Evaluation of the laparoscopic versus the open approach in patients with complicated appendicitis

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Context
Open appendectomy is the standard procedure for complicated appendicitis and is associated with an increased incidence of postoperative complications. Recently, laparoscopic approach for complicated appendicitis has been gaining ground against the open approach. Some studies still favor the open approach while others advocate the laparoscopic approach.
Aim
The present study aimed to compare the laparoscopic approach with the open approach in the management of patients with complicated appendicitis, and their postoperative complications.
Settings and design
This was a prospective, randomized, comparative study.
Patients and methods
Eighty-eight patients were included in the study and were divided into the laparoscopic group (33 patients) and the open group (55 patients). Each group was further divided into five subgroups according to the operative findings. All patients were monitored for early and late postoperative complications and followed up in the outpatient clinic for 6 months.

The operative time, rate of conversion, drain application, early and late complications, frequency of analgesia, time to start oral feeding, length of hospital stay, and time of returning to normal daily activity were all recorded.
Statistical analysis
Continuous variables were expressed as mean and SD. Categorical variables were expressed as frequencies and percentage.
Results
The open group showed less operative time. Patients in the laparoscopic group needed less analgesia, with early return of the bowel habits and early start of oral feeding. They also had shorter hospital stay and early return to the normal activities. The laparoscopic group had less postoperative complication in comparison with the open group.
Conclusion
The laparoscopic appendectomy was found to be better in comparison with the open approach as it involved less postoperative pain, shorter hospital stay, and fewer postoperative complications in addition to the possibility of exploring the whole abdomen.

Keywords:
laparoscopic appendectomy, open appendectomy, postappendectomy complications

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Introduction

Appendicitis was described for the first time as a disease in the 16th century and was known as perityphlitis [1]. Open appendectomy was the standard procedure; however, laparoscopic appendectomy, which was first reported by Semm [2], has been considered as safe as open appendectomy. Meanwhile, appendicitis complicated by perforation, pus collection, gangrene or abscess formation comprise about 20–30% of the appendicitis cases and is associated with increased incidence of postoperative complications such as surgical site infections and intra-abdominal pus collection [3]. In the recent years, laparoscopic approach for complicated appendicitis has been gaining ground in the face of the open approach but with more complications such as intra-abdominal pus collection [4]. Some studies still favor the open approach [5,6] while others advocate the laparoscopic approach [7,8].

This study aimed to compare the laparoscopic approach with the open approach in the management of patients

with complicated appendicitis, and also their post-operative complications.

Patients and methods

The study was conducted over a period of 30 months from November 2012 to April 2015. It involved the patients presenting at the emergency room who were suspected clinically of having complicated appendicitis, which was later confirmed by using ultrasound or computed tomography scan or both. Patients with noncomplicated appendicitis, generalized peritonitis, history of open abdominal or pelvic operations, and medical conditions that preclude pneumoperitoneum were excluded from the study.

Eighty-eight patients were included in the study and were divided into two groups: group A – the laparoscopic appendectomy group – which included 33 patients; and group B – the open appendectomy group – which included 55 patients. The patients were randomly allocated to the groups based on the fixed admission days. Each group was divided into five subgroups according to the operative findings into the following: subgroup A – appendicular abscess, subgroup B – appendicitis with purulent reaction, subgroup C – gangrenous appendix, subgroup D – appendicular mass, and subgroup E – appendicitis with pelvic abscess.

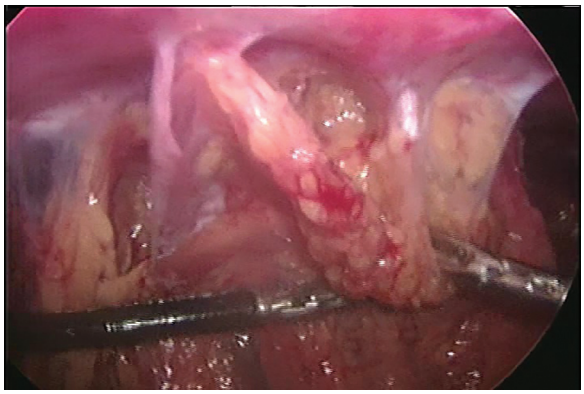
All patients participating in the study signed informed consent, as mandated by the Ethical Committee of the Faculty of Medicine, Ain Shams University.

All patients of both groups received preoperative intravenous third-generation cephalosporins and metronidazole, and, also, Foley's catheter was inserted as needed.

Surgical procedures

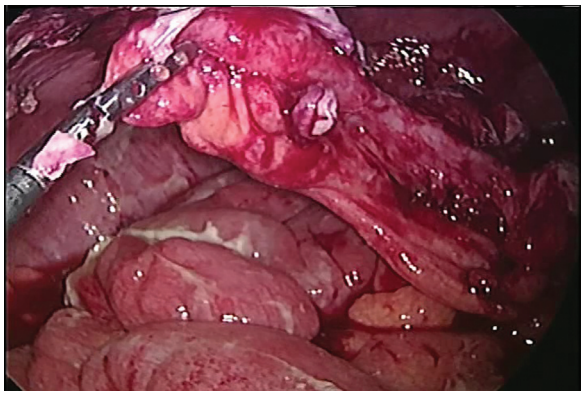
In the laparoscopic group, the pneumoperitoneum was established by using the open technique. Three-port method was carried out where a 10-mm port was inserted at the umbilicus for the 30° camera, a 10-mm port was inserted in the left iliac fossa, and a 5-mm port was inserted in the right subcostal region. An additional 5-mm port might be needed. All patients were supine in Trendelenburg's position, tilted to the left. Any adhesions were dissected to expose the appendix (Figs 1 and 2) and the mesoappendix was secured by ligature, clips (Fig. 3), or bipolar electrocautery, and then the stump of the appendix was secured by a pretied suture loop (Fig. 4) before retrieval of the appendix. The peritoneal cavity was then irrigated by warm saline and aspirated and the process was repeated till the aspirate became clear. A suction drain was left as needed. Open appendectomy was performed my making a McBurney's incision with or without extension or a midline incision. All patients received intravenous third-generation cephalosporins and metronidazole. Analgesics in the form of NSAIDs were administered as required by patients. Intravenous fluids were administered to all patients till return of the

Figure 1



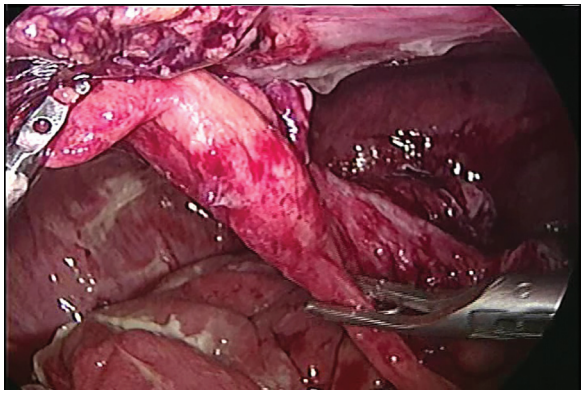
Dissection of adhesions.

Figure 2



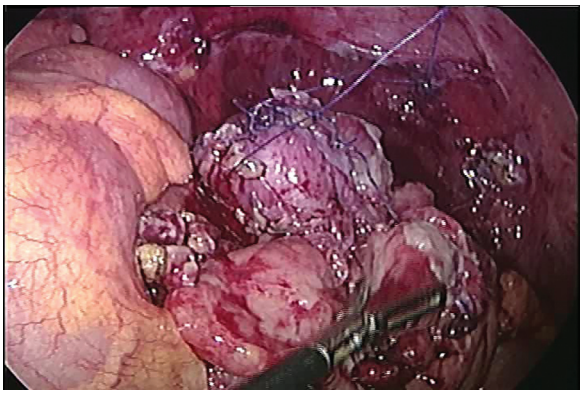
Exposure of the appendix.

Figure 3



Clipping of the mesoappendix.

Figure 4



Appendicular stump after ligation.

bowel function, when oral intake of clear fluids was started. All patients were monitored for early and late postoperative complications and followed up in the outpatient clinic for 6 months.

The operative time, rate of conversion to open approach, drain application, early and late complications, frequency of analgesics administration, time to start oral feeding, length of hospital stay, and time of returning to normal daily activity were all recorded and tabulated for statistical analysis.

Statistical analyses

The collected data were revised, coded, tabulated, and fed into a PC using the statistical package for the social sciences (SPSS 20; SPSS Inc., Chicago, Illinois, USA) software. Data were presented and suitable analyses were carried out according to the type of data obtained for each parameter.

Descriptive statistics

(1) Mean±SD and range for parametric numerical data.
(2) Frequency and percentage of non-numerical data.

Analytical statistics

(1) Student's *T*-test was used to assess the statistical significance of the difference between the mean of the two study groups.
(2) The χ^2-test was used to examine the relationship between two qualitative variables.
(3) Fisher's exact test was used to examine the relationship between two qualitative variables when the expected count was less than 5 in more than 20% of the cells.
(4) ANOVA test was used to assess the statistical significance of the difference between the means of more than two study groups.

Table 1 Sex differences and associated comorbidities among the two groups

	n (%)		χ^2-Test	
	Group A (*n*=33)	Group B (*n*=55)	*P*-value	Significance
Sex				
Male	14 (42.4)	29 (52.7)	0.349	NS
Female	19 (57.6)	26 (47.3)		
Comorbidity	26 (78.8)	40 (72.7)	0.525	NS

The *P*-value for sex difference between the two groups was 0.349, which was statistically nonsignificant. The *P*-value for associated comorbidities between the two groups was 0.525, which was statistically nonsignificant.

(5) Post-hoc test was used for comparisons of all possible pairs of group means.

Results

Patients' demographics

The sex distribution and associated comorbidities are represented in Table 1.

Operative findings

Each group was further subdivided into five subgroups according to the operative findings: subgroup A – appendicular abscess (localized peritonitis), subgroup B – appendicitis with periappendicular pus collection, subgroup C – gangrenous appendix, subgroup D – appendicular mass, and subgroup E – appendicitis with pelvic abscess (diffuse peritonitis with pus collection in the pelvis). The statistical distribution of operative findings among the groups and subgroups is presented in Table 2.

Operative time

The mean operative time for group A was 110.91± 19.50 min (range: 65–160 min), whereas in group B it was 88.09±28.16 min (range: 45–145 min), with a *P*-value of less than 0.001 by *t*-test, which was statistically significant.

The operative times among the subgroups in group A and B are demonstrated in Table 3.

Rate of conversion

The rate of conversion from the laparoscopic approach to open approach was 6% (two cases). One (14.2%) case with appendicular mass was converted to open approach by midline incision due to extensive adhesions, and one (10%) case with gangrenous appendix was converted to open approach by McBurney's incision due to gangrenous base with friable cecum that required trimming of the base with closure by interrupted suture and application of onlay omental patch.

Table 2 Case distribution according to the operative finding among the two groups

	n (%)		Fisher's exact test	
	Group A (*n*=33)	Group B (*n*=55)	*P*-value	Significance
Operative finding				
Appendicular abscess	4 (12.1)	7 (12.7)	0.922	NS
Appendicitis with periappendicular pus collection	2 (6.1)	7 (12.7)		
Gangrenous appendix	10 (30.3)	15 (27.3)		
Appendicular mass	7 (21.2)	11 (20.0)		
Appendicitis with pelvic abscess	10 (30.3)	15 (27.3)		

The *P*-value for the operative finding among the two groups was 0.922 by Fisher's exact test and was considered to be statistically nonsignificant.

Drain application

The rate of drain application was 27.3% (nine cases) in group A, whereas it was higher in group B, reaching 38.2% (21 cases), and yet with a *P*-value of 0.296, which was statistically nonsignificant.

In group A, cases with appendicitis with periappendicular pus collection (subgroup B) and appendicular mass (subgroup D) did not need drain application in comparison with group B where two (28.6%) cases with appendicitis with periappendicular pus collection (subgroup B) and four (36.4) cases with appendicular mass (subgroup D) had drains applied.

The rate of drain application among the subgroups is demonstrated in Table 4.

Use of analgesia

The frequency of the use of analgesia was recorded for both groups. For group A, the mean number for need of analgesia (mean±SD) was 4.09±1.96 times, whereas in group B, it was 5.18±2.03 times. The *P*-value for the use of analgesia was 0.015, which was statistically significant.

The use of analgesia among the subgroups is shown in Table 5.

Oral feeding, hospital stay, and return to normal activity

In group A, the mean time for starting of oral feeding was 21.45±14.22 h, whereas in group B, it was 32.04±20.9 h, with a *P*-value of 0.012, which was statistically significant.

In group A, the mean time for hospital stay was 3.03±2.01 days, whereas in group B, it was 4.69±3.07 days, with a *P*-value of 0.003, which was statistically significant.

Table 3 Operative time (min) among the different subgroups in groups A and B

	Appendicular abscess	Appendicitis with periappendicular pus collection	Gangrenous appendix	Appendicular mass	Appendicitis with pelvic abscess	ANOVA	
						P-value	Significance
Group A (mean±SD)	75±23.8	85±7.07	76.5±20.96	82.86±20.59	71±16.12	0.744	NS
Group B (mean±SD)	99.29±23.88	62.14±26.59	58.67±25.25	90.45±26.59	65.67±23.82	0.002	S

There was no statistically significant difference among the different subgroups in group A as the *P*-value by ANOVA test was 0.744, whereas in group B, *P*-value by ANOVA was 0.002, as there was a statistically significant difference in subgroup A (appendicular abscess) and subgroup C (appendicular mass) against the other subgroups by using the post-hoc test. S, significant.

Table 4 Rate of drain application among the subgroups

	Group A (*n*=33) [*n* (%)]	Group B (*n*=55) [*n* (%)]
Drain application		
Appendicular abscess	4 (100)	7 (100)
Appendicitis with periappendicular pus collection	0 (0)	2 (28.6)
Gangrenous appendix	2 (20)	3 (20)
Appendicular mass	0 (0)	4 (36.4)
Appendicitis with pelvic abscess	3 (30)	5 (33.3)

In group A, the mean time for returning to physical activity was 17.42±8.31 days, whereas in group B, it was 27.95±10.79 days, with a *P*-value of 0.000006, which was statistically significant.

Early and late complications

The incidence of early and late complications is shown in Table 6. In group A, four (12.1%) patients had early postoperative complications and one (3%) patient (that was converted from laparoscopic to open approach due to gangrenous base) had late postoperative complications, whereas in group B, 14 (25.4%) patients had early postoperative complications and five (9%) patients had late postoperative complications. The overall incidence of postoperative complications was five (15.1%) patients in group A and 19 (34.5%) patients in group B. The *P*-values for early complications and for late complications were more than 0.05, which were statistically nonsignificant.

Discussion

Surgeons have recommended the use of laparoscopy for appendectomy; however, the benefit for its use in complicated appendectomy is still controversial [5,9–11]. There has been lack of adequate evidence supporting the use of laparoscopy for the management of complicated appendicitis [12]. Some studies have shown almost equivalent results of the two approaches in respect to morbidity and mortality [13]; many studies clarified significant advantages of the laparoscopic approach, such as less postoperative pain, shorter hospital stay [14–16], chance of exploration of the peritoneal cavity, ease of suction irrigation under vision, and better cosmetic results [17].

In this study, there was no statistical significance between the two groups regarding the sex difference or associated comorbidities. Each group was divided into five subgroups according to the operative findings. The laparoscopic group included 33 patients. Of them, four (12.1%) patients had appendicular abscess, two

Table 5 The use of analgesia among different subgroups

Analgesia (times)	Appendicular abscess	Appendicitis with periappendicular pus collection	Gangrenous appendix	Appendicular mass	Appendicitis with pelvic abscess	ANOVA	
						P-value	Significance
Group A (mean±SD)	5.75±2.06	3±0	3.4±1.43	4.43±3.15	4.1±1.2	0.302	NS
Group B (mean±SD)	7.43±2.07	3.71±0.49	4.27±1.62	6.09±1.76	5.07±1.98	<0.001	S

There was no significant difference among the subgroups in group A as the *P* value by ANOVA test was 0.302, whereas in group B, there was a statistically significant difference in subgroup A (appendicular abscess) against subgroups B, C, and E and in subgroup D (appendicular mass) against subgroup B and C by using the post-hoc test. S, significant.

Table 6 Distribution of early and late complications among the two groups

	Group A [*N* (%)]	Group B [*N* (%)]
Early complication		
Chest infection	2 (6)	0 (0.0)
Intestinal obstruction	0 (0.0)	1 (1.8)
Pelvic collection	0 (0)	1 (1.8)
Prolonged ileus	1 (3)	3 (5.4)
Prolonged ileus+burst	0 (0.0)	1 (1.8)
Surgical site infection	1 (3)	8 (14.5)
Late complication		
Incisional hernia	1 (3)	3 (5.4)
Intestinal obstruction	0 (0.0)	2 (3.6)

(6.1%) patients had acute appendicitis with periappendicular pus collection, 10 (30.3%) patients had gangrenous appendix, seven (21.2%) patients had appendicular mass, and 10 (30.3%) patients had appendicitis with pelvic abscess. The open group included 55 patients. Of them, seven (12.7%) patients had appendicular abscess, seven (12.7%) patients had acute appendicitis with periappendicular pus collection, 15 (27.3%) patients had gangrenous appendix, 11 (20%) patients had appendicular mass, and 15 (27.3%) patients had appendicitis with pelvic abscess. There was no statistical difference between the two groups as regards the operative findings, with a *P*-value of more than 0.05.

The open group involved lesser operative time than did the laparoscopic group, as the mean operative time for the laparoscopic group was 110.91±19.50 min (range: 65–160 min), whereas for the open group, it was 88.09 ±28.16 min (range: 45–145 min), with a *P*-value of less than 0.001 by *t*-test, which was statistically significant. Similar results were obtained by Quezada *et al.* [18] with longer operative time for the laparoscopic group. This may be attributed to the time taken for the peritoneal lavage and securing the appendicular stump [19,20]. The rate of conversion was two out of 33 patients, reaching 6%, which was within the range compared with other studies [3,18]. There was no significant difference between the subgroups of the two groups regarding the need for drain application, except for the patients with appendicitis with periappendicular pus collection and the patients with appendicular mass in the laparoscopic group. This was due to the ability of the laparoscope to explore all parts of the abdominal cavity with easy lavage and suction of the purulent exudates alleviating the need for drain application in these patients.

Patients in the laparoscopic group needed less analgesia [21,22] as the *P*-value was 0.015, with early return of the bowel habits and early start of oral feeding (21.15 vs. 32.04 h, *P*=0.012) in comparison with the patients of the open group. They also had shorter hospital stay [19] (3.03 vs. 4.69 days, *P*=0.003) and early return to the normal activities (17.42 vs. 27.95 days, *P*=0.000006) compared with the patients in the open group.

Regarding the postoperative complications, the laparoscopic group had two patients with chest infection (6%), whereas no patients had chest infections in the open group. This was probably related to the general condition of the patients (as both of them affected in the laparoscopic group were heavy smokers) rather than to the approach carried out. No patients in the laparoscopic group had intestinal obstruction, whereas in the open group, one (1.8%) patient had intestinal obstruction in the early postoperative period due to fibrinous adhesions, and two (3.6%) patients had adhesive intestinal obstruction after 17 and 19 weeks, respectively. This can be attributed to the fact that the laparoscopic approach was more exploratory than the open approach and was able to dissect adhesions made by inflammatory processes compared with the open approach, and also to the fact that the absence of the large abdominal wall wounds prevents the intestine from adhering to the wound scar, which occurred with the open approach [23]. No patients suffered from postoperative collection in the laparoscopic group compared with one (1.8%) patient in the open group, with no statistical significance [24–26]. Only one patient had prolonged ileus more than 48 h in the laparoscopic group, whereas in the open group, three patients had prolonged ileus more than 48 h and one patient had prolonged ileus that remained for four days with distension that was complicated by burst requiring closure by secondary sutures. In the laparoscopic group, one (3%) patient had surgical site infection, whereas in the open group, eight (14.5%) patients had surgical site infection; similar results have been reported in other series [20–22]. In the laparoscopic group, one (3%) patient had incisional hernia after conversion to open approach, whereas in the open group, three (5.4%) patients had incisional hernia. This emphasizes the advantage of the laparoscopic approach in preventing the surgical site infection [27] and incisional hernia in septic operations as in complicated appendicitis.

Conclusion

The laparoscopic appendectomy is considered to be superior in comparison with the open approach as it involves less postoperative pain, shorter hospital stay, and fewer postoperative complications in addition to the possibility of exploring the whole abdomen without the need for midline incision.

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Nil.

Conflicts of interest
There are no conflicts of interest.

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