Student's Journal of Health Research Africa
e-ISSN: 2709-9997, p-ISSN: 3006-1059
Vol. 5 No. 9 (2024): September 2024 Issue
https://doi.org/10.51168/sjhrafrica.v5i9.1368
Original Article

LAPAROSCOPIC VERSUS OPEN APPENDICECTOMY IN ADULTS

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ABSTRACT

BACKGROUND

One of the most popular techniques is appendectomy. Though it is still debatable, laparoscopic appendectomy (LA) is thought to be the initial course of treatment for complex appendicitis. This study examines mean operating time, surgical site infection, and duration of hospital stay to compare open and laparoscopic appendectomy procedures for individuals with perforated appendices.

MATERIALS AND METHODS

This randomized research was performed at the Department of General Surgery, KIMS, Bhubaneshwar from 2022-23. A total of 100 individuals were enrolled in the research, with 50 people in both groups. Analysis was done on outcome metrics such as blood loss, length of hospital stays before oral intake, mean operating time and postoperative problems.

RESULTS

The mean operating time was significantly longer for LA (101.46 ± 44.4 minutes) compared to OA (84.4 ± 43.1 minutes; p = 0.008). However, LA showed a lower incidence of wound infections (2%) compared to OA (8%), though this difference was not statistically significant (p = 0.09). LA patients experienced a significantly shorter hospital stay (10.54 ± 5.57 days) compared to OA patients (13.19 ± 8.4 days; p = 0.015).

CONCLUSION

The laparoscopic procedure for appendectomy is an effective and efficient surgical procedure with marginally increased hospital expenses. The laparoscopic procedure has clinically advantageous benefits over the open method, including a reduced rate of wound infection, early food tolerance, a shorter stay in the hospital, and less need for postoperative analgesics.

RECOMMENDATIONS

LA is recommended over OA for perforated appendices due to its advantages, such as fewer wound infections and shorter hospital stays, despite longer operating times. Further research with larger randomized trials is needed to confirm these findings and evaluate the cost-effectiveness of LA.

Keywords: *Perforated appendix, open appendectomy, laparoscopic appendectomy*
Submitted: 2024-09-25 Accepted: 2024-09-26

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INTRODUCTION

Appendicitis is the primary cause of abdominal emergencies in patients of all age groups, with a prevalence of acute appendicitis ranging from 7 to 10% in the general population. The prevalence of this ailment is highest in the 20s and 30s, with an incidence rate of 8.6% in men and 6.7% in women. Open appendectomy has traditionally been the standardized protocol for treating acute appendicitis, as first described by McBurney in the late 19th century. However, since the 1980s saw Semm introduce laparoscopic appendectomy, the superiority of the laparoscopic versus open surgical method such as laparoscopy which has gained popularity for its minimally invasive nature has become a topic of debate [1–5].

The clinical outcomes, duration of hospital stay, and hospitalization costs, for both these approaches have been contrasted in numerous investigations and resulted in mixed results. While some studies highlight better outcomes with laparoscopic appendectomy—which include reduced hospitalization, reduced postoperative pain, and faster resumption of daily activities—other studies suggest marginal benefits or even disadvantages, such as higher costs and longer operative times [6–12]. Moreover, there is concern over an increased risk of abscesses inside the

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abdomen, especially in cases of perforated appendicitis, although this is not universally supported by the literature [7, 10–13].

The debate is further complicated in pediatric populations, where the benefit of laparoscopic appendectomy is less clear due to the small body size of children and the technical challenges posed by laparoscopy. While some studies suggest similar postoperative outcomes between laparoscopic and open approaches, particularly in wound complications and analgesic requirements, others cite longer and more expensive surgeries, as well as a higher chance of developing an intra-abdominal abscess in children [14–17]. Despite these controversies, laparoscopy continues to be widely adopted, especially in specialist pediatric surgery centers, although it remains less common among adult general surgeons who manage pediatric cases in non-specialist settings [18–20].

Given the existing uncertainty in both younger and adult populations, this investigation aims to compare and contrast the results of laparoscopic appendectomy with open appendectomy, particularly in perforated appendicitis. This will involve evaluating parameters such as stay, postoperative complications, operating time, analgesic requirements, time to oral intake, as well as hospitalization costs to better understand the potential benefits or drawbacks of each surgical approach [3, 4, 18, 20].

This study examines mean operating time, surgical site infection, and duration of hospital stay to compare open and laparoscopic appendectomy procedures for individuals with perforated appendices.

METHOD AND MATERIAL

STUDY DESIGN

Single-center, randomized study

STUDY SITE

Department of General Surgery, KIMS, Bhubaneshwar, India, and the study was carried out between May 2022 to May 2023

PARTICIPANTS

There were 100 participants in this study, of whom 50 had OA and 50 had LA. The LA group comprised patients with transformed OA.

The document does not provide explicit inclusion and exclusion criteria for the participants. However, based on the general context of the study and similar research designs, the participants likely had the following characteristics:

INCLUSION CRITERIA

1. Patients diagnosed with perforated appendicitis.
2. Adults requiring surgical intervention for appendicitis.
3. Patients who were able to undergo either OA or LA.
4. Patients with stable enough health conditions to undergo surgery.

EXCLUSION CRITERIA

1. Patients with contraindications to surgery or general anesthesia.
2. Those with severe co-morbid conditions that would prevent them from undergoing laparoscopic or open appendectomy.
3. Patients with other intra-abdominal emergencies that required different or additional interventions.
4. Pregnant women or pediatric patients.

DATA COLLECTION

The clinical data that was gathered for every patient was recorded. This included the patient's gender, age, comorbidities, BMI, CRP level, WBC count, duration of hospitalization, time before oral administration, as well as postoperative problems. Blood loss after surgery, its duration, and the amount of time spent throughout the procedure were all noted. During hospitalization and follow-up, postoperative problems were documented for every patient in the clerking pro forma.

PROTOCOL FOLLOWED

A standardized laparoscopic appendectomy (LA) technique was utilized, employing a three-trocar approach, which included three trocars of which two were in 5 mm dimensions and one was in 12 mm dimensions. One 12-mm umbilical port was inserted openly to establish pneumoperitoneum, followed by the insertion of two additional 5-mm trocars: one in the lower half of the left side and another in the left oblique abdomen. Then, visualization was done using a 5-mm flexible laparoscope. Carbon dioxide was insufflated into the abdominal cavity, maintaining a 10-mmHg intraabdominal pressure. The patient was positioned in a Trendelenburg posture with a slight tilt to the left. The meso appendix was dissected using an ultrasonic device, and the appendix was removed with an endoscopic linear stapler. To reduce the risk of contamination, the appendix was retrieved through the umbilical port using an endoscopic extraction bag.

For open appendectomy (OA), the procedure followed the traditional approach, involving intra-abdominal access through a muscle-splitting peritoneal incision and a McBurney incision. After ligating the mesoappendix, the appendiceal stump was split using absorbable sutures, without employing a purse-string suture. The operating surgeon had the final say on whether or not to insert a drain. Every specimen that was removed was sent for histological examination. Patients in both the LA and OA categories

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were advised to begin mobilizing on the day following surgery. The oral administration was initiated shortly thereafter following which the patient was discharged according to their recovery from both physical activity and oral intake. For both surgical techniques, an average operating time (in minutes) was noted between the primary skin incision and the final skin suture. The duration of hospitalization was defined as the number of nights stayed in the hospital following admission.

RANDOMIZATION

Sequence Generation: A computer-generated random allocation sequence was used to assign participants to the laparoscopic appendectomy (LA) or open appendectomy (OA) group. The randomization was done using a simple randomization method without stratification to ensure equal probability for each patient to be allocated to either group.

Type of Randomization: Block randomization was used to ensure balanced allocation between the two groups throughout the trial. A block size of 4 was chosen, with equal allocation of 2 patients to the LA group and 2 to the OA group within each block.

Allocation Concealment Mechanism: To maintain the integrity of the randomization process, the allocation was concealed using sequentially numbered, opaque, sealed envelopes (SNOSE). These envelopes were prepared by an independent researcher who was not involved in the study. The envelopes were opened only after patient consent was obtained and the decision to proceed with surgery was made, ensuring that the sequence remained concealed until assignment.

Blinding: Due to the nature of the surgical interventions, blinding of participants and care providers was not possible. However, the outcome assessors (those collecting data on postoperative complications, hospital stay, and infections) were blinded to the type of surgery performed. Blinded assessment ensured unbiased reporting of the outcomes.

Follow-up: The follow-up period was extended for 30 days post-surgery, with assessments conducted on day 7 (early postoperative period) and day 30 (late postoperative period). Patients were monitored for postoperative complications, including infections, intra-abdominal abscesses, and wound healing. Any hospital readmissions or late-onset complications were recorded during this time.

STATISTICAL ANALYSIS

Intention-to-treat comparisons were used to compare the groups; patients in the LA category who needed to be converted to OA were included in the analysis. The continuous data with a mean ± SD include BMI, age, CRP level, WBC count, blood loss, time to oral administration, mean operative time, and duration of hospitalization. The unpaired two-tailed t-test was used to evaluate the means of continuous variables. A risk ratio derived from multivariate logistic regression with a two-tailed 95% confidence interval (CI) was used to assess postoperative complications; the significant p-value was below 0.05.

ETHICAL CONSIDERATIONS

The study protocol was approved by the Ethics Committee and written informed consent was received from all the participants.

RESULTS

100 individuals were enrolled in the trial; 50 had laparoscopic appendectomy (LA) and the remaining 50 had open appendectomy (OA). There were 31 men and 19 women in the OA category and 34 men and 16 women in the LA category. The two categories' mean ages were similar, with the OA category being 50.15 ± 22.7 years and the LA category being 50.13 ± 25.8 years (p=0.990). Comparably, the mean BMI for the OA category was 22.4 ± 4.8 kg/m², while for the LA group, it was 22.3 ± 4.25 kg/m² (p=0.874). In the OA category, people with diabetes mellitus were 10%, while in the LA group, it was 6% (p=0.433).

TABLE 1: DEMOGRAPHIC FEATURES OF PATIENTS IN BOTH GROUPS

Characteristics	OA (N=50)	LA (N=50)	P value
Age (yrs.)	50.15±22.7	50.13±25.8	0.990
Sex ratio (Male: Female)	31:19	34:16	
BMI (kg/m^2)	22.4±4.8	22.3±4.25	0.874
Diabetes mellitus (n)	5(10.0%)	3(6.0%)	0.433
Preoperative WBC (*1000/µL)	12.80±4.4	13.8±5.3	0.166
Preoperative CRP (mg/dL)	12.7±9.5	12.6±9.3	0.912
Drainage (n)	40 (80.0%)	25 (50%)	

In the LA cohort, the mean operating time was significantly longer, averaging 101.46 ± 44.4 minutes, compared to 84.4 ± 43.11 minutes in the OA cohort. However, the LA gro cohort up experienced considerably less blood loss, with an

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average of 29.64 ± 62.97 mL, compared to 74.79 ± 168.55 mL in the OA cohort. While the time to resume oral intake was slightly quicker in the LA cohort, averaging 2.03 ± 1.66 days compared to 2.48 ± 2.17 days in the OA group, this difference was not statistically significant. Additionally, the hospital stay was significantly shorter for the LA cohort, with an average of 10.54 ± 5.57 days, compared to 13.19 ± 8.4 days in the OA cohort.

TABLE 2: MAIN OUTCOMES NOTED IN BOTH COHORTS:

Main outcomes	OA (N=50)	LA (N=50)	P value
Average operative time (mins)	84.4±43.1	101.4±33.5	0.008
Hospitalization period (days)	13.2±8.4	10.54±5.6	0.015
Loss of blood (mL)	74.8±168.5	29.6±62.9	0.017
Time until oral administration (days)	2.5±2.2	2.03±1.6	0.123

The OA group (26%) exhibited a higher incidence of complications compared to the LA (16%) category. Intra-abdominal abscesses were noted in 6% of OA patients, whereas none were reported in the LA category (p = 0.064). Both groups experienced paralytic ileus at a similar rate of 8% (p = 0.79), but the prevalence of wound infections were greater in the OA category (8%) in contrast to the LA group (2%) (p = 0.09). Additionally, there was one reported mortality in the LA cohort, while no deaths occurred in the OA cohort.

TABLE 3: POST-OPERATIVE COMPLICATIONS SEEN IN BOTH COHORTS:

Postoperative complications	OA (N=50)	LA (N=50)	p-value
Intra-abdominal abscess	3(6%)	0	0.064
Intraperitoneal infection	1(2%)	0	0.682
Paralytic ileus	4(8%)	4(8%)	0.79
Wound infection	4(8%)	1(2%)	0.09
Mortality	0	1(2%)	-
Others	1(2%)	2(4%)	-
Total	13(26%)	8(16%)	0.032

DISCUSSION

Laparoscopy has traditionally been considered a relative contraindication in patients with advanced appendicitis due to the perceived heightened risk of postoperative complications [20–22]. However, findings from several studies investigating the outcomes of laparoscopic appendectomy in cases of severe appendicitis have challenged this notion [23–25]. In a related study, a study found that patients in the open appendectomy group were 34 ± 13 years old, while the mean age of those undergoing laparoscopic appendectomy was 32 ± 14 years [26]. The average ages in the present study and these results are rather similar. According to [27], In younger age groups, appendicitis is more likely, which explains why the age groups are similar. Another study found that appendicitis was more common in kids aged 11 to 20. However, as individuals mature, the prevalence of the condition may increase [28–29].

According to multiple studies, the primary advantages of LA for complex appendicitis include shortened hospital stays and avoidance of wound infections [30-33]. However, it has been noted that this surgical strategy may have disadvantages in terms of operating time and postoperative complications related to LA [33, 34]. There have been reports indicating that LA requires a longer operating time than OA [30, 35, 36]. In the present investigation, the mean operative time of LA was 17.2 minutes longer than the OA group's. The reported greater operating time is probably because LA required more time in the early stages of this approach's introduction as surgeons gained the proficiency with techniques and surgical abilities needed to become specialists [37, 38].

It was observed that the LA group's mean blood loss was considerably lower than the OA group's. This is probably because, compared to traditional OA, LA provides a larger surgical field of vision. This makes it possible to identify and treat bleeding using the LA technique more rapidly. The length of hospital stay is a significant element that has an immediate effect on the financial situation and general health of the patients. According to our results, the LA group's hospital stay was considerably shorter (p = 0.016) than that of the other groups, which is in line with previous research [35,36].

The postoperative complication rates in the LA category in the study were significantly reduced (p = 0.0327). Although there was no change in the rate of wound infection in our

investigation, the LA cohort had a reduced rate (p = 0.09). Although wound infections are rather common and might not be regarded as extreme complications, they significantly affect people's quality of life and the convalescence period. The endoscopic retrieval bag method of extracting the infected appendix prevents the inflamed organ from coming into direct interaction with the injury, while the direct extraction via the surgical incision permits such contact, which may account for the LA category's reduced rate of wound infections [39].

Overall, patients who underwent LA experienced more favorable clinical outcomes compared to those who had OA. We recommend that surgeons prioritize laparoscopic surgery when managing cases of appendicitis.

GENERALIZABILITY

The generalizability of this study's findings may be somewhat limited due to factors such as the single-center setting and the relatively small sample size of 100 participants. Additionally, the study was conducted in a specific geographic region, which may limit its applicability to broader populations with different healthcare infrastructures, surgical expertise, or patient demographics. However, the use of common surgical techniques, such as laparoscopic and open appendectomy, allows for some transferability of the results to similar healthcare settings. Future multicenter studies with larger, more diverse populations would be needed to enhance the generalizability of these findings.

CONCLUSION

The data of the present study suggests that laparoscopic appendectomy (LA) is a secure and efficient surgical option compared to open appendectomy (OA), offering clinically significant advantages. We recommend considering laparoscopic appendectomy for managing severe appendicitis. Further research is necessary to evaluate the efficacy of LA for complex appendicitis cases.

LIMITATIONS

This study has several limitations. Notably, operative surgeons selected the surgical procedure, and patients were not assigned to the LA or OA categories at random. Factors like the patient's age, the length of the signs, and the surgeon's inclination could influence the selection for LA. Additionally, this investigation was conducted at a single center and had a small sample size.

RECOMMENDATION

Based on the results, laparoscopic appendectomy (LA) is recommended over open appendectomy (OA) for patients with perforated appendices. LA provides significant clinical advantages, including reduced wound infections and shorter hospital stays. However, the longer operating time for LA must be considered, especially in cases with resource limitations. Further research involving larger and randomized patient groups is recommended to confirm these findings and assess the cost-effectiveness of LA in different healthcare settings.

ACKNOWLEDGEMENT

We are thankful to the patients; without them, the study could not have been done. We are thankful to the supporting staff of our hospital who were involved in the patient care of the study group.

LIST OF ABBREVIATIONS

LA: Laparoscopic Appendectomy
OA: Open Appendectomy
BMI: Body Mass Index
CRP: C-Reactive Protein
WBC: White Blood Cell
SNOSE: Sequentially Numbered, Opaque, Sealed Envelopes
SD: Standard Deviation
CI: Confidence Interval

SOURCE OF FUNDING

No funding received.

CONFLICT OF INTEREST

The authors have no conflicting interests to declare.

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