

# Laparoscopic versus open appendectomy in children with complicated appendicitis

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**Introduction** Acute appendicitis represents one of the most common causes of urgent surgical interventions in pediatric age group. With the advances in minimal invasive surgery laparoscopic appendectomy (LA) has been introduced as a suitable line of treatment. We compare between laparoscopic and conventional open appendectomy in the treatment of complicated appendicitis in children.

**Patients and methods** During the period from October 2012 to March 2016, 390 children with acute complicated appendicitis diagnosed clinically and with laboratory and available imaging studies were operated. LA performed for 200 cases and open conventional appendectomy for 190 cases. Three ports technique was used in laparoscopic cases. The operating table is shifted in Trendelenburg position and towards the left side. The surgeon stands on the left side of the patient. The appendicular mesoappendix was secured using electro cautery. The base was secured by extracorporeal ties and the appendix was retrieval within the umbilical port. The wounds were closed. Open appendectomy was done through McBurney incision as the traditional approach.

## Introduction

Acute appendicitis is one of the most common surgical emergencies in childhood. Its incidence peaks between the ages of 11 and 12 years, and it has a lifetime risk of 7–9% [1]. Since Semm [2] performed the first laparoscopic appendectomy (LA) in 1983, this approach has gained popularity in the treatment of acute appendicitis over the past decades [3]. However, the use of LA as the first choice in the treatment of acute appendicitis is still debated because of longer operative time, higher risk of intra-abdominal abscesses postoperatively, and of course higher costs [4,5]. In addition, the role of LA in the management of complicated appendicitis in children remains controversial [6]. Several studies disapproved the concerns about increased postoperative complications in complicated appendicitis operated laproscopically, with some demonstrating lower complication rates and shorter hospital stay [7–9]. In this study, we compared between LA and conventional open appendectomy (COA) in the management of acute complicated appendicitis in children.

## Patients and methods

During the period from October 2012 to March 2016, 390 children who presented with acute complicated appendicitis were operated. It was a prospective randomized study. The method of randomization was closed envelop method. All children were diagnosed on clinical bases,

**Results** A total of 390 children diagnosed with acute complicated appendicitis were operated. The mean age was 12.04 years in group A and 12.2 in group B. There were 260 were boys and 130 were girls. The mean operative time in the laparoscopic group was 56.4 min; while in the conventional group was 63.42 min.

**Conclusion** LA was a suitable, effective and safe procedure in complicated cases that did not involve the base. It was associated with lower complications rate with all the advances of minimal invasive surgery when compared to the conventional open appendectomy. *Ann Pediatr Surg* 13:17–20 © 2017 Annals of Pediatric Surgery.

*Annals of Pediatric Surgery* 2017, 13:17–20

**Keywords:** appendectomy, children, complicated, laparoscopic

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Received 20 June 2016 accepted 21 August 2016

and this was followed by laboratory investigation in the form of total leukocytic count and C-reactive protein; in addition, abdominal ultrasound was performed in all cases. We excluded cases with severe chest or cardiac troubles and cases of catarrhal appendicitis and cases who presented with appendicular masses or abscesses. LA was performed for 200 cases (group A) and COA was performed for 190 cases (group B).

All operations were performed under general anesthesia. The patients received third-generation cephalosporin and metronidazole with the induction of anesthesia. In group A, we used three ports to operate. First port was 10 mm at the umbilicus while the other two ports were 5mm, one one at the Rt mid clavicular line at the level of umbilicus and the other at midway between umbilicus and symphysis pubis in the mid line. Exploration of the peritoneal cavity is done as the first step, which was followed by identification of the appendix. Then, we started to secure the mesoappendix using electrocautery close to the appendiceal wall. After that we secured the base of the appendix with two successive ties of Vicryl 2/0 (Ethicon J&J) in an extracorporeal manner by pushing through the port between the umbilicus and the symphysis pubis using a knot pusher. Next, resection of the appendix was performed, and it was extracted through the umbilical port. Peritoneal lavage and suction of any exudates were performed as expected in complicated cases. Drains were used in all cases.

**Table 1 Demographic and preoperative data**

	Group A (N=200)	Group B (N=190)	SD	P value
Sex				
Girls	60	70		
Boys	140	120		
Age	12.04	12.23	3.045	0.254
Weight (mean) (kg)	28	28.5	2.12	0.124
Duration of Symptoms and signs (mean) (days)	3.82	3.79	0.52	0.231
TLC	15.75	15.73	1.22	0.25
CRP	59.84	63.37	2.94	0.451
Ultrasound				
Inflamed	100	95		
Appendix				
Free fluid	50	70		

CRP, C-reactive protein; TLC, total leukocytic count.

The wounds were closed. In group B, classic McBurney approach was done and appendectomy was performed according to the usual steps. In addition, drains were inserted in all cases and the wound was closed in layers. Data collected included demographic records, total leukocytic count, duration of symptoms before admission, operative time, intraoperative problems or difficulties, length of hospital stay, and complications that occurred in both groups. Degree of satisfaction about the procedure of the parents or the child himself was obtained. Time length to normal life activity was documented.

## Results

During the period of our work, we operated 390 children who presented with symptoms and signs of acute complicated appendicitis. Diagnosis was accomplished with laboratory investigation (leukocytic count and C-reactive protein) and pelviabdominal ultrasound imaging as a routine. There were 260 boys and 130 girls. The mean age was 12.04 years in group A and 12.2 years in group B. The mean duration of symptoms and signs in the preoperative period was 3.82 days in group A and 3.79 days in group B. The mean leukocytic count was 15 500 in group A and 15 700 in group B. C-reactive protein was positive in all cases and ranged from 6 to 160 IU, with a mean value of 60 in both groups. Ultrasound could detect the inflamed appendix in 195 cases and free fluid in pelvis and right iliac fossa in 120 cases. In addition, ultrasound excluded other problems related to the urinary tract or the reproductive system in girls Table 1.

## Operative and postoperative results

### Group A

The mean operative time was 56.41 min. No cases were converted to open technique, and the procedure was completed laparoscopically. In 50 cases, there were omental adhesions with the appendix, which needed meticulous dissection. Localized turbid fluid collection at the right iliac fossa and free fluid in the pelvis were found in 55 cases, which were aspirated and lavage was performed. The appendix was gangrenous in 75 cases, suppurative in 20 cases, and perforated in 105 cases. No accidental visceral or vascular injuries occurred. The drains were inserted in all cases. The mean length of hospital stay was 2.7 days. Wound infection occurred in 38 cases at the umbilical wound responding to conservative

**Table 2 Operative and postoperative data**

	Group A	Group B	P value
Operative time (mean) (min)	56.28	63.37	0.001*
Visceral injury	No	No	–
Conversion to open procedure	No	–	–
Wound infection (number of cases)	38	55	0.039*
Postoperative pelvic collection (number of cases)	14	54	0.001*
Hospital stay (mean) (days)	2.73	4.39	0.002*
Return to normal activity (mean) (days)	8.95	12.39	0.005*

\*Significant.

measures. Fourteen cases had postoperative pelvic collections and were in need of hospital admission, as there was fever and other constitutional symptoms. They were treated by ultrasound-guided drainage and parental antibiotics at hospital and discharged after improvement. Patients received NSAIDs for 3 days postoperatively. No cases had postoperative port-site hernias. The children of that group return to normal activity in a mean period of 8.8 days. All parents and children were satisfied with the end result of operation.

### Group B

The mean operative time was 63.42 min. We found omental adhesions to the appendix in 43 cases. There was localized fluid collection, which was turbid in right iliac fossa, and fluid collection in the pelvis in 65 cases, and it was aspirated. The appendix was gangrenous in 66 cases, suppurative in 32 cases, and perforated in 92 cases. We required extension of the wound in 35 cases, as the appendices were either high subhepatic appendix or deeply seated appendix with omental adhesions. No accidental visceral injuries occurred. Drains were inserted in all cases. The mean hospital stay was 4.38 days. Wound infections occurred in 55 cases. Pelvic collections occurred in 54 cases, which required re-admission, and ultrasound-guided drainage was performed. One child had postoperative fecal fistula and required re-admission and received total parental nutrition and antibiotics until the output decreased, and the child resumed oral intake 5 days later. Patients received NSAIDs for 5 days postoperatively. They returned to normal activity in a mean period of 12.39 days. In this group, 120 parents were satisfied, whereas of the rest got annoyed with the appearance of the wound (Table 2).

## Discussion

Minimal-access surgical procedures are being applied across a variety of surgical specialties. Increasing laparoscopic experience, improvement in surgical techniques, and advances in technology have allowed for superior outcomes in these procedures when compared with conventional open procedures [6].

LA has intrinsic appeal shared in all minimal invasive surgeries. This may be because of reduced postoperative pain, early return to normal daily activity, and of course superior cosmetic results. On the other hand, several studies have detected that LA required longer operative time and had more postoperative complications than COA [2,10].

The mean operative time for LA in complicated cases was 56.41 min, whereas for OCA it was 63.42 min.

This was very close to Li *et al.* [11] who reported a mean operative time of 55.8 min for LA and of 57.94 min for OCA.

On the other hand, Frauquzzmann and Mazumder [12] showed that the mean operative time for the laparoscopic group was 112 min and for the conventional group it was 72 min, and he referred to the need for meticulous dissection of complicated appendicitis during the laparoscopic procedure.

Different studies of Ikeda *et al.* [13], Miyano *et al.* [14], and Wang *et al.* [9] reported that the mean operative time for LA ranged from 88 to 111 min and the mean operative time for the conventional group ranged from 71 to 108 min.

This most likely reflects the technical challenges associated with the laparoscopic procedure in challenging cases [15].

Some studies have demonstrated that with increased experience the operative time for complicated appendicitis is similar for LA and OCA [16].

We noticed that gross pathology of the inflamed appendix was either suppurative, perforated, or gangrenous.

Most other authors included only perforated appendicitis as the only type of complicated appendicitis during either laparoscopic or conventional procedures [9,13,14].

Menezes *et al.* [16] included both perforated and gangrenous appendicitis in his series for LA.

There was a difference as regards hospital stay in both groups during our study. The mean postoperative hospital stay was 2.75 days in group A and 4.38 days in group B.

Aziz *et al.* [17] 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.

Therefore, our results were similar to the series of Jen and Shew [18] who documented hospital stay of  $5.2 \pm 3.2$  days in LA and  $5.5 \pm 3.4$  days in COA.

Some authors such as Ikeda *et al.* [13], Miyano *et al.* [14], and Wang *et al.* [9] showed that the length of hospital stay was relatively long in both groups. It ranged from 6.5 to 14 days for LA and from 7.8 to 16 days for COA.

The incidence of wound infection was less in LA when compared with OCA in our work.

These results were supported by those of Yagmurlu *et al.* [19] who showed reduced incidence of wound infection in LA.

Pelvic collection occurred in 14 cases of LA and in 54 cases of OCA, and these children required re-admission and ultrasound-guided drainage was performed for all cases together with antibiotics for 1 week. Patients were discharged when the collection completely disappeared.

The risk factors for the development of intra-abdominal collections remain controversial. Several reports suggested that the incidence of this complication is higher after laparoscopic appendectomy among patients with perforated appendicitis [20].

On the other hand, Yagmurlu *et al.* [19] showed no significant increase in the incidence of postoperative intra-abdominal abscess after LA. He assumed that the use of a stapler rather than an endoloop reduces the risk of spillage [19].

Our patients in group A returned to normal daily activity within 8.98 days, whereas those of group B returned after 12.93 days.

Marker *et al.* [21] showed that in the pediatric population rapid return to normal activities might reduce the psychological effects of hospitalization, although solid evidence is lacking.

In addition, other studies did not consider the degree of parent and child satisfaction as regards the final appearance of the wound. In group A, all parents and children were satisfied with the operation, whereas in group B 120 parents were satisfied and the rest got annoyed with the appearance of the wound. We think that this point should be taken with great consideration.

## Conclusion

We assumed that LA for complicated appendicitis in children should be the first choice for the pediatric surgeons, as it is safe, effective, and associated with a relatively accepted rate of postoperative complications.

## Acknowledgements

### Conflicts of interest

There are no conflicts of interest.

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