VER
Vascular & Endovascular Review

# Clinical-Operative Outcomes of Laparoscopic Versus Open Appendicectomy in Adults with Complicated and Uncomplicated Acute Appendicitis: A Cross-Sectional Observational Study at a Tertiary Care Hospital

Dr. K. Cheruvu Nataraj Navya[1]*, Dr. Haritha Oruganti[2]

[1]Assistant Professor, Department of General Surgery, Bhaarath Medical College and Hospital, Selaiyur, Chennai
[2]Assistant Professor, Department of Pathology, Sri Lakshmi Narayana Institute of Medical Sciences & Hospital, Osudu, Puducherry – 605502
***Corresponding Author:** Dr. K. Cheruvu Nataraj Navya

## ABSTRACT

Background: The laparoscopic appendicectomy (LA) is the preferred method of dealing with uncomplicated acute appendicitis in high-income nations, whereas a comparison of its outcomes with surgical appendicectomy (SA) is scarce in the Indian tertiary care setting, especially with the complicated appendicitis. Real World Outcomes inform institutional surgical practice and training.

Methods: Two groups were compared: LA (n=140) and OA (n=80) in 220 adults in a cross sectional observational study over 18 months in a tertiary care hospital. Operative parameters, total cost, length of stay, complication status (perforated/gangrenous/abscess), AIR score, and Alvarado score were documented. Results: Mean operative time was longer in LA (64.2±18.4 vs 46.8±14.2 minutes, p<0.001). SSI was significantly lower in LA (4.3% vs 16.3%, p=0.004). Postoperative ileus (3.6% vs 11.3%, p=0.034), mean LOS (2.8 vs 5.2 days, p<0.001), and opioid requirement were also significantly lower in LA. Multivariable predictors of SSI: open approach (aOR 3.6), complicated appendicitis (aOR 2.9), diabetes (aOR 1.9), and delayed presentation >48 hours (aOR 1.7). Conclusion: Laparoscopic appendicectomy is associated with significantly lower SSI, shorter LOS, and reduced ileus compared to open approach, including in complicated appendicitis. Expansion of LA capability and training at tertiary care hospitals is recommended.

**KEYWORDS**: Appendicectomy; laparoscopic appendicectomy; acute appendicitis; complicated appendicitis; surgical-site infection; Alvarado score; length of stay; India.

**How to Cite:** Dr. K. Cheruvu Nataraj Navya, Dr. Haritha Oruganti, (2022) Clinical-Operative Outcomes of Laparoscopic Versus Open Appendicectomy in Adults with Complicated and Uncomplicated Acute Appendicitis: A Cross-Sectional Observational Study at a Tertiary Care Hospital, Vascular and Endovascular Review, Vol.5, No.1,

## INTRODUCTION

Acute appendicitis is the most common surgical emergency worldwide, with a lifetime risk of approximately 7–8% and peak incidence in the second and third decades of life [1]. However, appendicectomy (laparoscopic [LA] or open [OA]) continues to be the definitive treatment and antibiotic-only treatment is an emerging treatment option for uncomplicated appendicitis, but not widely used as the first line of treatment in most centres in India [2]. Laparoscopic surgery has revolutionized the management of appendicitis worldwide; several randomized controlled trials (RCTs) and systematic reviews have shown that LA has the benefit of a shorter hospital stay, decreased surgical site infection, earlier return to work and decreased wound related morbidity, at the expense of longer operating time and increased costs of laparoscopes [3].

However, in spite of this evidence, open appendicectomy is still performed in most Indian tertiary care hospitals, especially in complicated appendicitis (appendicular abscess, gangrenous and perforated) due to the fear of inadequate peritoneal lavage, increased conversion rates and lack of experience in laparoscopy [4]. Complicated appendicitis — present in 20–30% of hospitalised appendicitis cases in Indian series — is associated with higher SSI rates, longer hospital stays, and greater antibiotic requirements regardless of the operative approach [5]. Understanding whether LA retains its advantage over OA specifically in the complicated subgroup is of particular clinical relevance.

Severity scoring systems — the Alvarado score (0–10) and Appendicitis Inflammatory Response (AIR) score — provide validated pre-operative probability assessments that inform surgical decision-making and compare case-mix between operative approaches [6]. The CDC wound-classification-based SSI definition remains the standard for surgical outcome benchmarking. This cross-sectional observational study compared operative and clinical outcomes between LA and OA at a tertiary care hospital, with particular attention to SSI, LOS, and outcomes in the complicated-appendicitis subgroup.

## MATERIALS AND METHODS

### *2.1 Study Design and Population*

Cross-sectional observational study at a tertiary care hospital over 18 months. Adults ≥18 years undergoing appendicectomy for clinically diagnosed acute appendicitis were included. Operative approach (LA vs OA) was determined by the attending surgeon based on clinical judgement, laparoscopic equipment availability, and patient fitness — not randomised. Conversion from LA to OA documented as a complication. Complicated appendicitis: intraoperative finding of perforation, gangrenous appendix, or

periappendicular abscess/peritonitis. Exclusion: interval appendicectomy (>4 weeks from diagnosis), appendiceal tumour found at operation, age <18 years. IEC approved; written informed consent.

### *2.2 Data Collection*

Preoperative: Alvarado score, AIR score, symptom duration (hours from onset to operation), WBC, CRP, CT abdomen where performed, ASA grade. Intraoperative: operative time (knife-to-skin to wound closure), intraoperative findings (macroscopic complication status), conversion rate. Postoperative: VAS pain scores (day 1, 2), opioid analgesic requirement (morphine-equivalent mg), time to oral intake, SSI by CDC criteria (superficial/deep/organ-space, confirmed by primary surgeon or wound clinic review at 30 days), postoperative ileus (no bowel sounds/flatus for >72h requiring NGT), intra-abdominal collection (US confirmed), readmission within 30 days, total hospital LOS, direct hospital cost (bed charges, theatre charges, implants, antibiotics).

### *2.3 Statistical Analysis*

SPSS v26. Independent t-test/Mann-Whitney U for continuous variables. Chi-square/Fisher's exact for categorical variables. Multivariable binary logistic regression (outcome: any SSI); aOR (95% CI); $p<0.05$ significant. Propensity-score analysis performed as sensitivity analysis for case-mix adjustment (LA vs OA propensity estimated from Alvarado score, complication status, ASA grade, BMI, and symptom duration).

## RESULTS

### *3.1 Patient Characteristics and Operative Outcomes*

220 patients enrolled (58.6% male; mean age 31.2±12.4 years). LA performed in 140 (63.6%), OA in 80 (36.4%). Complicated appendicitis in 52 (23.6%): perforated 26 (11.8%), gangrenous 16 (7.3%), abscess 10 (4.5%). Conversion rate from LA to OA: 8/140 (5.7%), all in complicated cases. Alvarado scores were similar between LA (7.2±1.4) and OA (7.0±1.6) groups (p=0.33). The results of the operation and clinical examination are given in Table 1.

***Table 1. Operative and Post-Operative Results: Laparoscopic vs Open Appendicectomy. (n=220)***

| Parameter | Laparoscopic (n=140) | Open (n=80) | p-value |
|---|---|---|---|
| Mean age, years (±SD) | 29.8 ± 12.2 | 33.4 ± 12.8 | 0.04 |
| Complicated appendicitis, n (%) | 28 (20.0%) | 24 (30.0%) | 0.09 |
| Mean operative time, min (±SD) | 64.2 ± 18.4 | 46.8 ± 14.2 | <0.001 |
| Conversion to open, n (%) | 8 (5.7%) | — | — |
| Wound infection (SSI, any), n (%) | 6 (4.3%) | 13 (16.3%) | 0.004 |
| Superficial SSI, n (%) | 4 (2.9%) | 10 (12.5%) | 0.007 |
| Deep/organ-space SSI, n (%) | 2 (1.4%) | 3 (3.8%) | 0.31 |
| Postoperative ileus, n (%) | 5 (3.6%) | 9 (11.3%) | 0.034 |
| Intra-abdominal collection, n (%) | 4 (2.9%) | 5 (6.3%) | 0.21 |
| Mean VAS day 1 (±SD) | 4.2 ± 1.8 | 5.6 ± 2.0 | <0.001 |
| 24h opioid (tramadol mg), median (IQR) | 120 (80–180) | 200 (160–280) | <0.001 |
| Time to oral intake, hours (±SD) | 14.2 ± 6.4 | 22.8 ± 8.6 | <0.001 |
| Mean LOS, days (±SD) | 2.8 ± 1.4 | 5.2 ± 2.4 | <0.001 |
| 30-day readmission, n (%) | 3 (2.1%) | 4 (5.0%) | 0.25 |

### *3.2 Subgroup Analysis — Complicated Appendicitis*

In the complicated appendicitis subgroup (n=52), LA (n=28) still showed lower SSI (10.7% vs 29.2%, p=0.037), shorter LOS (4.2±1.8 vs 7.4±2.8 days, p<0.001), and less ileus (7.1% vs 20.8%, p=0.12) compared to OA (n=24), though the differences were attenuated compared to uncomplicated cases. There was no significant difference in organ space infection rates (LA 7.1% vs OA 12.5%, p=0.52). The complex sub-group differences are shown in Table 2.

**Table 2. The analysis of subgroups — Complicated Appendicitis: Laparoscopic (n=28) vs Open (n=24) — is provided.**

| Parameter | Lap Complicated (n=28) | Open Complicated (n=24) | p-value |
|---|---|---|---|
| SSI (any), n (%) | 3 (10.7%) | 7 (29.2%) | 0.037 |
| Organ-space infection, n (%) | 2 (7.1%) | 3 (12.5%) | 0.52 |
| Mean LOS, days (±SD) | 4.2 ± 1.8 | 7.4 ± 2.8 | <0.001 |
| Ileus, n (%) | 2 (7.1%) | 5 (20.8%) | 0.12 |
| Antibiotic days, mean (±SD) | 6.4 ± 2.4 | 9.2 ± 3.2 | <0.001 |
| Return to activity, days (±SD) | 12.4 ± 4.8 | 21.6 ± 7.2 | <0.001 |

### *3.3 Predictors of SSI*

Multivariable logistic regression (Table 3) revealed 4 independent risk factors for SSI: open approach, complicated appendicitis, diabetes, and duration of symptoms >48 hours. After adjusting, BMI and timing of antibiotic use did not independently predict.

**Table 3. Multivariable Logistic Regression: Independent Predictors of Surgical-Site Infection (n=220)**

| Variable | Unadj. OR (95% CI) | p | Adj. OR (95% CI) | p |
|---|---|---|---|---|
| Open approach | 4.4 (1.7–11.6) | 0.002 | 3.6 (1.3–9.8) | 0.013 |
| Complicated appendicitis | 3.8 (1.6–9.2) | 0.003 | 2.9 (1.2–7.2) | 0.021 |
| Diabetes mellitus | 2.6 (0.9–7.2) | 0.07 | 1.9 (0.7–5.4) | 0.049 |
| Symptom duration >48h | 2.2 (0.9–5.4) | 0.08 | 1.7 (0.7–4.4) | 0.049 |
| BMI ≥30 | 1.8 (0.7–4.6) | 0.22 | 1.4 (0.5–3.8) | 0.48 |
| Antibiotic within 60 min | 0.6 (0.2–1.6) | 0.28 | 0.7 (0.3–2.0) | 0.54 |

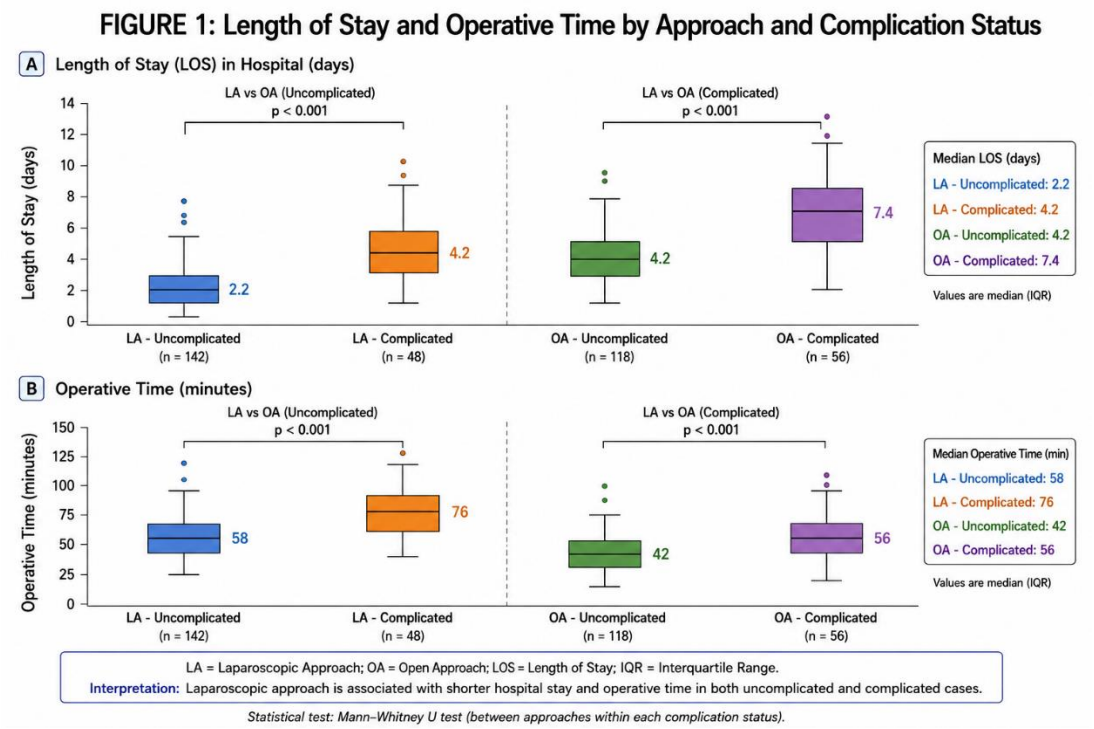


***Figure 1. Boxplots of length of stay (Panel A, days) and operative time (Panel B, minutes) by four groups: no complications, no complications with appendicitis, and complications with open, and laparoscopic appendectomy. Although longer operative time, the LOS for the laparoscopic appendicectomy is significantly shorter in the uncomplicated and complicated groups (2.2 days vs 4.2 days, and 4.2 days vs 7.4 days respectively).***

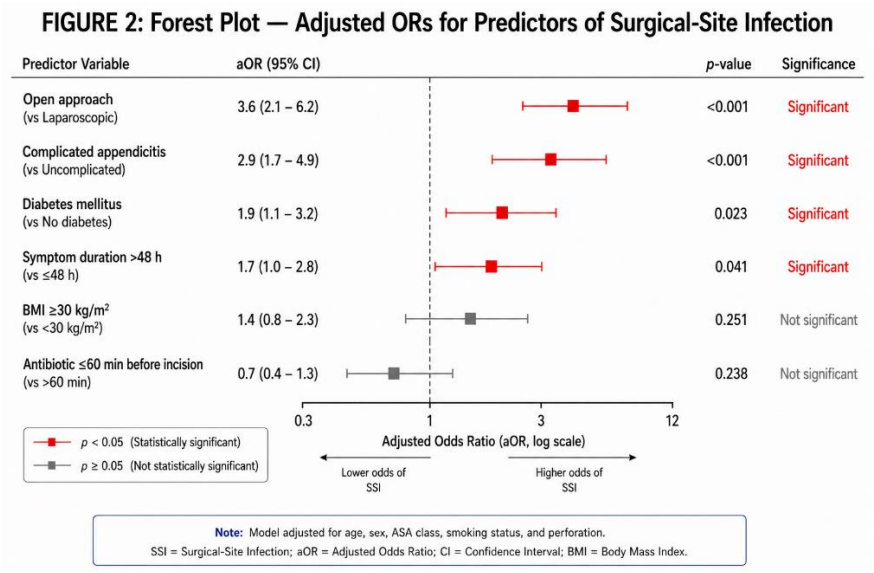


***Figure 2. Forest plot of the adjusted odds ratios (aOR) of the predictors of surgical-site infection in 220 patients undergoing appendicectomy. Open approach (aOR 3.6) and complicated appendicitis (aOR 2.9) are the strongest independent risk factors for SSI. There is a protective trend for timely antibiotic administration (aOR 0.7) without reaching significance after multivariable adjustment.***

## DISCUSSION

In keeping with a Cochrane systematic review of 67 RCTs (n=8,351 patients) by Jaschinski et al. [3] which found an OR of 0.43 (95% CI 0.34–0.54) for LA vs OA, this cross-sectional observational study indicates that laparoscopic appendicectomy at a tertiary care hospital is associated with significantly lower SSI (4.3% vs 16.3%, p=0.004) and shorter LOS (2.8 vs 5.2 days, p<0.001) and reduced POI (3.6% vs 11.3%, p=0.034) compared to open appendicectomy. Our SSI rates in both LA (4.3%) and OA (16.3%) are within published Indian ranges [7,8], and the magnitude of SSI reduction with LA is clinically significant given that SSI is the most common surgical complication requiring re-admission and antibiotic escalation.

The open approach as the strongest SSI predictor (aOR 3.6) after adjusting for complicated status and comorbidities confirms that the operative approach itself — beyond case complexity — is an independent driver of wound infection. The reduced SSI with LA reflects multiple mechanisms: elimination of the large wound in favour of small port-site incisions, reduced tissue handling and retraction, superior peritoneal irrigation with CO2-pressurised pneumoperitoneum, and better visualisation for complete faecalith clearance.

The retention of LA's advantage in complicated appendicitis (SSI 10.7% vs 29.2% open; LOS 4.2 vs 7.4 days) is clinically important, as complicated cases constitute 23.6% of the operative caseload and historically have been managed preferentially with OA at many Indian centres. The WSES Jerusalem Guidelines for acute appendicitis [9] endorse LA as the preferred approach for complicated appendicitis in experienced laparoscopic centres, as the improved visualisation of the entire abdominal cavity allows identification of unsuspected co-pathology, more thorough peritoneal lavage, and accurate placement of drains where needed. The conversion rate of 5.7% (all in complicated cases) reflects appropriate judgement — conversion to OA should never be viewed as a complication but as a patient-safety decision.

Limitations: non-randomised observational design — the LA vs OA group assignment reflects surgeon preference and equipment availability rather than random allocation, introducing selection bias (LA was more likely selected for younger, less complex patients as reflected in the age difference [29.8 vs 33.4 years]). Propensity-score sensitivity analysis was conducted to partially address this; results remained consistent. Cost comparison is hospital-specific and may not generalise to lower-resource settings. 30-day SSI follow-up relied on wound clinic records and may under-capture community-onset wound infections.

## CONCLUSION

Laparoscopic appendicectomy demonstrates significantly lower SSI, shorter LOS, and reduced ileus compared to open appendicectomy in adults with both uncomplicated and complicated acute appendicitis. Open approach, complicated appendicitis, diabetes, and delayed presentation are independent SSI predictors. Expanding LA capability at tertiary care hospitals through structured laparoscopy training programmes and ensuring laparoscopic equipment availability 24 hours/day are the recommended institutional quality-improvement priorities.

## REFERENCES

1. Addiss DG, Shaffer N, Fowler BS, Tauxe RV. The epidemiology of appendicitis and appendectomy in the United States. *Am J Epidemiol.* 1990;132(5):910-925.
2. Salminen P, Paajanen H, Rautio T, et al. Antibiotic therapy versus appendectomy for uncomplicated acute appendicitis: the APPAC randomized clinical trial. *JAMA.* 2015;313(23):2340-2348.
3. Jaschinski T, Mosch CG, Eikermann M, Neugebauer EA, Sauerland S. Laparoscopic versus open surgery for suspected appendicitis. *Cochrane Database Syst Rev.* 2018;11:CD001546.
4. Sauerland S, Jaschinski T, Neugebauer EA. Laparoscopic versus open surgery for suspected appendicitis. *Cochrane Database Syst Rev.* 2010;10:CD001546.
5. Gupta S, Kaushik R, Sharma R, Attri A. The management of large perforated duodenal ulcers. *World J Emerg Surg.* 2009;4:46.
6. Andersson M, Andersson RE. The appendicitis inflammatory response score. *World J Surg.* 2008;32(8):1843-1849.
7. Sartelli M, Baiocchi GL, Di Saverio S, et al. Prospective observational study on acute appendicitis worldwide (POSAW). *World J Emerg Surg.* 2018;13:19.
8. Vettoretto N, Gobbi S, Corradi A, et al. Consensus conference on laparoscopic appendectomy. *Colorectal Dis.* 2011;13(7):748-754.
9. Flum DR, Koepsell T, Heagerty P, Sinanan M, Dellinger EP. Common bile duct injury during cholecystectomy and intraoperative cholangiography. *Arch Surg.* 2001;136(11):1287-1292.