

## ORIGINAL ARTICLE

## Laparoscopic Appendectomy in Children-Study of 331 Cases and Analysis of Outcome

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## ABSTRACT

**Objective:** The aim of this study was to present the experience of 331 cases treated by laparoscopic appendectomy in children operated by single pediatric surgeon and to analyze the outcome.

**Study Design:** A descriptive retrospective study design

**Place and Duration of Study:** All the children treated by laparoscopic appendectomy between period of June 15, 2011, to October 15, 2021 at Northern Area Armed Forces Hospital, Hafr al Batin, Saudi Arabia.

**Materials and Methods:** This was a retrospective study of 331 cases of acute appendicitis in children treated by laparoscopic appendectomy between the period of June 15, 2011, to Oct 15, 2021. Acute appendicitis was diagnosed on clinical basis supported by lab tests including leukocytosis and increased neutrophils count and occasionally by radiological studies including AXR showing fecalith, ultrasound abdomen showing free pelvic fluid and CT scan abdomen with thick walled or perforated appendix. All cases were operated by the same pediatric surgeon. Patient's gender, age, weight, clinical symptoms and signs, laboratory and radiological data, results of surgical treatment, operative and post-operative complications and outcome were studied. The electronic data of the operation room was collected and analyzed by the operating pediatric surgeon with permission from the hospital ethical committee. The outcome of laparoscopic appendectomy was analyzed.

**Results:** Three hundred and thirty-three children with acute appendicitis were treated by laparoscopic appendectomy. There were 199 males and 132 female patients. The mean age was 10 years (1 to 14 years). The mean surgery time was 45 minutes. The peritoneal suction -wash was performed in 300 cases and drainage of peritoneal cavity was done in 3 cases of perforated appendicitis. No conversion to open appendectomy was done in this series. The rate of operative and post-operative complications was zero percent. The overall incidence of postoperative wound infection was low (<1%). All the children resumed normal daily activities after 7 days of average time. The families and the children were found satisfied with the outcome.

**Conclusion:** Laparoscopic appendectomy in children is a feasible, effective, safe and appropriate procedure in the treatment of acute appendicitis in children with excellent cosmetic outcome.

**Key Words:** Acute Abdomen, Acute Appendicitis, Laparoscopic Appendectomy, Complications, Follow Up.

## Introduction

Acute appendicitis (AA) is one of the most common surgical emergencies that requires surgical intervention in children. It represents 15% to 20% of surgical emergencies in pediatric age. AA is seen in all ages, but it peaks between the ages of 8 to 14 years.<sup>1</sup> AA is a childhood disease being more common in

boys (63%). The mean age of AA is 10 years. AA is classified as simple when there's no perforation and is defined as advanced when the appendix is gangrenous with peri appendicular abscess formation or it is perforated with peritonitis<sup>2</sup>.

In children perforation may occur after 12 to 15 hours of start of abdominal pain. Twenty-five percent patients have perforation after 24 hours, 50% after 36 hours and 80% have perforation by 48 hours.

Gangrenous or perforated appendix is seen in one third to one half of the admitted patients.<sup>3</sup> Although morbidity of ruptured appendicitis is high, the mortality has been reduced to less than 1%. Most deaths are noted in very young when the diagnosis is not considered.

Appendicitis is for sure cured by appendectomy performed by conventional open appendectomy

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(OA) or by laparoscopic appendectomy (LA).<sup>4</sup> Minimal invasive surgery in the pediatric age is being practiced all over the world like in other surgical specialties.

Kurt Semm treated the first patient in 1983 with LA. Since that time, this method has gained attention in management of AA. With advances in minimal invasive surgery, LA is a suitable procedure for treatment of AA in children.<sup>5</sup>

Many authors have disregarded the perceptions of increased rate of intra-abdominal abscess formation in post-operative cases of LA in advanced appendicitis. In fact, the complication rate is low and hospital stay is shorter in patients with advanced appendicitis treated by LA leading to financial advantage for the family and the health care providing facility.<sup>6</sup>

Increasing LA experience, improvement in surgical techniques and advancement in technology have led to superior outcome of LA as compared to OA. LA is the most common procedure being performed in children followed by laparoscopic orchiopexy for abdominal testis and laparoscopic cholecystectomy.<sup>7</sup> LA has intrinsic appeal shared by all minimal invasive surgeries. This is due to reduced postoperative pain, short hospital stays, early return to normal activities and superior cosmetic outcome. Delay in diagnosis leads to advanced appendicitis with gangrene and perforation depending on nature of disease. The incidence of wound infection is less in LA as compared to OA. LA provides a good opportunity to follow surgical principle "to see to properly operate."<sup>8</sup>

LA is no longer considered a luxury but an important surgical break through as it can resolve many problems which are encountered in OA.<sup>9</sup> The Meckel's diverticulitis with normal appendix is especially diagnosed at laparoscopy and Meckel's diverticulectomy is performed to treat it.<sup>10</sup>

The aim of this retrospective study of acute appendicitis treated by three trocars LA by single pediatric surgeon is to present the experience and review of literature to compare the outcome with published literature in a series of 331 cases in children for analysis of outcome.

## Materials and Methods

This was a retrospective study of all the consecutive patients of AA admitted in our hospital at Northern

Area Armed Forces Hospital, Hafer Al Batin, Saudi Arabia, who underwent LA between June 15, 2011, and Oct 15, 2021, by single Pediatric surgeon. All the patients presented in emergency department directly or were referred from primary health care centers. The total number of patients treated was 331. There were 199 boys and 132 girls. AA was diagnosed on clinical bases supported by laboratory and occasionally by radiological studies. The lab tests showed leukocytosis and raised neutrophils in most of the patients. AXR showed appendicolith in 9 patients. Ultrasound abdomen showed free pelvic fluids especially in advanced acute appendicitis. CT scan abdomen showed thick-walled appendix with perforation in advanced cases. All patients were operated by same pediatric surgeon.

All patients presented in emergency department with complain of sudden severe abdominal pain associated with vomiting and fever. The diagnosis of AA was supported by leukocytosis and abdominopelvic ultrasound which was done in all female patients to exclude genitourinary pathologies and occasionally in male patients in case of any doubt. The classification of advanced appendicitis was made based on clinical findings of generalized abdominal pain and tenderness and operative findings of gangrenous perforated appendix with peri appendicular abscess and signs of peritonitis. In the absence of these findings AA was classified as simple appendicitis. All the patients who were diagnosed as a case of mesenteric appendicitis improved with conservative management and were excluded from the study.

The parameters including gender, age, weight, clinical features (abdominal pain, vomiting, fever, tenderness and rebound tenderness RIF), leukocytosis and abdominal ultrasound data, duration of surgery, operative and post-operative complications, length of hospital stay, time till resumption of normal activities, outcome of LA and degree of satisfaction of parents and child himself were studied. The electronic data of operation room was collected and analyzed by the operating pediatric surgeon with permission from hospital ethical committee. The outcome of LA was analyzed. An average follow-up of 12 months showed no long-term problem. There were 199 boys and 132 girls. All patients received 2<sup>nd</sup> generation cephalosporin and

metronidazole at admission. In our series all children underwent LA under general anesthesia. The stomach was emptied by nasogastric tube and urinary bladder was also catheterized. The patients were kept in supine position on operating table with head side down and right side raised, keeping left arm secured by the side of the body. The surgeon and the assistants were operating on the left side of the patient with the position of laparoscopy monitor towards the surgeons.

The umbilicus was held with two arteries, everted and incised. The Linea Alba and peritoneum were opened with a pair of scissors. The 10 mm umbilical trocar was introduced, and pneumoperitoneum was established with CO<sub>2</sub> insufflation with a flow of 6 l/min and a pressure of 8 mm of Hg to 12 mm of Hg depending upon the age of the patient. Two 5 mm working trocars were inserted in the right upper abdominal quadrant in midclavicular line and left iliac fossa.

The abdominal cavity was explored with a 30-degree camera and appendix were identified and the diagnosis of AA was confirmed.

Findings of suppuration, gangrene, or perforated appendicitis with or without peri appendicular pus or free fluid were noted to define simple and advanced AA. Hemostasis was secured by coagulation of mesoappendix along the surface of appendix with bipolar hook. Appendix was ligated at its base with three vicarly endo loops. Appendectomy was done between the 2<sup>nd</sup> and 3<sup>rd</sup> ligature. The appendix was removed through umbilical trocar to avoid port site infection. Suction washing of peritoneal cavity was optionally performed with drainage if required in perforated appendicitis. The trocars were removed under direct vision and complete exsufflation was done.

Umbilical wounds for camera ports were closed with absorbable sutures. The two working ports wounds of 5 mm each were closed by a subcuticular stitch. (Figures 1-5).

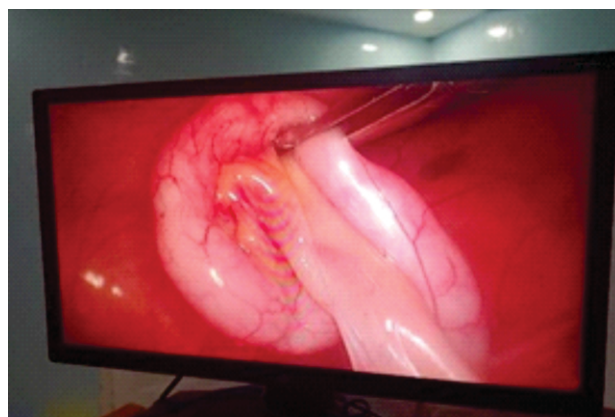
Intravenous paracetamol was given to all patients for perioperative analgesia. Two doses of post-operative antibiotic therapy were administered in simple cases of AA and after 48 hours of being afebrile with an average of 5 days in advanced appendicitis.

## Results

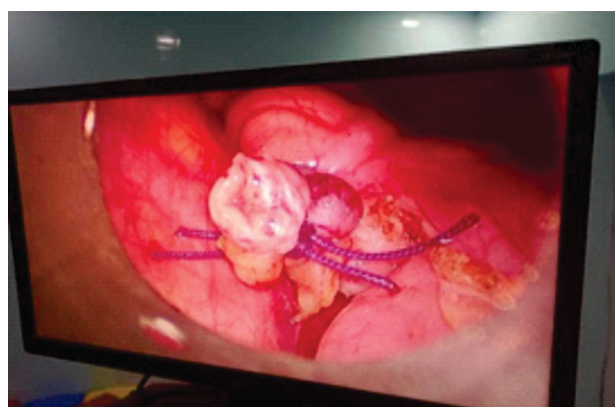
In this series 331 children with AA were treated by



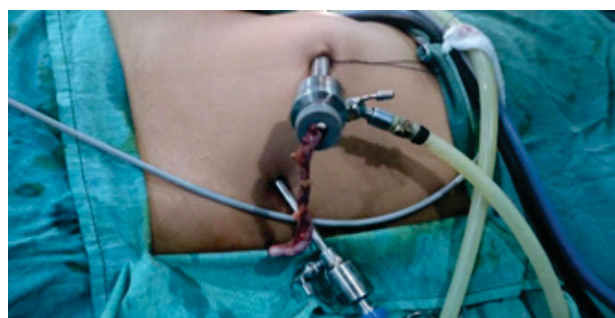
**Figure 1; All Three Ports in Place**



**Figure 2: Acute Appendicitis with Free Peri-Appendicular Fluid**



**Figure 3: Ligated Appendicular Stump**



**Figure 4: Removal of Appendix Through Umbilical Port**





**Figure 5: Closed Wounds of All 3 Ports**

LA. There were 199 boys (62%) and 132 girls (38%). There were 194 patients in the 10 to 14 years of age group, 122 patients in range of 5 to 9 years and 15 patients in 2 to 4 years of age group. The mean age in our series was 10 years (2 years to 14 years). The average weight of patients between the ages of 2 to 4 years was 16 kg (ranging between 11-17 kg), average weight of patients between the ages of 5 to 9 years was 28 kg (ranging between 18-34 kg) and average weight of patients between the ages of 10 to 14 years was 39 kg (ranging between 22-58 kg). The overall mean weight of our patients in this series was 27 kg. LA was performed as emergency surgery. The patients presented in the emergency department after an average delay of 48 hours (ranging between 48 to 250 hours or 1 to 7 days) with predominant symptoms of pain abdomen, vomiting and fever. Examination findings showed sick look, tachycardia, tenderness and rebound tenderness in right iliac fossa with an average of unremarkable systemic examination. The AXR done in emergency department showed appendicolith in 9 cases. Ultrasound abdomen and pelvis were performed in 150 cases which reported free pelvic fluid. Laboratory tests showed an increase in total and differential leukocytes counts in 300 patients (Table 1).

LA was associated with cleansing of peritoneal cavity by suction-washing in 300 cases. Peritoneal drain was not kept in any patient. The mean operating time was 45 minutes (35 min-120 min). There was no conversion to OA in this series. Oral feeding was on an average allowed after 24 hours in simple AA and after 72 hours in advanced appendicitis. Most patients were discharged home after 72 hours of surgery. There were no operative complications in this series. One patient had umbilical wound

infection which was treated by intravenous antibiotics according to culture sensitivity. In our series, the mean hospital stay of patients was 3 days (1-10 days). There is no complication of intrabdominal access formation in our series. There is no mortality. There was no problem found after a mean follow-up of 12 months (Table 2). Our patients and the parents were found happy with the results of LA.

**Table I: Preoperative and Per-Operative Demographic Data**

Demographic Data	Number of Patients	Percentage
<b>Gender</b>		
Boys	199	62 %
Girls	81	38%
<b>Age (Mean)</b>		
2-4 years	15	4.5 %
5-9 years	122	36.8 %
10-14 years	194	58.6 %
<b>Weight (Mean)</b>		
2-4 years	16 (11-17)	4.8 %
5-9 years	276 (18-34)	83.3 %
10-14 years	39 (22-58)	11.7 %
Fever >38 C	305	92.1 %
Leukocytosis	308	93 %
Ultrasound	150	45.3 %
Free Fluid	130	39.2 %
<b>Grade of Inflammation</b>		
Suppuration	200	60.4 %
Gangrenous	81	24.4 %
Perforated	50	15.1 %

**Table II :Per-Operative and Post-Operative Complications**

Complications	Number of patients	Percentages
Visceral injury	Nil	0%
Vascular injury	Nil	0%
Bleeding	Nil	0%
Conversion to open	Nil	0%
Wound infection	1	0.3 %
Post-operative intraabdominal collection	Nil	0%

## Discussion

Acute appendicitis (AA) is a childhood disease being more common in boys (63%).<sup>11</sup> In our series, there are 62% boys and 38% girls.

The mean age of AA is 10 years<sup>12,13</sup>. Diagnostic delay in AA leads to advanced appendicitis with gangrene and perforation<sup>14,15</sup>. In our series, there is an average

delay of consultation for AA within 2 days. In another study a duration of 6 days prior to consultation showed 74% cases of advanced appendicitis. In cases where there is doubt in diagnosis, clinical evaluation should be complemented with abdominal and pelvic ultrasound and CT scan abdomen for confirmation.<sup>16,17</sup>

Preoperative antibiotics including 2<sup>nd</sup> generation cephalosporin and metronidazole were given in all patients prior to surgery in our series.

Minimal invasive surgery in pediatric age group is being practiced all over the world as in other surgical disciplines. Increasing experience in minimal invasive surgery, improvement in surgical techniques and advancement in technology all have made superior outcome possible with LA possible as compared to open appendectomy (OA).<sup>18,19</sup>

LA is the most common procedure in children followed by laparoscopic cholecystectomy. LA has a natural attraction as in all minimal invasive procedures.<sup>20, 21</sup> This is due to decrease in postoperative pain, early return to routine activities and excellent cosmetic outcome.<sup>22</sup>

The mean operating time in our series was 45 minutes which is comparable to that of the literature.<sup>23, 24</sup> Several authors have already demonstrated that, with increased experience, the operative time with LA for advanced appendicitis is same as with OA.<sup>25</sup> The conversion of LA to OA varies from 0% to 11%. The average conversion rate is reported as 2.8%.<sup>26,27</sup> The conversion reasons may include unusual appendicular position, perforated appendicitis, and a gangrenous appendix involving its base or Meckel's diverticulitis.<sup>28</sup> Another reason for conversion reported is technical difficulties.<sup>29</sup> In our series we did not need conversion to OA in any patient.

The gross pathology noticed in our series of AA is either suppurative, gangrenous or perforated appendix. Two doses of post-operative antibiotic therapy were administered in simple cases of AA and after 48 hours of being afebrile with an average of 5 days in advanced appendicitis. The mean hospital stay in our series is 3 days in simple appendicitis which is comparable with other studies<sup>30,31</sup>. The rate of wound infection is reported less in LA as compared to OA<sup>32, 33</sup>. In our series only one patient had an umbilical wound infection which was treated by

intravenous antibiotics according to report of culture sensitivity. There is controversy in determination of risk factors leading to intraabdominal collections in advanced appendicitis. Some authors have reported higher incidence of this complication after LA with perforated appendicitis. However, most of the series have reported decreased rate of intraabdominal abscess formation in advanced appendicitis treated by LA<sup>34</sup>. In our series, there is no case of postoperative intraabdominal collection.

The overall incidence of adhesive small bowel obstruction due to adhesions following appendectomy in children is reported relatively low (0.7-3%)<sup>35,36</sup>. However appendectomy is the most common abdominal surgical procedure in childhood with a lifelong risk of developing small bowel obstruction of 7-8%<sup>37,38</sup>. LA may have the advantage of decreased formation of adhesions compared to OA as it causes less trauma to abdominal wall and operative site<sup>39,40</sup>. Available studies on adhesive small bowel obstruction in children comparing LA and OA are relatively few compared to studies in adults and the results are conflicting.

Laparoscopy provides a good opportunity to follow surgical principle "to see in order to properly operate"<sup>41</sup>. LA is no longer considered as a luxury but an important surgical treatment as it can resolve many problems under direct vision<sup>42</sup>. Marker et al<sup>24</sup> have reported that decreased duration of hospital admission and early resumption of routine life activities minimizes the psychological effects on children. In our series, all patients returned to routine life activities within 8 days and the families and children were found happy as regards the cosmetic outcome of LA. This is an important point to keep into consideration while treating children.

## Conclusion

LA in children is feasible, effective, safe and appropriate procedure in treatment of AA in children with excellent cosmetic outcome.

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#### CONFLICT OF INTEREST

Authors declared no conflicts of Interest.

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#### DATA SHARING STATMENT

The data that support the findings of this study are available from the corresponding author upon request.

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