Efficacy of Laparoscopy in Complicated Appendicitis

Mohamed W. Arafa, MD; Ayman Mohammad Ahmad Ali, MD
Department of General Surgery, Faculty of Medicine, Sohag University, Egypt

Introduction: Laparoscopic appendectomy (LA) is the recommended treatment for uncomplicated appendicitis and is increasingly preferred nowadays over open appendectomy (OA), the ideal procedure for patients with complex appendicitis (CA)is debatable.

Aim of work: This study aims to evaluate the effectiveness of the LA and OA techniques in individuals with CA.

Patients and methods: 80 patients were enrolled in this trial between November 2022 and August 2024, 58 had LA while 22 underwent OA. Demographics, operating time, hospital stay and postoperative complications were gathered and evaluated.

Results: Although LA demonstrated significantly more time-consuming than open approach (p 0.0002), it was linked to a considerably lower median hospital stay (p <0.05) and significantly less analgesic usage (p <0.05). The LA group's oral intake resumed earlier than the OA groups but this difference was statistically insignificant. A fewer incidence of wound infections was linked to LA (p=0.0005). While there were no appreciable differences between the two groups, two patients in the OA group and four in the LA group developed an intra-abdominal abscess. Two patients in the LA group and two in the OA group had postoperative ileus; there were no appreciable differences between the two groups. Fecal fistula was observed in one of OA patients (4.5%), and it resolved conservatively ten days later. One patient in the OA group had adhesive intestinal obstruction and no mortality were reported in both groups.

Conclusion: LA is a better option for patients with complicated appendicitis since it is safe and has a lower rate of readmission and wound infection while other complications are comparable to OA.

Key words: Appendicitis, complicated appendicitis, laparoscopic appendectomy.

Introduction

The most frequent surgical cause of excruciating abdominal pain that necessitates surgical intervention is acute appendicitis with a 7-8% lifetime risk. Between 20% and 30% of individuals with appendicitis will develop severe acute appendicitis.[2]

Appendicular perforation, gangrene, severe peri-appendicular inflammation, peritonitis, mass development, and purulent intra-abdominal or pelvic collections are all indicators of CA.[3] Surgery is The mainstay of treatment for CA, a serious illness that can be lethal if left untreated.[4]

For almost a century, OA has been the paramount for treatment of acute appendicitis, having been invented by McBurney in 1889. Despite being safe, it is plagued by postoperative problems in 10% to 20% of patients.[5]

Patients who have CA are more likely to experience surgical stress because an OA requires a more extensive abdominal incision. And a longer operating time than one performed for simple appendicitis. Additionally, the site is exposed to tainted fluid, which might lead to a higher incidence of wound infections.[6]

Compared to an open procedure, LA is currently seen to be the preferred surgical option for treating acute appendicitis because it reduces postoperative discomfort, lowers the risk of surgical site infections, speeds up recovery, and improves postoperative quality of life.[7]

Since Semm's initial report of LA in 1983, several researches comparing LA and OA have been carried out.[8]

LA has an advantage, when compared to OA, because of its ability to explore the whole peritoneal cavity through tiny incisions.[9] According to a recent recommendation by the World Society of Emergency Surgery (WSES), LA is a safe surgical treatment for CA when performed by qualified surgeon.[10] However, because the pneumo-peritoneum primarily exposes the intra-abdominal spaces, laparoscopy in cases of severe appendicitis may raise the chance of post-operative abscess development.[11] In addition, it requires more technical expertise and longer operating times than OA.[12]

Aim of work

The aim of this study is to compare the effectiveness of the OA vs LA in individuals with CA.

Patients and methods

This prospective comparative study comprised 80 consecutive patients who had appendectomies for CA at Sohag University Hospital's emergency unit, General Surgery department, between November 2022 and August 2024.

After gaining acceptance from the Medical Ethics Committee (IRB: 22-10-29 Soh-Med) and written

DOI: 10.21608/asjs.2025.346005.1172

approval to the procedure from all patients, we included patients with CA (appendicular mass < 1 week, gangrenous appendix, perforated appendix and appendicular abscess (Not amenable for drainage under ultrasonic guide) in our study; however, we excluded patients with non-complicated appendicitis, appendicular mass > 1 week, history of complicated laparotomy, general contraindications to laparoscopy, and those who refused laparoscopy.

A comprehensive history, clinical examination, abdominal ultrasound and CT scan (Performed for a questionable diagnosis and if the patient was older than 50 years) Laboratory tests, including inflammatory markers, standard preoperative laboratory tests were routinely performed for all patients.

Operative technique

General anesthesia was administered to all patients. Upon inducing anesthesia, 500 mg of metronidazole and 1 gram of ceftriaxone were administered and continued for 3 days postoperatively.

Laparoscopic appendectomy: With the Trendelenburg at 15° and rotation to the left, the patients were placed in a supine position with the camera man and surgeon standing on the patient's left while the monitor was On the patient's right side. The standard three trocars were then inserted (10mm supra umbilical for the camera and two 5mm ports at right hypochondrium and left iliac fossa and an additional 5mm trocar was inserted in the suprapubic region in difficult cases) **(Fig. 1)**, after that CO2 pneumo-peritoneum was achieved using a veress needle at 12 to 14 mmHg. In all cases, a 30° laparoscopic camera was employed. To verify the diagnosis and exclude other problems, diagnostic laparoscopy was the initial step **(Figs. 2-5)**. Non-traumatic graspers were employed for grasping and retraction. Bipolar diathermy was used to separate the appendix from the mesoappendix and associated adhesions **(Fig. 6)**. Either an intra-corporeal knot or an endo loop was used to ligate the base of the appendix. **(Fig. 7)** Either through sterile glove or the 10 mm port, the appendix was extracted outside the abdomen **(Fig. 8)**. In the presence of purulent collection, local irrigation and drain insertion were carried out **(Fig. 9)**. The collected specimens and samples were sent for pathological analysis. After that Drains were placed in the pelvis **(Fig. 10)**, all wounds were closed after extraction of trocars under vision.

Open appendectomy: Was carried out by making an incision on the lower midline. After formal exploration to confirm diagnosis and exclusion of other pathologies, 2/0Vicryl® was used to control the meso-appendix and appendicular stump. Warm saline was used for peritoneal lavage until the drainage fluid became clear, after that pelvic Drains were inserted. Absorbable sutures were used to close the abdominal wall in layers and skin staples were used to secure the skin.

After surgery, antibiotics were continued for three days while parentral analgesics were administered on demand. Oral intake was started after bowel function was adequate and the patient could tolerate it. As soon as the patients were mobilized and taking their medications as prescribed, they were discharged.

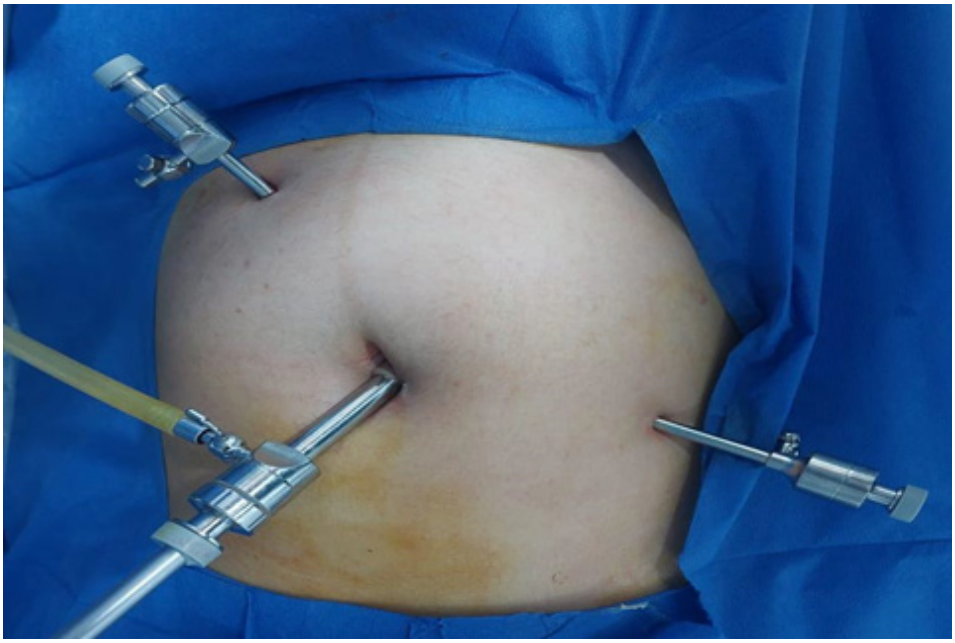

Fig 1: Ports design.

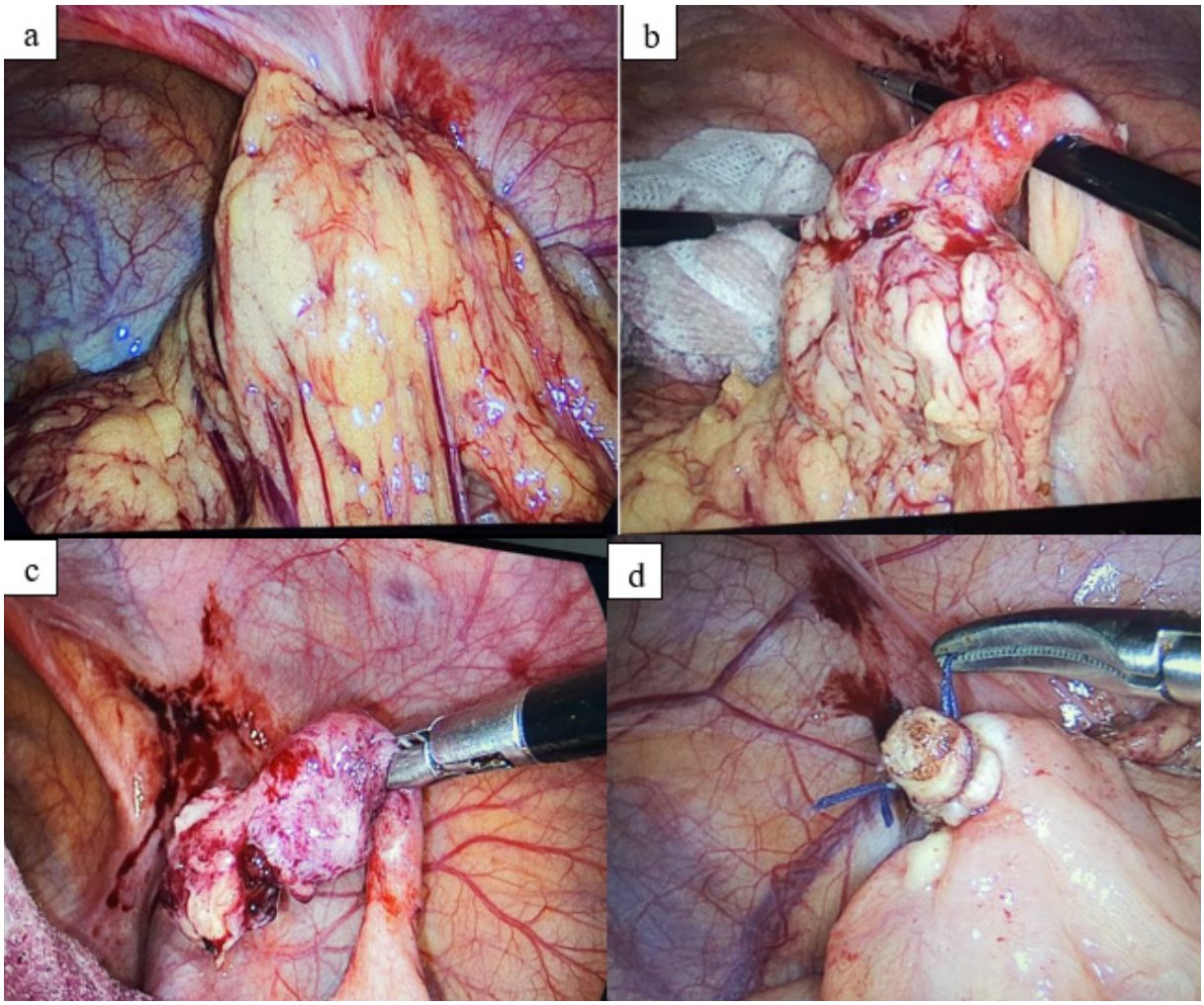

Fig 2 a-d: A case of appendicular mass.

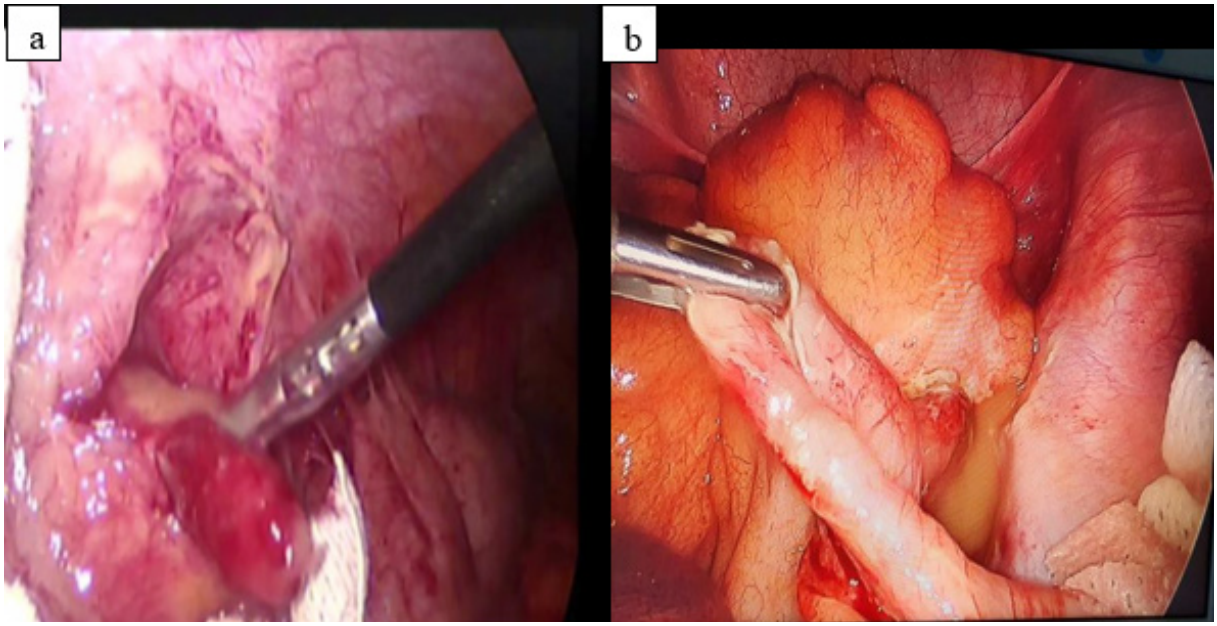

Fig 3 a,b: A case of appendicular abscess.

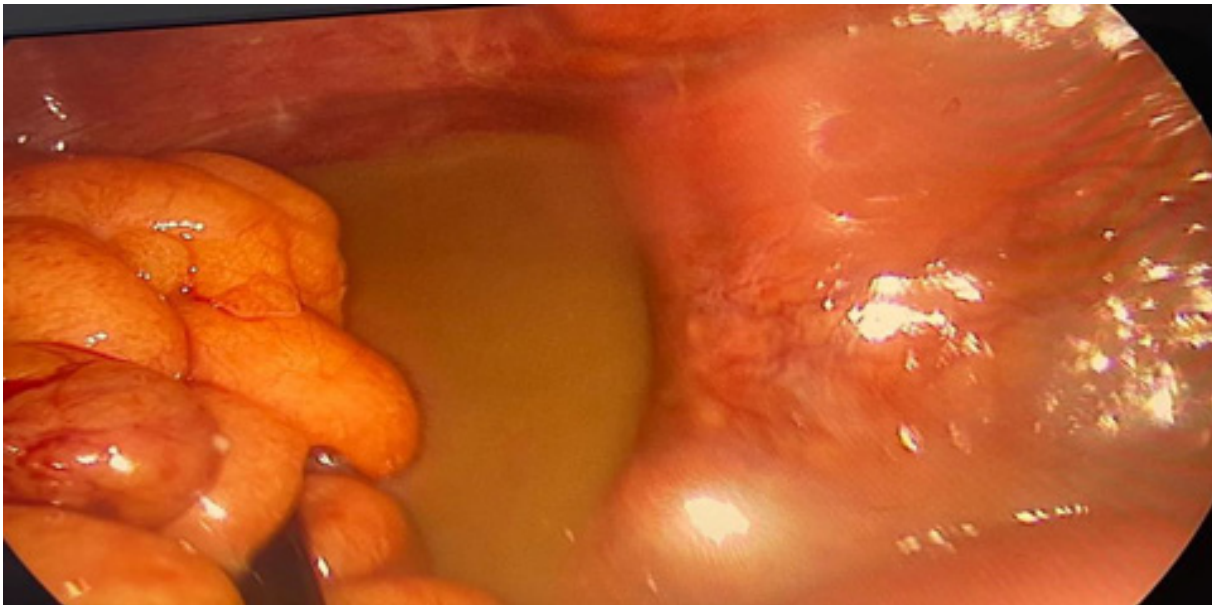

Fig 4: A case of complicated appendicitis with pelvic peritonitis.

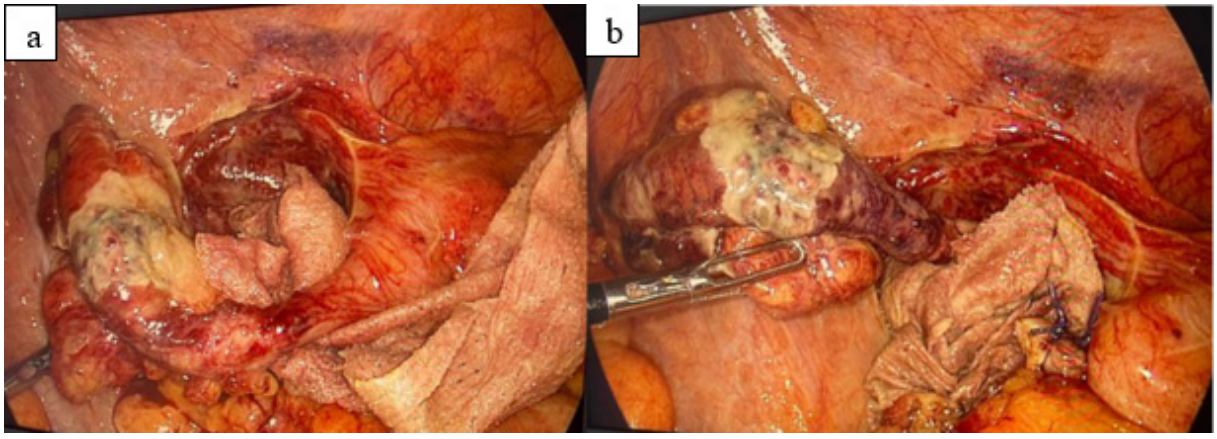

Fig 5 a & b: A case of gangrenous appendicitis.

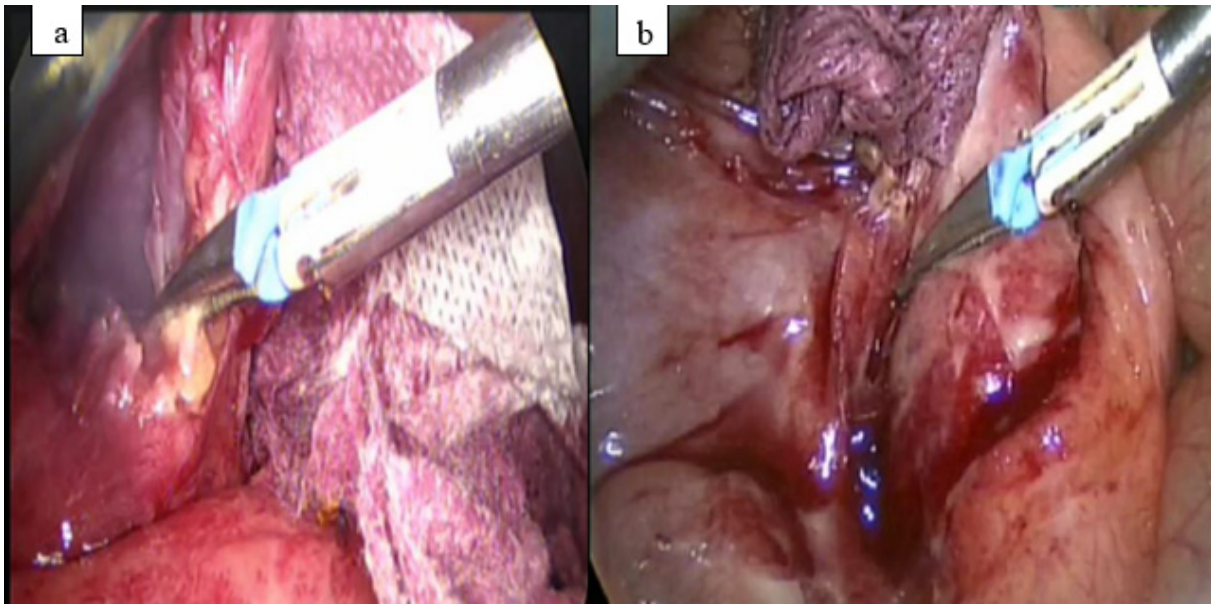

Fig 6 a,b: The use of bipolar diathermy for dissection of the appendix.

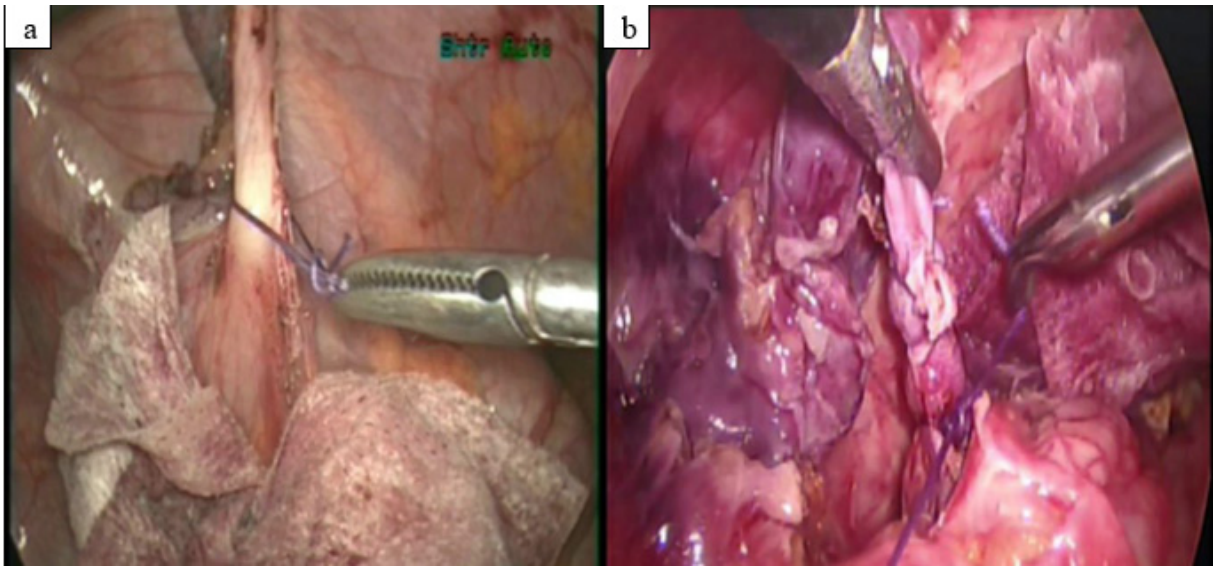

Fig 7 a,b: The base of appendix was controlled by endoloop (a) & intra-corporeal knotting (b).

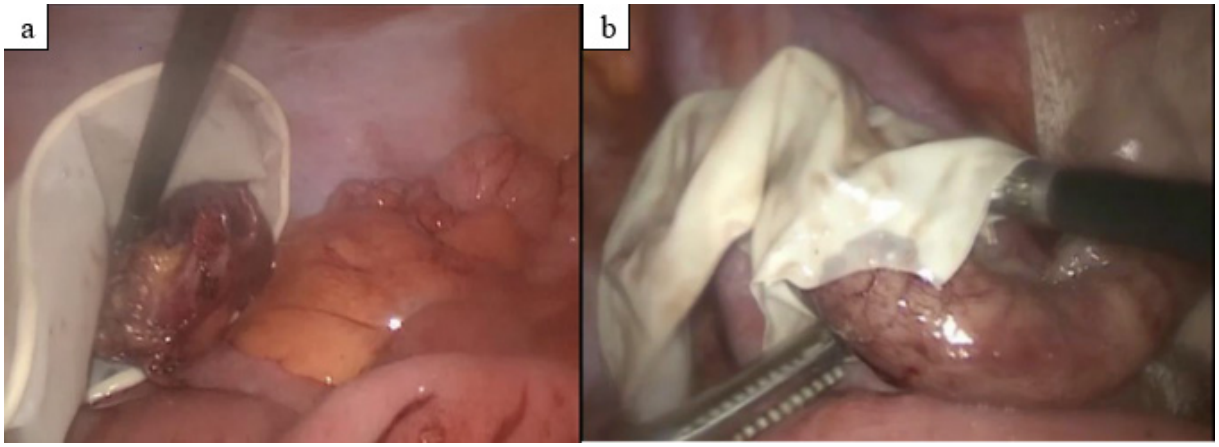

Fig 8 a,b: Retrieval of the appendix by sterile glove.

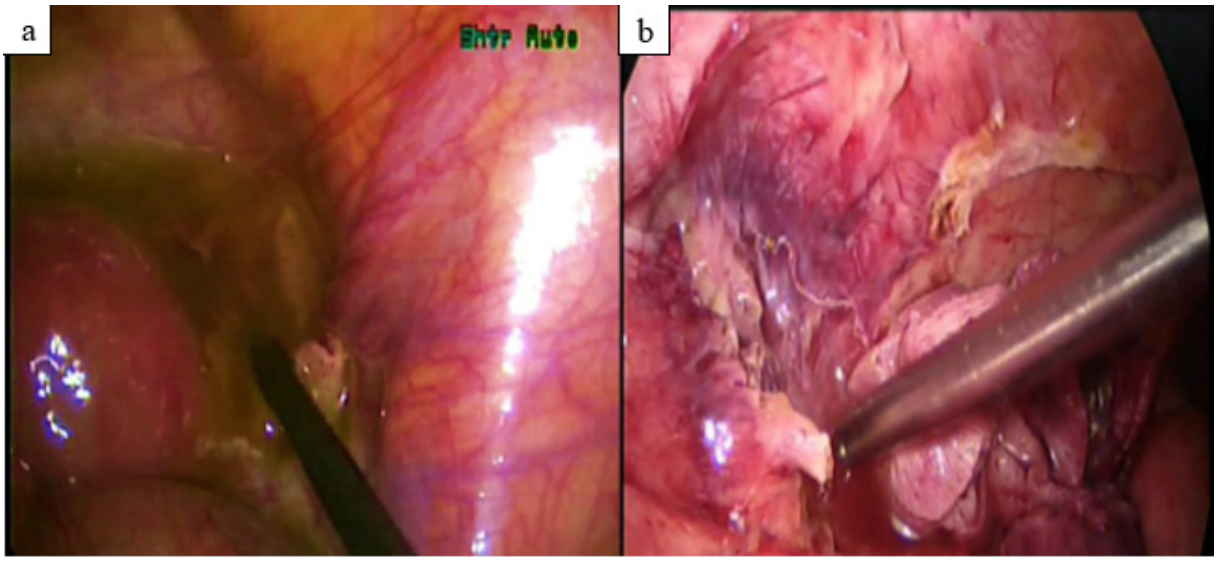

Fig 9 a,b: Aspiration and peritoneal lavage using warm saline.

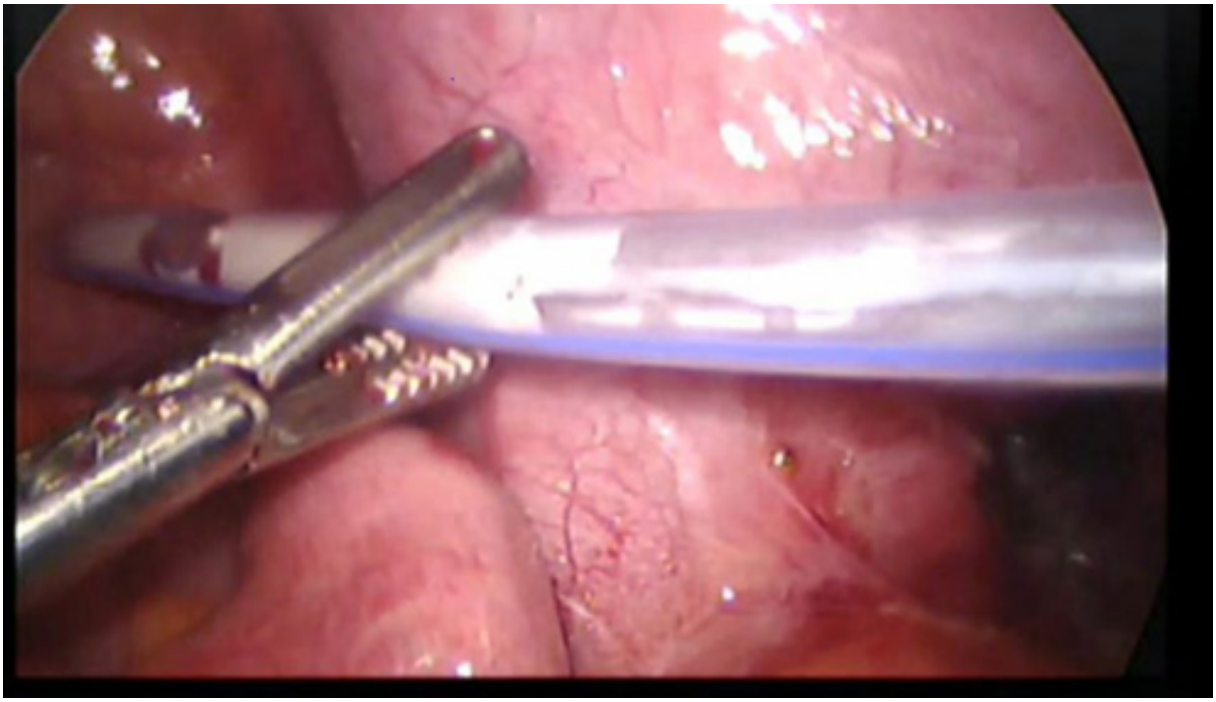

Fig 10: Insertion of pelvic drain.

Post-operative follow-up

In the outpatient clinic patients were seen weekly in the first month then monthly for six months. Patients were told to return right away if they had any surgical complications.

Data collection and statistical analysis

Patients, Demographics, intraoperative information (such as procedure type, duration of operation) , postoperative information (the use of analgesia, length of hospital stay, days until the first bowel flatus and motion , time to resume a liquid diet), complications (such as wound infections, intra-abdominal collection, bowel obstruction, ileus, faecal fistula and incisional hernia), reoperation, and mortality (any death within 30 days after surgery) all were gathered in a database sheet. Data from follow-up was recorded and updated.

The SPSS® software program was used to assess and analyse the gathered data (IBM-SPSS®22, Chicago, IL, USA). Whereas quantitative data were displayed as means, standard deviations, and ranges, qualitative data were displayed as numbers and percentages. The Chi-square test was employed to compare two groups with qualitative data, and when the anticipated count in any cell was less than 5, the Fisher exact test was used in its place. A 95% confidence interval and a 5% acceptable margin of error were established. The statistical studies that were utilized have a significance cut-off of $P > 0.05$: Non significant, $P < 0.05$: Significant, and $P < 0.01$: Highly significant.

Results

During the study period from November 2022 to August 2024, 22 patients had (OA) and 58 patients had (LA). Figure 11 displays the intraoperative findings among patients under the study. **Table 1** lists the patient's demographics and perioperative information, while provides a summary of postoperative problems.

Age, sex distribution, ASA classification, and intraoperative findings of complicated appendicitis did not significantly differ between the two groups.

Laparoscopic appendectomy took longer time to conduct than open approach (p 0.0002), but it was linked to a shorter median hospital stay (LA-2 days; OA-5 days; $p<0.05$) and considerably reduced analgesic usage (LA-2 days; OA-5 days; $p<0.05$). Although the LA group's oral intake returned earlier than the OA group's, the difference was negligible.

In terms of surgical consequences, wound infections were more common in OA patients (OA, 31.8%; LA, 8.6%; p=0.0005). Six of the 18 patients who had generalized peritonitis experienced postoperative intra-abdominal abscesses, two of whom were in the OA group and four of whom were in the LA group; there were no appreciable differences between the two groups, and all patients were effectively treated with ultrasonic guided percutaneous drainage. Two patients in the OA group and one patient in the LA group experienced postoperative ileus; there were no appreciable differences between the two groups. Five days after surgery, faecal fistula was discovered in one patient in OA group (4.5%). This patient required readmission, however he

was treated conservatively and recovered in ten days. Two weeks following hospital release, one patient in the OA group had adhesive intestinal obstruction, responded well to conservative protocol and discharged after 3 days. Postoperative mortality was not reported.

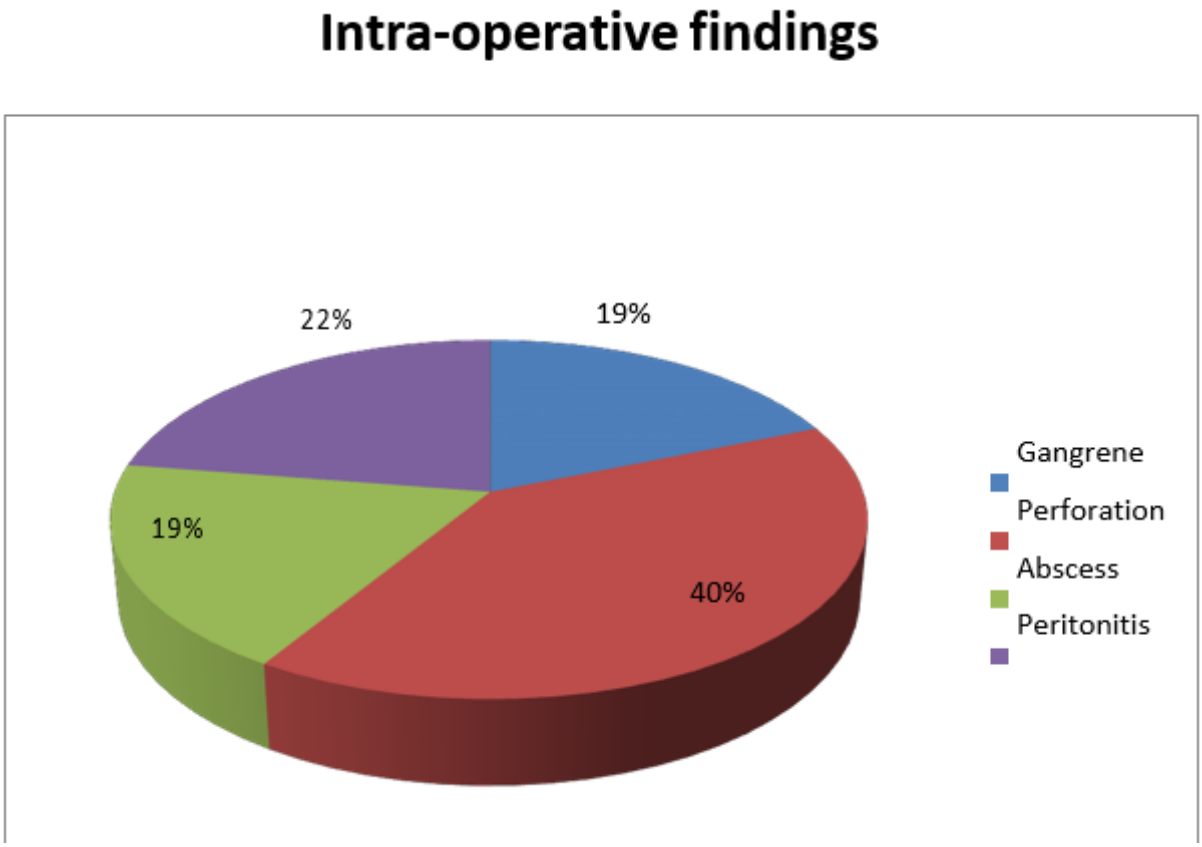

Fig 11: Diagram showing intra-operative findings among studied patients.

Table 1: Demographics & peri-operative details

	LA Group (n= 58)	Open group (n=22)	P value
Age (years) mean ± SD	34 ±12.8	32 ±14.6	NS
Gender ratio (male: female)	37/21	14/8	---
ASA classification			
1	54	19	NS
2	4	3	
Operative time mean ± SD	73.1 ± 45.7	62.9 ± 17.2	0.0002
Intraoperativefinding			
Perforation	24	8	NS
Gangrene	11	4	NS
Abscess	13	2	NS
Peritonitis	9	9	NS
Return to oral feeding (median) (range)	2 (1–4)	3 (2–6)	NS
Analgesia use(median) (range)	2 days (1–4)	5 days (2–8)	<0.05
Hospital stay(day) (median) (range)	2 days (1-5)	5 days (2-8)	<0.05

P-value >0.05: Non significant (NS); P-value <0.05: Significant (S); P-value< 0.01: highly Significant (HS).

Table 2: Postoperative complications

	LA Group (n= 58)	Open group (n=22)	P value
Wound infection	5 (8.6 %)	7 (31.8%)	0.0005
Intra-abdominal abscess	4 (6.9 %)	2 (9.09 %)	NS
Ileus	1 (1.7 %)	2 (9.09 %)	NS
Fecal fistula	0	1 (4.54%)	NS
intestinal obstruction	0	1 (4.54%)	NS
Hernia	0	0	---
Readmission	1 (1.7%)	4	<0.05
Mortality	0	0	---

P-value >0.05: Non significant (NS); P-value <0.05: Significant (S); P-value< 0.01: highly Significant (HS).

Discussion

The introduction of minimally invasive surgery transformed the surgical field offering significant advantages over traditional methods. According to reports, LA is widely regarded as the best approach for treating simple appendicitis. However, its use in CA is debated due to challenges in managing distorted anatomy and severe inflammation.[13]

The first series of use of laparoscopy in treatment of complicated appendicitis was described in 2001,[14] and the first prospective research showing that LA was feasible was published in 2006.[15] Since then, a number of relevant studies have established the use of laparoscopy as a safe way to manage CA.[16]

On the other hand, the use of laparoscopic approach in CA may predispose to postoperative abscess formation, with an incidence up to 26% in some studies.[17,18]

Reduced post-operative pain, quicker recovery, shorter hospital stay, the advantage of exploring the whole peritoneal cavity, adequate irrigation and aspiration under direct vision and improved cosmoses, are among the major advantages of the laparoscopic approach as reported by many studies.[18,19,20]

In our study, LA took significantly longer time to complete than OA (p=0.0002), likely due to the additional training and expertise required for laparoscopic surgery. This difference is consistent with other studies showing prolonged operating times for LA, in cases of complicated appendicitis, which often necessitate meticulous dissection and lavage in the presence of purulent accumulation.[21]

A study conducted by Athanasiou et al., highlights the benefits of LA over OA in reducing post-operative wound infections.[21] The lower incidence of infections in LA in our study (LA :8.6% compared to 31.8% in OA, P =0.0005) could be attributed to the use of a sterile bag for extracting the appendix that minimizes contamination risks, effective aspiration of infected fluid reducing the potential for exposure to trocar wounds. These findings are comparable with other studies that also report favorable outcomes for LA regarding infection rates.[21,22]

According to Alfredo et al., the OA required significantly more analgesia compared to the LA[23] This finding aligns with the research conducted by Long et al., which reported similar outcomes regarding the need for analgesia and levels of post-operative discomfort.[24] these findings are comparable to the results of our study, where a significant difference was also observed (median analgesia use: 2 days in LA and 5 days for OA , p < 0.05).

A study by Kassem et al. comparing the results of LA and OA approaches showed that the LA has several advantages, such as being less traumatic to the abdominal wall and peritoneal cavity, reducing the risk of introducing foreign bodies, providing better haemostasis, and promoting quicker return of bowel motility.[25] These factors contributed to the early resumption of oral feeding in LA group than the OA group in our trial, with a median of 2 days for LA compared to 3 days for OA. However, it's important to note that feeding resumption had no statistically significant difference and the results may not have been strong enough to draw a definitive conclusion.

Several studies that compare LA with OA regarding post-operative outcomes concluded that LA is associated with several benefits, such as reduced surgical stress, earlier mobilization, faster return to oral intake, and less postoperative pain[26,27] which explain the shorter median hospital stays observed among LA patients compared to OA group who were included in our study (LA, median: 2 days & OA, median: 5 days). The statistical significance (p<0.05) indicates that these findings are unlikely to be due to chance.

One of the topics that generated a lot of discussion was the formation of postoperative intra-abdominal abscesses. Horwitz et al.,[28] founded that postoperative residual collection occurred in 9% of

OA patients compared to 41% of LA in his study. However, (28.4%) in OA group and (7%) in LA group developed postoperative intraperitoneal collection in a study conducted by Khirallah et al.[29] Four patients (6.9%) in the LA group and two patients (9.9%) in the OA group had intra-abdominal abscesses in our study, with a non-significant difference. This is consistent with a meta-analysis by Athanasiou et al. that found no significant difference in intra-abdominal abscess rates (p=0.43).[21] Operative technique, the surgeon's level of expertise, the degree of intraperitoneal contamination, the degree of inflammation, the timing of the diagnosis, and the timing of the intervention might all contribute to this dispute.[30]

The incidence of postoperative ileus in our trial was not statistically significant, but it was larger after OA than after LA (9.09% vs. 1.7%, respectively). Additionally, this is similar to previous published research that suggested that less postoperative discomfort, little abdominal trauma, and less hand manipulation of the intestine might be the cause of the lower frequency of postoperative ileus following LA.[31,35]

With a reported frequency of 1.8% to 2.8%, early postoperative small intestinal obstruction is a major surgical issue and a dangerous non-infectious complication following appendectomy.[32] This is consistent with our study, which found that one patient (4.54%) in the OA group had adhesive intestinal obstruction on the fifth postoperative day who improved on conservative treatment. The incidence rate was significantly lower in the laparoscopic group (1.56% vs. 3.72%, $p < 0.01$), according to Masoomi et al., who reports it in patients with perforated appendicitis.[33]

In line with Kocatas et al.'s findings that recorded one patient in their OA group had an enterocutaneous fistula with spontaneous fistula closure after 20 days, we recorded one patient in the OA group with a faecal fistula which was detected on the 5th postoperative day and improved after 10 days of conservative treatment.[34]

After doing a meta-analysis using data from three RCTs and thirty CCS on 6428 patients, Quah and his colleagues[35] came to the conclusion that, in comparison to OA, there is unmistakable proof that LA is a safe treatment for complex appendicitis. Additionally, compared to OA, it is linked to lower mortality, wound infection, ileus and respiratory problems without a greater frequency of IAA, which is in line with our study's findings.

Conclusion

LA is a better option for patients with complicated appendicitis since it is safe and has a lower rate of readmission and wound infection while other complications are comparable to OA.

References

1. Merhoff AM, Merhoff GC, Frankin ME: Laparoscopic versus open appendectomy. ***Am J Surg.*** 2000; 179: 375-378.
2. Moraitis D, Kini SU, Annamaneni RK, Zitsman JL: Laparoscopy in complicated pediatric appendicitis. ***JSLS.*** 2004; 8: 310-313.
3. Maxime Mariage, Charles Sabbagh, Gerard Grelpois, et al: Surgeon's definition of complicated appendicitis: A prospective video survey study. Euroasian ***J Hepatogastroenterol.*** 2019; 9(1): 1-4.
4. Masoomi H, Nguyen NT, Dolich MO, et al: Laparoscopic appendectomy trends and outcomes in the United States: Data from the Nationwide Inpatient Sample (NIS), 2004–2011. ***Am Surg.*** 2014; 80: 1074–1077.
5. Navarra G, Ascanelli S, Turini A, Carcoforo P, Tonini G, Pozza E: Laparoscopic appendectomy versus open appendectomy in suspected acute appendicitis in female patients. ***Annali Italiani di Chirurgia.*** 2002; 73(1): 59-63.
6. Mancini GJ, Mancini ML, Nelson HS: Efficacy laparoscopic appendectomy in appendicitis with peritonitis. ***Am Surg.*** 2005; 71: 1-5.
7. Yu MC, Feng YJ, Wang W, Fan W, Cheng HT, Xu J: Is laparoscopic appendectomy feasible for complicated appendicitis ?A systematic review and meta-analysis. ***Int J Surg.*** 2017; 40: 187-197.
8. Semm K: Endoscopic appendectomy. ***Endoscopy.*** 1983; 15(2): 59–64.
9. Garg CP, Vaidya BB, Chengalath MM: Efficacy of laparoscopy in complicated appendicitis. ***Int J Surg.*** 2009; 7: 250-252.
10. Di Saverio S, Podda M, De Simone B, et al: Diagnosis and treatment of acute appendicitis. ***World J Emerg Surg.*** 2020; 15: 27.
11. Piskun G, Kozik D, Rajpal S, Shaftan G, Fogler R: Comparison of laparoscopic, open, and converted appendectomy for perforated appendicitis. ***Surg Endosc.*** 2001; 15: 660-662.
12. Merhoff AM, Merhoff GC, Frankin ME: Laparoscopic versus open appendectomy. ***Am J Surg.*** 2000; 179: 375-378.
13. Di Saverio S, Birindelli A, Kelly MD, Catena F, Weber DG, Sartelli M, et al: WSES guidelines for diagnosis and treatment of acute appendicitis. ***World J Emerg Surg.*** 2016; 11(34): 1–25.

14. Wullstein C, Barkhausen S, Gross E: Results of laparoscopic vs. conventional appendectomy in complicated appendicitis. **Dis Colon Rectum.** 2001; 44(11): 1700–1705.

15. Towfgh S, Chen F, Mason R, Katkhouda N, Chan L, Berne T: Laparoscopic appendectomy significantly reduces length of stay for perforated appendicitis. ***Surg Endosc.*** 2006; 20(3): 495–499.

16. Manish M Tiwari, Reynoso Jason, Tsang Albert, Oleynikov Dmitry: Comparison of outcomes of laparoscopic and open appendectomy in management of uncomplicated and complicated appendicitis. ***Annals of Surgery.*** 2001; 254: 927–932.

17. Menezes M, Das L, Alagtal M, Haroun J, Puri P: Laparoscopic appendectomy is recommended for the treatment of complicated appendicitis in children. ***Pediatr Surg Int.*** 2008; 24: 303-305.

18. Cueto J, D'Allemagne B, Vazquez-Frias JA, Gomez S, Delgado F, Trullenque F, et al: Morbidity of laparoscopic surgery for complicated appendicitis: An international study. ***Surg Endosc.*** 2006; 20: 717-720.

19. Piskun G, Kozik D, Rajpal S, Shaftan G, Fogler R: Comparison of laparoscopic, open, and converted appendectomy for perforated appendicitis. ***Surg Endosc.*** 2001; 15(7): 660-662.

20. Sauerland S, Jaschinski T, Neugebauer EA: Laparoscopic versus open surgery for suspected appendicitis. ***Cochrane Database Syst Rev.*** 2010, 10:CD001546.

21. Athanasiou C, Sonia L, Georgios A: Systematic review and meta- analysis of laparoscopic versus open appendicectomy in adults with complicated appendicitis: An update of the literature. ***World Journal of Surgery.*** 2017; 12: 3083-3099.

22. Garg CP, Vaidya BB, Chengalath MM: Efficacy of laparoscopy in complicated appendicitis. ***Int J Surg.*** 2009; 7: 250-252.

23. Alfredo M, Carbonell DO, Justin MB, Amy E, Kristi L, Harold T: Outcomes of laparoscopic versus open appendectomy, from the Carolinas laparoscopic and advanced surgery program, department of general surgery. ***The American Surgeon.*** 2004; 70: 759-766.

24. Long KH, Bannon MP, Zietlow SP: A prospective randomized comparison of laparoscopic appendectomy with open appendectomy: Clinical and economic analyses. ***Surgery.*** 2009; 129: 390–400.

25. Kassem R, Shreef K, Khalifa M: Effects and clinical outcomes of laparoscopic appendectomy in young children with complicated appendicitis: A case series. ***Egypt J Surg.*** 2017; 36: 152–155.

26. Quah Gs, Eslick Gd, Cox Mr: Laparoscopic appendicectomy is superior to open surgery for complicated appendicitis. ***Surg Endosc.*** 2019; 33(7): 2072-2082.

27. Dumas, et al: Laparoscopic Appendectomy: A report on 1164 operations at a single-institution, Safety-Net Hospital. ***Am Surg.*** 2018; 84(6): 1110–1116.

28. Horwitz JR, Custer MD, May BH, Mehall JR, Lally KP: Should laparoscopic appendectomy be avoided for complicated appendicitis in children? ***J Pediatr Surg.*** 1997; 32(11): 1601–1603.

29. Khirallah MG, Eldesouki NI, Elzanaty AA, Ismail KA, Arafa MA: Laparoscopic versus open appendectomy in children with complicated appendicitis. ***Ann Pediatr Surg.*** 2017; 13: 17–20.

30. Xuan Z, Glenn L, Bonney K, Bok J, So Y, Lincoln D, et al: Laparoscopicversus open appendectomy in pediatric patients with complicated appendicitis: A meta-analysis. ***Surg Endosc.*** 2019; 33(12): 4066–4077.

31. Chang HK, Han SJ, Choi SH, Oh J: Feasibility of a laparoscopic approach for generalized peritonitis from perforated appendicitis in children. ***Yonsei Med J.*** 2013; 54(6): 1478–1483.

32. Leung TT, Dixon E, Gill M, Mador BD, Moulton KM, Kaplan GG, MacLean AR: Bowel obstruction following appendectomy: What is the true incidence? ***Ann Surg.*** 2009; 250: 51–53.

33. Masoomi H, Nguyen NT, Dolich MO, et al: Laparoscopic appendectomy trends and outcomes in the United States: Data from the Nationwide Inpatient Sample (NIS), 2004–2011. ***Am Surg.*** 2014; 80: 1074–1077.

34. Kocatas A, Kinaci E, Bozkurt MA, Gemici E, Akarsu C, Kones O, Alis H: The efficiency of laparoscopy in patients with complicated appendicitis. ***Journal of Turgut Ozal Medical Center.*** 2017; 24(1).

35. Quah GS, Guy DE, Michael RC: Laparoscopic appendicectomy is superior to open surgery for complicated appendicitis. ***Surgical Endoscopy.*** 2019; 33(7): 2072-2082.