Laparoscopic versus open appendectomy for treatment of acute appendicitis: A prospective comparative study

Original Article

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ABSTRACT

Background & Aim: Appendicitis is the most prevalent operational emergency that occurs in any operative unit. It is the most prevalent disorder, necessitating an appendectomy. This research aimed to compare laparoscopic appendectomy (LA) and open appendectomy (OA) results regarding surgical duration, hospital stay, postoperative pain, wound infection, hospital mortality rate, and conversion rate from LA to OA.

Patients and Methods: It is a prospective comparative study of randomized double-blinded research for cases with clinical presentation of acute appendicitis conducted on 100 patients at Mansoura University Hospital, General Surgery Department. The period of study was 1 year from October 5, 2022 till October 5, 2023.

Results: There was a statistically significant higher rate of wound infection and a higher rate of postoperative pyrexia in the OA group compared with the LA) group with a *P value* less than 0.05. The conversion rate from LA to OA was 6% (three cases). None of the patients developed pelvic abscess or fecal fistula. Also, there was statistically significant longer operative time, longer hospital stay duration and more severe pain in the OA group compared to LA group P value less than 0.05.

Conclusion: We conclude that the laparoscopic approach is a safe and effective surgical technique for appendectomy, which provides clinically positive benefits over the open procedure, like a shorter hospitalization, a lower wound infection rate, and a lower VAS score postoperatively.

Key Words: Acute appendicitis, laparoscopic, open appendectomy.

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INTRODUCTION

Appendicitis is the most prevalent operational emergency that occurs in any operative unit. It is the most prevalent disorder, necessitating an appendectomy. Appendicitis presents a 6% lifelong risk. Acute appendicitis occurs in around 7–10% of the general public. Acute appendicitis is most frequently documented in individuals who are in their second or third decade of life[1].

In 1983, Kurt Semm, a German gynecologist, introduced laparoscopic appendectomy (LA). LA's popularity increased following its introduction. The laparoscopic method is currently the gold standard in the field of cholecystectomy, and was encouraged by its success in this field to be utilized in other operational fields. Additionally, this method has gained popularity[2].

In recent years, randomized research has demonstrated the superiority of LA over open appendectomy (OA). This method was established as having advantages over OA procedures regarding decreased wound infections, fewer incidences of vomiting, and lesser pain. Additionally, it is related to shorter hospitalizations and a quicker recovery duration[3].

If intraoperative complications or the disease extent prevent a safe laparoscopic intervention, a LA might require to be changed to an OA. This might manifest as adhesions resulting from prior inflammations, diffuse peritonitis, a perforated appendix, an appendix mass or abscess, other pelvic or right iliac fossa pathologies, or technical issues like insufficient space for dissection. Conversion to open operation might be necessary in a few cases despite the fact that these pathologies may be handled with limited operation[4].

This research aimed to compare LA and OA results regarding surgical duration, hospital stay, postoperative pain, wound infection, hospital mortality rate, and conversion rate from LA to OA.

PATIENTS AND METHODS:

The study is a prospective comparative study randomized double-blinded research for cases with

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clinical presentation of acute appendicitis conducted on 100 patients at Mansoura University Hospital, General Surgery Department. The period of the study was 1 year from October 5, 2022 till October 5, 2023. Patients have been randomly distributed into two equal groups utilizing the closed envelope technique: group I, which involved 50 cases that underwent OA and group II, which involved 50 cases that underwent LA.

Sample size calculation and power of the research

The sample size has been determined by comparing the pain score of cases that underwent LA versus OA for acute appendicitis, as determined by previous studies[5]. The sample size has been estimated utilizing the G power program, version 3.1.9.7, with an expected variance of 22.3%, a two-tailed test, an α error of 0.05, and a power of 95.0%. The total determined sample size was at least 50 in every group.

Inclusion criteria

Age group between 18 and 60 years old, both sexes and clinical diagnosis of acute appendicitis by history taking, laboratory investigation, as well as radiological investigations.

Exclusion criteria

Presence of appendicular mass, appendicular abscess, coagulation disorder, patients in whom laparoscopy is contraindicated, surgical history of having a previous major intraabdominal operation, age group below 18 years old or above 60 years old, psychiatric patients, and patients refuse the study.

Outcomes

Primary outcome measures: pain following surgery and secondary outcome measures: operative period, hospital stay duration, conversion rate from laparoscopic to OA, postoperative wound infection, wound dehiscence, and postoperative pyrexia.

Patients consent

Before participating in the trial, all cases provided written informed consent following being fully informed of the steps and drawbacks of each technique. Furthermore, the research has been accepted by Mansoura University's Institutional Research Board. Each individual has been evaluated by the same operational team, and each case has been operated on by a competent surgeon with a consultant degree at the time of operation, using standard method and technique.

Methods

All cases have been subjected to the following.

Patient evaluation

History: personal history, comorbid medical conditions and presenting symptoms and their duration. Examination: general examination and abdominal examination: palpation, inspection, auscultation, and percussion. Acute appendicitis is diagnosed by appendicitis is a common condition with early signs being subtle, such as low-grade fever reaching 38.3°C. In the initial stages, a physical examination may be irrelevant, as the visceral organs are not innervated with somatic pain fibers[6]. Localized tenderness in the right iliac fossa is induced by the involvement of the overlying parietal peritoneum as inflammation progresses, which can be detected on the abdominal examination. Common physical signs include Rovsing's sign, McBurney's point tenderness, obturator sign, and psoas sign. McBurney's point tenderness is maximal, while Rovsing's sign refers to right iliac fossa pain with left iliac fossa palpation[7]. The psoas sign is associated with a retrocecal appendix, while a pelvic appendix is linked to the obturator sign[8]. Routine laboratory examinations: hepatic and renal function tests, complete blood count, bleeding profile and prothrombin activity, urine analysis and urine pregnancy test beta-hCG (for any women of childbearing age). Ultrasound examination: abdominal ultrasonography was performed to assess radiological features of acute appendicitis, which include blind-ended tube with a diameter of more than 6 mm, single wall thickness more than or equal to 3 mm, surrounding fat stranding and periappendicular free fluid or collection, computed tomography abdominal examination: technique of choice for definitive assessment of suspected appendicitis[8]. Anesthetic consultation: all patients were assessed by anesthetic team, and they were classified according to American Society of Anesthesiologists score system for physical status.

The laparoscopic approach

LA is typically performed under general anesthesia[9]. The physician and assistant are situated on the patient's left side while the case is lying supine on the surgical table. Port placement is done to allow appropriate vision and exposure of the appendix[10]. A 12-mm periumbilical port has been utilized to obtain pneumoperitoneum, and exploratory laparoscopy is conducted through two ports. After identifying the appendix (Fig. 1), any adhesions to the adjacent structures might be dissected. Mesoappendix dissection is done using a monopolar cautery (Fig. 2). Appendix transaction involves ligation of the base using vicryl 2/0 and transition from its base (Fig. 3). For preventing wound infection, the appendix has been extracted through the umbilical port and placed in a specimen bag[11]. The operating field was checked for hemostasis and irrigated with saline if necessary (Fig. 4) before closing the skin incisions and fascial defect.

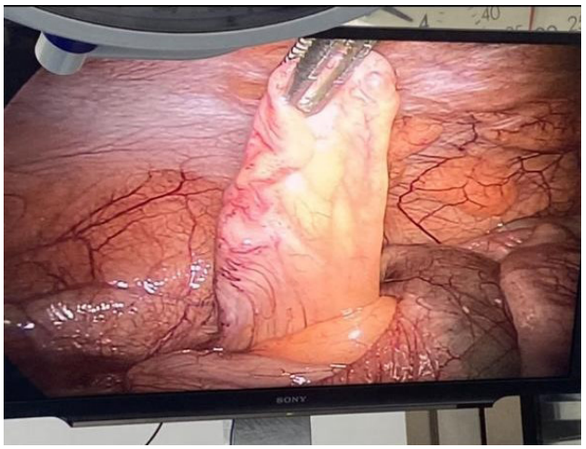


Fig. 1: Identification of the appendix.

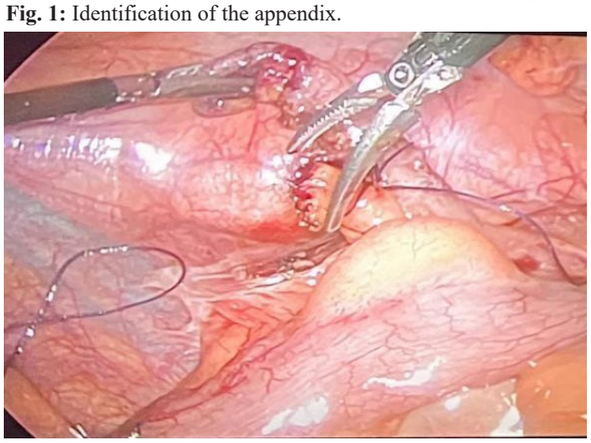


Fig. 2: Ligation of the mesoappendix.

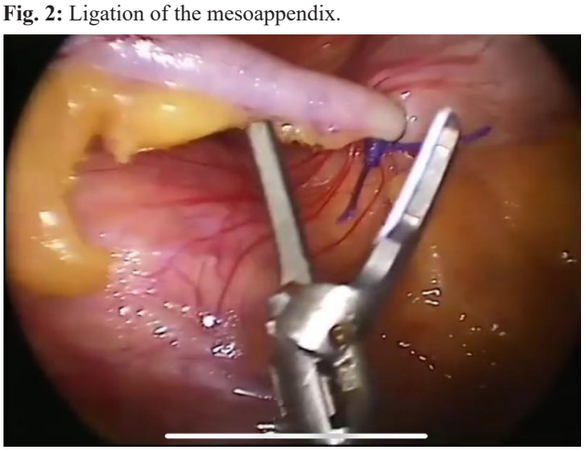


Fig. 3: Ligation of the base of the appendix.

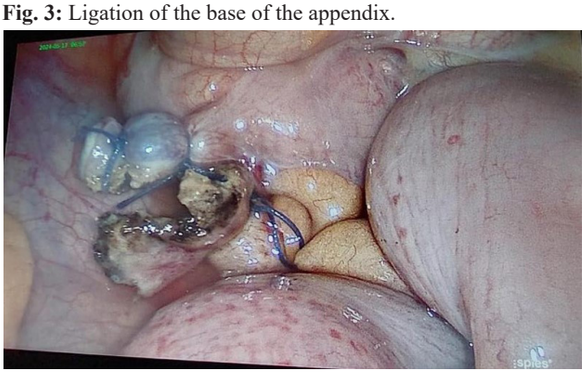


Fig. 4: Final view after ligation of both mesoappendix and appendicular base.

The surgical procedure

Open appendectomy

Anesthesia – OA in adults may be conducted under spinal or general anesthesia[12]. Gridiron incision – a third of the way from the anterior superior iliac spine to the umbilicus, an incision must be made over McBurney's point[13]. Mobilization and resection – starting with the subcutaneous tissue, the dissection advances to the external oblique fascia, which is incised sharply lateral to the rectus sheath. The external oblique, internal oblique, and transversus abdominis muscles are also bluntly separated in the direction of the muscle fibers using a muscle-splitting technique. The underlying intestine is protected by the sharp invasion of the peritoneum[14]. The right paracolic gutter can be utilized to locate the appendix by sweeping a finger laterally to medially. Blunt dissection is usually sufficient to release thin adhesions among the appendix and adjacent structures; severe dissection is occasionally necessary for more extensive adhesions. It is possible to locate the appendix by following the teniae coli back to its origin at the cecal base if it cannot be located by palpation. The appendix is delivered through the incision when it has been located and freed of adhesions (Fig. 5). The mesoappendix may be secured with a Babcock clamp, providing that the appendicular wall is not damaged and enteric contents do not spill out. The appendicular artery is secure with 3-0 absorbable sutures in the mesoappendix after being separated among hemostats[15]. A purse-string suture is inserted into the cecal wall to encircle the appendix. 2-0 absorbable sutures are used to double-tie the appendix following the appendicular base is crushed with a Kelly clamp. The appendix is excised using a scalpel, and the residual stump is cauterized to prevent the formation of a mucocele. Although the purse-string suture is being tightened, the appendicular stump is usually turned into the cecum, although the efficacy of stump inversion is in dispute. This is followed by the irrigation of the surgical bed with saline[16]. Closure – the incision is closed in layers utilizing a 2-0 absorbable suture, starting with the peritoneum and progressing to the transversus abdominis, internal oblique, and external oblique. Each layer undergoes irrigation. The external oblique fascia might be injected with a local anesthetic to enhance analgesia and reduce the need for postoperative narcotics. The fascia of Scarpa is closed with an interrupted 3-0 absorbable suture, and the skin is subsequently closed with a 2-0 nonabsorbable suture[17].

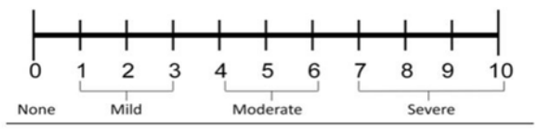
Fig. 5: Different cases of perforated appendicitis.

Outcome measurements

Postoperative pain: pain following surgery was evaluated using the Numeric Pain Rating Scale. The patient was requested to provide three pain ratings, one for the current pain, one for the best pain, and one for the worst pain, all of which were evaluated within the previous 24 h. The patients' level of pain over the past 24 h was represented by the mean of the three ratings.

Patient instructions (adopted from McCaffery, Beebe *et al*. 1989)

Please indicate the intensity of current, best, and worst pain levels over the past 24 h on a scale of 0 (no pain) to 10 (worst pain imaginable).



Hospital stays was calculated from the entrance of the operation room to discharge from the hospital, surgical duration has been determined from inducing anesthesia to skin closure.

Surgical site infection

Criteria of surgical site infection include purulent discharge from the wound, erythema, leukocytosis, separation of deep tissues, fever, and a swab from the wound for culture can be confirmatory. Postoperative pyrexia: postoperative fever is characterized by a body temperature exceeding 38°C on two consecutive postoperative days or more than 39°C on any 1 day following surgery. Temperature following surgery has been measured by thermometer every 4 h postoperatively.

Statistical analysis

Statistical analysis was done using IBM SPSS statistics for windows, Version 22.0. Armonk, NY: IBM Corp, has been used for analyzing the data. The qualitative data has been presented as a percentage and a number. The quantitative data was analyzed for normality using the Shapiro–Wilk test and subsequently defined as the mean and SD for normally distributed data and the median and range for nonnormally distributed data. Regarding the data type, the proper statistical analysis was performed as indicated by the subsequent recommended tests: continuous variables were correlated using Spearman or Pearson correlation, while categorical variables were correlated using χ^2. Mann–Whitney U test and Student t test have been utilized for analyzing data that was either normally distributed or nonnormally distributed for two independent groups (Fig. 6).

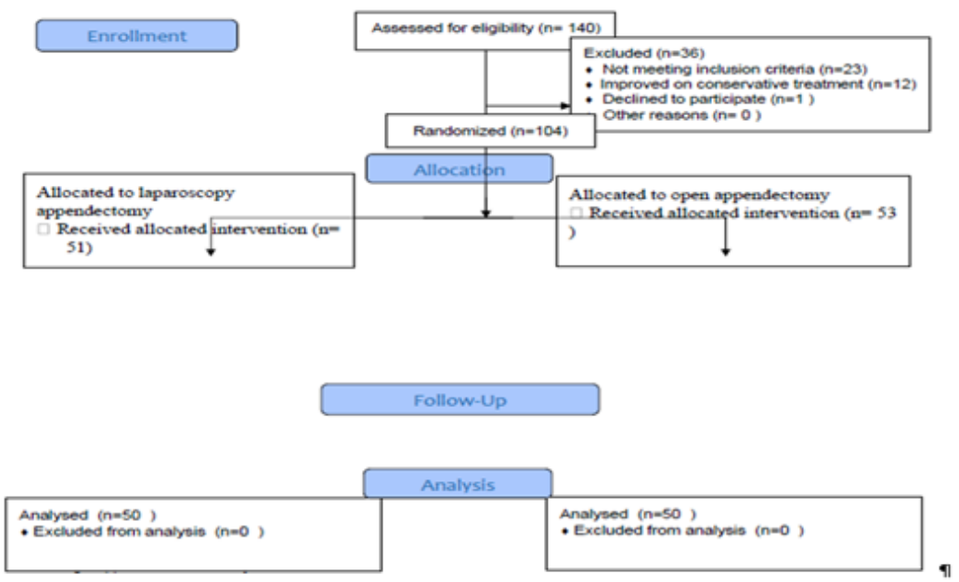


Fig. 6: Flow chart of the study.

RESULTS:

A statistically insignificant variance was observed among the two groups regarding sex, age, smoking, BMI, and other comorbidities (*P>0.5*) (Table 1).

A statistically insignificant variance has been found among both groups according to clinical presentation (*P>0.05*) (Table 2).

A statistically significant higher wound infection rate and a higher rate of postoperative pyrexia in the OA group compared to the LA group (*P<0.05*). The conversion rate from LA to OA was 6% (three cases). None of the patients developed a pelvic abscess or fecal fistula (Table 3).

There was statistically significant longer operative time and longer hospital stay duration, and more severe pain in the OA group compared with the LA group (*P<0.05*) (Table 4).

A statistically significant, more severe pain with a higher numerical rating pain score postoperative was observed within the OA group compared with the LA group (*P≤0.0001*) (Table 5).

Table 1: Comparison of participating patient's characteristics

	Laparoscopic appendectomy		Open appendectomy			
	N=50		*N*=50		Independent student *t* test/χ^2 test	
	Mean	SD	Mean	SD	*t*	*P* value
Age, years	42.73	6.34	41.36	7.25	1.006	0.317
BMI	29.87	5.74	30.25	6.12	0.320	0.749
Sex	*n* (%)		*n* (%)		χ^2	*P* value
Male	32 (64)		35 (70)		0.407	0.523
Female	18 (36)		15 (30)			
Smoking						
No	28 (56)		25 (50)		0.361	0.546
Yes	22 (44)		25 (50)			
DM						
No	40 (80)		42 (84)		0.271	0.603
Yes	10 (20)		8 (16)			
Hypertension						
No	38 (76)		36 (72)		0.208	0.648
Yes	12 (24)		14 (28)			
Ischemic heart						
No	46 (92)		44 (88)		0.444	0.505
Yes	4 (8)		6 (12)			

Table 2: Comparison of clinical presentation of the studied groups

			χ^2 test	
	Laparoscopic appendectomy (*N*=50) [*n* (%)]	Open appendectomy (*N*=50) [*n* (%)]	χ^2	*P* value
Nausea	4 (8)	6 (12)	0.444	0.505
Anorexia	8 (16)	6 (12)	0.177	0.674
Vomiting	12 (24)	15 (30)	0.369	0.543
Abdominal pain	47 (94)	45 (90)	0.543	0.461
Distension	4 (8)	3 (6)	0.154	0.695
Diarrhea	3 (6)	2 (4)	0.211	0.646
Constipation	5 (10)	7 (14)	0.379	0.538

Table 3: Comparison of complication rate of participating patients

			Independent Student *t* test/χ^2 test	
Complications	Laparoscopic appendectomy (*N*=50) [*n* (%)]	Open appendectomy (*N*=50) [*n* (%)]	χ^2	*P* value
Postoperative wound infection	1 (2)	7 (14)	4.891	0.027
Postoperative pyrexia	2 (4)	9 (18)	5.005	0.025
Conversion rate from lap to open appendectomy	3 (6)	–	–	–

Table 4: Comparison of hospital stay and operative time of participating patients

	Laparoscopic appendectomy		Open appendectomy			
	N=50		*N*=50		Independent Student *t* test/χ^2 test	
	Mean	SD	Mean	SD	*t*	*P* value
Operative time (min)	23.56	9.34	36.19	12.54	5.712	≤0.0001
Hospital stay (h)	20.35	9.32	36.74	10.76	8.141	≤0.0001

Table 5: Comparison of postoperative pain of participating patients' assessment using the Numerical Rating Scale

	Laparoscopic appendectomy		Open appendectomy			
	N=50		*N*=50		Independent Student *t* test/χ^2 test	
Numerical rating score	Mean	SD	Mean	SD	*t*	*P* value
At 30 min	3.21	1.33	5.76	2.87	5.700	≤0.0001
At 1 h	2.65	1.98	6.53	3.21	6.899	≤0.0001
At 3 h	2.23	1.26	6.86	3.79	8.197	≤0.0001
At 6 h	2.12	1.76	5.87	3.65	6.544	≤0.0001
At 8 h	1.89	1.21	5.75	3.72	6.977	≤0.0001

DISCUSSION

The present study showed that according to demographic data in the studied groups, a statistically insignificant variance was observed among both groups regarding age, sex, BMI, smoking, and comorbidities (diabetes mellitus, hypertension, ischemic heart) (*P>0.05*).

In the same line, Destek *et al*.[18], intended to compare the efficacy of LA and OA surgeries in the management of asymptomatic appendicitis. The data of 236 cases managed with the diagnosis of acute appendicitis. They reported that a statistically insignificant variance was observed among the two groups regarding sex, age, and BMI.

In our study, we found that according to the complication rate of participating patients, a statistically significant greater rate of wound infection and a higher rate of postoperative pyrexia was observed within the OA group compared to the LA group. LA to OA conversion rate was 6% (three cases). A statistically insignificant variance was observed among both groups regarding wound dehiscence and chest infection. None of the patients developed pelvic abscess or fecal fistula.

This result was parallel to Bajwa and Brar[19], who intended to compare the outcomes of LA and OA. In the Department of Surgery, they have conducted a randomized, prospective investigate comparing LA to OA. A total of 144 cases comprised the population group. They documented a statistically significant rise in wound infection rate within the OA group compared with the LA group.

Additionally, Pradhan *et al*.[20] revealed that at the 1-week follow-up, nine (8.5%) cases in group OA and three (2.5%) in group LA developed wound infections following surgery. A statistically significant elevated rate of wound infection was found within the OA group compared to the LA group.

In our research, we observed that there was statistically significant longer operative time, longer hospital stay duration, and more severe pain in the OA group compared with the LA group (*P≤0.0001*).

This agreed with Bhosle and Degloorker[21], who intended to compare the results of LA with those of OA. Within 2 years, a total of 120 appendectomy patients have been retrospectively examined. They reported that the LA resulted in a significant decrease in pain

within 2 days. The average hospitalization length for open appendectomy was 6.5 days, which is longer than that of LA (3.5 days). However, the duration of hospitalization differed from case to case.

In the same line, Pradhan *et al*.[20] revealed that average hospitalization for the laparoscopic group was significantly shorter (2.75±0.7 days) than that of the open group (3.19±2.16 days) (*P<0.01*).

CONCLUSION

We conclude that the laparoscopic approach is a safe and efficient surgical technique for appendectomy, which provides clinically positive benefits over the open procedure, like a shorter hospitalization, a lower wound infection rate, and a lower VAS score postoperatively.

CONFLICT OF INTEREST

There are no conflicts of interest.

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