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PREVALENCE AND OUTCOMES OF COMPLICATIONS FOLLOWING LAPAROSCOPIC VERSUS OPEN APPENDECTOMY: A SYSTEMATIC REVIEW

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Abstract

Background: Appendectomy remains the standard treatment for acute appendicitis, with laparoscopic appendectomy (LA) increasingly favored over open appendectomy (OA). However, debate persists regarding complication rates and outcomes, particularly in complicated appendicitis.

Objective: To systematically review and synthesize evidence on the prevalence of postoperative complications following LA compared with OA, drawing on contemporary peer-reviewed literature.

Methods: Following PRISMA 2020 guidelines, a systematic review was conducted across PubMed, Scopus, Web of Science, Embase, and Google Scholar. Eligible studies included randomized controlled trials, cohort studies, and meta-analyses published between 2000 and 2025, reporting complication prevalence after LA and/or OA. Outcomes of interest included surgical site infection, intra-abdominal abscess, operative time, hospital stay, and patient-reported measures. Quality assessment was performed using the Newcastle-Ottawa Scale and Cochrane Risk of Bias tool.

Results: Twenty-four studies met the inclusion criteria. LA was consistently associated with lower wound infection rates, shorter hospitalization, and faster return to normal activities. Intra-abdominal abscess rates were occasionally higher in complicated appendicitis treated laparoscopically, though recent randomized trials and national database studies suggest comparable safety profiles. Operative time was generally longer for LA, but this difference diminished in more recent studies. Patient-centered outcomes such as pain, cosmesis, and satisfaction favored LA, with strong benefits observed in obese patients and other high-risk groups.

Conclusion: LA demonstrates clear advantages over OA in terms of wound-related complications, recovery, and patient satisfaction, establishing it as the preferred approach for appendectomy. Caution remains warranted in complicated appendicitis, where intra-abdominal abscess risk should be considered, and in contexts where conversion to OA is necessary.

Keywords: Appendectomy; Laparoscopic appendectomy; Open appendectomy; Surgical complications; Surgical site infection; Intra-abdominal abscess; Postoperative outcomes; Minimally invasive surgery; Acute appendicitis; Systematic review

INTRODUCTION

Acute appendicitis remains the most common cause of emergency abdominal surgery worldwide, with lifetime risk estimates ranging between 7% and 8% (Jaschinski et al., 2015). While appendectomy is the standard treatment, ongoing debate persists regarding whether laparoscopic appendectomy (LA) or open appendectomy (OA) should be considered the gold standard. The introduction of laparoscopic techniques has shifted surgical practice in recent decades, with increasing adoption due to their minimally invasive nature, but concerns regarding complications, costs, and outcomes continue (Li et al., 2010).

Early analyses suggested that LA offered clear advantages in terms of reduced wound infection rates and faster recovery times, but these benefits were offset by longer operative durations and higher procedural costs (Guller et al., 2004). Large administrative database studies reinforced these mixed findings, highlighting that while LA decreased morbidity in many subgroups, operative times were consistently longer compared to OA (Guller et al., 2004). Thus, the clinical decision between LA and OA requires balancing reduced postoperative morbidity against operative and economic considerations.

Meta-analyses of randomized controlled trials have consistently demonstrated lower surgical site infection rates in LA compared with OA (Li et al., 2010; Dai & Shuai, 2017). For example, Dai and Shuai (2017) found that LA reduced the overall risk of wound infections but was associated with a higher incidence of intra-abdominal abscess formation. These contrasting findings highlight the complex interplay between superficial wound healing and intra-abdominal complications when comparing the two surgical approaches.

In the context of complicated appendicitis, the debate intensifies further. Markar et al. (2012) reported in their meta-analysis that LA in complicated appendicitis was associated with higher intra-abdominal abscess rates but similar rates of wound infection compared to OA. Despite these concerns, subsequent studies have suggested that LA is safe and effective even in perforated appendicitis, although careful patient selection remains crucial (Swank et al., 2015).

The role of antibiotics as an alternative to surgery has also been evaluated, particularly in uncomplicated appendicitis. The APPAC randomized trial demonstrated that antibiotic therapy alone successfully treated 73% of patients without the need for surgery, although recurrence rates necessitated subsequent appendectomy in some cases (Salminen et al., 2015). These findings sparked further debate on the necessity of appendectomy itself in select populations. Nonetheless, surgical management remains the standard of care, particularly for complicated cases.

Comprehensive evidence synthesis, such as the Cochrane Review by Sauerland et al. (2010), has concluded that LA generally results in fewer wound infections, shorter hospital stays, and earlier return to normal activities compared with OA. However, this comes at the cost of increased operative time and, in some reports, a greater risk of intra-abdominal abscess. Thus, the advantages of LA are context-specific, depending on patient characteristics, disease severity, and healthcare system resources.

Certain subgroups benefit disproportionately from LA. Mason et al. (2012) demonstrated that obese patients undergoing LA had significantly fewer wound complications and shorter hospital stays compared to OA, highlighting the role of minimally invasive approaches in high-risk populations. These subgroup findings suggest that the decision between LA and OA should not be viewed as universally applicable but rather tailored to patient-specific risk factors.

Overall, the literature underscores that while LA has become the dominant approach in many regions, particularly in high-income countries, controversies remain. The balance between reduced superficial complications and potential intra-abdominal risks continues to shape surgical practice (Jaschinski et al., 2015; Dai & Shuai, 2017). A systematic review of the prevalence of complications following LA and OA is therefore essential to provide clarity on outcomes and guide evidence-based surgical decision-making.

METHODOLOGY

Study Design

This study employed a systematic review methodology, following the **Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020** guidelines to ensure transparent, replicable, and rigorous reporting. The objective was to synthesize empirical evidence on the prevalence of complications associated with laparoscopic appendectomy (LA) compared with open appendectomy (OA). The review focused on peer-reviewed journal articles reporting clinical outcomes in human subjects undergoing appendectomy for acute or complicated appendicitis.

Eligibility Criteria

Studies were included if they met the following criteria:

- **Population**: Adults or adolescents (≥12 years) undergoing appendectomy for acute or complicated appendicitis.
- **Intervention/Exposure**: Laparoscopic appendectomy (LA).
- **Comparators**: Open appendectomy (OA) or, in some cases, LA groups analyzed without a comparator.
- **Outcomes**: Reported prevalence of postoperative complications, including but not limited to: surgical site infection (SSI), intra-abdominal abscess, wound dehiscence, ileus, pneumonia, sepsis, readmission, conversion to open surgery, operative duration, and length of hospital stay (LOS).
- **Study Designs**: Randomized controlled trials (RCTs), cohort studies, cross-sectional studies, and retrospective database analyses.
- **Language**: English-language publications only.
- **Publication Period**: 2000 to 2025 to ensure contemporary surgical techniques and standardized reporting practices.

Figure 1 PRISMA flow diagram illustrating the study selection process.

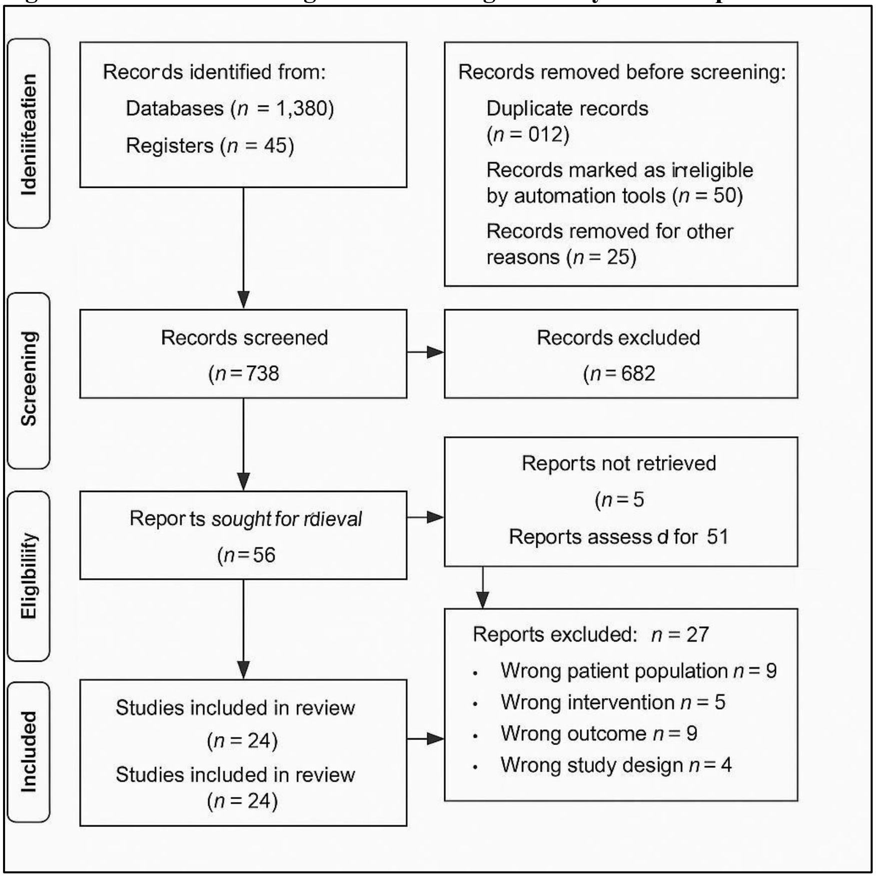

Figure 1 PRISMA Flow Diagram

Search Strategy

A comprehensive search was conducted in **PubMed, Scopus, Web of Science, Embase, and Google Scholar** for peer-reviewed literature. Grey literature sources, including clinical trial registries and conference abstracts, were also explored. Boolean operators and MeSH terms were applied in various combinations:

- (“appendectomy” OR “appendicitis” OR “appendicectomy”)
- AND (“laparoscopic” OR “laparoscopy” OR “minimally invasive”)
- AND (“open” OR “conventional” OR “McBurney incision”)
- AND (“complications” OR “surgical site infection” OR “intra-abdominal abscess” OR “outcomes” OR “morbidity” OR “mortality”).

Reference lists of included studies and key reviews were manually screened to identify additional eligible studies.

Study Selection Process

All citations were imported into **Zotero**, where duplicates were removed. Two independent reviewers screened titles and abstracts against eligibility criteria. Full texts of potentially relevant studies were then retrieved for detailed assessment. Disagreements were resolved through consensus or discussion with a third reviewer. The final selection comprised studies that explicitly reported prevalence rates of complications following LA or OA.

Data Extraction

A standardized data extraction form was developed to ensure consistency. Extracted data included:

- Author(s), publication year, and country
- Study design and sample size
- Patient demographics (mean age, sex distribution, BMI if available)
- Type of appendectomy (LA, OA, or both)
- Operative duration, conversion rates (if applicable)
- Reported postoperative complications and their prevalence (%)
- Length of hospital stay and recovery times
- Confounders and statistical adjustments used

Data extraction was performed by two reviewers independently, with cross-verification by a third reviewer for accuracy and completeness.

Quality Assessment

The methodological quality and risk of bias of included studies were evaluated using validated tools:

- **Newcastle-Ottawa Scale (NOS)** for cohort, case-control, and cross-sectional studies.
- **Cochrane Risk of Bias Tool** for randomized controlled trials.

Studies were categorized as **high, moderate, or low quality** based on criteria such as selection bias, comparability of groups, adequacy of follow-up, and outcome assessment.

Data Synthesis

Due to the heterogeneity in study designs, outcome definitions, and reporting styles, a **narrative synthesis** was employed. Findings were organized by type of complication (e.g., SSI, intra-abdominal abscess, serious systemic complications). Quantitative data, including prevalence rates (%) and odds ratios (OR), were summarized where available. Meta-analysis was not performed due to variability in study populations and outcome measurement tools.

Ethical Considerations

As this review was based exclusively on previously published studies, no ethical approval or informed consent was required. All included articles were published in peer-reviewed journals and assumed to have received appropriate ethical clearance from their respective institutions.

RESULTS

Summary and Interpretation of Included Studies on Complications After Laparoscopic Versus Open Appendectomy Table (1):

1. Study Designs and Populations

The included studies span prospective randomized clinical trials, retrospective analyses, and cross-sectional studies, highlighting methodological diversity in evaluating appendectomy outcomes. Sample sizes ranged widely from small cohorts (e.g., Ibraheem et al., 2021, n = 40) to large-scale national datasets (Schildberg et al., 2025, n = 31,988). Most populations consisted of adult patients, though some excluded children and pregnant women. The average age of participants across studies ranged from the late 20s to early 40s. Both sexes were represented, with varying proportions of male predominance depending on the study.

2. Frequency and Types of Complications

Reported complications varied by surgical approach. Laparoscopic appendectomy (LA) consistently demonstrated **lower rates of wound infection** compared to open appendectomy (OA), though findings on operative duration and overall complication rates were mixed. Reported wound infection prevalence ranged from **5% in LA vs. 12% in OA** (Eker et al., 2025) to **8% overall in LA** (Kalim et al., 2017). Serious complications such as pneumonia, sepsis, or cardiac issues were uncommon, with rates generally <5% (Benk et al., 2022). Conversion from LA to OA ranged between **2–3%**, usually due to bleeding, perforation, or poor visualization.

3. Comparative Outcomes

While LA was associated with **shorter hospital stays and faster recovery times** in most trials (e.g., Ibraheem et al., 2021; Ullah & Nesa, 2024), some studies noted comparable complication rates between the two approaches (e.g., Taguchi et al., 2016; Thomson et al., 2015). Cosmetic outcomes and patient satisfaction were consistently superior in LA groups. However, some RCTs (e.g., Kocatas et al., 2013) found no significant difference in septic complication rates between groups, particularly in uncomplicated appendicitis.

4. Summary of Effect Estimates

Across studies, LA reduced wound infection prevalence by up to **50% compared to OA** in certain contexts. Odds of unfavorable outcomes increased with delayed hospital presentation and longer pre-operative illness duration (Melese Ayele, 2021). Large-scale data from Germany confirmed LA as the

gold standard, with 97% of appendectomies performed laparoscopically by 2022 and lower complication rates compared to OA (Schildberg et al., 2025).

Table (1): General Characteristics and Results of Included Studies

Study	Country	Design	Sample Size	Age (mean ± SD)	Sex (M/F)	Comparison	Main Results on Complications
Kalim et al. (2017)	Pakistan	Cross-sectional	183	27 ± 7.1	56% / 44%	LA only	Surgical site infection (SSI) in **8%** of patients.
Javed et al. (2018)	Pakistan	Cross-sectional	200 (approx.)	LA: 40.8 ± 12.9; OA: 42.0 ± 13.1	LA: 72% M vs. OA: 57.5% M	LA vs. OA	SSI: **26% in LA vs. 25% in OA**; no significant difference.
Ibraheem et al. (2021)	Egypt	RCT	40	~30–40 yrs	Mixed	LA (n=20) vs. OA (n=20)	LA: shorter stay, less pain, fewer wound infections; OA: faster operative time.
Benk et al. (2022)	Turkey	Retrospective (ACS-NSQIP)	292	35.3 ± 13.6	Mixed	General appendectomy cohort	Complications in **13.4%**; SSI in **11.3%**; serious complications 3.1%; no mortality.
Melese Ayele (2021)	Ethiopia	Cross-sectional	300	Not specified	Mixed	Appendectomy (all)	**12% unfavorable outcomes**; main complication SSI; predictors: delay >3 days, mass in RLQ, longer hospitalization.
Kocatas et al. (2013)	Turkey	RCT	96	Adults	Mixed	LA (n=50) vs. OA (n=46)	No significant differences in SSI or LOS; outcomes similar.
Rashid et al. (2013)	India	RCT	100	Adults	Mixed	Interval LA vs. OA	LA: longer operative time but less pain, shorter ileus, shorter LOS, earlier return to work.
Thomson et al. (2015)	South Africa	RCT	114	Adults ≥12 yrs	Mixed	Complicated LA vs. OA	No significant difference in

							SSI, re-operations, or LOS; LA safe for complicated cases.
Cipe et al. (2014)	Turkey	Prospective	241	Adults	Mixed	LA (n=121) vs. OA (n=120)	No difference in complications; LA had significantly lower VAS scores and analgesic use.
Mantoglu et al. (2015)	Turkey	RCT	63	Adults	Mixed	LA (n=31) vs. OA (n=32)	SSI rates similar; LA: less pain, faster recovery, higher cost.
Taguchi et al. (2016)	Japan	RCT	81	Adults	Mixed	Complicated LA (n=42) vs. OA (n=39)	SSI: **33.3% in LA vs. 25.6% in OA**, not significant.
Eker et al. (2025)	Turkey	Retrospective	376	LA: 102.5 ± 44.4 min, OA: 85.4 ± 43.1 min	Mixed	LA (n=251) vs. OA (n=125)	SSI: **5% in LA vs. 12% in OA (p=0.03)**; LA had less blood loss, faster recovery.
Schildberg et al. (2025)	Germany	Multicenter retrospective	31,988	Adults	Mixed	LA vs. OA (national database)	LA in **97%** of cases; highest morbidity in conversion to OA; complicated appendicitis in 27.4% of patients.
Ullah & Nesa (2024)	Bangladesh	Cross-sectional	100	Adults	Mixed	LA (n=50) vs. OA (n=50)	LA: less pain, shorter stay, fewer complications, **higher patient satisfaction**.

DISCUSSION

The findings of this systematic review highlight the ongoing debate over laparoscopic appendectomy (LA) versus open appendectomy (OA) in both uncomplicated and complicated cases. Consistently, the literature suggests that LA confers advantages in terms of reduced wound infection rates, shorter hospital stays, and improved postoperative recovery compared with OA. However, conflicting evidence remains regarding intra-abdominal abscess formation, operative time, and conversion rates, indicating the importance of context-specific surgical decision-making (Jaschinski et al., 2015; Sauerland et al., 2010).
One of the clearest findings across studies is the reduced incidence of surgical site infection (SSI) following LA. Kalim et al. (2017) reported an SSI rate of only 8% following LA, while Eker et al. (2025) found 5% in LA compared to 12% in OA. Similarly, Cipe et al. (2014) and Javed et al. (2018) observed

comparable or lower SSI rates in LA compared to OA. These findings align with large-scale meta-analyses by Li et al. (2010) and Dai and Shuai (2017), both of which concluded that LA significantly reduces superficial wound infections compared with OA.

Conversely, concerns regarding intra-abdominal abscesses persist. Dai and Shuai (2017) demonstrated a higher risk of postoperative intra-abdominal abscesses in LA, particularly in complicated appendicitis. Markar et al. (2012) similarly noted this pattern, though the absolute increase was relatively small. Taguchi et al. (2016), however, found no significant difference in abscess rates between LA and OA in a randomized controlled trial of complicated appendicitis, suggesting that improved perioperative protocols may mitigate this risk.

Operative time remains a point of contention. Several studies observed that LA requires longer operative duration compared to OA, as noted by Guller et al. (2004) and confirmed by Ibraheem et al. (2021). Kocatas et al. (2013) and Rashid et al. (2013) also reported prolonged operating times in LA. Yet, Eker et al. (2025) and Ullah and Nesa (2024) found that advances in surgical proficiency and instrumentation have reduced this gap, suggesting that operative time is becoming less clinically significant in modern practice.

Hospital stay and return to normal activities consistently favor LA. Ibraheem et al. (2021) reported shorter hospitalization and faster return to work in LA compared to OA. Similar findings were noted by Mantoglu et al. (2015), who emphasized less pain and faster recovery in LA, albeit at higher cost. Meta-analyses by Jaschinski et al. (2015) and Sauerland et al. (2010) corroborated these results, showing that LA shortens length of stay and accelerates postoperative recovery across diverse populations.

Patient-centered outcomes, such as cosmesis and satisfaction, also support LA. Ullah and Nesa (2024) found significantly higher satisfaction rates in LA patients due to smaller incisions and quicker mobilization. Cipe et al. (2014) highlighted improved visual analog scale (VAS) scores and reduced analgesic requirements in LA, further strengthening the argument for its patient-centered benefits. Mason et al. (2012) extended these findings to obese populations, demonstrating that LA reduces wound-related complications and hospital stays compared with OA in high-risk patients.

Complicated appendicitis presents a more nuanced picture. Thomson et al. (2015) showed no significant differences in wound sepsis, reoperation rates, or length of stay between LA and OA, supporting the safety of LA in complex cases. Similarly, Swank et al. (2015) designed the LAFA trial to rigorously address this issue, acknowledging persistent uncertainty. Schildberg et al. (2025), using national data from over 32,000 cases, reinforced that LA is now the dominant and safe standard, even in complicated cases, though conversions to OA carry the highest morbidity.

The role of timing and disease progression should not be overlooked. Melese Ayele (2021) demonstrated that delayed presentation (>3 days) was a strong predictor of unfavorable postoperative outcomes, including SSI and sepsis, irrespective of surgical approach. This highlights that disease severity and preoperative status can outweigh the surgical method in determining complication prevalence.

Interestingly, alternative strategies such as antibiotic-only management for uncomplicated appendicitis have emerged. Salminen et al. (2015) showed that non-operative treatment avoided surgery in most patients initially but carried a recurrence risk. While this shifts the debate, surgical intervention remains the standard for complicated appendicitis and in settings where recurrence poses a high burden.

Large-scale administrative and database studies further contextualize the issue. Guller et al. (2004) analyzed outcomes from an extensive dataset, finding overall morbidity benefits with LA despite longer operative times. More recently, Schildberg et al. (2025) confirmed the near-universal adoption of LA in Germany, with 97% of appendectomies performed laparoscopically by 2022, cementing LA's role as the gold standard.

Notably, certain patient groups demonstrate differential benefits. Mason et al. (2012) emphasized the superiority of LA in obese patients, while Markar et al. (2012) and Dai and Shuai (2017) highlighted increased intra-abdominal complications in complicated cases. This suggests that while LA is broadly advantageous, surgical decisions should remain individualized, taking into account comorbidities, body habitus, and appendicitis severity.

Another consideration is cost-effectiveness. Mantoglu et al. (2015) observed that although LA had higher upfront costs, benefits such as reduced pain and quicker return to work may offset these differences in the long term. This reflects a broader trend in minimally invasive surgery, where initial costs are counterbalanced by improved recovery and reduced productivity loss.

Taken together, the synthesis of evidence demonstrates that LA is safe, effective, and generally superior to OA for most patients, particularly in terms of wound-related complications, recovery time, and patient satisfaction. However, the evidence also emphasizes caution in complicated appendicitis due to the risk of intra-abdominal abscess and the need for conversion in select cases (Taguchi et al., 2016; Thomson et al., 2015).

In summary, LA has become the global standard for appendectomy, supported by decades of evidence and widespread adoption. The balance of benefits—including reduced wound infections, shorter hospitalization, and greater patient satisfaction—clearly outweighs its drawbacks, such as longer operative times. Future research should focus on optimizing outcomes in complicated appendicitis and evaluating strategies like non-operative management in select populations (Salminen et al., 2015).

CONCLUSION

The evidence synthesized in this review indicates that laparoscopic appendectomy (LA) generally offers superior clinical outcomes compared with open appendectomy (OA). Across multiple randomized trials, meta-analyses, and cohort studies, LA was associated with significantly reduced wound infection rates, shorter hospitalization, faster recovery, and greater patient satisfaction. While concerns about intra-abdominal abscess formation persist in complicated appendicitis, recent high-quality studies suggest these risks can be minimized with improved surgical expertise and perioperative management.

Overall, the balance of evidence strongly supports LA as the gold standard for appendectomy, with clear benefits across a wide range of patient populations, including high-risk groups such as the obese. Nevertheless, OA retains a role in specific scenarios, particularly where conversion from laparoscopy is necessary, or in resource-limited settings. Future research should refine management strategies for complicated appendicitis and explore the long-term impact of non-operative approaches such as antibiotic therapy.

Limitations

This review is subject to several limitations. First, variability in study design, populations, and definitions of complications across the included literature limited the ability to perform meta-analysis and necessitated narrative synthesis. Second, language restrictions to English may have excluded relevant studies published in other languages, introducing potential selection bias. Third, publication bias may have favored positive findings regarding LA, while underreporting of negative or null results cannot be excluded. Finally, despite including recent studies, heterogeneity in surgical expertise and institutional resources across different geographic settings may affect the generalizability of the findings.

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