

Original Research Article

Beyond the incisions: unraveling the superiority between laparoscopic versus open appendectomy

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Received: 19 June 2023

Accepted: 15 July 2023

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ABSTRACT

Background: Appendectomy is one of the most common surgical emergencies worldwide and is performed using either an open or a laparoscopic approach. Although minimally invasive surgeries are replacing open surgical procedures, laparoscopic appendectomy (LA) has not yet been established as the gold standard procedure compared to open appendectomy (OA). This study aimed to compare the outcomes of LA and OA in 100 cases and evaluate the feasibility, safety, and efficacy of LA as the preferred method for treating acute appendicitis.

Methods: This study was a prospective comparative analysis of 100 patients with acute appendicitis who underwent LA or OA. This study was conducted at a tertiary care hospital (CMH Chattogram) between January 2021 and April 2023. Patients were divided into two groups: laparoscopic (n=50) and open (n=50) appendectomy. Both groups were compared for operative time, length of hospital stay, postoperative pain, complication rate, time to return to normal activity, and cosmetic outcome.

Results: The mean operative time was significantly longer in the LA group (43 minutes) compared to the OA group (36.4 minutes) ($p<0.001$). However, the LA group had significantly less postoperative pain with a mean VAS score of 2.04 at 48 hours postoperatively compared to 5.7 in the OA group ($p<0.001$). LA group had a shorter length of hospital stay compared to the OA group (3.12 days versus 6.48 days, $p<0.001$) and a faster time to return to normal activities (7.68 days versus 16.58 days, $p<0.001$). The LA group had less surgical site infection compared to the open group, with 2 out of 50 compared to 8 in the open group ($p<0.46$). The cosmetic outcome was measured with the scar scale where the LA group had a significantly better-looking scar with a score of 4.28 versus the score of 8.86 ($p<0.001$) in the case of the OA group.

Conclusions: While the longer operative time of LA was a drawback, its benefits in terms of the better visual field of vision during operation and improved patient outcomes make it the more favorable option for appendectomy.

Keywords: Appendicitis, Laparoscopic appendectomy, Open appendectomy, Post-operative outcome

INTRODUCTION

Since its discovery, the appendix has been regarded as a mysterious organ in terms of its less-understood physiological function and pathogenesis. Nevertheless, acute appendicitis is one of the most common surgical emergencies worldwide, affecting people of all ages.¹ In 1889, an American surgeon, Charles Mcburney described appendectomy as the standard surgical procedure for the

treatment of acute appendicitis.² Since then, the surgical technique has evolved significantly. At present, two surgical techniques, laparoscopic appendectomy (LA) and open appendectomy (OA), are commonly used. The traditional OA has been the gold standard for the past few decades, but the development of minimally invasive techniques has raised the issue of declaring LA to be the superior method of treatment.^{3,4} Although it is easy to perform, OA can become difficult due to the limited field

of vision through the small incision (Grid iron or Lanz) and variability of the position of the appendix. The laparoscopic approach provides the surgeon with a better vision of the peritoneal cavity, easy identification of the appendix, and visualization of concomitant pathologies. LA has also been shown to have several benefits over OA, including reduced post-operative pain, shorter hospital stays, faster recovery time, and reduced wound related complications.⁵⁻⁷ Despite these advantages, LA is still not universally accepted as the standard of care mainly because of the steep learning curve, longer operative time, and cost effectiveness.⁸⁻¹¹ In this context, this study aims to compare the outcomes of laparoscopic versus open appendectomy in 100 cases and evaluate the feasibility, safety, and efficacy of LA as a preferred method for the treatment of acute appendicitis. The results of this study may provide valuable insights into the benefits and limitations of laparoscopic and open appendectomy and guide the current clinical practice and decision-making.

METHODS

Study design

This study was a prospective comparative analysis of 100 cases of acute appendicitis who underwent either laparoscopic or open appendectomy. The study was conducted at a tertiary care hospital (CMH Chattogram) between January 2021 and April 2023.

Participants

The study included 100 patients who were diagnosed with acute appendicitis and underwent surgical intervention. The patients were divided into two groups: laparoscopic (n=50) and open (n=50) appendectomy.

Inclusion criteria

Patients with clinical presentation of acute appendicitis with Alvarado's score >7. Age between 12 and 40 years. Nonpregnant patients. Patients of American Society of Anesthesiologists (ASA) class 1 and 2. Patients with informed written consent.

Exclusion criteria

Patients presenting with an appendicular lump or abscess formation. Patients with a history of previous abdominal surgeries. Lap converted to open cases. Open cases which required the incision to be extended.

Procedure

Patient selection was done by the operating surgeon through a lottery method to prevent selection bias. Patients were explained about the risks and benefits of both the procedures and written informed consents were obtained. Surgeries were performed by three different

surgeons with similar skills in OA and LA. All patients received an intravenous dose of third-generation cephalosporin and metronidazole at the time of induction.

OA was performed under spinal anesthesia with a traditional Lanz incision. Appendectomy was done after ligating the meso appendix and the base of the appendix with Vicryl (2-0). Skin was closed with prolene (3-0). LA was performed with a 3-port technique. A 10 mm umbilical port for the pneumoperitoneum and camera. A 5 mm port in right iliac fossa and a 10 mm port in left iliac fossa. Appendectomy was done after ligating the base of the appendix with vicryl (2-0) and coagulation of the appendicular artery with unipolar diathermy. The skin was closed with the same suture used for ligating the base.

Data collection

Data were collected prospectively and included patient demographics, preoperative laboratory and imaging findings, operative details, postoperative complications, length of hospital stay, and time to return to normal activities. The duration of the operation (in minutes) was defined as the time from the skin incision to the last stitch of skin closure in all cases. Postoperative pain was assessed on the 12th, 24th, and 48th hour using the visual analogue scale (VAS). Oral feeding was introduced if the bowel sound was present 24 hours following the surgery. Patients were discharged from the hospital when the patients were afebrile and the pain was tolerable. Sutures were removed on the 8th postoperative day (POD) in all cases. Surgical site infection (SSI) was recorded as a parameter of postoperative complication. Sutures were removed at the end of 1st postoperative week in all cases. Time for returning to normal activities was defined as the time taken after surgery (in days) when abdominal discomfort did not interfere with normal daily activities. Cosmetic outcome was recorded after 1 month following the surgery as perceived by the patient using the scar scale on a range of 3 to 15, with 3 being the best result and 15 being the worst. Patients were followed up at the end of 1st and 4th week after the surgery.

Statistical analysis

Statistical analysis was performed using SPSS software version 29.0. Descriptive statistics were used to summarize the data, and the chi-square test or Fisher's exact test was used to compare categorical variables. The independent samples t-test was used to compare continuous variables. A p value of <0.05 was considered statistically significant.

Ethical considerations

The study was conducted in accordance with the principles of the Declaration of Helsinki and approved by the institutional review board. All patients provided

written informed consent, and all patient data were kept confidential and anonymous.

RESULTS

A total of 100 patients were included in the study, with 50 patients undergoing LA and 50 undergoing OA. Demographic data and preoperative total white blood cell (WBC) count between the OA group and LA group were found to be comparable (Table 1). There was slight female preponderance in the LA group but it was not statistically significant. There was no significant difference concerning age and white blood cell count.

The mean operative time was significantly longer in the LA group (43 minutes) compared to the OA group (36.4 minutes) ($p<0.001$). However, the LA group had significantly less postoperative pain compared to the OA group, with a mean VAS score of 4 at 12 hours postoperatively compared to 7.1 in the OA ($p<0.001$). This difference persisted at 12 hours and 24 hours postoperatively. Bowel sound returned significantly earlier in the laparoscopic group with a mean duration of 9.24 hours compared with the 13.84 hours in the open group ($p<0.001$) but the time needed for starting oral feeding was not significantly affected as the OA group needed 25 hours and the LA group required 24.04 hours ($p=0.101$).

Table 1: Demographic and preoperative clinical data.

Parameters	OA (n=50)	LA (n=50)	P value
Gender	Male	28 (56%)	0.161
	Female	22 (44%)	
Age (mean±SD)	23.26±4.66	22.5±5.47	0.46
Total WBC count per mm³ (mean±SD)	14360±1407	14020±993	0.173

Table 2: Operative and postoperative clinical data.

Parameters	OA (n=50)	LA (n=50)	P value
Duration of operation in mins (mean±SD)	36.4±8.42	43±7.982	<0.001
Post-operative VAS pain score at 12 hours (mean±SD)	7.1±0.886	4±0.782	<0.001
Post-operative VAS pain score at 24 hours (mean±SD)	6.32±0.653	3.3±0.463	<0.001
Post-operative VAS pain score at 48 hours (mean±SD)	5.7±0.789	2.04±0.283	<0.001
Bowel sound (in hours)	13.84±6.23	9.24±2.75	<0.001
Time until oral feeding (in hours)	25±4.08	24.04±0.28	0.101
SSI (Post-operative complication)	8 (16%)	2 (4%)	0.046
Hospital stay in days (mean±SD)	6.66±4.86	3.12±2.63	<0.001
Return to normal activity in days (mean±SD)	16.78±9.82	7.68±3.26	<0.001
Cosmesis (scar scale)	8.86±1.76	4.28±1.03	<0.001

The laparoscopic group had a shorter length of hospital stay compared to the open group (3.12 days versus 6.48 days, $p<0.001$) and a faster time to return to normal activities (7.68 days versus 16.58 days, $p<0.001$). The laparoscopic group had less surgical site infection compared to the open group, with 2 out of 50 compared to 8 in the open group but it was not statistically significant ($p<0.46$). There were no significant differences between the two groups in terms of developing intra-abdominal abscesses but all 6 patients developing wound infection following OA required a second surgery in the form of delayed primary closure under local anesthesia.

The cosmetic outcome was measured with the scar scale where the LA group had a significantly better-looking scar with a score of 4.28 versus the score of 8.86 ($p<0.001$) in the case of the OA group.

DISCUSSION

The purpose of the vermiform appendix in human physiology is still under research. For quite a long period, it has been regarded as a vestigial organ of the human body undergoing an evolutionary process. But the recent studies have revealed that the appendix may have some specific roles. It can act as a storehouse for normal flora of the gut and helps to restore the gut microbiome after episodes of diarrhea which wash out the normal flora from the gut wall.¹²⁻¹⁴

Nevertheless, Appendectomy is practiced as the standard treatment for appendicitis for the prevention of complications such as perforation, lump, and abscess formation. In this prospective comparative study of 100 cases, we compared the outcomes of laparoscopic versus open appendectomy for the treatment of acute appendicitis.

Operative time

In our study, LA has been found to have a statistically significant (p value <0.001) longer mean operative time (43 ± 7.98 mins) compared to OA (36.4 ± 8.42 mins). This is due to the additional time required for insufflation, port placement, and the use of specialized instruments. However, studies have shown that experienced surgeons can perform LA in a similar amount of time as OA.¹⁵ Our finding is comparable to the results of similar studies (Table 3) by Aftab et al (47.17 minutes in LA and 36.9 minutes in OA groups) and by Rashid et al (33.9 minutes in OA group and 57.64 minutes in LA group).^{16,17} It is also similar to Milewczyk et al where LA versus OA operation duration was 47.75 versus 36.99 minutes.⁶

Postoperative pain

LA was associated with significantly ($p < 0.001$) less postoperative pain compared to OA with the mean post-operative VAS pain score at 12, 24, and 48 hours being 4, 3.3, and 2.04 in LA compared to 7.1, 6.32 and 5.7 in OA (Table 2). This is due to the smaller incisions and less tissue trauma associated with LA. Patients who undergo LA also require less pain medication postoperatively. Our finding is comparable to the results of similar studies (Table 3) by Aftab et al, Rashid et al, and Milewczyk et al.^{6,16,17}

Post-operative follow-ups revealed that the return of bowel sound was significantly earlier in LA (13.84 ± 6.23 mins) than in OA (9.24 ± 2.75 mins). This is probably due to less gut tissue handling in the laparoscopic approach. Although, that did not affect the mean duration until the commensal of oral feeding (24.04 hours in LA versus 25 hours in the OA group).

Length of hospital stay

LA has been associated with a statistically significant shorter length of hospital stay (3.12 ± 2.63 days) compared to OA (6.66 ± 4.86 days). This is due to the quicker recovery time and less postoperative pain associated with LA. Patients who underwent LA were often able to return home on the following day, whereas patients undergoing OA required a longer hospital stay. Our finding is comparable to the results of similar studies (Table 3) by Aftab et al¹ (5.28 days in OA and 3.69 days in LA groups) and by Rashid et al (3.1 days in OA and 1.06

days in LA groups).^{16,17} However, a study by Milewczyk et al showed no significant difference in postoperative hospital stays in the OA group compared with the LA group (Table 3).⁶

Postoperative complications

LA has been associated with fewer postoperative complications compared to OA. While the overall complication rate for both techniques is low, studies have shown that LA is associated with a lower rate of wound infection, abscess formation, and intestinal obstruction.^{6,16,17} This is probably due to the fact that in the laparoscopic approach, the infected appendix did not come in touch with the skin wound whereas all the layers of the abdominal wall were susceptible to exposure with the infected appendix during the operation in the OA group. Our finding is comparable to the results of similar studies (Table 3) by Aftab et al, Rashid et al, and Milewczyk et al.^{6,16,17}

Return to normal activity

The mean time taken for returning to normal activity was significantly lower in the LA group (7.68 days) compared with the OA group (16.78 days). This was because of the more incidences of post-operative SSI in OA which required a second surgery in the form of delayed primary closure. The intensity of postoperative pain was also a contributing factor in this matter. Our finding is similar to the results of other studies (Table 3) by Aftab et al, Rashid et al, and Milewczyk et al.^{6,16,17}

The cosmetic outcome was measured with the scar scale where the LA group had a significantly better-looking scar with a score of 4.28 versus the score of 8.86 ($p < 0.001$) in the case of the OA group. This was due to the minimally invasive nature of LA with 2×10 mm and 1×5 mm transverse incisions compared with 40 to 50 mm incision of OA.

The overall cost of LA is not significantly higher than OA. While the cost of the anesthesia, equipment, and specialized instruments required for LA may be higher, the benefits of LA in terms of shorter hospital stay, less postoperative pain, and fewer postoperative complications requiring fewer medications resulted in lower overall costs for the patient and the healthcare system.

Table 3: Comparing our study with the various parameters of other similar studies.

Parameter	Study							
	Aftab et al ¹⁶		Rashid et al ¹⁷		Milewczyk et al ⁶		Our study	
	OA	LA	OA	LA	OA	LA	OA	LA
Operative Duration (hours)	36.9	47.17	33.9	57.64	36.99	47.75	36.4	43
Post Op VAS score	5	3.5	6.01	5.14	4.77	2.79	5.7	2.04
Hospital stay (days)	5.28	3.69	3.1	1.06	5.03	4.71	6.66	3.12
Return to normal activity (days)	10.10	8.13	9.64	3.6	19.65	15.85	16.78	7.68
Post op complication	13.33%	6.66%	2%	2%	9.4%	6.7%	16%	4%

A systematic review and meta-analysis conducted by Sauerland et al in 2004, including 15 randomized controlled trials (RCTs), found that laparoscopic appendectomy was associated with a shorter length of hospital stay, reduced postoperative pain, and fewer wound infections compared to open appendectomy.¹⁸ However, the study also found that laparoscopic appendectomy was associated with a longer operative time and higher costs compared to open appendectomy.

A more recent meta-analysis by Zhang et al in 2022, including 777 articles, reported similar results, with laparoscopic appendectomy being associated with a shorter length of hospital stay, less postoperative pain, and fewer wound infections compared to open appendectomy.¹⁹ The study also found that laparoscopic appendectomy was associated with a lower risk of complications and readmissions and a faster return to normal activities compared to open appendectomy.

In terms of long-term outcomes, several studies have reported no significant differences in the rates of complications, recurrence, or mortality between laparoscopic and open appendectomy. A retrospective cohort study conducted by Al-Guller et al in 2004, including 43,757 patients, found that laparoscopic appendectomy has significant advantages over open appendectomy concerning the length of hospital stay, rate of routine discharge, and postoperative in-hospital morbidity.²⁰

Overall, the evidence suggests that laparoscopic appendectomy is safe and effective and can be considered the preferred method for the treatment of acute appendicitis. However, more randomized controlled trials are required to confirm the long-term outcomes and cost-effectiveness of laparoscopic appendectomy. Additionally, factors such as surgeon experience, patient selection, and availability of resources may also influence the choice between laparoscopic and open appendectomy.

Limitations of our study include its small sample size and the single-center design. In addition, the study was not randomized, and the decision to perform laparoscopic or open appendectomy was made by the treating surgeon. However, our study adds to the growing body of evidence that supports the use of laparoscopic appendectomy as a safe and effective alternative to open appendectomy for the treatment of acute appendicitis

CONCLUSION

This study found that LA was associated with less postoperative pain, shorter hospital stays, fewer postoperative complications, and a faster return to normal activities in a sample of 100 cases. While the longer operative time of LA was a drawback, its benefits in terms of a better visual field of vision during operation and improved patient outcomes make it the more favorable option for appendectomy. Further studies with

larger sample sizes are warranted to validate these findings. Both laparoscopic and open appendectomy are safe surgical approaches for the treatment of acute appendicitis, and the choice of surgical technique should be based on the surgeon's experience, patient-specific factors, and the availability of resources.

Funding: No funding sources

Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

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Cite this article as: Islam MT, Hasan MM, Ahmed S, Basir AK, Hasnat F. Beyond the incisions: unraveling the superiority between laparoscopic versus open appendectomy. *Int Surg J* 2023;10:1289-94.