

Assessment of the Outcomes of Laparoscopic Versus Open Appendectomy: A Cross-sectional Study

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ABSTRACT

Introduction: We conducted a cross-sectional study in two institutions for reviewing the postoperative complications of laparoscopic appendectomy vs open appendectomy for complicated appendicitis. The primary objectives were detection of surgical site infection and reoperation within 30 days postoperatively. The secondary objectives were reducing the length of hospital stay, increasing patient satisfaction level, and identifying other diseases and postoperative complications like pneumonia, deep vein thrombosis, bedsores, and enterocutaneous fistulas. **Materials and Methods:** We analyzed 683 patients that met the inclusion criteria and their clinical data and hospital costs. The patients were divided into two groups: open appendectomy (OA) group and laparoscopic appendectomy (LA) group. The collected clinical data included demographic data, co-morbidities, initial laboratory findings, operation time, intraoperative findings (acute, gangrenous or perforated appendix), time to soft diet, postoperative hospital stay, amount of analgesics and postoperative complications. **Results:** The laparoscopic group required fewer doses of parenteral and oral analgesics in the operative and postoperative periods compared with the open appendectomy ($P < 0.0001$). Bowel movements in the first postoperative day were observed in 93.5% patients subjected to laparoscopic appendectomy and 68.1% in the open group ($P < 0.001$). As a result, 86.8% patients in the laparoscopic group and 61.1% in the open group were able to tolerate a liquid diet within the first 24 postoperative hours ($P < 0.001$). **Conclusion:** Our results showed the advantages of the laparoscopic approach over open appendectomy including shorter hospital stay, decreased need for postoperative analgesia, early food tolerance, earlier return to work, lower rate of wound infection, against only marginally higher hospital costs. Furthermore we found a considerable preference (during the collection of consent) of patients and a high satisfaction after the surgery in the laparoscopic group.

Keywords: Laparoscopic, appendectomy, Surgery, Management

Asian Pac. J. Health Sci., (2021); DOI: 10.21276/apjhs.2021.8.1.23

INTRODUCTION

Approximately 7–10 % of the general population develops acute appendicitis with the maximal incidence being in the second and third decades of life.¹ Open appendectomy has been the gold standard for treating patients with acute appendicitis for more than a century, but the efficiency and superiority of laparoscopic approach compared to the open technique is the subject of much debate nowadays.¹⁻³ There is evidence that minimal surgical trauma through laparoscopic approach resulted in significant shorter hospital stay, less postoperative pain, faster return to daily activities in several settings related with gastrointestinal surgery.^{4,5}

The basic surgical approach involved in the management of perforated appendicitis has not undergone remarkable change over the past century. Laparoscopic appendectomy (LA) is minimally invasive and associated with less postoperative pain.⁶ LA has been widely practiced for the treatment of uncomplicated appendicitis; various reports have demonstrated its merits in assisting diagnosis, reducing postoperative pain, and requiring an analgesic, thereby reducing the incidence of surgical site infection. However, the advantages of laparoscopic surgery in the management of complicated appendicitis, i.e. gangrenous, perforated appendicitis, and appendicular abscess remain unclear. Park et al. suggested that a laparoscopic approach should be the treatment of choice for presumed perforated appendicitis. It has the benefit of simultaneously addressing alternative pathologies.⁷ Currently, the choice of operative approach depends mostly at the surgeons' discretion.⁸ A Cochrane study conducted by Koch et al. reported that LA increases the rate of intra-abdominal abscess (IAA) in adults and observed a similar trend in children. However, another Cochrane study

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How to cite this article: Agarwal G. Assessment of the Outcomes of Laparoscopic Versus Open Appendectomy: A Cross-sectional Study. *Asian Pac. J. Health Sci.*, 2021;8(1):104-107.

Source of support: Nil

Conflicts of interest: None.

Received: 06/12/2020 **Revised:** 11/01/2021 **Accepted:** 21/01/2021

published in 2010 performed on adults noted that laparoscopic appendectomy is advantageous in complicated appendicitis in terms of reducing surgical site infections (SSIs), causing no significant additional risk of IAA.⁹

The first laparoscopic appendectomy (LA) was performed by Semm, a German gynecologist in 1983,¹⁰ while the first LA in children was performed in 1992 by Ure and coworkers.¹¹ Since that, many trials reported good outcomes with LA for uncomplicated appendicitis due to its advantages, especially faster return to normal activity, less postoperative pain, and decreased postoperative complications.¹²

The advantages of laparoscopic appendectomy in complicated appendicitis have been reported by many studies.¹³⁻¹⁶ On the other hand, others reported some disadvantages including intra-abdominal abscess and wound infection, longer operative time, increased skill level needed, and higher costs.¹⁷⁻¹⁹

Our work aims to compare the intraoperative and postoperative outcomes of LA versus OA in complicated appendicitis in children in our center.

METHODS

The decision about the type of the operation was made according to the preference and experience of the surgical team on duty. We analyzed 683 patients that met the inclusion criteria and their clinical data and hospital costs. The patients were divided into two groups: open appendectomy (OA) group and laparoscopic appendectomy (LA) group. The collected clinical data included demographic data, co-morbidities, initial laboratory findings, operation time, intraoperative findings (acute, gangrenous or perforated appendix), time to soft diet, postoperative hospital stay, amount of analgesics and postoperative complications. We analyzed data on cost separately. The diagnosis was made clinically with history (right iliac fossa or periumbilical pain, nausea/vomiting), physical examination (tenderness or guarding in right iliac fossa). In patients where a clinical diagnosis could not be established, imaging studies such as abdominal ultrasound or CT were performed. Both groups of patients were given a prophylactic dose of third-generation cephalosporin and metronidazole at induction of the general anesthesia as part of the protocol. OA was performed through standard McBurney incision. After the incision, peritoneum was accessed and opened to deliver the appendix, which was removed in the usual manner. A standard 3-port technique was used for laparoscopic group. Pneumoperitoneum was produced by a continuous pressure of 12–14 mmHg of carbon dioxide via a Verres canula, positioned in infraumbilical site.

The collected data was analyzed using the software SPSS version 20. Quantitative variables were described using their means and standard deviations. Categorical variables were described using their absolute frequencies and were compared using Chi square test and Fisher exact test when appropriate. Independent sample *t* test (used with normally distributed data) was used to compare means of two groups. The level of statistical significance was set at 5% ($p < 0.05$). Highly significant difference was present if $p \leq 0.001$.

RESULTS

Out of 683 patients with acute appendicitis, 355 patients underwent open appendectomy and 328 patients underwent laparoscopic appendectomy. Demographic data and preoperative clinical feature between OA group and LA group are showed in Table 1.

Table 1: Demographic and preoperative clinical data

	Open appendectomy (n = 355)	Laparoscopic P appendectomy (n = 328)	P value
Gender			<0.001
Male	206 (58.0)	143 (43.5)	
Female	149 (41.9)	185 (56.4)	
Mean age	30.63 ± 16.11	28.71 ± 15.21	0.58
WBC count (per mm ³)	14906 ± 4689	13348 ± 5453	0.0002
Co-morbidities			0.248
CAD	7 (1.9)	6 (1.8)	
Hypertension	19 (5.3)	10 (3.0)	
COPD	10 (2.8)	7 (2.1)	
DM	13(3.6)	6(1.8)	

There were no significant differences with respect to age and associated comorbidities. On the contrary, the difference in gender and in the white blood cell count at presentation was statistically significant. Out of the total 355 open procedures, 245 (69.0 %) were performed for uncomplicated appendicitis and 110 (30.9%) for complicated disease including appendiceal perforation with local or widespread peritonitis. In the laparoscopic group, 280 (85.5%) procedures involved uncomplicated disease and 48 (14.6%) complicated appendicitis. Noteworthy, we did not observe differences between groups for all the grades of appendicitis (Table 2).

The laparoscopic group required fewer doses of parenteral and oral analgesics in the operative and post-operative periods compared with the open appendectomy ($P < 0.0001$). Bowel movements in the first postoperative day were observed in 93.5% patients subjected to laparoscopic appendectomy and 68.1% in the open group ($P < 0.001$). As a result, 86.8% patients in the laparoscopic group and 61.1% in the open group were able to tolerate a liquid diet within the first 24 postoperative hours ($P < 0.001$). Hospital stay was significantly shorter in the laparoscopic group with a mean ± SD of 1.3 ± 0.8 days compared with 3.4 ± 3.2 of the open appendectomy group ($P = 0.018$). A highly significant difference existed between the 2 groups in time taken to return to routine daily activities, which was less in the laparoscopic group with a mean 12.6 ± 4.4 days compared with mean 17.3 ± 4.1 days in the open appendectomy group (Table 3).

DISCUSSION

The possibility of appendicitis must be considered in any patient presenting with an acute abdomen, and a certain pre-operative diagnosis is still a challenge.^{20,21} Although more than 20 years have elapsed since the introduction of laparoscopic appendectomy (performed in 1983 by Semm, a gynaecologist), open appendectomy is still the conventional technique. Some authors consider emergency laparoscopy as a promising tool for the treatment of abdominal emergencies able to decrease costs and invasiveness and maximize outcomes and patients' comfort.^{22,23}

The need for intraperitoneal drain insertion was significantly lower with LA than OA ($p = 0.001$). This significance was also reported by Horvath et al.²⁴ we explained that the laparoscopic technique offers a good vision to the entire abdomen and that enables the surgeon to achieve a careful suction from every quadrant having collections.

Conversion from laparoscopic to OA occurred with 2 cases included in this study (6.7%); one of them, the appendix was inaccessible due to extensive adhesions, and the other was perforated closely to the cecum, and it was difficult to ligate the appendix. This rate of conversion was nearly the same with that published by Thomson et al.²⁵ which occurred with 5% of their

Table 2: Surgical findings

	Open appendectomy (n = 355)	Laparoscopic P appendectomy (n = 328)	P value
Surgical findings, n (%)			0.074
Uncomplicated acute appendicitis	245 (69.0)	280 (85.5)	
Gangrenous appendicitis	27 (7.6)	15 (4.5)	
Appendiceal abscess	43 (12.1)	24 (7.3)	
Peritonitis	40 (11.2)	9 (2.7)	

Table 3: Operative and postoperative clinical data

	Open appendectomy (n = 355)	Laparoscopic P appendectomy (n = 328)	P value
Operative time (min)	32.31 ± 12.48	55.7 ± 15.9	<0.0001
Bowel movements (1 st POD)	242 (68.1)	307 (93.5)	<0.001
Time until diet (1 st POD)	218 (61.4)	285 (86.8)	<0.001
Parenteral analgesics (doses/day)	2.3 ± 0.8	1.3 ± 0.8	0.001
Oral analgesics (doses/ day)	3.00 ± 3.21	1.89 ± 1.19	<0.0001
Hospital Stay (day)	3.4 ± 3.2	1.8 ± 0.8	0.018
Return to normal activity (day)	17.3 ± 4.1	12.6 ± 4.4	<0.001

cases. Other publications reported fewer rate of conversion from laparoscopic to open, such as Kassem et al.²⁶ who reported the conversion to open in 2.4% of cases. This rate may differ according to the severity of the individual case. Additionally, using "Ligasure[®], Covidien, USA" was reported to decrease the rate of conversion to open, especially in case of gangrenous tissue.²⁷

The time taken to start oral intake was significantly shorter after LA than OA by 0.47 days, which was comparable to other published studies.^{28,29} This could be explained by the advantages of the laparoscopic technique which is less traumatic to the abdominal wall and peritoneal cavity, associated with lower chance for introducing foreign bodies, provides better ability for hemostasis and associated with quicker return of bowel motility.

The present study showed that the hospital stay was significantly shorter after LA than OA by (0.9 day), which was nearly similar to that reported by Xuan et al. in their meta-analysis³⁰ and also the recent Cochrane systemic review which was (0.8 day) in favor of LA.³¹ These results could be explained as LA is associated with less surgical stress, early mobilization, early oral intake, and less postoperative pain.

The reoperation rate in LA (0.7%) and OA (1%) group was lower despite statistically insignificant data. This does not correspond to a study done by Vahdad et al. who stated that LA had reduced reoperation compared to OA.³² Wound infection remains the highest morbidity after appendectomy; however, the intraabdominal collection is a major concern after performing operation for perforated appendicitis in the pediatric population. In our study, surgical site infection was low in the LA group compared to the OA group which corroborates findings in previous studies.³²⁻³⁴

Limitations of our study included the lack of evaluation of laparoscopic surgery in obese patients, as we did not collect data on body mass index (BMI). Moreover the follow up period was only limited to two weeks after hospital discharge.

CONCLUSIONS

Our results showed the advantages of the laparoscopic approach over open appendectomy including shorter hospital stay, decreased need for postoperative analgesia, early food tolerance, earlier return to work, lower rate of wound infection, against only marginally higher hospital costs. Furthermore we found a considerable preference (during the collection of consent) of patients and a high satisfaction after the surgery in the laparoscopic group. Although the incidence of intra-abdominal abscess formation was higher after laparoscopic appendectomy,

greater experience and improvements in our technique may have eradicated this catastrophic complication. Provided that surgical experience and equipment are available, laparoscopy could be considered safe and equally efficient compared to open technique and should be undertaken as the initial procedure of choice for most case of suspected appendicitis.

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