ORIGINAL ARTICLE

Laparoscopic or Open Appendectomy: Which Approach is the Best for Complicated Appendicitis?

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Abstract

Introduction: Appendicitis is more common in children and young adults. Treatment of appendicitis is either laparoscopic appendicectomy (LA) or open appendicectomy (OA) surgery.

Aim and objective: The 30-day postoperative morbidity, surgical site infection, and reoperation rate were compared between open and laparoscopic appendicectomies for complicated appendicitis. Secondary outcome measures were the length of hospital stay, duration of surgery, surgical waiting time, identification of other diseases, and patient satisfaction.

Materials and methods: This retrospective study was conducted in two institutions: Hospital Selayang, Selangor, Malaysia, and HUKM, Kuala Lumpur, Malaysia. Data were collected from January 2014 to December 2015 were reviewed.

Results: The mean age (±SD) for LA and OA were 32 (±15) and 30 (±14) years, respectively. The males showed predominance in LA and OA with 52 and 72%, respectively ($p < 0.001$). The majority of LA (73%) and OA (88%) were performed by the trainees ($p < 0.001$). There was a significant reduction in postoperative morbidity in LA compared to OA in terms of surgical site infection, LA vs OA [$n = 8$ (2.7) vs 26 (6.3), $p = 0.029$] and duration of surgery [LA vs OA 84 (±39) vs 68 (± 6) days ($p < 0.001$)]. However, for LA and OA, there were no significant differences in reoperation, 0.7 and 1.0%, respectively ($p = 1.000$), and length of stay in LA vs OA 3.55 (±2) vs 3.89 (±3) days, respectively ($p = 0.103$). Overall, patient satisfaction scores were not found statistically significant as the response rates were only 32% in LA and 30% in OA.

Conclusion: LA significantly reduced surgical site infection and offered an advantage in the detection of other pathologies. Hence, a laparoscopic approach should be offered to patients whose clinical diagnoses are challenging.

Keywords: Laparoscopic, Appendectomy, Complicated appendicitis.

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Introduction

Appendicitis is more common among children and young adults. It is uncommon in the elderly where the differential diagnoses are variable. In young patients, the perforation rate of acute appendicitis is less than 20%. However, among the elderly patients, perforation rate accounts for about 70% or even as high as 90%.[1]

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.[2] 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.[3] Currently, the choice of operative approach depends mostly at the surgeons' discretion.[4] 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 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.[5]

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.

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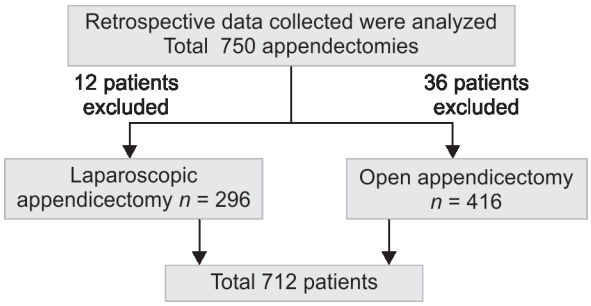
Table 1: Inclusion and exclusion criteria for patient selection for the study

Inclusion criteria	*Exclusion criteria*
Age 13 years and over	Age under 13-years
Patient with confirmed complicated appendicitis intraoperative or histologically	The patient presented with an appendicular mass
Patient with laparoscopic converted to open appendectomy	The patient who had developed complications like abscess collection, reoperation, etc. after 30 days postoperatively

Flowchart 1: Patients recruitment



Materials and Methods

Background and Study Design

The medical records of the patients who underwent LA from January 2014 to December 2015 were reviewed. Two clinical centers: Hospital Selayang in Selangor, and Hospital University Kebangsaan Malaysia (HUKM) in Kuala Lumpur were chosen for this study. These two hospitals are the tertiary hospitals that offer wide spectra of medical services including minimally invasive surgery (MIS) facilities. LA and OA were performed by different specialists or trainees in both hospitals. The patients were selected depending on the inclusion and exclusion criteria (Table 1).

Patients with earlier laparoscopic appendectomy and converted to open appendectomy were included in the study and grouped into the laparoscopic group (Flowchart 1).

Data on preoperative, intraoperative, and postoperative parameters were collected and properly maintained. The variable analyses included demographics data, comorbid factors, operative procedures and duration, and postoperative complications and outcomes, such as surgical site infection, reoperation, length of hospital stay, and patient satisfaction level. The 30-day postoperative morbidity data collected were: surgical site infection, reoperation, length of hospital stay, and enterocutaneous fistula rate.

Operative Method

A clinical diagnosis of perforated appendicitis was done by the on-call surgeon based on the signs and symptoms, i.e., right lower abdominal pain, particularly in the right iliac fossa, fever, and other associated symptoms. Antibiotics were started while waiting for the operation. The operation was done immediately after the operation theatre was available. Surgery was performed under general anesthesia and the patient was placed in a supine position. All patients underwent laparoscopic and open appendectomy depending upon the surgeon's preferences. A standard laparoscopic approach was employed for laparoscopic appendectomy using 3-port LC techniques with surgeons on the left side of the patient. The patient was catheterized preoperatively. A midline infraumbilical skin incision was made followed by the insertion of a 10-mm trocar for the camera-port. Carbon dioxide gas was insufflated at a pressure of 10–12 mm Hg. Another 5-mm trocar was inserted under camera vision, at the suprapubic area on the midline. At the last port, a 5-mm trocar was inserted on a left side abdomen under direct vision. For open appendectomy, Lanz incision was performed on almost all the patients; all appendectomies involved a muscle-splitting right lower quadrant incision. The appendix and any adherent omentum were removed. Irrigation was performed for both LA and OA.

Postoperatively, most of the patients were prescribed oral analgesics and allowed orally gradually. Intravenous antibiotics were continued for a few days postoperatively and the patients were subsequently discharged with oral antibiotics to complete one week course.

Definition of Terms

Perforated appendicitis: Intraoperative evidence of perforation or intra-abdominal fecalith.

Complicated appendicitis: Gangrenous, macerated, or grossly inflamed with pus collection or suppurative appendicitis and including perforated appendicitis.

Surgical site infection (SSI): Operative wound site that showed purulent discharge associated with surrounding cellulitis with other inflammatory signs and that needed to be opened. It can be superficial incisional, deep incisional, and organ or space infection. Superficial incisional SSI is infection up to subcutaneous tissue; deep incisional SSI is infection up to fascia and muscle; organ and space infection SSI is an abdominal infection.

Abscess collection: The intra-abdominal collection is confirmed by radiological imaging and needs to be drained by surgery, percutaneous drainage, or continuation of antibiotics.

Enterocutaneous fistula: Communications between bowel and skin causing discharging of bowel contents.

Reoperation: Reoperation is a second surgical procedure performed in the same site for the same indications.

Specialist: A person who has completed a Master's in surgery or any other specific fellowship training program.

Trainee: A person who performs the duty of a medical officer and/or is in the Master of the surgery training program.

Results

A total of 712 patients with acute appendicitis were admitted to and operated upon during the study period of two years from January 2014 to December 2015 at Hospital Selayang and Hospital Universiti Kebangsaan Malaysia (HUKM). A majority (58.4%) of the cases involved open appendectomy. The mean age of the patients for OA and LA were 30 (±14) and 32 (±15) years, respectively. The majority of cases were male in both procedures; 72.8% for open appendectomy and 52.4% for laparoscopic appendectomy (Table 2). Most of the

Table 2: Sociodemographic characteristics, procedure characteristics, intraoperative findings, and histopathological examination report of two procedures

Characteristics	*Open appendectomy n (%)*	*Laparoscopic appendectomy n (%)*	*p-value*
Age (years)[a], mean ± SD	30.12 ± 14.26	32.16 ± 14.87	0.065
Gender[b]			<0.001*
Male	303 (72.8)	155 (52.4)	
Female	113 (27.2)	141 (47.6)	
Surgeon[b]			<0.001*
Trainee	370 (88.9)	217 (73.3)	
Surgeon	46 (11.1)	79 (26.7)	
Intraoperative findings[b]			<0.001*
Perforated appendicitis	231 (55.5)	83 (28.0)	
Gangrenous appendicitis	18 (4.3)	3 (1.00)	
Macerated appendicitis	18 (4.3)	3 (1.0)	
Grossly inflamed appendicitis	127 (30.6)	111 (37.5)	
Appendicular mass	3 (0.7)	4 (1.4)	
Suppurative appendicitis	9 (2.2)	44 (14.9)	
Other pathologies	6 (1.4)	35 (11.8)	
Acute appendicitis	4 (1.0)	13 (4.4)	
HPE[b]			
Acute appendicitis with perforation	135 (32.5)	78 (26.4)	<0.001*
Gangrenous appendicitis with perforation	20 (4.8)	8 (2.7)	
Suppurative appendicitis with perforation	100 (24.0)	30 (10.1)	
Acute suppurative appendicitis	58 (13.9)	37 (12.5)	
Acute appendicitis	87 (20.9)	96 (32.4)	
Gangrenous appendicitis	1 (0.2)	0 (0.0)	
Other pathology	15 (3.6)	24 (8.1)	
Appendicular abscess	0 (0.0)	1 (0.3)	
Normal appendix	0 (0.0)	19 (6.4)	

*Significant if *p*-value < 0.05; [a]Independent *t*-test; [b]Chi-squared test

patients (>88.0%) for both the procedures reported no prior medical illness and some of the cases with premorbid reported more than one disease for both procedures (>3.0%); usually diabetes mellitus ($n = 18$) and hypertension ($n = 17$).

The majority of appendectomies were performed by the trainees as compared to the surgeons. The intraoperative findings showed variation. Intraoperative findings and histopathology reports that fulfilled the inclusion criteria were included in this study. Other pathologies that were identified in OA and LA group included gynecological pathologies, such as pelvic inflammatory disease, ovarian tumor, colonic tumor, diverticulitis, and colitis, and a bowel perforation. Most of the other pathologies were identified in LA group: 35 (11.8) vs 6 (1.4) in the OA group. Gender of the patients ($p < 0.001$), operating surgeon ($p < 0.001$), intraoperative findings, and histopathology examination results revealed a significant association with the method of appendectomy performed.

Outcomes and Complications

Overall, the rate of reoperation for open appendectomy was 1.0% and reoperation for laparoscopic appendectomy was 0.7%. The reoperation was performed mainly due to intra-abdominal sepsis. Surgical site infection was higher for open appendectomy compared to laparoscopic appendectomy, 26 (6.3%) vs 8 (2.7), respectively, with a statistically significant *p*-value of 0.029. In the LA group, there were two patients with abscess collection: one required open drainage, and the other required laparotomy drainage. In the OA group, 11 patients needed abscess collection, two patients required drainage percutaneous and one patient required laparotomy. The subsequent patients were treated conservatively. There were no patients with enterocutaneous fistulas and no postoperative deep vein thrombosis in both groups. Only one patient developed sacral sore postoperatively and two patients developed hospital-acquired pneumonia. One patient had intestinal obstruction which required laparotomy.

Length of stay for the LA group was 3.55 ± 2 days while for the OA group, 3.89 ± 3 days, with a *p*-value of 0.103 which was statistically insignificant. Duration of surgery was longer in the LA group with a mean of 84.38 ± 39.13 days compared to in the OA group, 68.36 ± 35.97 days, with a *p*-value of <0.001 which was statistically significant. Waiting time in the OA group, 427.34 ± 398.97 days, was longer compared to 320.30 ± 222.36 days in the LA group with a *p*-value < 0.001, which was statistically significant.

There was a significant association of postoperative complications between LA and OA groups in surgical site infection ($p = 0.029$), duration of surgery ($p < 0.001$), and waiting time of surgery ($p < 0.001$).

The subanalysis of the SSI and reoperation rate association between the trainees and the surgeon showed insignificant association (Table 3). However, there was a significant association between surgeon and SSI for OA and LA. Of total, 16/26 (61.5%) OA surgeries were done by the trainees and 10/26 (38.5%) OA surgeries were done by the surgeons developed SSI with a *p*-value of 0.001.

Table 3: Association between surgeon and trainee SSI

Surgeon	*Surgical site infection[a]*					
	Open appendectomy			*Lap appendectomy*		
	Yes	*No*	*p-value*	*Yes*	*No*	*p-value*
Trainee	16 (61.5)	354 (90.8)	<0.001*	4 (50.0)	213 (74.0)	0.216
Surgeon	10 (38.5)	36 (9.2)		4 (50.0)	75 (26.0)	
Surgeon	*Reoperation[a]*					
	Open appendectomy			*Lap appendectomy*		
	Yes	No	*p-value*	Yes	No	*p-value*
Trainee	2 (50.0)	368 (89.3)	0.062	1 (50.0)	216 (73.5)	0.463
Surgeon	2 (50.0)	44 (10.7)		1 (50.0)	78 (26.5)	

*Significant if *p*-value < 0.05; [a]Chi-squared test

Discussion

Acute appendicitis course of the disease may later progress to complicated appendicitis if not treated at an earlier stage. The late presentation may lead to disastrous morbidity and mortality.

In our study, appendicitis was more common in young male adults, as the mean age group for LA vs OA was 32 (±15) and 30 (±14) years, respectively. A study done by Yau et al. demonstrated similar demographic patient presentation.[6] However, different population studies conducted on pediatrics[4] and elderly patients' populations[7] found no significant difference in males and females in both OA and LA groups. Since the patients were young, no statistically significant comorbidities of patients with LA and OA groups could be observed.

In a tertiary center, surgeries were mostly done by a trainee rather than a surgeon, 88.9 vs 11.1% in the OA group and 73.3 vs 26.7% in the LA group. This is because appendicitis is among the most common acute surgical emergency and is one of the core competencies required for surgical trainees. Although most hospitals in developed countries are managing appendectomy laparoscopically, some hospitals are still practicing open appendectomy as the primary procedure for appendicitis.

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.[4] Wound infection[8] remains the highest morbidity after appendectomy; however, the intra-abdominal collection is a major concern after performing operation for perforated appendicitis in the pediatric population.[8] In our study, surgical site infection was low in the LA group compared to the OA group which corroborates findings in previous studies.[4,9,10]

Duration of surgery was longer in the LA group compared to the OA group with a *p*-value of <0.001. Because most of the cases in both groups were done by trainees, the duration of surgery was probably longer as the trainee was still in the learning curve of the laparoscopic procedure.[10,11]

The average length of hospital stays in this study was 3.55 days in the LA group compared to 3.89 days in the OA group as most of the patients were young and they progressed well after surgery.[9] However, in a meta-analysis done among the elderly patients, LA reduced in-hospital stay compared to OA.[12]

Mean waiting time for surgery in our study was longer in the OA group compared to the LA group 427 vs 320 minutes. We cannot explain this because we were doing studies in two hospitals and the cases waiting for emergency surgery in each hospital were different. However, most cases were managed to be done within 24 hours. Hornby et al., in their study, concluded that appendicitis is not more likely to lead to perforation if a short delay before surgery is allowed.[13]

We observed other advantages in the LA group that can identify other pathologies, such as gynecological pathology, particularly in women patients, colonic tumor, and diverticular disease. Casarotto et al. in their study among women patients suggested that the laparoscopic approach should be used in case of unclear abdominal pain.[14]

Many studies were done to compare laparoscopic appendectomy and open appendectomy; however, there is still not enough evidence to support that the laparoscopic approach is the standard procedure for complicated appendicitis. The shortcoming of the study is the lack of defined selection criteria for an operative approach for each patient. The decision for the operative approach is based on the surgeon's preferences. Hence, selection bias for the decision for surgical approach in this study could not be excluded.

Conclusion

Laparoscopic appendectomy is becoming more popular nowadays. The decision for laparoscopic or open appendectomy depends on the surgeon's preferences and hospital facility. Laparoscopic appendectomy is better than open appendectomy as it reduces surgical site infection. The other advantage of doing LA is we might be able to identify other pathology while doing the laparoscopic operation.

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