



ORIGINAL ARTICLE

# Laparoscopic versus Open Appendectomy in the Management of All Stages of Acute Appendicitis in Children: A Retrospective Study

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Received Feb 4, 2010; received in revised form Oct 4, 2011; accepted Nov 3, 2011

## Key Words

children;  
laparoscopic  
appendectomy;  
open appendectomy

**Background:** We conducted this study in order to evaluate whether laparoscopic appendectomy was an alternative therapeutic tool to open appendectomy for all stages of pediatric appendicitis.

**Materials and Methods:** Between January 2000 and November 2004, the charts of 177 children who underwent appendectomy by a single surgeon were reviewed. The patients were divided into open and laparoscopic appendectomy groups. Each group was subdivided into three stages: simple appendicitis, perforated appendicitis, and appendicitis with abscess. The age, gender, white blood cell count, absolute neutrophil count, C-reactive protein, operating time, duration of postoperative hospital stay, minor and major complications, and use of intravenous analgesia were recorded. Fisher's exact and Student's *t*-test were used for statistical analysis.

**Results:** There were fewer minor complications (9/32 vs. 0/20,  $p = 0.009$ ) in perforated appendicitis stage and fewer major complications (9/26 vs. 1/24,  $p = 0.011$ ) in appendicitis with abscess stage between open and laparoscopic appendectomy group. But surgery for each laparoscopic appendectomy group took longer to perform than for the corresponding open appendectomy group in each stage ( $p < 0.05$ ). There was no significant difference in other data between corresponding groups in each stage.

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*Conclusion:* Laparoscopic appendectomy may be considered a better alternative to open appendectomy for children with perforated appendicitis and appendicitis with abscess. Copyright © 2012, Taiwan Pediatric Association. Published by Elsevier Taiwan LLC. All rights reserved.

## 1. Introduction

Acute appendicitis is one of the most common indications for emergent surgical intervention in children. Laparoscopic appendectomy (LA) has been adopted by pediatric surgeons for several years, and most comparative studies of laparoscopic and open appendectomy have supported laparoscopic appendectomy as an alternative to open appendectomy (OA) in management of simple appendicitis.<sup>1,2</sup> However, the role of LA in management of complicated appendicitis in children is controversial.<sup>3–7</sup> We were particularly interested in the comparative outcomes of laparoscopy for complicated appendicitis. In this study, complicated appendicitis was further subdivided to perforated appendicitis and appendicitis with abscess on the basis of severity. The aim of this study was to evaluate whether LA was an alternative therapeutic tool to OA in all stages of pediatric appendicitis, including simple appendicitis, perforated appendicitis, and appendicitis with abscess.

## 2. Materials and Methods

Patients with principal International Classification of Disease, Ninth Revision, Clinical Modification (ICD-9-CM) codes for appendicitis and age  $\leq 18$  years old were selected at the Kaohsiung Chang Gung Memorial Hospital between January 2000 and November 2004. These patients received appendectomy mostly because of common symptoms of acute appendicitis such as abdominal pain, especially over the right lower quadrant, fever, anorexia, nausea and vomiting (duration of symptoms  $< 5$  days) as well as laboratory data including leukocytosis or high C-reactive protein (CRP). In addition, it was also a common indication for appendectomy that acute appendicitis was suspected highly by abdominal ultrasound or abdominal computed tomography (CT). If duration of symptoms had lasted for more than 5 days, the patient would receive empirical antibiotics treatment first and received interval appendectomy 12 weeks later. These patients receiving interval appendectomy were not enrolled in this study. Antibiotics were not used routinely before surgery. The usage of postoperative antibiotics was generally for 2–3 days in the simple appendicitis group and 5–7 days in the perforated appendicitis and appendicitis with abscess groups, in accordance with the patient's situation.

Clinical and laboratory information was obtained by reviewing patients' medical records, including the age, gender, white blood cell count (WBC), absolute neutrophil count (ANC), CRP, operating time, duration of postoperative hospital stay, minor and major complications, as well as the use of intravenous (IV) analgesia. All patients received OA during the duration before laparoscopy

became available in our hospital, and all patients received LA during the duration after laparoscopy was available in our hospital. However, when reviewing the charts, conversion from LA to OA was found in two patients with appendicitis with abscess due to severe inflammatory adhesions. These two patients were not enrolled in this study. Thus, these patients were divided by the procedure for appendectomy into two groups, OA and LA. Each group was further subdivided into three stages: simple appendicitis, perforated appendicitis, and appendicitis with abscess formation. These three stages were mainly divided by the description of operation notes, and the allocation was assisted by pathological report. Erythematous change and swelling of appendices were allocated into the groups of simple appendicitis. Gangrenous change and microscopic or gross perforation of appendices with / without minimal clear ascites were allocated into the groups of perforated appendicitis. Ruptured appendices with gross pus coating or turbid ascites or abscess formations with severe inflammatory adhesion were allocated into the groups of appendicitis with abscess. So there were a total of six subgroups in this study.

OA was performed by using a standard muscle-splitting approach in the right iliac fossa. The appendix was removed and stump was ligated. LA was performed by three-trocar technique (Karl Storz, Germany), the meso-appendix was controlled with laparoscopic bipolar cautery (Karl Storz, Germany), and the appendix base was tied with a single endoloop (Covidien, USA). The appendix was removed through the left iliac fossa port or the umbilical port. All appendices were examined histologically. All operations were performed by a single pediatric attending surgeon experienced in open and laparoscopic appendectomies.

The operating time was from finishing anesthesia to the last suture insertion, obtained in the operation notes. The hospital stay was the duration between the date for surgery and the date of discharge. The criteria for discharge of patient included no fever, eating well, and no tenderness over the abdomen in physical examination.

Minor complications were defined as abdominal distension / vomiting or paralytic ileus, development of an antibiotic-related rash, suture granuloma, as well as outpatient evaluation of complaints of nausea / vomiting, fever, pain or diarrhea. Major complications included wound infections, intra-abdominal abscess, as well as 30-day readmission for evaluation of complaints of nausea / vomiting, fever, pain or diarrhea.

The intravenous analgesia (meperidine or ketorolac for those over 2 years old and diphenhydramine for those less than 2 years old) was administered when patients voiced complaints of severe abdominal pain.

Statistical analysis was performed by Fisher's exact test and Student's *t*-test using the Statistical Package for the

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