

Original Research

Comparative evaluation of intraoperative and post-operative outcome in laparoscopic vs open appendectomy in patients of acute appendicitis

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Received date: 2 January, 2024

Acceptance date: 29 January, 2024

Abstract:

Background Acute appendicitis is the most common cause of abdominal surgeries in all the age groups. The present study was conducted to compare intraoperative and post-operative outcome in laparoscopic vs open appendectomy in patients of acute appendicitis.

Material & Methods: The present study was conducted in the Department of Surgery of MAMC, Agroha over the course of 12 months, from February 2021 to March 2022. After the diagnosis of acute appendicitis was made, allocation of patients for laparoscopic and open appendectomy was done. Intraoperative and post-operative outcome of both groups were noted. The collected data was analyzed with the statistical program Statistical Package for the Social Sciences (IBM SPSS, version 22).

Results: The difference between the surgical times of the two study groups was found to be statistically significant on analysis (p-value 0.016). It was seen that the postoperative pain was significantly higher among the patients undergoing the open appendectomy as compared to those undergoing laparoscopic appendectomies (p-value 0.043). 32% of the study participants of the open appendectomy group and 28% of those of the laparoscopic group had postoperative incidence of vomiting. Open appendectomy was found to be associated with a higher proportion of postoperative wound infection, postoperative paralytic ileus. The mean time to return of bowel sounds for patients, the mean hospital stay for patients undergoing open appendectomy was higher than the patients undergoing laparoscopic appendectomy. Laparoscopic appendectomy was found to be associated with a lesser hospital stay. It was found that the mean time to return to work for patients undergoing open appendectomy was 14.1±2.8 days, and that of the patients undergoing laparoscopic appendectomy was 8.2±1.4 days. Laparoscopic appendectomy was associated with a faster return to work, and the difference between the two study groups were found to be statistically significant on analysis (p-value <0.001).

Conclusion: It is concluded that intraoperative and post-operative outcome in laparoscopic was better than open appendectomy in patients of acute appendicitis. The laparoscopic approach is a safe and efficient operative procedure in appendectomy and it provides clinically beneficial advantages over open method (including shorter hospital stay, earlier return to work, lower rate of wound infection).

Keywords: Laparoscopic appendectomy, open appendectomy, outcome, acute appendicitis.

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Introduction:

Appendicitis is the inflammation of vermiform appendix. Appendicitis is the most common cause of surgical abdomen in all age groups. Persons between 10 and 19 years of age have the highest incidence of appendicitis, with males having a higher rate than females for all age groups. The lifetime risk for appendicitis has been estimated at 8.6% for males and

6.7% for females. Overall, the incidence appears to be approximately 120 per 100 000 population.¹ MC Burney introduced appendectomy as the treatment of choice for appendicitis which involved the open approach.² Nowadays laparoscopic method of appendectomy has come as a new procedure for appendectomy.³ The field of surgery has dramatically changed since the advent of laparoscopy.⁴ Laparoscopic

appendectomy was first introduced by Semm.⁵ It has gained much popularity among surgeons because of the use of minimally invasive techniques, but some remain skeptical about its use instead of open appendectomy.⁶ Minimal surgical trauma, less postoperative pain, and duration of hospital stay are seen in the laparoscopic approach.³ But the higher cost of the treatment and longer duration of the operation remains the lagging step for laparoscopic surgery. Better outcomes have been shown by some studies favoring the laparoscopic approach,⁷ while some studies show laparoscopic surgery has a minimal benefit or no benefit compared to open surgery.⁸ The present study was conducted to compare intraoperative and post-operative outcome in laparoscopic vs open appendectomy in patients of acute appendicitis.

Material & Methods:

The present study was an institution-based observational study with a prospective longitudinal design conducted in the Department of Surgery of MAMC, Agroha over the course of 12 months, from February 2021 to March 2022. The Institutional Ethics Committee of Maharaja Agrasen Medical College Agroha, the study institution reviewed and approved the project before it was carried out. All of the participants were informed in their own language about the study and their rights for participation before providing data for the researcher-administered questionnaire. The study population was comprised of those patients presenting to the study institution with a diagnosis of acute appendicitis and scheduled to undergo appendectomy either via open or laparoscopic procedure. Patients aged 14 years or above, patients providing written informed consent to take part in the present research and patients diagnosed with acute appendicitis and scheduled to undergo appendectomy either by open or laparoscopic method were included in the study. Patients not providing written informed consent, patients aged <14 years, patients with palpable mass in the right iliac fossa, patients with severe medical disease (hemodynamic instability, psychiatric illness, cirrhosis, coagulopathies) requiring intensive care and patients with other conditions such as pregnancy, neoplasms, and generalized peritonitis were excluded from the study. All the patients with age more than 14 years with appendicitis admitted in Department of Surgery were subjected to a detailed history using a structured questionnaire and were examined clinically. Baseline investigations of the patients were done which includes complete blood count, fasting and post-prandial blood sugar, urea, creatinine, electrocardiogram (ECG), chest X ray, PT/ INR. USG findings were taken into account or if required CT scan was also done. After the diagnosis of acute appendicitis was made using

ALVARADO score, USG whole Abdomen and in some cases by CT Scan, informed consent for surgery was taken. Allocation of patients for laparoscopic and open appendectomy was done through the double blinding technique in order to avoid the bias. Patients undergoing laparoscopic surgery were explained about the possible conversion to open surgery and separate consent was taken. In the present study sample was taken as 25 in each group due to more number of surgeries being done at our institution. A consecutive sampling technique was employed for the present study. Each of the participants who fulfilled the inclusion and exclusion criteria were assigned a unique identification four-digit number. A random number table was used to assign patients to either the open or the laparoscopic appendectomy groups. The study was conducted using a predesigned questionnaire to obtain the sociodemographic and clinical data of the patients. Following the collection of the data, operative and post-operative complication related data were obtained for each patient. Each of the patients was followed up from their admission into the study institution till their death or discharge from the institution. After the initial data collection during admission of the patients, they were followed up to establish final etiology, and operative considerations, which were also noted down in their respective case record proforma. Finally, the patients were followed up till the end of their stay in the hospital and the outcomes were noted as either death or discharge. All the patients in both groups received 1 gm of cefotaxime every 8 hours intravenously from the time of diagnosis until surgery. Open appendectomy- At McBurney point Grid-Iron muscle-splitting incision 1.5 inches in the right lower quadrant. A double ligation of the stump was performed with an absorbable suture. Appendix was removed, and the distal ileum was visualized for detection of possible Meckel's diverticulum. The closure was done in multiple layers with peritoneum and muscles closed with 3-0 vicryl and sheath with 1-0 vicryl. The skin incision was closed with 2-0 nylon. Nonsuction drainage were left in situ in cases of abscess and residual cavity. Laparoscopic appendectomy was performed using 3 ports, with the laparoscope positioned at the umbilicus. One 10-mm port was inserted in supraumbilical region and two 5mm ports were inserted in suprapubic and left iliac region. The abdominal cavity was explored to locate the appendix and rule out other possible diagnoses. Mesoappendix was cauterized with bipolar or harmonic scalpel. Two pretied endoloop of vicryl no. 1 was applied at the base of the appendix. Appendix was cut above the tied loop. And taken out after putting in endobag through 10mm port. The right lower quadrant, the right colic gutter and the subhepatic space in the case of purulence were irrigated and the fluid was suctioned. Fascial defects in the port sites were closed

using 0 Vicryl suture. The skin incisions was closed in every case using 2-0 nylon. Nonsuction drainage were left in situ in cases of abscess and residual cavity. Various intraoperative and postoperative parameters like operative time, postoperative pain, duration of ileus, postoperative stay, wound infection and time to return to activities of daily life were evaluated. For Open appendectomy, operative time was defined as the time taken from skin incision to the time of suturing of skin, whereas for Laparoscopic appendectomy it was defined as the time taken from insertion of ports up to the closure of port site. The collected data were checked for consistency, completeness and entered into Microsoft Excel (MS-EXCEL, Microsoft Corp.) data sheet. Analyzed with the statistical program Statistical Package for the Social Sciences (IBM SPSS, version 22). Data were organized and presented using the principles of descriptive and inferential statistics. The data were categorized and expressed in proportions. The continuous data were expressed as mean \pm SD.

Results:

A total of 50 patients of acute appendicitis scheduled to undergo appendectomy in the study institution were recruited for the purposes of the study, 25 patients in each of the two study groups. It was observed that the most common presenting complaint of patients was abdominal pain, followed by nausea and vomiting, fever and past h/o pain. It was found that the mean total leukocyte count of the patients undergoing open appendectomy was $(10.5 \times 10^3) \pm (2.5 \times 10^3) / \text{mm}^3$, and that of the patients undergoing laparoscopic appendectomy was $(10.7 \times 10^3) \pm (2.1 \times 10^3) / \text{mm}^3$. It was found that 56 % of the patients had leukocytosis at presentation. Among the study population in calculation of Alvarado Score, in clinical symptoms, migration of pain was observed in 70% of patients, anorexia was present in 90% of patients, nausea and vomiting in 88% of patients. In clinical signs, RIF tenderness was most consistent sign present in 100% of patients, rebound tenderness was present in 29 (58.00%) of patients and

elevated temperature was present in 30 (60.00%) of patients. In laboratory findings, 28 (56.00%) patients had total Leukocyte Count ($>10000/\text{mcl}$) and 28% of patients had differential counts shift to left. Among the study population with Alvarado Score, 14 (28.00%) patients had <7 score and remaining 36 (72.00%) patients had ≥ 7 . It was seen that 14% of the study participants had a normal appendix as per abdominal USG as compared to 86 % having inflamed appendix on USG findings. In cases suspected to be having acute appendicitis clinically but USG showing normal appendix, CT scan was done to confirm the diagnosis. It was found that the mean time taken to perform surgery for patients undergoing open appendectomy was 57.2 ± 17.7 mins, and that of the patients undergoing laparoscopic appendectomy was 68.6 ± 14.3 min. The difference between the surgical times of the two study groups was found to be statistically significant on analysis (p-value 0.016). It was found that the mean hospital stay for patients undergoing open appendectomy was 3.1 ± 1.5 days, and that of the patients undergoing laparoscopic appendectomy was 2.2 ± 1.1 days. Laparoscopic appendectomy was found to be associated with a lesser hospital stay, and the difference between the surgical times of the two study groups were statistically significant on analysis (p-value 0.011). It was found that the mean time to return to work for patients undergoing open appendectomy was 14.1 ± 8.2 days, and that of the patients undergoing laparoscopic appendectomy was 8.2 ± 1.4 days. Laparoscopic appendectomy was associated with a faster return to work, and the difference between the surgical times of the two study groups were found to be statistically significant on analysis (p-value <0.001). It was seen that the most common postoperative symptom was postoperative vomiting followed by postoperative pain, fever, wound infection, paralytic ileus and postoperative urinary retention.

Table 1. Descriptive analysis of chief presenting complaints of study population.(n=50)

Characteristics	Frequency(n=50)
Abdominal pain (%)	100 (100)
Nausea and vomiting (%)	44 (88)
Fever (%)	30 (60)
Past h/o pain (%)	20 (40)

Table 2. Distribution of study participants according to their total leukocyte count(n=50)

TLC	Open appendectomy (n=25)	Laparoscopic appendectomy (n=25)
Mean	10.5×10^3	10.7×10^3
SD	2.5×10^3	2.1×10^3

Table 3: Descriptive analysis of Alvarado Score in the study population (N=50)

Parameters	Frequency	Percentages
Migration Of Pain	35	70.00%
Anorexia	45	90.00%
Nausea/ Vomiting	44	88.00%
Right iliac fossa tenderness	50	100.00%
Rebound Tenderness	29	58.00%
Elevated Temperature ($\geq 99.5^{\circ}\text{f}$)	30	60.00%
Leukocyte Count ($>10000/\text{mcl}$)	28	56.00%
DLC Shift to left	14	28.00%
Alvarado Score		
<7	14	28.00%
≥ 7	36	72.00%

Table 4. Descriptive analysis of Ultrasonography abdomen findings in study population (n=50)

USG findings	Frequency (n=50)
Normal (%)	07 (14)
Inflamed (%)	43(86)
Total (%)	25 (100)

Table 5. Distribution of study participants according to the duration of surgery(completed minutes) (n=50)

Duration of surgery (min)	Open appendectomy (n=25)	Laparoscopic appendectomy (n=25)	t-value	p-value
Mean	57.2	68.6	-2.487	0.016*
SD	17.7	14.3		

*Statistically significant

Table 6. Distribution of study participants according to the patients' mean hospital stay (completed days) (n=50)

Hospital stay (days)	Open appendectomy (n=25)	Laparoscopic appendectomy (n=25)	t-value	p-value
Mean	3.1	2.2	2.629	0.011*
SD	1.5	1.1		

Table 7. Table showing comparison of post operative length of stay (In Days)

PO STAY	OA	LA	TOTAL
0-2	12	19	31
2-4	07	05	11
4-6	04	01	05
6-8	02	-	03

Table 8. Distribution of study participants according to the participants' meantime to return to work (completed days) (n=50)

Time to return to work (days)	Open appendectomy (n=25)	Laparoscopic appendectomy (n=25)	t-value	p-value
Mean	14.1	8.2	7.731	<0.001*
SD	2.8	1.4		

*Statistically significant

Table 9. Distribution of study participants according to postoperative symptoms(n=50)

Postoperative morbidities*	Open appendectomy (n=25) (%)	Laparoscopic appendectomy (n=25) (%)
Vomiting	8 (32)	7 (28)
PO Pain (VAS Grade>2)	07(28)	04(16)
Fever	07 (28)	06 (24)
Paralytic ileus	3 (12)	0 (0)
Wound Infection	06(24)	01(04)
PO Urinary Retention	02(08)	0(0)

*Multiple symptoms possible

Discussion:

The present study was undertaken in order to assess and compare the intraoperative and postoperative outcomes of laparoscopic and open approaches to appendectomy. A total of 50 patients of acute appendicitis scheduled to undergo appendectomy in the study institution were recruited for the purposes of the study, 25 patients in each of the two study groups. It was observed that all of the patients taking part in the study presented to the study institution with the primary complaint of severe abdominal pain in the paraumbilical region or localized to the right iliac fossa, a finding that is consistent with the classical symptomatology of acute appendicitis. A majority of them (88% of both the study groups) also suffered from nausea and vomiting at presentation. Other important presenting symptoms in the patients were fever (60% of the patients in both groups) and rebound tenderness (total of 58% of the patients in both groups). These findings were also consistent with the existing literature. Stringer MD et al. and Becker T et al. both reported in their individual reports that the most common signs and symptoms of a patient of acute appendicitis are the characteristic migratory RIF pain, followed by vomiting, rebound tenderness, and fever.^{9,10} Pertinently it was seen in the present study that a significant number of the patients of both the study groups reported a history of past episode of a similar abdominal pain. While such a pain might be indicative of a past episode of acute appendicitis that spontaneously subsided, it is more likely that these patients misidentified an acute onset abdominal pain due to any other cause with that caused by a case of acute appendicitis. Such misreporting of appendicitis-induced pain is common, as abdominal pain similar to that caused by an episode of acute appendicitis can be mimicked by a number of other medical and surgical conditions.¹¹

At the time of admission, each of the patients underwent a thorough clinical as well as laboratory examination. It was observed that the total leukocyte count of the patients, although raised, remained largely within the normal range, with the mean TLC of the open appendectomy group being $(10.5 \times 10^3) \pm (2.5 \times$

$10^3) /\text{mm}^3$ and that for the laparoscopic appendectomy group being $(10.7 \times 10^3) \pm (2.1 \times 10^3) /\text{mm}^3$. Some studies also report a slight rise in the total leukocyte count of patients suffering from acute appendicitis. These include the prospective longitudinal studies conducted by Davies MS et al., and Dueholm S et al., where they reported that one of the markers of an acute appendicular inflammation was the rise in the white blood cell count from the baseline.^{12,13} Another observation that both of these studies reported was the differential count with shift to the left observed in some patients.

This was also observed in the present study, with around a third of the patients of both the study groups reporting a shift to the left in their differential counts. Ultrasound of the abdomen in the recent years has established itself as a reliable laboratory tool to identify and diagnose acute appendicitis. As was expected, the ultrasound of the abdomen of the patients revealed that a majority of the patients of both the study groups had inflamed appendix on visualization with USG (86% of patients in both the groups). Ultrasound evaluation of appendicitis has been observed to be a sensitive but non-specific method of evaluation of acute appendicitis.¹⁴ This was observed to be the case in the present study also, with patients who were found to be normal on ultrasound being suspected to have appendicitis clinically were confirmed by a computed tomography analysis of their abdomen.

When the two study procedures, i.e., open laparoscopic appendectomy were compared, mean operating time was 57.2 ± 17.7 minutes in open appendectomy and 68.6 ± 14.3 minutes in laparoscopic appendectomy in the present study and it was observed that the time to conduct laparoscopic appendectomies was higher than that required to conduct open appendectomies, and these differences were statistically significant. Due to the higher complexity of the equipment and the processes involved, laparoscopic appendectomies have been historically associated with a longer duration of surgery. Evidence towards this assertion is provided by Jamy et al., who reported that laparoscopic appendectomies took on an average at least 20 or more minutes longer than their open counterparts.¹⁵ However, with

advances in the protocols, infrastructure, and methods of surgery, this time gap between the two modalities have been reduced in the recent years. However, most of the research done on the topic reported a statistically significantly higher time to perform surgery among the laparoscopic appendectomy cases as compared to the open cases, as can be observed in the present study as well has been reported by Wei et al.¹⁶

In OA group each patient was assessed and traced till point of meckel's diverticulum and in none of the patients meckel's diverticulum was found. In LA group diagnostic laparoscopy was done and in none of the patients in our study had any other incidental pathology. Another advantage of the minimally invasive nature of the laparoscopic procedure is the comparatively lower days of hospital stay and a faster return to work. Advances in the open approach has also reduced the postoperative hospital stay of the open appendectomy procedure significantly in the recent years. However, one aspect of the postoperative outcome where the minimally invasive laparoscopic appendectomy still edges out on the open appendectomies is the time to return to everyday work for the patients. This is evident from the statistically significant difference in the mean days of postoperative stay which was 3.1 ± 1.5 days for open group and 2.2 ± 1.1 days for the laparoscopic group (p-value 0.009). As the open procedure requires a large incision and considerable manipulation of the underlying muscle and tissue structure of the lower abdomen, the recovery and return to preoperative levels of activity is much slower for those patients undergoing the procedure. Evidence supporting this assertion has been provided by research conducted by authors such as Prodromidou et al. and Naraintran et al.^{17,18} This was observed to be true for the patients of the present study too.

The time to return to work was significantly higher among the open appendectomy patients as compared to the laparoscopic group, which indicates a much slower time of overall recovery among the patients. Similarly higher time to return to work among the study participants undergoing open appendectomy have been reported by Lippert et al., Masoomi et al.^{19,20} Although all of the operations were successful, with patients making full recoveries, it was observed that the postoperative pain was significantly lesser in the laparoscopic appendectomy group as compared to the open appendectomy group. Masoomi et al., reported that the postoperative pain perception was significantly lower among the patients undergoing laparoscopic appendectomy as compared to those undergoing open appendectomy.²⁰

A statistically comparable proportion of patients experienced nausea and vomiting in the postoperative period in the study groups. Finding

similar to these have been reported by Wei et al. in the research.¹⁶ Incidence of fever in the postoperative period was also comparable between the study groups, with the difference being statistically non-significant (p-value 0.747). Mhoberg et al., in their studies have shown that small number of patients in each group having mild postoperative fever.²¹

However, when postoperative wound infection was considered, it was present in 6(24%) of the patients of the open appendectomy group but only 1 (4%) of the patients undergoing laparoscopic appendectomy. Rahman et al., reported that wound site infection is significantly higher in open group (p=0.019).²²

Similarly in our study there was no incidence of any intrabdominal abscess formation post operatively in our study. Talha et al., Wei et al., reported in their studies no significant difference in both the groups in respect to intrabdominal abscess formation.^{23,16} Similarly significant difference was observed between the two study groups with respect to the incidence of paralytic ileus, whose incidence was significantly high in the open appendectomy group 3(12%), while none of the patients undergoing laparoscopic appendectomy developed the condition (p-value 0.037).

By virtue of the minimally invasive nature of the surgery, laparoscopic appendectomies have been associated with a significantly lower incidence of wound infection and paralytic ileus, as well as a faster return of bowel sounds in the postoperative period.²⁰ In our study two patients in open appendectomy group had post operative urinary retention which was statistically significant (p value=0.013). Attwood et al., noted that urinary retention in two patients in open appendectomy group and none laparoscopic group, so that's why they opined that post laparoscopic surgery patients is more comfortable than open group of cases.²⁴

Therefore, the findings of the present study point to the fact that of the two procedures, laparoscopic appendectomy is the better approach in the management of an episode of acute appendicitis, owing to its excellent success rate, significantly lower postoperative pain and complications, and a much faster time to full recovery as compared to the open appendectomy procedure.

Conclusion:

It is concluded that intraoperative and post-operative outcome in laparoscopic was better than open appendectomy in patients of acute appendicitis. The laparoscopic approach is a safe and efficient operative procedure in appendectomy and it provides clinically beneficial advantages over open

method (including shorter hospital stay, earlier return to work, lower rate of wound infection).

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