespective of the choice of surgery [14,16] as it was dependent on the degree of inflammation. Contrary to many studies that report a shorter hospital stay for patients following LA [3,4,6,8,13,18-20], we did not find a significant difference between the two groups when compared for the length of hospital stay. The patients were followed up for 6 months in the post-operative period and a significant incidence of delayed complications in the OA group was observed. All these complications were seen within 3–4 months after the primary surgery and required reoperation. Higher rates of reoperation were also seen following OA in the study by Low *et al*. [8].

Our study had certain limitations. Several impediments such as the retrospective nature of the study, variation in the surgeons' experience, and diversity in the degree of peritoneal contamination were not considered. We are unsure of the selection bias if any that would have led to the choice of procedure in a particular patient.

CONCLUSION

In children with complicated appendicitis, LA should be the initial procedure of choice based on the available expertise. However, the operative times appear to be prolonged with an increased incidence of immediate post-operative intestinal obstruction. Nevertheless, it avoids the late complications of OA.

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