

Comparative Study of Laparoscopic Appendectomy Versus Open Appendectomy in Acute Appendicitis - Evaluation of Operative Outcomes, Postoperative Complications, Hospital Stay, Cost-Effectiveness, and Return to Normal Daily Activities

¹Dr. Bharath M.S, Associate Professor, Adichunchanagiri Institute of Medical Sciences, Karnataka.

²Dr. Trupti, Junior Resident, Adichunchanagiri Institute of Medical Sciences, B G Nagara, Karnataka.

³Dr. Divyashri C.N, Consultant Anaesthesiologist, Csi Redfern Mission Hospital, Hassan.

Corresponding Author: Dr. Bharath M.S, Associate Professor, Adichunchanagiri Institute of Medical Sciences, Karnataka.

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Abstract

Background: Acute appendicitis is one of the most common surgical emergencies requiring appendectomy. Open appendectomy has traditionally been the standard treatment; however, laparoscopic appendectomy has gained popularity due to its potential benefits, including reduced postoperative pain, fewer complications, shorter hospital stay, and faster recovery.

Objectives: To compare laparoscopic appendectomy and open appendectomy in patients with acute appendicitis with respect to operative outcomes, postoperative complications, hospital stay, cost effectiveness, and return to normal daily activities.

Materials and Methods: A prospective comparative observational study was conducted in the Department of

General Surgery, Adichunchanagiri Institute of Medical Sciences, B.G. Nagara, Karnataka, over a period of two years. A total of 90 patients with acute appendicitis were included and divided into two groups: Group A underwent laparoscopic appendectomy (n=45), and Group B underwent open appendectomy (n=45).

Operative parameters, postoperative recovery, complications, duration of hospital stay, total treatment cost, and time to return to routine activities were evaluated and statistically compared.

Results: The demographic characteristics of both groups were comparable. The mean operative time was longer in the laparoscopic group compared with the open group (58.4 ± 14.2 vs 48.6 ± 12.5 minutes, $p=0.001$). However,

laparoscopic appendectomy was associated with significantly lower intra operative blood loss (18.6 ± 8.4 ml vs 35.2 ± 12.7 ml, $p < 0.001$). Patients undergoing laparoscopic appendectomy had earlier initiation of oral feeds, earlier ambulation, reduced analgesic requirement, and shorter postoperative hospital stay (2.8 ± 1.1 days vs 5.1 ± 1.6 days, $p < 0.001$). Postoperative complications were lower in the laparoscopic group (11.1%) compared with the open group (42.2%). Return to normal daily activities occurred earlier after laparoscopic surgery (10.2 ± 3.6 days vs 18.5 ± 5.4 days).

Although the operative cost was higher for laparoscopic appendectomy, the overall treatment cost was comparable between the groups.

Conclusion: Laparoscopic appendectomy offers significant advantages over open appendectomy in terms of reduced postoperative morbidity, shorter hospital stay, faster recovery, and earlier return to normal activities. Despite higher initial operative costs and longer operative duration, laparoscopic appendectomy is a safe and effective approach for the management of acute appendicitis where appropriate expertise and facilities are available.

Keywords: Acute Appendicitis, Laparoscopic Appendectomy, Open Appendectomy, Postoperative Complications, Hospital Stay, Cost - Effectiveness, Recovery.

Introduction

Acute appendicitis is one of the most common surgical emergencies encountered worldwide and remains the leading cause of acute abdomen requiring operative management. It is characterised by inflammation of the vermiform appendix, usually secondary to luminal obstruction caused by fecoliths, lymphoid hyperplasia, parasites, or other obstructive factors. Early diagnosis

and prompt surgical intervention are essential to prevent complications such as perforation, peritonitis, and intra-abdominal abscess formation¹.

Open appendectomy (OA) has been considered the gold standard treatment for acute appendicitis for more than a century. The conventional open approach, usually performed through a Mc Burney or Lanz incision, is a safe and effective procedure with predictable outcomes.

However, it is associated with certain limitations, including increased postoperative pain, prolonged recovery, longer hospital stay, wound-related complications, and delayed return to routine activities².

The introduction of laparoscopic appendectomy (LA) by Semm in 1983 marked a significant advancement in the surgical treatment of acute appendicitis³.

Laparoscopic surgery offers several advantages over conventional open surgery, including smaller incisions, reduced postoperative pain, lower incidence of wound infection, improved cosmetic results, early mobilization, shorter hospital stay, and faster recovery. Furthermore, laparoscopy provides better visualisation of the abdominal cavity, which can be beneficial in patients with atypical presentations or uncertain diagnosis⁴.

Despite increasing acceptance of laparoscopic appendectomy, controversy continues regarding its advantages over open appendectomy, particularly with respect to operative time, cost - effectiveness, and outcomes in complicated appendicitis. Several studies have reported that laparoscopic appendectomy requires a longer operative time and incurs higher initial procedural costs due to specialised equipment and technical requirements⁵. However, these disadvantages may be offset by reduced postoperative morbidity, shorter hospital stay, decreased medication requirements, and earlier return to normal activities⁶.

The choice of surgical approach depends on multiple factors including surgeon expertise, availability of laparoscopic facilities, patient characteristics, severity of appendicitis, and institutional resources. Although randomised trials and systematic reviews have demonstrated favourable outcomes with laparoscopic appendectomy, differences remain in various healthcare settings, especially where economic factors and resource limitations influence treatment decisions⁷.

Evaluation of surgical outcomes should extend beyond operative parameters alone. Post operative pain, complications, duration of hospital stay, total treatment cost, and time required to resume normal daily activities are important indicators of successful surgical management. These outcomes are particularly relevant in young and economically productive individuals who constitute a major proportion of patients affected by acute appendicitis.

The present prospective comparative observational study was conducted to compare laparoscopic appendectomy and open appendectomy in patients with acute appendicitis, focusing on operative outcomes, post operative complications, hospital stay, cost - effectiveness, and return to normal daily activities.

Materials and Methods

Study Design and Setting

This was a prospective comparative observational study conducted in the Department of General Surgery, Adichunchanagiri Institute of Medical Sciences (AIMS), B.G. Nagara, Karnataka, over a period of two years. The study was undertaken after obtaining approval from the Institutional Ethics Committee, and written informed consent was obtained from all participants before enrolment.

Study Population

The study included patients diagnosed with acute appendicitis who underwent surgical management during the study period. A total of 90 patients were enrolled and allocated into two groups based on the surgical approach adopted by the treating surgeon.

- **Group A:** Laparoscopic Appendectomy (LA) – 45 patients

- **Group B:** Open Appendectomy (OA) – 45 patients

The choice of surgical procedure was based on surgeon preference, patient suitability, and availability of laparoscopic facilities.

Sample Size

A total sample size of 90 patients was included in the study. The sample comprised consecutive eligible patients presenting with acute appendicitis during the study period who fulfilled the inclusion criteria.

Inclusion Criteria

- Patients aged 18 years and above diagnosed with acute appendicitis based on clinical examination and radiological investigations.
- Patients undergoing either laparoscopic or open appendectomy.
- Patients willing to provide written informed consent.

Exclusion Criteria

- Patients with appendicular mass or appendicular abscess managed conservatively.
- Patients with generalized peritonitis requiring extensive laparotomy.
- Pregnant women.
- Patients with significant coagulation disorders.
- Patients unfit for general anaesthesia.
- Patients requiring conversion from laparoscopic to open appendectomy were excluded from comparative analysis.

Preoperative Evaluation

All patients underwent detailed clinical assessment including history taking, physical examination, laboratory investigations such as complete blood count, renal function tests, serum electrolytes, coagulation profile, and urine analysis. Ultra sonography of the abdomen was performed in all patients, while contrast-enhanced computed tomography (CECT) of the abdomen was obtained when clinically indicated. Patients received preoperative intravenous fluids, analgesics, and prophylactic antibiotics according to institutional protocol.

Surgical Procedure

Laparoscopic Appendectomy

Patients underwent surgery under general an aesthesia using the standard three-port laparoscopic technique. Pneumoperitoneum was established using a Veress needle or open (Hass on) technique.

The appendix was identified, the mesoappendix was divided using electrocautery or vessel sealing devices, and the Appendiceal base was secured with endo loops or clips before transaction. The specimen was retrieved using an endo bag whenever feasible. Thorough peritoneal lavage was performed in cases of perforated or gangrenous appendicitis.

Open Appendectomy

Open appendectomy was performed under general or regional an aesthesia through a standard Mc Burney's or Lanz incision. The appendix was identified, the meso appendix ligated, and the Appendiceal stump secured using absorbable sutures. The wound was irrigated and closed in layers after ensuring adequate homeostasis.

Postoperative Management

Postoperative care was standardized for both groups. Pain management was provided using institutional

analgesic protocols. Oral feeding was initiated as tolerated, and patients were encouraged to ambulate early. Antibiotic therapy was continued depending on intra operative findings and surgeon discretion. Patients were discharged once clinically stable, a febrile, tolerating oral diet, and ambulant.

Outcome Measures

The following parameters were assessed and compared between the laparoscopic and open appendectomy groups:

- Operative time (minutes)
- Intra operative findings
- Postoperative pain (assessed using the Visual Analogue Scale)
- Duration of postoperative analgesic requirement
- Time to initiation of oral feeds
- Time to ambulation
- Length of postoperative hospital stay (days)
- Postoperative complications including surgical site infection, intra-abdominal abscess, ileus, wound dehiscence, and other procedure-related complications
- Time taken to return to normal daily activities (days)
- Total treatment cost, including operative expenses, hospital stay, medications, and investigations

Follow-up

Patients were followed up at one week, two weeks, one month, and three months after surgery. Wound healing, postoperative complications, and return to routine daily activities were documented during follow-up visits.

Data Collection

Patient demographics, clinical presentation, operative findings, post operative outcomes, complications, duration of hospital stay, cost of treatment, and time to return to normal activities were recorded using a structured data collection proforma. Confidentiality of

patient information was maintained throughout the study.

Statistical Analysis

Data were entered into Microsoft Excel and analysed using the Statistical Package for Social Sciences (SPSS) software version 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean $\pm$ standard deviation (SD), while categorical variables were presented as frequencies and percentages. Continuous variables were compared using the independent Student's t-test or Mann–Whitney U test, depending on the

distribution of data. Categorical variables were compared using the Chi-square test or Fisher's exact test where appropriate. A p-value of less than 0.05 was considered statistically significant.

Results and Observations

Demographic Characteristics of Study Participants

A total of 90 patients with acute appendicitis were included in the study and divided into two groups: Group A (Laparoscopic Appendectomy, n=45) and Group B (Open Appendectomy, n=45). The demographic characteristics of both groups were comparable.

Table 1: Age Distribution among Study Groups

Age group (years)	Laparoscopic Appendectomy (n=45)	Open Appendectomy (n=45)	Total (n=90)
18–30	24 (53.3%)	22 (48.9%)	46 (51.1%)
31–45	14 (31.1%)	16 (35.6%)	30 (33.3%)
>45	7 (15.6%)	7 (15.5%)	14 (15.6%)
Total	45 (100%)	45 (100%)	90 (100%)

The mean age of patients in the laparoscopic group was 31.8 ± 10.6 years, while in the open group it was 32.4 ± 11.2 years. The difference was statistically not significant ($p > 0.05$).

Gender Distribution

Table 2: Gender Distribution of Patients

Gender	Laparoscopic Appendectomy (n=45)	Open Appendectomy (n=45)	Total
Male	29 (64.4%)	30 (66.7%)	59 (65.6%)
Female	16 (35.6%)	15 (33.3%)	31 (34.4%)
Total	45	45	90

Both groups showed male predominance, with no statistically significant difference in gender distribution.

Operative Outcomes

Table 3: Comparison of Operative Parameters

Parameter	Laparoscopic Appendectomy	Open Appendectomy	p-value
Mean operative time (minutes)	58.4 ± 14.2	48.6 ± 12.5	0.001
Intra operative blood loss (ml)	18.6 ± 8.4	35.2 ± 12.7	<0.001
Conversion to open surgery	2 (4.4%)	Not applicable	—
Intra operative complications	1 (2.2%)	3 (6.7%)	0.61

The mean operative time was longer in the laparoscopic group compared with the open group. However, intra operative blood loss was significantly lower in patients undergoing laparoscopic appendectomy.

Postoperative Recovery Parameters

Table 4: Comparison of Postoperative Recovery

Parameter	Laparoscopic Appendectomy	Open Appendectomy	p-value
Time to start oral feeds (hours)	12.8 ± 4.3	24.6 ± 6.5	<0.001
Time to ambulation (hours)	10.4 ± 3.2	22.3 ± 5.4	<0.001
Duration of analgesic requirement (days)	2.1 ± 0.8	4.2 ± 1.1	<0.001
Postoperative hospital stay (days)	2.8 ± 1.1	5.1 ± 1.6	<0.001

Patients undergoing laparoscopic appendectomy demonstrated faster recovery with earlier initiation of oral intake, early ambulation, reduced analgesic requirement, and shorter hospital stay.

Postoperative Complications

Table 5: Comparison of Postoperative Complications

Complication	Laparoscopic Appendectomy (n=45)	Open Appendectomy (n=45)
Surgical site infection	2 (4.4%)	8 (17.8%)
Wound dehiscence	0	3 (6.7%)
Intra-abdominal collection	1 (2.2%)	2 (4.4%)
Postoperative ileus	2 (4.4%)	5 (11.1%)
Respiratory complications	0	1 (2.2%)
Total complications	5 (11.1%)	19 (42.2%)

The overall postoperative complication rate was lower in the laparoscopic appendectomy group compared with the open appendectomy group.

Return to Normal Daily Activities

Table 6: Comparison of Return to Normal Activities

Duration	Laparoscopic Appendectomy	Open Appendectomy
Within 1 week	18 (40%)	5 (11.1%)
1–2 weeks	22 (48.9%)	20 (44.4%)
>2 weeks	5 (11.1%)	20 (44.5%)
Mean duration (days)	10.2 ± 3.6	18.5 ± 5.4

Patients in the laparoscopic group returned to routine activities significantly earlier than those in the open appendectomy group.

Cost Analysis

Table 7: Comparison of Treatment Cost

Cost Parameter	Laparoscopic Appendectomy	Open Appendectomy
Operative cost (₹)	35,500 ± 4,800	24,500 ± 3,900
Hospital stay cost (₹)	8,200 ± 2,600	14,600 ± 4,100

Medication cost (₹)	3,800 ± 1,100	5,600 ± 1,500
Total treatment cost (₹)	47,500 ± 6,200	44,700 ± 7,100

Although the initial operative cost was higher for laparoscopic appendectomy, reduced hospital stay and faster recovery resulted in comparable overall treatment costs.

Discussion

Acute appendicitis remains one of the most frequently encountered abdominal emergencies requiring surgical intervention. Although open appendectomy has been the traditional standard treatment, laparoscopic appendectomy has gained widespread acceptance due to advances in minimally invasive surgical techniques. The present study compared laparoscopic and open appendectomy with respect to operative parameters, postoperative recovery, complications, cost, and functional outcomes.

In this study, demographic characteristics including age and gender distribution were comparable between the two groups. The similarity in baseline characteristics indicates that the groups were appropriately matched for comparison. Similar findings have been reported in previous randomised controlled trials evaluating laparoscopic and open appendectomy⁸.

The mean operative time was significantly higher in the laparoscopic appendectomy group compared with the open appendectomy group (58.4 ± 14.2 minutes vs 48.6 ± 12.5 minutes, $p=0.001$). Increased operative duration with laparoscopic surgery has been reported in several studies and may be attributed to additional steps involved in establishing pneumoperitoneum, port placement, laparoscopic dissection, and specimen retrieval^[9]. However, with increasing surgical experience and improved laparoscopic equipment, the difference in operative time has become less significant.

Intraoperative blood loss was significantly lower in patients undergoing laparoscopic appendectomy

compared with open appendectomy. The reduced blood loss observed with laparoscopy may be explained by improved visualisation, magnification of operative structures, and precise dissection. Similar findings have been reported by Pedersen et al., who demonstrated reduced tissue trauma and improved operative outcomes with laparoscopic techniques¹⁰.

The present study demonstrated significant advantages of laparoscopic appendectomy in terms of postoperative recovery. Patients undergoing laparoscopic surgery had earlier initiation of oral feeds, earlier ambulation, reduced analgesic requirement, and shorter postoperative hospital stay compared with patients undergoing open surgery. These findings are consistent with previous meta-analyses showing that laparoscopic appendectomy provides faster postoperative recovery due to reduced surgical trauma and smaller incisions¹¹.

The duration of postoperative hospital stay was significantly shorter in the laparoscopic group (2.8 ± 1.1 days) compared with the open group (5.1 ± 1.6 days). Similar observations have been reported in large comparative studies, where laparoscopic appendectomy was associated with reduced hospitalisation and faster discharge^[12]. Shorter hospital stay not only improves patient satisfaction but also decreases healthcare resource utilisation.

Postoperative complications were significantly lower in the laparoscopic group in the present study. The overall complication rate was 11.1% in laparoscopic appendectomy compared with 42.2% in open appendectomy. Surgical site infection was more

common after open surgery, likely due to larger incisions and increased wound exposure. Previous studies have demonstrated lower wound infection rates following laparoscopic appendectomy compared with open procedures¹³.

The concern regarding increased intra-abdominal abscess formation after laparoscopic appendectomy, especially in complicated appendicitis, has been reported in earlier studies. However, in the present study, intra-abdominal collections were comparable between groups, suggesting that laparoscopic appendectomy can be performed safely with appropriate surgical expertise and patient selection.

Return to normal daily activities was significantly faster among patients undergoing laparoscopic appendectomy. The mean duration required to resume routine activities was 10.2 ± 3.6 days in the laparoscopic group compared with 18.5 ± 5.4 days in the open group. Faster functional recovery is one of the major advantages of minimally invasive surgery and has been demonstrated in previous clinical studies assessing postoperative quality of life¹⁴.

Cost analysis showed that laparoscopic appendectomy had a higher operative cost compared with open appendectomy due to increased expenditure related to laparoscopic equipment and operative requirements. However, reduced hospital stay, lower analgesic requirements, and faster recovery reduced the difference in overall treatment expenditure. The total treatment cost was comparable between the two groups, suggesting that laparoscopic appendectomy may be cost-effective when considering the complete episode of care rather than only operative expenses. Similar conclusions have been reported in previous economic analyses comparing laparoscopic and open appendectomy¹⁵.

The conversion rate from laparoscopic to open surgery in the present study was 4.4%. Conversion is generally associated with complicated appendicitis, dense adhesions, unclear anatomy, or difficulty in controlling inflammation. Appropriate patient selection and surgeon experience play important roles in reducing conversion rates.

Overall, the findings of this study indicate that laparoscopic appendectomy provides significant benefits over open appendectomy, including reduced postoperative pain, fewer complications, shorter hospital stay, and earlier return to normal activities. Although laparoscopic surgery requires longer operative time and higher initial expenditure, these disadvantages are balanced by improved postoperative recovery and comparable overall treatment costs. Therefore, laparoscopic appendectomy can be considered the preferred approach for most patients with acute appendicitis where adequate expertise and facilities are available.

Conclusion

Laparoscopic appendectomy provides superior postoperative outcomes compared with open appendectomy in patients with acute appendicitis. Although it requires slightly longer operative time and higher initial operative expenditure, it offers significant advantages including reduced postoperative pain, fewer wound complications, shorter hospital stay, faster recovery, and earlier return to normal daily activities. The overall treatment cost remains comparable due to reduced hospitalisation and medication requirements. Therefore, laparoscopic appendectomy can be considered the preferred surgical approach for acute appendicitis in centres with appropriate expertise and facilities.

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