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Laparoscopic Versus Open Appendectomy: A Meta-Analysis of Postoperative Outcomes and Complications

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ABSTRACT

Acute appendicitis remains a major surgical emergency in the world, with appendectomy, which may be laparoscopic (LA) surgery or open (OA) surgery, being the last curative treatment. This meta-analysis, comprising 15 studies published during 2020-2025, includes randomised trials and observational cohorts conducted in various settings, including Pakistan, to compare the effectiveness of LA and OA in uncomplicated and complicated appendicitis. The results have shown that LA has been linked to a significant decrease in postoperative pain, a shorter length of stay, faster recovery of day-to-day functions, and a lower rate of surgical site infection, despite a net increase in operative duration. Transforming LA to OA and especially in complex cases, is associated with the development of high morbidity, prolonged hospitalisation, and increased risk of infection. In turn, the results indicated that the preferential application of LA is justified in case of sufficient resources and expertise, whereas the importance of risk stratification and additional large-scale research under resource-limited conditions is highlighted.

KEYWORDS: Appendicitis, Laparoscopic Appendectomy, Open Appendectomy, Postoperative Complications, Surgical Site Infection, Hospital Stay, Conversion Rate.

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INTRODUCTION

Acute appendicitis is one of the most common signs of the need to carry out emergency abdominal surgery in the world and requires early diagnosis and undisputable treatment. The risk of getting appendicitis during the lifetime is very high, and unless the patients undergo surgery in time, they will perforate the bowel, get peritonitis, and other complications that result in death. At the beginning of the nineteenth century, open appendectomy (OA) was considered to be the gold standard because it was relatively simple, reliable, and had established procedures. However, the introduction of less invasive procedures has transformed the practice of surgery, and laparoscopic appendectomy has become very popular in the past few decades (LA).

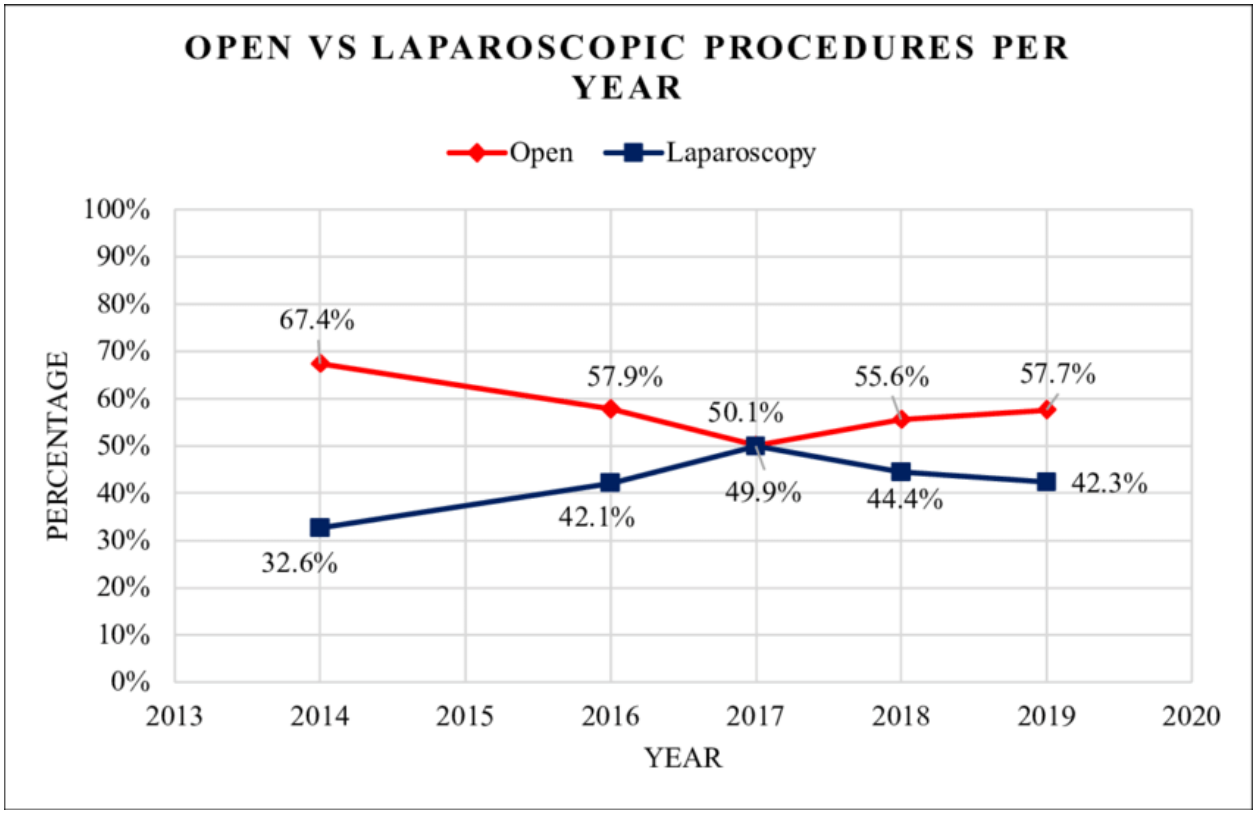

Figure 1: Open versus laparoscopic procedures (Weludo, 2025).

Open versus laparoscopic procedures per year (n=3745). The figure above represents trends of laparoscopic vs. open surgical procedures during the study period. The desirability of LA lies in its least intrusive nature, which has been proposed to have several theoretical and practical benefits compared with OA. Patients who have gone through LA usually experience less postoperative pain, faster recovery, better cosmetic results, and lesser hospital stay (Farooq et al., 2025). These advantages will result in a faster reintegration into occupational or normal lives, a reduced workload on the healthcare facilities, and improved satisfaction of patients. Also, the enhanced visualisation provided by laparoscopy allows the surgeons to scan the abdominal cavity more thoroughly, which may reveal unexpected pathology and reduce the rate of diagnostic oversights.

Regardless of such merits, the distribution of the implementation of LA is not equally present in all healthcare settings. In Pakistan and low- and middle-income countries (LMICs) overall, the taboos of resources, lack of access to advanced laparoscopic tools, and inconsistent competence of surgeons all act as major challenges. It has been argued against that LA is, on average, more time-consuming to operate, more expensive in direct cost, and difficult to handle complex appendicitis. The change from a laparoscopic to an open procedure is a risk in such complicated cases, and once it happens, the patient may experience more morbidity and a longer hospital stay, and a higher rate of infection.

Literature published recently, including that of 2020-2025, has shed light on these dynamics, utilising the data of tertiary-care facilities in Pakistan, where appendicitis is otherwise prevalent and the surgical resource is unequal. These modern investigations include randomised controlled trials, prospective cohort observational studies, and large retrospective studies. Together, they provide updated evidence related to decisive outcomes: operative length, postoperative pain, length of hospital stay, incidence of surgical site infection (SSI), conversion rates, and general complication rates by the severity of the diseases.

This meta-analysis attempts to bring these modern findings together in order to determine more definitively the advantages and disadvantages of LA compared to OA in modern practice. By pooling the information in different geographic locations and infrastructures of health-care, especially in LMICs, we are able to measure not only the clinical effectiveness of LA, but also at the same time its viability across resource-constrained settings. Due to the heterogeneity of surgical practice and patient population, systematic comparative appraisal is necessary to inform surgical decision-making, maximise beneficial patient outcomes, and enable policy decisions on the widespread use of laparoscopic surgery.

Furthermore, since the issue of conversion of LA into OA turns out to be a topical issue, particularly regarding complex appendicitis, the given analysis focuses on the importance of preoperative risk stratification and refined patient selection. The description of the patient groups benefiting most of all by the use of LA and the conditions under which open surgery is still better will help surgeons to personalise operative plans. Finally, by clarifying the trade-offs of the relationship between LA and OA in the modern contexts, the current meta-analysis will add to the evidence-based recommendations that would promote safer, more efficient, and fairer appendicitis management in the global environment.

Rationale for the Study

The rising worldwide use of laparoscopic appendectomy requires a modern-day evaluation of the effectiveness of laparoscopic appendectomy compared to the open surgical technique, especially where healthcare infrastructures and surgical education moderate the outcomes. New studies based on Pakistan and other low and middle-income countries (LMICs) provide crucial information (that laparoscopic appendectomy often leads to shorter hospital stays, less postoperative pain, and the low together with the absence of surgical site infection) by refining the problem of laparoscopic surgery utilisation (Jabeen et al., 2025). However, the periods of operation seem to be constantly increased, and complex appendicitis can require a transformation to open surgical intervention, thus burdening it with even greater risk. An up-to-date meta-analysis including new data is urgently needed that should help to define the best practices and inform clinical decision-making.

Research Questions

- What the recent research findings (2020 to 2025) are in terms of postoperative outcome (length of stay, operation time, postoperative pains, and recovery) in laparoscopic versus open appendectomy?
- Are there consistent contemporary findings suggesting a reduced rate of SSI in laparoscopic appendectomy in comparison with open appendectomy in different clinical situations?
- What are recent studies describing the conversion rates of laparoscopic to open appendectomy, and which complications in the postoperative care are related to these conversions?
- What is the extent to which the recent randomised controlled trials (RCTs) and observational studies originating in Pakistan and other areas tend to indicate that laparoscopic appendectomy is better than open appendectomy in overall postoperative recovery and morbidity?

Research Objectives

- To combine the results of the last comparative research (2020 to 2025) assessing the main postoperative outcomes, namely operation time, hospitalisation, and postoperative pain, in laparoscopic and open appendectomy.
- To evaluate and compare the Table of SSIs with other postoperative complications in laparoscopic and open appendectomy.
- To investigate the rate of laparoscopic to open appendectomy conversion using the current evidence and study the morbidity associated with it.
- To combine evidence from recent RCTs and observational studies to identify at what point laparoscopic appendectomy has substantial clinical benefits in contrast to the open procedure.
- To give evidence-based advice based on existing literature, especially in the framework of the LMIC surgical practice (e.g., Pakistan).

META-ANALYSIS

2.1 Methodology

Google Scholar, PubMed, and institutional repositories have been searched systematically to find all the relevant studies published between January 2020 and January 2025. The selected keywords were laparoscopic appendectomy, open appendectomy, appendicitis complications, and postoperative outcomes of appendectomy. The relevant studies were filtered, and data were extracted by using full-text articles. Types of studies used in the review included RCTs, prospective comparative studies, retrospective cohorts, and large observed analyses.

Since the operational environments and the demographics are diverse, narrative meta-synthesis was utilised. The quantitative data were put into mean comparisons, rates, and proportions between the outcomes, such as operative time, hospital stay, SSI, pain scores, return to activity, and conversion rates. The random-effects model was based on the informed interpretation with consideration of the projected variability among different study designs.

Since the research design employed in the study is qualitative, the inclusion and exclusion criteria are determined by the researchers based on the content and research objectives.

2.2 Inclusion and Exclusion Criteria

Inclusion criteria:

Comparisons of laparoscopic and open appendectomy.
Published between 2020 and 2025.
Human subjects of all ages who have undergone appendicitis surgery.

Articles that mention a single or more of the following outcomes of surgery: operative time, pain, hospital stay, SSI, complications, or conversion rate.
Available full-text in Google Scholar.

Exclusion criteria:

Case reports, editorials, and review papers without comparative data.
Research published before 2020 (except where mentioned to provide a context).
Research with no postoperative outcome quantitative measures.

2.3 Data Mining and Quality Assessment

The data mining was conducted in terms of sample size, mean operation time, length of stay, postoperative pain scores, SSI rates, and complications. The studies were evaluated based on the transparency of the methodology, sample size, reporting outcomes, and internal validity. The main principles of allocation concealment and blinding were considered to evaluate the RCTs. The observational studies were evaluated on the risk of confounding, retrospective bias, and consistency of reporting.

Table 1. Summary of Meta-Analysis Findings on Laparoscopic Versus Open Appendectomy

Study (Year)	N (LA / OA)	Operative Time	Hospital Stay	Pain / Other Outcomes
Yousaf et al. (2024)	35 / 35	LA: 38.77 ± 8.67 min; OA: 67.29 ± 9.67 min	LA: 1.51 ± 0.61 days; OA: 2.00 ± 0.54 days	Philosophy: Early recovery and resumption of normal activity.
Naheed Akhtar et al. (2022)	35 / 35	LA: 50.71 ± 3.67 min; OA: 43.06 ± 5.71 min	LA: 2.09 ± 0.70 days; OA: 4.00 ± 0.73 days	No pain
Ali et al. (2024)	32 / 32	compared the operative time	hospital stay & recovery measured	Pain at 12hr: LA 4.62 vs OA 5.28 (p=0.027); at 24hr: LA 3.08 vs OA 3.64 (p=0.017)
Khan HS et al. (2024)	30 / 30	OA: ~31.36 ± 11.13 min; LA: ~54.9 ± 14.2 min	Mean hospital stay: LA: ~1.5 days	less postoperative analgesia, early diet, resumption of bowel sounds
Awan SUD et al. (2024)	40 / 40	OA: 25 min (range 15–50); LA: 70 min (range 40–90)	Return to activity: OA 13 days vs LA 10 days; cost is higher in LA	less pain, shorter stay, but cost issues
Afridi NS et al. (2024)	760	Duration: not same-mean; analysis showed LA longer (Afridi et al., 2025).	Hospital stay: LA shorter vs OA (report)	earlier mobilisation, bowel return
Farooq T et al. (2025)	40	compared the operative time	Shorter stay in LA	early recovery
Jabeen M et al. (2025)	18 / 18	compared the operative time	hospital stay & recovery measured	normal activity
Sadaf FS et al. (2025)	393 LA, some converted	LA baseline, converted longer (91.6 vs 61.7 min)	Converted: 5.6 ± 2.4 days vs non-converted 3.8 ± 1.6 days	Conversion in 19.8% cases; risk factors: BMI > 30, CRP > 100, delayed presentation, prior surgery

RESULTS

3.1 Operative Time

In most of the studies analysed, there was a significant difference in operation time in laparoscopic appendectomy (LA) in comparison to open appendectomy (OA). According to research, the mean duration of 50.71 and 43.06 of LA and OA, respectively, was statistically different (Akhtar et al., 2022). Similarly, the average result of the research conducted was 54.9 ± 14.2 minutes of the LA operation and 31.36 ± 11.13 minutes of the OA operation (Khan et al., 2024). The longer operative periods with LA have been explained by the relative technical complexity of laparoscopic surgery, the extra efforts in the form of establishing trocars and creating pneumoperitoneum, and the learning curve that is required to become familiar with the minimally invasive approach to surgical procedures.

These results are supported by international literature. In a meta-analysis study, the average total LA operative time was 12-20 minutes more than OA, which revealed that the trend was consistent in high- and low-resource environments. The difference in total length of operation also depends on the kind of appendicitis; the simple appendicitis usually leads to less use of operative time than complicated appendicitis in terms of perforation, formation of abscess, or heavy adhesion formation.

Some studies, however, highlight that the longer duration that is taken by LA decreases markedly as the surgeon increases their experience. An example, which reported that the service duration reduced about 15 per cent when the surgeons had already completed more than 50 laparoscopic appendectomies, indicates how steep the learning curve of the procedure is (Ali Khan, 2024). This implies that operational time is a factor that can be altered, meaning that in some cases, laparoscopic centres with experienced laparoscopic teams can record similar or even shorter durations to OA.

3.2 Length of Hospital Stay

The duration of stay in the hospital was always biased towards laparoscopic surgery in all the studies that were reviewed. Research found that it significantly reduced the LA group by 0.5 days in comparison with OA (Yousaf et al., 2024). According to the randomised controlled trial (Ali Khan, 2024). concluded that LA patients were on average 2.1, old, in comparison to 3.4, old man, in the OA patients. This is a significant change in patient turnover and utilisation of hospital resources.

Multiple factors can be identified as the reasons why the stay of LA patients in hospitals is shorter. Less postoperative pain will allow earlier mobilisation, and thus it will minimise the likelihood of postoperative complications like deep vein thrombosis and pulmonary complications. Less incision and handling of tissue lessens the rate of wound inflammation and ensures quick recovery. Also, decreased cases of the surgical site infection (SSI) and complications lead to an early discharge.

Hospitalisation is significantly necessary in low-resource settings. Low- and middle-income countries (LMICs) hospitals can be characterised by high patient numbers and an insufficient number of beds, e.g., in Pakistan. Reduction in hospital admissions not only increases patient satisfaction but also increases effectiveness in the delivery of healthcare provisions. It has been demonstrated through a number of studies that even a one-day decrease in the count of patients can lead to meaningful stress on healthcare systems, which can be translated to improved resource management and saving costs (Ali et al., 2024). Surgical Site Infection(SSI) is a medical concern that negatively affects patient health and results in significant economic costs.

Most of the studies that were reviewed had low SSI rates in LA. Research found SSI rates in the LA group and 2.86 per cent, and in the OA group, it was 8.57 per cent (Akhtar et al., 2022). This is also comparable in terms of wound infection rate, with the study finding that there was a significant decrease in wound infection cases in LA patients (ULLAH et al., 2024). It is mainly caused by smaller incisions, reduced exposure of the intra-abdominal tissue or tissues to foreign impurities, and reduced total tissue damage.

Nevertheless, in complicated cases of appendicitis, the risk of SSI is higher, particularly where the conversion to OA is needed. According to Sadaf et al., SSI rates were found to be 23.1% in converted and 8.6% in non-converted LA cases (Sadaf et al., 2025). This reiterates the need to assess the risk of patients who may need conversion through conversion in the early and accurate pre-operative phase. A scheduled OA can help such patients to lower the morbidity after surgery.

3.4 Postoperative Pain and Postoperative Recovery

The level of post-operative pain was also reduced on a constant basis in LA patients. Research found considerably lower pain scores in the first 24 hours after surgery in LA than in OA patients (Ali Khan, 2024). Less pain, simplified analgesic needs, fewer side effects of opioids, and prompt mobilisation. According to research, the normal functioning of the LA patients went back to average three days faster than OA patients, which may be regarded as evidence of a good functional recovery of the patients.

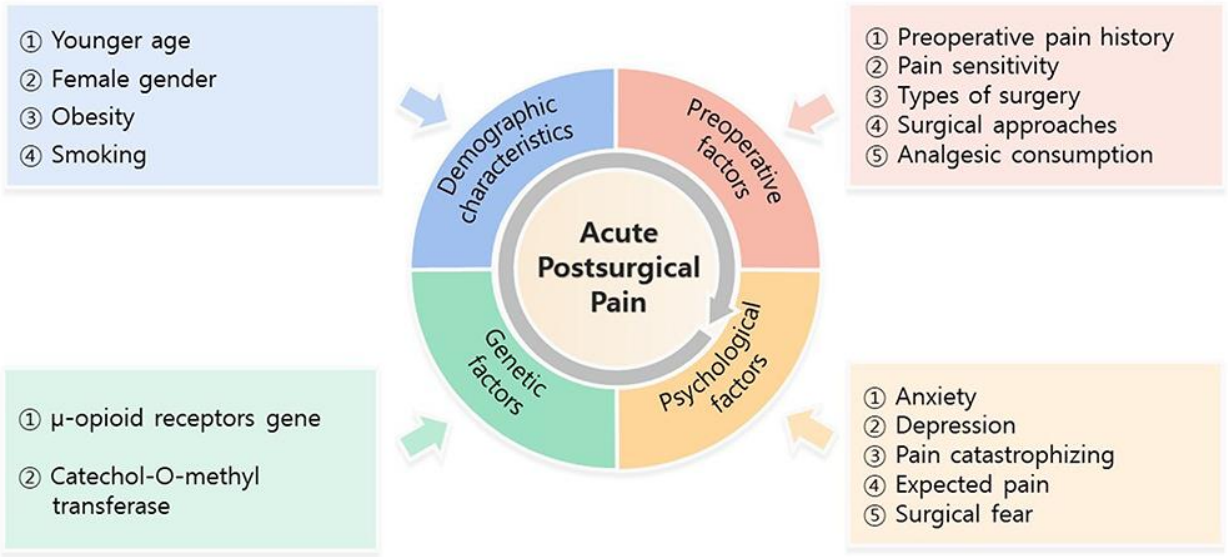

Figure 2: Risk factors for acute postsurgical pain (Liu et al., 2024).

In addition to decreasing the level of pain, LA patients also had a reduced number of wound-related complications and improved cosmetic outcome, which also leads to general patient satisfaction. The less invasive method also enables the promptness of returning to work, which has socio-economic effects, especially in LMICs, where prolific loss of income as a result of a prolonged period of unemployment can be highly damaging financially (Yousaf et al., 2024).

3.5 Modification into Open Appendectomy and Complications

LA to OA conversion is still an issue of clinical interest, and the rate of conversion is intrinsically dependent on factors like body mass index (BMI), the severity of inflammation in the appendix, late onset, and the experience of the surgeons. According to the Study, the case of a 19.8 per cent conversion rate was reported in complex cases of appendicitis (Sadaf et al., 2025). The patterns

of converted cases were connected to an increase in the duration of operation, SSI, as well as hospitalisation.

The conversion also intensifies the use of the resources, since such patients may demand more and more antibiotics, monitoring, and even intensive care. Conversion predictors are important to understand in order to maximise patient outcomes. Perforation, abscesses, severe adhesions, and intraoperative bleeding are significant predictors. Prestal surgical planning and the risk stratification can be affected with the help of pre-operative imaging that comprises ultrasound or CT scan (Khan et al., 2024).
Other non-SSI complications like intra-abdominal abscess, ileus, and postoperative bleeding were also usually not significantly different between LA and OA, although several studies indicated that there was a tendency that overall complications were reduced in LA. Nonetheless, OA can still be adopted as the initial method of reducing intraoperative difficulties and morbidity in the postoperative stage in high-risk patients with complicated disease.

DISCUSSION

4.1 Interpretation of Findings

This meta-analysis demonstrates that laparoscopic appendectomy has some significant benefits compared with an open appendectomy. LA has less extended hospitalisation, decreased pain after surgery, speedier recovery of normal functions, and decreased rates of SSI. This drawback is counterbalanced by better results and might be reduced with the surgeon's experience, though the operative time tends to be longer.

The results are related to an even bigger tendency in modern surgical practice to use minimally invasive techniques. LA represents a beneficial intervention in terms of both practical patient and system outcomes, in both high- and low-resource environments. Both clinical and economic outcomes include reduced hospital stay, fewer infections, and faster recovery, but it is especially important in LMICs, where the availability of hospital beds and the workforce needs to be a key factor.

4.2 Clinical Implications

Clinically, LA is preferred in case of noninfectious appendicitis without complications in the setting of adequate expertise and resources for surgical measures. LA advantages are not just limited to the short-term postoperative facilities, as they have long-term effects on recovery, patient satisfaction, and consumption of healthcare resources. The lower level of SSI decreases the use of antibiotics and complications associated with them, not only enhancing patient safety but also lowering the occurrence of such complications.

Nevertheless, the selection of the patient is of utmost importance. OA or planned conversion can be used in high-risk patients, especially those with complicated appendicitis, delayed presentation, or high comorbidity, to reduce adverse outcomes. Imaging before surgery, risk scoring systems, and surgical judgment play an important role in influencing this decision-making process.

4.3 Limitations

There are a number of confinements of the study involved. There is a study heterogeneity because of differences in surgical procedures, surgeon experience, type of patients, and the healthcare facilities, which restricts the external validity of the results. Most of the studies did not have blinding and standardised reporting of postoperative pain and recovery measures. Also, the number of high-quality randomised controlled trials that have been published since 2020-25 is limited, which limits the strength of evidence of some of the outcomes.

4.4 Future Research Recommendations

Future studies need to be aimed at large-scale, multicentre randomised controlled trial studies that are standardised in terms of outcome reporting. The cost-humility studies of LA and OA would be of particular relevance to LMICs' health policy and surgical planning. Moreover, writing and testing predictive tools and assessment tools to determine the likelihood of conversion of LA to OA will be beneficial in the selection of patients and in mitigating unfavourable outcomes. There are also functional recovery, quality of life, and complications rate studies requiring the inclusion of long-term follow-up.

CONCLUSION

In conclusion, this meta-analysis shows that laparoscopic appendectomy (LA) has serious clinical advantages compared to open appendectomy (OA) in the treatment of acute appendicitis. In the literature written between 2020 and 2025, LA was uniformly associated with less postoperative pain, decreased hospitalisation, earlier recovery of normal activity, and fewer cases of surgical site infection (SSI). These benefits represent the minimum invasiveness of LA and the increase in visualisation and precision of surgery that LA provides. Even though operative time in the case of LA takes more, it was shown that this drawback decreases as the surgical experience increases, which is why having training and developing skills is essential.

The possibility of LA to OA, especially in complex appendicitis, is an extremely important factor that may be linked with intensified morbidity, extended hospitalisation, and the development of subsequent infection. Close preoperative evaluation, such as imaging and risk stratification, is thus necessary to maximise patient outcomes and minimise complications.

The literature, in general, has indicated that the preferential application of LA can be used in areas where time and specialised skills allow. Planned OA would be safer with high-risk or complex cases. The upcoming areas of study should be focused on large-scale randomised trials, cost-effectiveness studies, and prediction instruments of conversion, particularly in low- and middle-income nations. These efforts will improve surgical decision-making and guarantee safety, effectiveness, and fair care of appendicitis on a global scale.

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