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Laparoscopic Versus Open Appendectomy in Management of Complicated Acute Appendicitis: A Comparative Prospective Study

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Abstract

Background: Complicated acute appendicitis is acute inflammation in the appendix complicated by perforation, gangrenous appendicitis, periappendicular mass or abscess. Perforation is the most concerning complication of acute appendicitis and may lead to abscesses, peritonitis, bowel obstruction, fertility issues, and sepsis. Appendicular perforation is associated with increased morbidity and mortality compared with non-perforating acute appendicitis. Appendectomy for acute appendicitis is the standard treatment and a common emergency surgical procedure, either via open or via laparoscopy. With the great advances in technology and the surgical techniques, laparoscopic appendectomy has become the novel alternative in the treatment of appendicitis in the last 2 decades.

Aim of Study: This study aims to compare open and laparoscopic appendectomy in the management of complicated acute appendicitis as regard operative time, postoperative complications as wound infection, postoperative sepsis, ileus, start of oral intake, length of hospital stay and return to normal activities.

Patients and Methods: This study is prospective randomized controlled clinical trial, including 50 patients, randomly allocated into 2 groups, 25 patients for each group, group (A) open appendectomy and group (B) complete laparoscopic appendectomy, compared in operative time, postoperative complications as wound infection, postoperative sepsis, ileus, start of oral intake, length of hospital stay and return to normal activities.

Results: Statistical analysis of the collected data, in the current study the operative time was significantly longer in the laparoscopic group, howeverlaparoscopic approach had several advantages over open appendectomy, it has less incidence of wound infection, less incidence of post-operative ileus and faster return of patients to normal activities.

Conclusion: Laparoscopic appendectomy is safe and feasible surgical option for complicated acute appendicitis.

Key Words: *Laparoscopic appendectomy – Complicated appendicitis.*

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Introduction

ACUTE appendicitis (AA) is among the most common causes of lower abdominal pain leading patients to attend the emergency department and the most common diagnosis made in young patients admitted to the hospital with an acute abdomen **[1,2]**.

Perforation is the most concerning complication of acute appendicitis. Appendicular perforation is associated with increased morbidity and mortality compared with non-perforating AA. The mortality risk of acute but not gangrenous AA is less than 0.1%, but the risk rises to 0.6% in gangrenous AA. On the other hand, perforated AA carries a higher mortality rate of around 5% **[3]**.

Appendectomy for acute appendicitis is the standard treatment and a common emergency surgical procedure, either via open laparotomy through a limited right lower quadrant incision or via laparoscopy **[4,5]**.

Some authors consider laparoscopic appendectomy a promising method regarding its less invasiveness with shorter hospital stays, less postoperative pain, less incidence of surgical site infections, and the ability to explore most of the abdomen through small incisions and reduced the risk of post-operative adhesions. Still open appendectomy might be selected as the practical choice, specifically in the management of complicated appendicitis as in an abscess or advanced infection **[5,6]**.

Aim of the work:

This study aims to compare open and laparoscopic appendectomy in the management of complicated acute appendicitis as regard operative time, postoperative complications as wound infection, postoperative sepsis, ileus, start of oral

intake, length of hospital stay and return to normal activities.

Patients and Methods

Patients employed in the study were recruited from Ain Shams University Hospitals, and Al-Sahel Teaching Hospital, Cairo, Egypt.

Male and female patients who attended to the emergency department in the past 6 months (from January 2022 to June 2022), meeting the study criteria, age from15-55y, patient provisionally diagnosed as complicated appendicitis (either perforated, gangrenous appendicitis or periappendicular mass) with full history taking, clinical examination, laboratory tests and pelvi-abdominal U/S.

Exclusion criteria: Patient had chronic medical illness as DM, HTN, CKD or with immunological disease, patients unfit for laparoscopic intervention as patients with cardiac or pulmonary disease.

After patients were fully be informed about the risks and benefits of the two procedures. Informed consent was obtained from all patients, all patients were consented to undergo conversion to open appendectomy if necessary.

They were randomly allocated into 2 groups; 25 patients in each group, group (A) had open appendectomy and group (B) had laparoscopic appendectomy.

In the operating room, the patient was placed in the supine position with both arms extended for open appendectomies and both arms tucked to the side for laparoscopic appendectomies. For both laparoscopic and open methods, a sterile surgical field was created from just above the bilateral costal margins extending inferiorly to the pubic tubercle and laterally to both the right and left flanks.

Group (A) Open appendectomy:

Classically, a 5cm Grid-iron incision made on McBurney's point The epidermis and dermis were then incised using a scalpel. Blunt dissection and electrocautery were used to dissect the external aponeurosis. Using blunt dissection the internal oblique, transverse abdominal muscle were divided exposing the peritoneum, the peritoneum was grasped and incised. Attention was then turned to locating the appendix, Once the appendix was identified, the mesoappendix was dissected and ligated with vicryl 2-0. Then theappendiceal base was crushed and ligated.The appendix was excised and removed (Fig. 1).

Hemostasis was confirmed. Good mopping of surgical field, paracolic gutter and pelvis, insertion of intra-peritoneal drain might be needed especially if there is pus collection. Lastly, Closure of incision in layers.

Group (B) Laparoscopic appendectomy:

Access to the abdomen was achieved by making a 10mm infraumbilical incision and using either the Hasson technique or a Veress needle, insufflating the peritoneal cavity with carbon dioxide gas. A 10-mm angled laparoscope was then inserted. Then a 5mm port was placed midline above the pubic bone, and a 10mm port was then placed in the left lower quadrant laterally.

Next, the abdomen was explored to rule out other diseases. Then, attention is turned to the right lower quadrant. To facilitate exposure, at this point, the patient was positioned into steep Trendelenburg with the right side up. The cecum is identified by following the terminal ileum. Then usually, by following the cecum's taenia, the appendix could be identified.

Often, adhesions formed by inflammatory processes between the appendix, small bowel, and cecum were encountered, which can be divided using blunt dissection. However, sharp dissection might be necessary. Of note, when operating near the bowel, electrocautery should be avoided to prevent contact and conductive injury.

Once the tip of the appendix was visualized, it could be grasped and elevated off the cecum anteriorly. Using a Maryland dissector, a window was created between the mesoappendix and the base of the appendix. Using an endoscopic stapler loaded with vascular staples, the mesoappendix was divided and dissected using electrocautery. Harmonic scalpel or ligusure could also be used if available. Then the endoscopic stapler was used to divide the appendix at its base, a ligature on the base of vicryl 2-0 might be used. Caution must be taken to ensure the stapler is brought together close to the cecum to prevent the creation of an appendiceal stump.

The resected appendix was removed through the left iliac port. Good peritoneal toilet with irrigation and suction was done. The laparoscope was inserted and used to directly visualize the removal of the remaining ports and to assess the hemostasis of the anterior abdominal wall. The skin was then closed.

The 2 groups were compared in the following parameters, operative time from skin incision to

skin closure, post-operative complications as wound infection and post-operative sepsis and ileus by measuring vital signs, abdominal examination, wound examination and pelvi-abdominal US if needed. And also in time needed to start oral intake, length of hospital stay and return to normal activities.

Descriptive statistics was done in terms of frequency and percentages for categorical variables. Mean +/- standard deviation (SD) or median (interquartile range) was used for continuous variables. Statistical tests for comparing between groups was considered significant at a *p*-value less than or equal to 0.05. The collected data was revised for accuracy and completeness, then coded and entered a personal computer to be analyzed using IBM SPSS version 24.

Fig. (1): Perforated appendix in open appendectomy.

Fig. (2): Perforated appendix with fecolithin laparoscopic appendectomy.

Results

Clinical and Demographic features of the patients:

The mean age of the all patients was 26 years old, and they ranged from a minimum value of 15 years old to maximum value of 55 years old. Among group A open appendectomy the mean age of patients was 29.56 years old and median 26 years old, and among group B laparoscopic appendectomy the mean age of patients was 22.56 years old and median 20 years old. Overall data were 48% of patients were males and 52% were females, however, within the group, males were 20% and females were 30% in the group A, while in the group B males and females were 28% and 22% respectively.

Table (1): Comparison between open appendectomy and lap appendectomy in demographic data.

	Open appendectomy	Lap appendectomy	*p*-value	#x^2
Sex:				
Male	10 (20%)	14 (28%)	0.285	1.282
Female	15 (30%)	11 (22%)		
Age: (years)			*t*-test	Sig.
Range	15-55	15-35	2.307	0.025
Mean ± SD	29.56 (±14.024)	22.56 (±5.788)		

p-value >0.05 NS. *t*-test=Independent.

Outcome of open and laparoscopic appendectomy in complicated acute appendicitis:

The operative details, in open appendectomy 19 (76%) of patients were given spinal anesthesia and 6 (24%) general anesthesia, but All laparoscopic appendectomy patients went under general anesthesia (100%). The complicated appendicitis found to be 38 (76%) perforated, 10 (20%) perforated with gangrenous appendix and 2 (4%) formed appendicular mass, there was pus collection in 15 (30%) of patients. A drain was inserted in all laparoscopic patients 25 (100%) and in 10 (40%) of open appendectomy patients.

Mean time of the operation was found to be significantly shorter in the open appendectomy group 77.8min (±1.555), when compared to laparoscopic group 107.2min (±2.082).

Table (2): Comparison between open appendectomy and laparoscopic appendectomy according operative time.

Operative time	Open appendectomy	Lap appendectomy	*p*-value	X^2
≤ 1h 30min	22 (44%)	7 (14%)	<0.001 *	19.528
>1h 30min And ≤2h	3 (6%)	10 (20%)		
>2h	0	8 (16%)		

X^2=Chi-square test. ***p*-value less than 0.001 HS.

26% of the study population was complicated with postoperative wound infection; 20% of them in the open group, and 6% in the laparoscopic group, which was a statistically significant between open and laparoscopic group. 4% were complicated with postoperative ileus; all in the open group.

Table (3): Comparison between open appendectomy and laparoscopic appendectomy according post-operative complication.

	Open appendectomy	Lap appendectomy	*p*-value	X^2
Wound infection	10 (20%)	3 (6%)	0.024*	5.094
Ileus	2 (4%)	0	0.149	2.083
Sepsis	0	0		

X^2=Chi-square test. **p*-value=Less than 0.05 S.

82% of patients started oral sips in the first day postoperative; 44% of open group and 38% of laparoscopic group, while 18% started sips second day postoperative; 6% of open group and 12% of laparoscopic group.

Mean duration of hospital stay after operation is 3.56 (±1.044) days in open group and 4.08 (±1.187) days among laparoscopic group.

Mean duration of return to normal activity in open group is 12.6 (±2.93) days and in laparoscopic group 10.6 (±1.658) days. Statistical analysis ellaborated that mean postoperative time for return of the patients to normal activities was shorter in laparoscopy group, compared to open group.

Table (4): Comparison between open appendectomy and laparoscopic appendectomy according starting oral sips post operative.

Start oral sips	Open appendectomy	Lap appendectomy	*p*-value	X^2
Day 1	22 (44%)	19 (38%)	0.269	1.220
Day 2	3 (6%)	6 (12%)		

X^2=Chi-square test. **p*-value more than 0.05 NS.

Table (5): Comparison between open and laparoscopic appendectomy according duration of hospital stay and return to normal activity.

	Open appendectomy	Lap appendectomy	*t*-test	*p*-value
- Duration of hospital stay (days) Mean (± SD)	3.56 (±1.044)	4.08 (±1.187)	1.644	0.107
- Duration of return to normal activity (days) Mean (± SD)	12.6 (±2.93)	10.6 (±1.658)	2.97	0.005*

**p*-value less than 0.05 S. *t*-test=Independent.

Discussion

Acute appendicitis (AA) is among the most common causes of lower abdominal pain leading patients to attend the emergency department and the most common diagnosis made in young patients admitted to the hospital with an acute abdomen [1].

Complicated appendicitis is perforated, gangrenous appendicitis, periappendicular mass or abscess. Appendicular perforation is associated with increased morbidity and mortality compared with non-perforating AA [3].

Appendectomy for acute appendicitis is the standard treatment and a common emergency surgical procedure, either via open laparotomy through a limited right lower quadrant incision or via laparoscopy. Some authors consider laparoscopic appendectomy a promising method regarding its less invasiveness with shorter hospital stays, less postoperative pain, less incidence of surgical site infections, and the ability to explore most of the abdomen through small incisions and reduced the risk of post-operative adhesions [5].

In our study, The mean age of the all patients was 26 years old , and they ranged from a minimum value of 15 years old to maximum value of 55 years old. Among group A open appendectomy the mean age of patients was 29.56 (±14.024) years old and median 26 years old, and among group B laparoscopic appendectomy the mean age of patients was 22.56 (±5.788) years old and median 20 years old. This came in agreement with Shakya et al., [7] who found The highest incidence of complicated appendicitis is observed among 11 to 20 years (26.44%) of age group followed by 21 to 30 years (18.97%).

In our study, 48% of patients were males 52% were females, among group A 20% were males and 30% were females, group B 28% were males and 22% were females, which is non-significant.

The complicated appendicitis found to be 38 (76%) perforated, 10 (20%) perforated with gangrenous appendix and 2 (4%) formed appendicular mass, there was pus collection in 15 (30%) of patients. This came in agreement with Wagh and Joshi, [8] who found that 61.6% of patients had perforated appendix while 36.6% had gangrenous appendix.

In general, the operative time should be calculated from the insertion of first trocar to the end of skin suturing in laparoscopic surgery. In open

surgery, the operating time as the time from incision to wound closure [9].

In the current study the operative time was significantly longer in the laparoscopic group (Group B) with mean time 107.2min (±2.082) than open group (Group A) with mean time 77.8min (±1.555), (p-value was 0.001).

This can be contributed by several factors, the more equipment used and longer setup time in LA procedure, the learning curve of laparoscopy and the status of the appendix. This was in accordance to the study by Yang et al., [10], that showed that the mean operative time for the LA group was significantly longer (80min) than the OA (65min) with p (p=0.042) and Mohamed and Mahran [11], that revealed also that LA took longer time to perform, but Fukami et al., [12] showed No significant difference was found in the operating time between the two groups.

In this study 26% of the study population was complicated with postoperative wound infection; 10 (20%) in the open group, and 3 (6%) in the laparoscopic group, which was a statistically significant (p-value = 0.024).

On the other hand, Shirazi et al., reported in his study that the rate of overall post-operative complications (LA: 15%, OA: 31.8%, p<0.0001) was significantly lower in LA patients group [13]. In study by Taguchi et al., [14], the overall rate of post-operative complications, including incisional or organ/space SSI and stump leakage, did not differ significantly between groups.

Mishra et al., [15], reported higher wound infection rates after LA, but most of the literature supports the view that wound infection is less common after a laparoscopic procedure.

In the present study, no cases (0%) in the laparoscopic group were unable to tolerate oral feeding, in comparison with 2 (4%) cases in the open group that developed ileus.

There were several explanations for the reduction of ileus following LA. Firstly, decreased handling of the bowel during the procedure leads to less postoperative adhesion, and such adhesion may be responsible for ileus. Secondly, patients after LA had less opiate analgesics, which inhibited bowel movements in the postoperative period. Lastly, earlier mobilization after LA may also contribute to the reduction of adhesion [16].

In the present study, no patient developed sepsis nor intra abdominal abscess. However, in previous study by Horvath et al., [17], intra abdominal abscess formation is more common in LA (ten patients) compared with the OA (two patients). This can be explained on the basis that CO_2 insufflation in LA may facilitate spreading of microorganisms in the peritoneal cavity, especially in perforated appendicitis.

Although, in this study there is no significant difference between the two groups in starting oral sips in the first day postoperative; 88% of open group and 76% of laparoscopic group, while 12% of open group and 24% of laparoscopic group started oral sips second day postoperative.

Mean duration of hospital stay after operation is 3.56 (±1.044) days in open group and 4.08 (±1.187) days among laparoscopic group.

Sayed et al., [5] revealed that the mean period of hospital stay was (1.13 ±0.75 days) in OA group and (1.00±0.00 days) in LA group.

Oka et al., [18], mentioned that the length of hospital stay in the OA group was 5.2 days and for the LA group, it was 4.3 days, and this was statistically insignificant.

Esposito et al., [19], mentioned the median hospital stay for LA was 3 days in case of simple appendicitis and 5.2 days in case of peritonitis (range: 1-12). For OA, the median hospital stay was 4.3 days in case of simple appendicitis and 8.3 days in case of peritonitis (range: 2-22). Statistical analysis showed a significant difference in the length of hospital stay between the two groups in favor of LA.

Also, Ali et al., study showed that the mean length of hospital stay was shorter in the LA group (34±13h. in LA vs. 40±1 1h in OA; p=0.01) [20]. Svensson et al., (21) showed that laparoscopic appendectomy had a shorter median post-operative length of stay, 43 vs. 57 hours (p<0.05). In study by Karakus, et al., [22] the hospital stay of LA group (2.15±0.7 days) is less than OA groups (2.25±0.7 days) (p<0.001).

In this study, Mean duration of return to normal activity in open group is 12.6 (±2.93) days and in laparoscopic group 10.6 (±1.658) days. Statistical analysis ellaborated that mean postoperative time for return of the patients to normal activities was shorter in laparoscopy group compared to open group.

In a study by Talha et al., the mean time taken to resume routine work for laparoscopic procedure was 15.3±3.4 days and for open procedure was

22.3±3.7 days, which signifies that laparoscopic group resumed routine work early compared to open group **[23]**. In a study by Resutra & Gupta, the mean time taken to resume daily routine activities was 8.16±0.553 days in LA group and 10.16±0.681 days in OA group and the difference was statistically significant (p<0.05) **[24]**.

Conclusion:

Laparoscopic appendectomy is safe and feasible surgical option for complicated acute appendicitis.

Despite that the operating time for laparoscopic appendectomy is still longer than that for open appendectomy, this can be contributed by several factors, the more equipment used and longer setup time in LA procedure, the learning curve of laparoscopy and the status of the appendix.

The present study elucidate that laparoscopic approach had several advantages over open appendectomy, it has less incidence of wound infection, less incidence of post-operative ileus and faster return of patients to normal activities.

There is no significant difference between laparoscopic and open appendectomy in and duration of starting oral sips after operation and duration of hospital stay.

We must convert laparoscopic procedure to open surgery when indicated for the safety of the patients.

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الجراحة بمنظار البطن مقابل الجراحة المفتوحة فى علاج الزائدة الدودية الملتهبة المعقدة : دراسة مستقبلية

يعتبر استئصال الزائدة الدودية بالمنظار خياراً جراحياً آمناً ومجدياً لالتهاب الزائدة الدودية الحاد المعقد على الرغم من أن وقت إجراء عملية استئصال الزائدة الدودية بالمنظار لا يزال أطول من وقت استئصال الزائدة الدودية المفتوح، إلا أنه يمكن تفسير ذلك من خلال عدة عوامل، فالمنظار الجراحى يتطلب عدد المعدات المستخدمة أكثر ووقت الإعداد أطول، ومنحنى التعلم أطول لتنظير البطن وحالة الزائدة الدودية نفسها أثناء العملية.

توضح الدراسة الحالية أن استخدام منظار البطن فى استئصال الزائدة الدودية المعقدة له العديد من المزايا مقارنة باستئصال الزائدة الدودية بالجراحة المفتوحة، وله معدل أقل لعدوى الجرح، ونسبة أقل للكسل الأمعاء بعد الجراحة، وعودة أسرع للمرضى إلى الأنشطة اليومية العادية بعد الجراحة.

لكن من خلال هذه الدراسة لا يوجد فرق كبير بين استئصال الزائدة الدودية بالمنظار واستئصال الزائدة الدودية بالجراحة المفتوحة من حيث مدة بدء رشفات الفم بعد العملية ومدة الإقامة فى المستشفى.