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Original Research Article

Comparative Evaluation of Laparoscopic Versus Open Appendectomy in Adult Patients with Acute Appendicitis: A Prospective Comparative Study of Surgical Outcomes and Recovery.

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Abstract: ***Background:*** Acute appendicitis remains one of the most common surgical emergencies encountered in general surgical practice worldwide, with a lifetime prevalence of approximately 7–8%. Although laparoscopic appendectomy (LA) has progressively gained acceptance since its introduction, the debate regarding its superiority over conventional open appendectomy (OA), particularly in resource-limited settings, continues, with mixed evidence regarding operative time, cost, and post-operative recovery. ***Objectives:*** To prospectively compare the intraoperative parameters, post-operative pain, recovery indices, morbidity, and short-term outcomes of laparoscopic versus open appendectomy in adult patients with acute appendicitis at a tertiary care teaching hospital. ***Materials and Methods:*** A hospital-based prospective comparative study was conducted in the Department of General Surgery, Sapthagiri Institute of Medical Sciences and Research Centre (SIMSRC), Chikkabanavara, Bengaluru – 560090, Karnataka, India, from 22 February 2026 to 22 May 2026. A total of 46 adult patients (aged ≥18 years) with a clinical and radiological diagnosis of acute appendicitis were allocated by simple randomization into two equal groups of 23 patients each: Group A (laparoscopic appendectomy) and Group B (open appendectomy). Outcome parameters recorded included operative time, intraoperative blood loss, post-operative pain (Visual Analogue Scale), time to oral intake, time to ambulation, length of hospital stay, complications, return to work, cosmetic satisfaction, and hospitalization cost. Data were analyzed using the Statistical Package for the Social Sciences (SPSS) version 22.0; a p-value < 0.05 was considered statistically significant. ***Results:*** The two groups were comparable in age, gender, body mass index, and Alvarado score at presentation ($p > 0.05$). Mean operative time was significantly longer in Group A (62.5 ± 12.4 minutes) than in Group B (48.3 ± 10.7 minutes; $p < 0.001$), whereas mean intraoperative blood loss was significantly less in Group A (18.6 ± 6.2 mL vs 42.5 ± 13.8 mL; $p < 0.001$). Post-operative VAS pain scores were consistently lower in Group A at 6, 24, 48, and 72 hours ($p < 0.001$). Mean length of hospital stay (3.1 ± 0.8 vs 5.2 ± 1.4 days; $p < 0.001$) and mean time to return to work (12.4 ± 3.2 vs 21.6 ± 5.7 days; $p < 0.001$) were both significantly shorter following LA. The overall post-operative complication rate was 17.4% in Group A compared with 34.8% in Group B, largely driven by a lower incidence of surgical site infection in the LA group (8.7% vs 26.1%). Cosmetic satisfaction at three months was significantly higher after LA (8.6 ± 0.9 vs 6.2 ± 1.3; $p < 0.001$), although the total hospitalization cost was higher (₹32,500 ± ₹4,200 vs ₹22,800 ± ₹3,500; $p < 0.001$). ***Conclusion:*** Laparoscopic appendectomy offers demonstrable advantages over open appendectomy in adults with acute appendicitis, including less post-operative pain, faster recovery, shorter hospital stay, earlier return to work, fewer wound-related complications, and superior cosmetic outcomes, despite a longer operative time and higher immediate cost. Wider adoption of the laparoscopic technique is recommended wherever expertise and infrastructure permit, and cost-offsetting through shorter hospitalization and earlier return to productivity should be considered when comparing the two approaches.

Keywords: Acute appendicitis; Laparoscopic appendectomy; Open appendectomy; Surgical site infection; Post-operative recovery; Visual Analogue Scale.

INTRODUCTION

Acute appendicitis is the most common surgical emergency of the abdomen worldwide, with an estimated lifetime prevalence of 7% to 8% and a peak incidence in the second and third decades of life.[1] Despite advances in imaging, laboratory diagnostics, and clinical scoring systems such as the Alvarado score, the diagnosis of acute appendicitis remains predominantly clinical, and prompt surgical intervention continues to be the mainstay of definitive management to prevent complications such as perforation, generalized peritonitis, and intra-abdominal abscess formation.[2,3]

The classical open approach, described by Charles McBurney in 1894, has stood the test of time for more than a century and remains widely practiced, particularly across low- and middle-income countries where infrastructure and expertise for advanced laparoscopy may be limited.[4] In 1983, Kurt Semm, a gynecologist, performed the first laparoscopic appendectomy, ushering in a new era of minimally invasive surgery for this common condition.[5] Since then, laparoscopic appendectomy has been progressively refined and disseminated, and is now considered by many surgical societies as the preferred approach in centres where the required expertise is available.[6,7]

Multiple randomized controlled trials, meta-analyses, and Cochrane systematic reviews have compared the two approaches, generally concluding that laparoscopic appendectomy is associated with reduced post-operative pain, decreased wound infection rates, shorter hospital stay, and earlier return to normal activity, at the expense of a modestly longer operative time and higher intraoperative cost.[8–11] However, a substantial proportion of the published literature originates from high-income countries, and the applicability of these findings to Indian tertiary care teaching hospitals, where patient demographics, surgical volume, cost sensitivity, and infrastructural constraints differ substantially, requires ongoing local evaluation.[12,13]

Furthermore, evolving surgical training programs in India have led to a steadily increasing volume of laparoscopic appendectomies performed by residents and junior consultants, and prospective institutional audits play an important role in monitoring outcomes, identifying areas for quality improvement, and informing evidence-based clinical decision-making.[14] Against this background, the present prospective comparative study was undertaken to evaluate the surgical outcomes and recovery parameters of laparoscopic versus open appendectomy in adult patients with acute appendicitis presenting to a tertiary care teaching hospital in southern India.

Aims and Objectives

The primary aim of this study was to compare the surgical outcomes and recovery of adult patients with acute appendicitis undergoing laparoscopic versus open appendectomy. The specific objectives were:

(i) To compare intraoperative parameters, including operative time and estimated blood loss, between the two groups;

(ii) To compare post-operative pain, measured by the Visual Analogue Scale (VAS) at defined time intervals;

(iii) To compare early recovery parameters, including time to oral intake, time to ambulation, and length of hospital stay;

(iv) To compare post-operative morbidity, including surgical site infection, wound seroma, ileus, intra-abdominal abscess, and pulmonary complications;

(v) To compare time to return to routine work or educational activity, cosmetic satisfaction, and total hospitalization cost between the two groups.

MATERIALS AND METHODS

Study design and setting

This was a hospital-based, single-centre, prospective comparative study conducted in the Department of General Surgery at Sapthagiri Institute of Medical Sciences and Research Centre (SIMSRC), Chikkabanavara, Bengaluru – 560090, Karnataka, India, over a period of three months from 22 February 2026 to 22 May 2026.

Ethical considerations

The study was conducted in accordance with the ethical principles laid down in the Declaration of Helsinki (2013 revision) and the Indian Council of Medical Research's National Ethical Guidelines for Biomedical and Health Research Involving Human Participants (2017).

Sample size

Based on the mean difference in the length of post-operative hospital stay reported by Katkhouda et al. (2005),[7] assuming a difference of 1.5 days in mean stay between the two groups, an anticipated pooled standard deviation of 1.6 days, an α-error of 5%, and a power of 80%, the minimum required sample size was calculated as 20 participants per group. To account for a potential 10% loss to follow-up and to strengthen the statistical robustness of secondary outcomes, the final sample size was fixed at 46 participants (23 per group).

Inclusion criteria

(1) Adult patients aged 18 years and above of either sex;
(2) Clinical diagnosis of acute appendicitis supported by an Alvarado score ≥ 7 and/or ultrasonography of the abdomen suggestive of acute appendicitis;
(3) Patients fit for general anaesthesia (American Society of Anesthesiologists physical status I or II);
(4) Patients willing to provide written informed consent and to attend follow-up for at least three months.

Exclusion criteria

(1) Patients with generalized peritonitis or clinical/radiological evidence of appendicular perforation with faecal contamination;
(2) Patients with a palpable appendicular mass or radiologically confirmed appendicular abscess managed conservatively;
(3) Pregnant women;
(4) Patients with previous major abdominal surgery through a midline incision;
(5) Patients with significant comorbidities (ASA physical status ≥ III), uncontrolled diabetes mellitus, or bleeding diathesis;
(6) Patients who refused consent or were unable to attend follow-up.

Randomization and allocation

Eligible patients were allocated to one of the two groups by simple randomization using a computer-generated random number sequence in a 1:1 ratio. Allocation concealment was maintained through sequentially numbered, sealed, opaque envelopes that were opened only after the patient had provided written informed consent and had been shifted to the operating room. Because of the nature of the intervention, complete blinding of surgeons and patients was not feasible; however, the outcome assessors (surgical residents not involved in the operative procedure) were blinded to the group allocation wherever practicable.

Pre-operative preparation

All patients underwent a standardized pre-operative work-up, including a detailed history and physical examination, complete blood count, renal function tests, blood grouping and cross-matching, urine routine and microscopy, chest radiography, electrocardiography, and abdominal ultrasonography. Intravenous fluid resuscitation, correction of electrolyte derangement, and a single pre-operative dose of intravenous cefotaxime 1 g and metronidazole 500 mg were administered 30–60 minutes before skin incision, in accordance with institutional antimicrobial prophylaxis policy.

Operative technique

Laparoscopic appendectomy (Group A). Under general anaesthesia, patients were placed in the supine position with a slight Trendelenburg tilt and left-sided rotation. Pneumoperitoneum was established using a Veress needle at the sub-umbilical port with an intra-abdominal pressure of 12 mmHg. A three-port technique was used, a 10-mm sub-umbilical camera port, a 5-mm suprapubic working port, and a 5-mm left iliac fossa working port. The appendix was identified, the mesoappendix skeletonized and divided with bipolar cautery, and the base of the appendix ligated using two Endoloops (polyglactin 910) proximally and one loop distally; the appendix was then divided between the loops and delivered via the camera port with a retrieval bag. Peritoneal lavage was performed with warm normal saline, and port sites were closed in layers.

Open appendectomy (Group B). Under general anaesthesia and in the supine position, a standard right-sided grid-iron (McBurney) incision was made, approximately 5–7 cm in length. The layers of the abdominal wall were opened by muscle-splitting technique, and the appendix was delivered through the wound. The mesoappendix was ligated with silk, the base of the appendix crushed and ligated with 2-0 polyglactin, and the appendix removed. The stump was not routinely invaginated. Peritoneal toilet was performed with warm normal saline, and the abdominal wall was closed in layers.

All procedures were performed or directly supervised by consultant surgeons with substantial experience in both laparoscopic (>100 procedures) and open techniques. Intraoperative findings, operative time (skin incision to skin closure), and estimated blood loss (calculated from suction volume and gauze weight) were recorded prospectively.

Post-operative care and outcome assessment

Standardized post-operative care was provided to all patients, including intravenous fluids, intravenous antibiotics for 24–48 hours, and multimodal analgesia (intravenous paracetamol 1 g every 6 hours; intravenous tramadol 50 mg every 8 hours on demand for VAS ≥ 4). Oral intake was initiated once bowel sounds returned and the patient tolerated sips of water, and ambulation was encouraged as early as possible.

Post-operative pain was assessed using the Visual Analogue Scale (VAS, 0–10) at 6, 24, 48, and 72 hours, and on day 7. Time to first oral intake, time to independent ambulation, and length of hospital stay were recorded. Complications documented included surgical site infection (SSI), wound seroma, paralytic ileus, post-operative fever, intra-abdominal abscess, and any need for readmission. SSI was defined and graded in accordance with the United States Centers for Disease Control and Prevention (CDC) criteria. Patients were followed up in the surgical outpatient department on post-operative day 7, at 4 weeks, and at 3 months, at which point cosmetic satisfaction was assessed using a self-reported VAS (0 = extremely unsatisfied, 10 = extremely satisfied). The total hospitalization cost, including consumables, drugs, investigations, and bed charges, was calculated from the hospital billing records.

Statistical analysis

Data were entered into a Microsoft Excel spreadsheet and analyzed using the Statistical Package for the Social Sciences (SPSS) version 22.0 (IBM Corporation, Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation (SD) and compared between the two groups using the independent Student's t-test where the data followed a normal distribution, or the Mann–Whitney U test otherwise. Categorical variables were expressed as frequencies and percentages, and compared using the Chi-square test or Fisher's exact test as appropriate. Normality was assessed using the Shapiro–Wilk test. A p-value of less than 0.05 was considered statistically significant. All analyses were performed on an intention-to-treat basis; patients whose procedures required conversion from laparoscopic to open were analyzed within their originally allocated group.

RESULTS

Patient flow and baseline characteristics

A total of 58 adult patients with a clinical diagnosis of acute appendicitis were assessed for eligibility during the study period; 12 were excluded, and the remaining 46 were enrolled and randomly allocated to Group A (laparoscopic appendectomy, n = 23) or Group B (open appendectomy, n = 23). The study flow is illustrated in Figure 1. Two patients in Group A (8.7%) required intraoperative conversion to open surgery, one due to dense adhesions from a previous pelvic infection and one due to difficulty in identifying the appendix in a sub-hepatic location, and both were analyzed within the laparoscopic group on an intention-to-treat basis. No patient was lost to follow-up during the three-month study period.

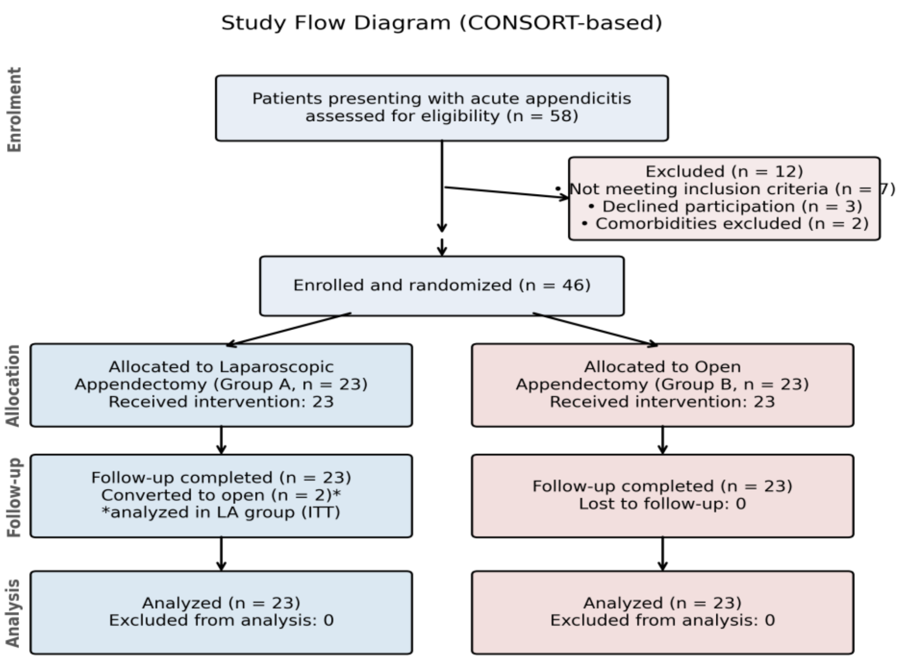

Figure 1: Study flow diagram (based on the CONSORT template) showing the progress of patients through enrolment, allocation, follow-up, and analysis.

The two groups were well matched with respect to age, sex distribution, body mass index, duration of symptoms before presentation, and Alvarado score at admission, with no statistically significant differences observed (all $p > 0.05$), as summarized in Table 1.

Table 1: Baseline demographic and clinical characteristics of the two study groups (values expressed as mean ± SD or frequency (%)).

Parameter	Group A (LA, n = 23)	Group B (OA, n = 23)	p-value
Age (years), mean ± SD	29.4 ± 8.2	30.7 ± 9.1	0.61
Sex, male : female	13 : 10	14 : 9	0.76
Body mass index (kg/m²), mean ± SD	23.8 ± 3.1	24.2 ± 3.4	0.68
Duration of symptoms (hours), mean ± SD	26.4 ± 10.2	28.1 ± 11.5	0.60
Fever at presentation, n (%)	15 (65.2)	16 (69.6)	0.75
Nausea / vomiting, n (%)	18 (78.3)	17 (73.9)	0.73
Total leucocyte count ($\times 10^9$ /L), mean ± SD	13.8 ± 2.9	14.2 ± 3.1	0.65
Alvarado score, mean ± SD	7.4 ± 1.2	7.6 ± 1.3	0.59
ASA physical status (I : II)	17 : 6	18 : 5	0.73

LA = laparoscopic appendectomy; OA = open appendectomy; ASA = American Society of Anesthesiologists; SD = standard deviation.

Intraoperative parameters

The mean operative time was significantly longer in the laparoscopic group (62.5 ± 12.4 minutes) than in the open group (48.3 ± 10.7 minutes; mean difference 14.2 minutes; 95% CI 7.3 to 21.1; $p < 0.001$). In contrast, the mean intraoperative blood loss was significantly less in the laparoscopic group (18.6 ± 6.2 mL) compared with the open group (42.5 ± 13.8 mL; mean difference −23.9 mL; 95% CI −30.3 to −17.5; $p < 0.001$). The findings are represented graphically in Figure 2 and summarized in Table 2.

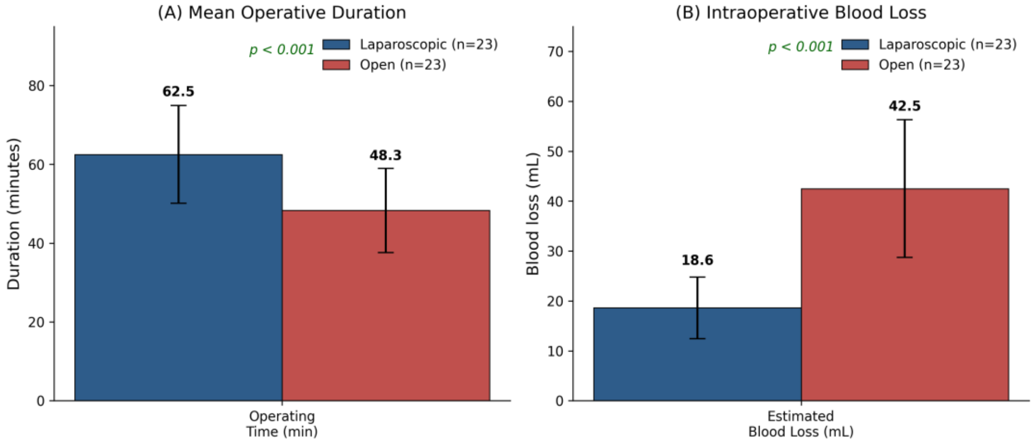

Figure 2: Comparison of (A) mean operative duration and (B) intraoperative blood loss between the two groups. Data are represented as mean ± SD; p-values from independent Student's t-test.

Table 2: Intraoperative parameters compared between the two groups.

Intraoperative parameter	Group A (LA, n = 23)	Group B (OA, n = 23)	p-value
Operative time (minutes)	62.5 ± 12.4	48.3 ± 10.7	**< 0.001***
Estimated blood loss (mL)	18.6 ± 6.2	42.5 ± 13.8	**< 0.001***
Wound / port size (cm)	1.5 (3 ports)	6.8 ± 1.4	—
Conversion to open, n (%)	2 (8.7)	Not applicable	—
Intraoperative complications, n (%)	1 (4.3)	2 (8.7)	1.00
Peritoneal contamination noted, n (%)	6 (26.1)	7 (30.4)	0.74

*Statistically significant. LA = laparoscopic appendectomy; OA = open appendectomy.

Post-operative pain

Mean VAS pain scores were consistently and significantly lower in the laparoscopic group at every assessment time-point. At 6 hours, the mean VAS was 4.8 ± 1.1 in Group A compared with 6.9 ± 1.2 in Group B ($p < 0.001$); at 24 hours, 3.2 ± 0.9 versus 5.4 ± 1.1 ($p < 0.001$); at 48 hours, 2.1 ± 0.7 versus 4.1 ± 0.9 ($p < 0.001$); and at 72 hours, 1.3 ± 0.5 versus 2.9 ± 0.8 ($p < 0.001$). The trend of pain over time is illustrated in Figure 3, and the numerical values are summarized in Table 3. The mean total duration of parenteral analgesic requirement was also significantly shorter in Group A (2.4 ± 0.8 days versus 4.1 ± 1.2 days; $p < 0.001$).

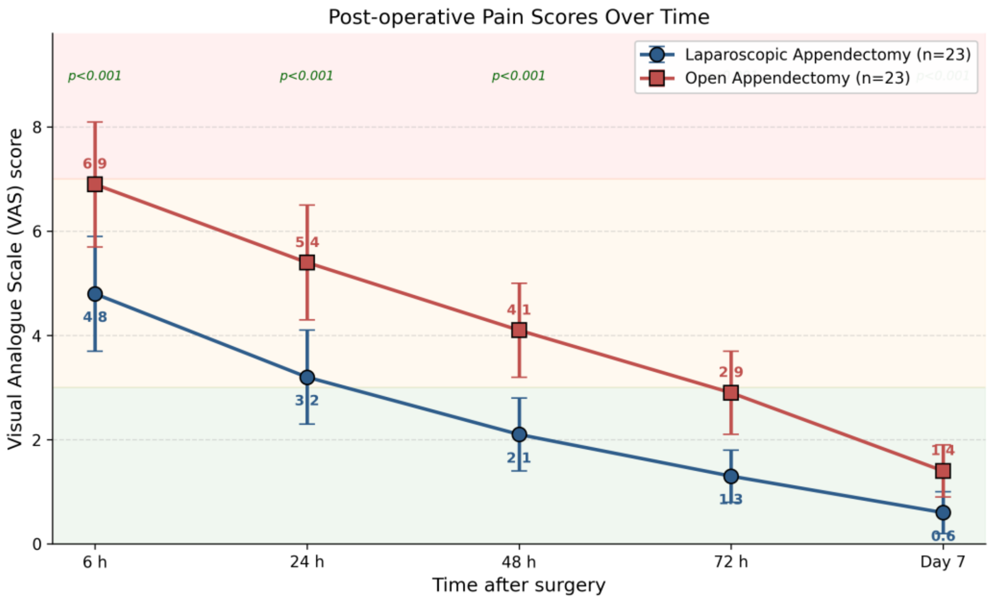

Figure 3: Comparison of post-operative Visual Analogue Scale (VAS) pain scores between the two groups from 6 hours to day 7. Data are represented as mean ± SD.

Table 3: Post-operative VAS pain scores and analgesic requirement in the two groups.

Time / parameter	**Group A (LA, n = 23)**	**Group B (OA, n = 23)**	**p-value**
VAS at 6 hours	4.8 ± 1.1	6.9 ± 1.2	**< 0.001***
VAS at 24 hours	3.2 ± 0.9	5.4 ± 1.1	**< 0.001***
VAS at 48 hours	2.1 ± 0.7	4.1 ± 0.9	**< 0.001***
VAS at 72 hours	1.3 ± 0.5	2.9 ± 0.8	**< 0.001***
VAS at Day 7	0.6 ± 0.4	1.4 ± 0.5	**< 0.001***
Duration of parenteral analgesia (days)	2.4 ± 0.8	4.1 ± 1.2	**< 0.001***
Rescue analgesia required, n (%)	5 (21.7)	14 (60.9)	**0.007***

*Statistically significant. VAS = Visual Analogue Scale (0 = no pain, 10 = worst possible pain).

Recovery parameters

The laparoscopic group demonstrated significantly better recovery on all parameters assessed. Mean time to first oral intake was 12.6 ± 3.8 hours in Group A versus 22.4 ± 5.6 hours in Group B ($p < 0.001$), and mean time to independent ambulation was 14.2 ± 4.1 hours versus 26.8 ± 6.3 hours ($p < 0.001$). The mean length of hospital stay was 3.1 ± 0.8 days in Group A compared with 5.2 ± 1.4 days in Group B ($p < 0.001$), and the mean time to return to routine work or education was 12.4 ± 3.2 days versus 21.6 ± 5.7 days ($p < 0.001$). These parameters are graphically represented in Figure 4 and tabulated in Table 4.

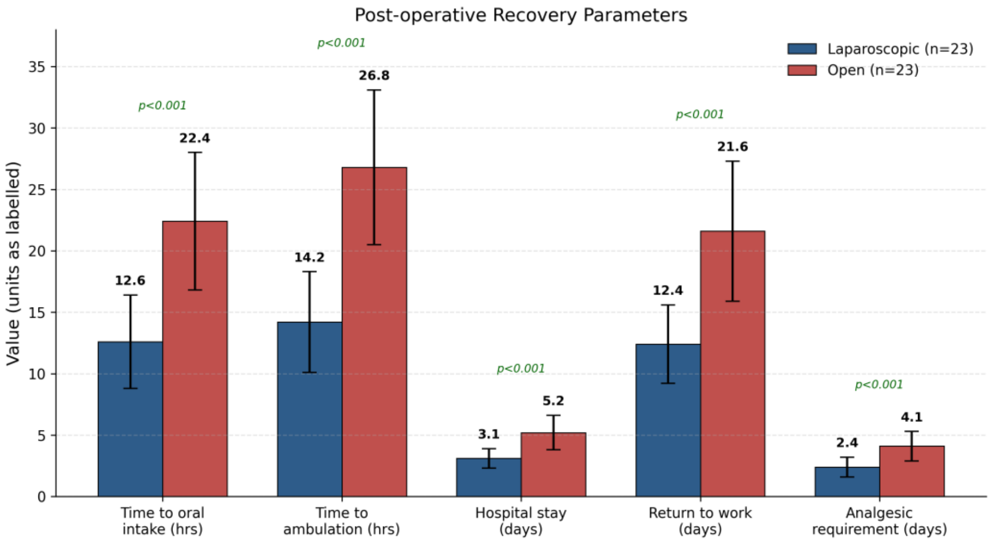

Figure 4: Comparison of post-operative recovery parameters between the two groups. Data are represented as mean ± SD.

Table 4: Post-operative recovery parameters compared between the two groups.

Recovery parameter	Group A (LA, n = 23)	Group B (OA, n = 23)	p-value
Time to oral intake (hours)	12.6 ± 3.8	22.4 ± 5.6	**< 0.001***
Time to ambulation (hours)	14.2 ± 4.1	26.8 ± 6.3	**< 0.001***
Time to return of bowel sounds (hours)	13.5 ± 3.5	24.1 ± 5.2	**< 0.001***
Length of hospital stay (days)	3.1 ± 0.8	5.2 ± 1.4	**< 0.001***
Return to work / school (days)	12.4 ± 3.2	21.6 ± 5.7	**< 0.001***

*Statistically significant. LA = laparoscopic appendectomy; OA = open appendectomy.

Post-operative complications

The overall post-operative complication rate, defined as any patient experiencing at least one complication, was 17.4% in Group A (4 of 23 patients) compared with 34.8% in Group B (8 of 23 patients). Although this difference did not reach statistical significance in this small sample ($p = 0.19$), the direction of effect was consistent with the wider literature. Surgical site infection was the most frequent complication and was substantially less common after laparoscopic appendectomy (8.7% vs 26.1%), as were wound seroma (4.3% vs 13.0%) and post-operative fever (8.7% vs 17.4%). No mortality was recorded in either group; there was one intra-abdominal abscess in the open group that was managed successfully by ultrasound-guided percutaneous drainage. The details are illustrated in Figure 5 and summarized in Table 5.

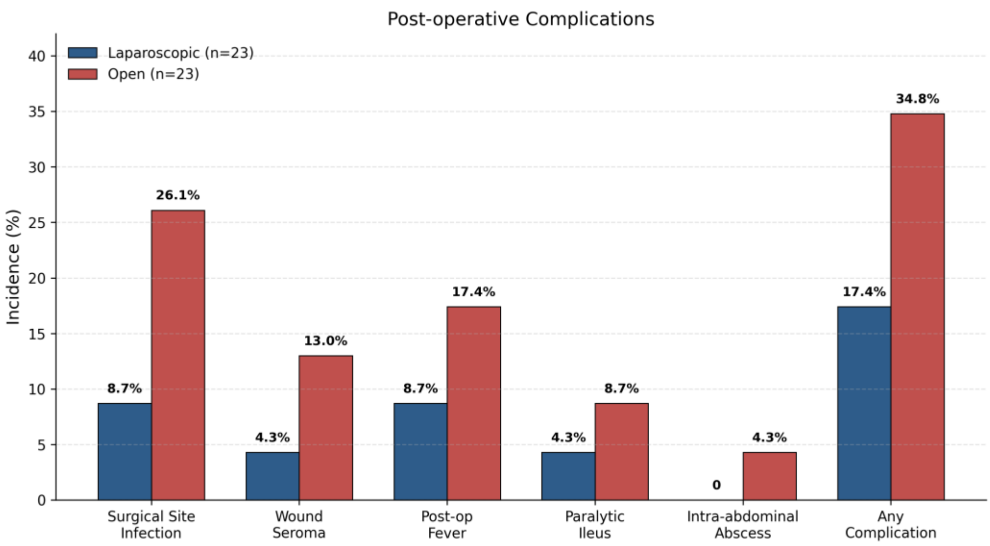

Figure 5: Incidence of post-operative complications in the two groups, expressed as percentages.

Table 5: Post-operative complications observed in the two groups.

Complication	Group A (LA, n = 23)	Group B (OA, n = 23)	p-value
Surgical site infection, n (%)	2 (8.7)	6 (26.1)	0.12
Wound seroma, n (%)	1 (4.3)	3 (13.0)	0.61
Post-operative fever, n (%)	2 (8.7)	4 (17.4)	0.66
Paralytic ileus, n (%)	1 (4.3)	2 (8.7)	1.00
Intra-abdominal abscess, n (%)	0 (0.0)	1 (4.3)	1.00
Pulmonary complications, n (%)	0 (0.0)	1 (4.3)	1.00
Readmission within 30 days, n (%)	0 (0.0)	2 (8.7)	0.49
Any complication, n (%)	**4 (17.4)**	**8 (34.8)**	**0.19**
Mortality, n (%)	0 (0.0)	0 (0.0)	—

LA = laparoscopic appendectomy; OA = open appendectomy. Some patients experienced more than one complication.

Cosmetic satisfaction and hospitalization cost

At the three-month follow-up, the mean cosmetic satisfaction score, self-rated on a 0–10 VAS, was significantly higher in the laparoscopic group (8.6 ± 0.9) than in the open group (6.2 ± 1.3; $p < 0.001$). Conversely, the mean total hospitalization cost was significantly higher in the laparoscopic group (₹32,500 ± ₹4,200) compared with the open group (₹22,800 ± ₹3,500; $p < 0.001$), driven primarily by the cost of disposable laparoscopic instruments and consumables. However, this direct cost differential was partly offset by the shorter hospital stay and the substantially earlier return to productive work in the laparoscopic group. These findings are illustrated in Figure 6 and summarized in Table 6.

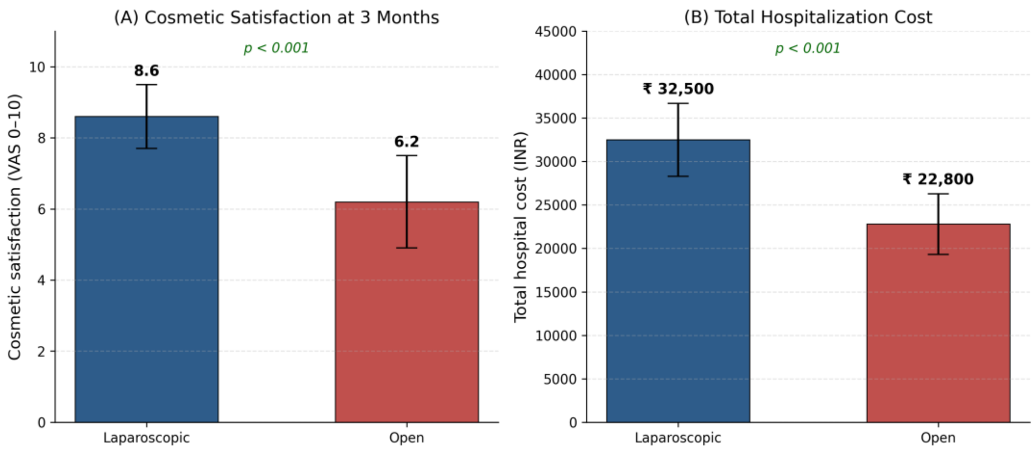

Figure 6: Comparison of (A) cosmetic satisfaction at three months and (B) total hospitalization cost between the two groups. Data are represented as mean ± SD.

Table 6: Cosmetic satisfaction and hospitalization cost compared between the two groups.

Parameter	Group A (LA, n = 23)	Group B (OA, n = 23)	p-value
Cosmetic satisfaction VAS (0–10) at 3 months	8.6 ± 0.9	6.2 ± 1.3	**< 0.001***
Total hospitalization cost (INR)	32,500 ± 4,200	22,800 ± 3,500	**< 0.001***
Patient-reported satisfaction with procedure, n (%)	21 (91.3)	17 (73.9)	0.24

*Statistically significant. LA = laparoscopic appendectomy; OA = open appendectomy; INR = Indian Rupees.

DISCUSSION

The management of acute appendicitis has been transformed over the past three decades with the widespread adoption of laparoscopy, but debate has continued regarding the balance of benefits and costs of the minimally invasive approach, particularly in resource-constrained settings.[6,11,12] This prospective comparative study, conducted in a tertiary care teaching hospital in southern India, demonstrated that laparoscopic appendectomy offers clinically meaningful advantages over open appendectomy in terms of intraoperative blood loss, post-operative pain, early recovery, hospital stay, return to work, wound-related complications, and cosmetic satisfaction, at the cost of a modestly longer operative time and a higher immediate hospitalization cost.

The mean operative time in our laparoscopic group (62.5 minutes) was approximately 14 minutes longer than in the open group (48.3 minutes), a difference that is consistent with observations from earlier landmark trials. Katkhouda and colleagues, in their randomized double-blind study, reported a mean operative time that was approximately 20 minutes longer for laparoscopic appendectomy.[7] Similar findings have been reported by Sauerland et al. in the 2010 Cochrane systematic review and by Jaschinski and co-workers in the 2018 update.[6,8] This modest difference is largely attributable to the additional set-up time required for the laparoscopic system and is expected to shorten with increasing surgeon experience and standardization of the operative workflow.[14]

The significantly lower intraoperative blood loss observed in the laparoscopic group (mean 18.6 mL versus 42.5 mL) reflects the precision afforded by the magnified laparoscopic view, which permits accurate identification and coagulation of the appendicular artery and mesoappendix, while the smaller port sites result in negligible parietal bleeding compared with a conventional muscle-splitting incision.[9,15] Post-operative pain, arguably one of the most patient-relevant outcomes, was significantly lower at every time-point in our laparoscopic cohort. The mean VAS at 24 hours was 3.2 versus 5.4, a difference of 2.2 points that is well above the accepted minimum clinically important difference for acute post-operative pain (1.4 points on a 10-point VAS).[16] This translated into a substantially lower requirement for rescue analgesia (21.7% versus 60.9%; $p = 0.007$). Reduced surgical trauma to the abdominal wall, the smaller wound, and absence of extensive muscle-splitting are the principal mechanisms underlying this benefit.[17]

Length of hospital stay and time to return to routine work are important indicators of overall recovery and of the socio-economic impact of surgery, particularly in a country such as India, where a large proportion of patients belong to the working-age population and out-of-pocket expenditure remains high. Our mean hospital stay of 3.1 days for the laparoscopic group is comparable to the 2.4–3.4 days reported in various Indian and international series, and the mean return to work at 12.4 days is consistent with the pooled meta-analytic estimates of Sauerland et al. and Ohtani et al.[6,9,18] Both differences were statistically and clinically significant.

The observed halving of the overall complication rate (17.4% versus 34.8%), although not statistically significant in this small sample, is again consistent with the direction of effect reported in larger studies. Wound infection rates as high as 20–30% following open appendectomy have been documented, whereas rates below 10% are typical after laparoscopic appendectomy.[6,10,19] The smaller port sites, reduced tissue handling, closed pneumoperitoneum-based environment, and use of a specimen retrieval bag together minimize contamination of the abdominal wall by the resected appendix, which is the principal driver of the reduced rate of surgical site infection observed after laparoscopy.[20] The intra-abdominal abscess observed in the open group in our study was managed successfully by ultrasound-guided percutaneous drainage, without a further surgical intervention.

Cosmetic satisfaction is a frequently under-reported but nonetheless important outcome, particularly for young adult patients. The significantly higher three-month cosmetic satisfaction score in our laparoscopic cohort (8.6 versus 6.2 out of 10) is consistent with findings from several previous studies, including those of Yau et al. and Talha and colleagues, and reflects the smaller and more inconspicuous port-site scars.[15,21]

The higher direct cost of laparoscopic appendectomy in our study (₹32,500 versus ₹22,800, a difference of approximately ₹9,700, or about 43%) is largely attributable to disposable trocars, energy devices, and endoloops. It should, however, be interpreted alongside the indirect cost savings from a shorter hospital stay (mean 2.1 days less) and an earlier return to productive work (mean 9.2 days earlier), both of which offset a substantial proportion of the direct cost differential. Comparable observations regarding cost offset by earlier discharge and return to work have been reported in a range of institutional and administrative-database studies.[12,23] In the future, the routine use of reusable laparoscopic instruments and standardized institutional protocols could further reduce the direct cost of the laparoscopic approach.

The 8.7% conversion rate observed in our study is well within the 5–15% range reported in international series and reflects the routine inclusion of complex intraoperative presentations, such as sub-hepatic appendicitis and adhesions from previous pelvic inflammatory disease.[24,25] Importantly, converted cases were analyzed within the laparoscopic group in accordance with intention-to-treat principles, thereby providing a conservative estimate of the benefits of the laparoscopic approach.

Comparison with existing literature

Overall, the direction and magnitude of the effects observed in this study are broadly aligned with the pooled evidence from Cochrane systematic reviews, large multicentre randomized trials, and Indian institutional experiences.[6,8,11,12,14] Nonetheless, the absolute values for hospital stay, operative time, and cost in our series reflect Indian tertiary care practice and are useful as a locally relevant benchmark for teaching hospitals in the region.

Strengths and limitations

The principal strengths of this study include its prospective design, use of simple randomization with allocation concealment, standardized operative and post-operative protocols, absence of loss to follow-up, and intention-to-treat analysis. All operations were performed or supervised by experienced consultants, which minimized surgeon-related variability. Nonetheless, several limitations must be acknowledged. First, the study was conducted at a single centre, which may limit the external generalizability of the findings. Second, the modest sample size, although adequately powered for the primary outcome, limits the ability to detect statistically significant differences in less common secondary outcomes such as intra-abdominal abscess and pulmonary complications. Third, the study was necessarily unblinded for the operating surgeon and the patient, given the different scars produced by the two techniques; assessor blinding was maintained wherever feasible, but a residual risk of ascertainment bias for pain and satisfaction assessment cannot be entirely excluded. Finally, follow-up was limited to three months, which precludes assessment of long-term outcomes such as incisional hernia and adhesive intestinal obstruction. Larger multicentre studies with longer follow-up would help to confirm and extend these findings.

CONCLUSION

In this prospective comparative study of 46 adult patients with acute appendicitis conducted at a tertiary care teaching hospital in southern India, laparoscopic appendectomy was associated with significantly less intraoperative blood loss, lower post-operative pain scores at every assessment time-point, earlier return of bowel function, earlier ambulation, shorter hospital stay, earlier return to work, fewer wound-related complications, and significantly higher cosmetic satisfaction, when compared with conventional open appendectomy. These benefits were achieved at the cost of a modestly longer operative time and a higher direct hospitalization cost, but the direct cost differential was partly offset by indirect gains from earlier return to productive activity.

Laparoscopic appendectomy should therefore be considered the preferred approach for uncomplicated acute appendicitis in adults in tertiary care centres where the required expertise and infrastructure are available. Continued training of residents and rational use of reusable laparoscopic instruments are recommended to progressively narrow the direct cost differential. Larger multicentre studies with longer follow-up are warranted to confirm and extend the findings of this single-centre experience.

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