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Outcomes of appendicitis in children: open vs laparoscopic approach

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ABSTRACT

Background: Acute appendicitis is a common surgical emergency in children. While open appendectomy has been traditionally practiced in Pakistan, laparoscopic appendectomy is increasingly being adopted due to its minimally invasive nature.

Objective: To compare the postoperative outcomes of open versus laparoscopic appendectomy in pediatric patients with acute appendicitis.

Methodology: This comparative cross-sectional study was conducted at the Surgical Unit DHQ Teaching Hospital Mardan KPK from March 2024 to March 2025. including 168 children aged 5–15 years diagnosed with acute appendicitis. Patients were divided into two groups: Group A (open appendectomy) and Group B (laparoscopic appendectomy). Demographic data, operative findings, postoperative complications, length of hospital stay, and time to functional recovery were **recorded**. Results: Out of the 168 patients, 94 (56.0%) underwent open appendectomy and 74 (44.0%) underwent laparoscopic appendectomy. The laparoscopic group had a longer mean operative time ($p < 0.001$) but experienced significantly lower postoperative pain, fewer wound infections, shorter hospital stay, and earlier return to normal activities (all $p < 0.001$). Intra-abdominal abscess formation was slightly higher in the laparoscopic group, though not statistically significant ($p > 0.05$). No mortality was observed in either group.

Conclusion: Laparoscopic appendectomy demonstrated superior postoperative recovery outcomes compared with open appendectomy in children, despite longer operative duration. Its wider adoption in pediatric surgical practice in Pakistan may improve patient-centered outcomes, provided adequate resources and surgical expertise are available.

Keywords: *acute appendicitis, pediatric surgery, open appendectomy, laparoscopic appendectomy, postoperative outcomes*

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1. INTRODUCTION

In pediatric surgery, the choice of operative technique is not merely a matter of tradition or preference but directly shapes the child's postoperative experience, recovery trajectory, and long-term quality of life [1]. While adults often tolerate postoperative pain and scarring with relative ease, children are uniquely vulnerable to behavioral and psychological consequences of surgery, repeated hospital visits, and visible scars, all of which must be factored into the evaluation of

surgical outcomes [2]. Laparoscopy, therefore, has been increasingly advocated as a child-friendly intervention in many

high-resource centers; however, its universal application remains limited in low- and middle-income countries, where open procedures still dominate routine practice due to logistic and economic constraints [3]. Another dimension shaping the open versus laparoscopic debate is the stage of appendicitis at presentation. Pediatric patients often experience diagnostic delays because younger children cannot articulate their symptoms clearly, and classical signs are frequently absent or nonspecific [4]. This leads to a higher risk of perforation, peritonitis, or abscess formation at the time of presentation compared to adults. In such complicated appendicitis cases, surgeons are divided; some argue that laparoscopy provides superior visualization and precise peritoneal lavage, while others consider open appendectomy more controlled and accessible in resource-challenged and contamination-heavy environments. The heterogeneity of disease severity thus directly impacts the comparative outcomes reported in the literature [5].

Postoperative infection rates, particularly wound infection and intra-abdominal abscess, are central endpoints in most comparative studies. Evidence is mixed: while wound infection tends to be lower with laparoscopic appendectomy due to minimal incision size, some reports indicate a slightly higher incidence of postoperative intra-abdominal abscess, especially in perforated appendicitis managed laparoscopically [6]. Explanations range from the technical complexity of irrigation through a scope to the aerosolization of infected fluid during trocar insufflation. Whether these complications reflect technical factors, hygiene protocols, or selection bias is still debated [7].

Length of hospital stay, time to resume diet, and return to school or daily activities are also meaningful outcomes in children whose development, schooling, and social stability can be disrupted by prolonged illness [8]. Laparoscopic surgery consistently demonstrates faster functional recovery in multiple cohorts, reducing school absence and caregiver burden. Cost considerations, however, raise legitimate concerns. While laparoscopy may reduce indirect costs through faster rehabilitation, the upfront cost of instruments, equipment maintenance, and skilled personnel may outweigh benefits in public hospitals with constrained budgets [9]. From a systems perspective, surgeon expertise and institutional infrastructure are pivotal. Laparoscopic appendectomy, despite being a standardized procedure, undergoes a learning curve that influences early complication rates [10]. Outcomes in teaching hospitals, therefore, may differ significantly from mature high-volume centers. Similarly, in emergency night time surgeries handled by trainees, the safety of minimally invasive procedures may vary depending on supervision and facility readiness [11].

2. OBJECTIVE

To compare the postoperative outcomes of open versus laparoscopic appendectomy in pediatric patients with acute appendicitis.

3. METHODOLOGY

This comparative cross-sectional study was conducted at the Surgical Unit DHQ Teaching Hospital Mardan KPK from March 2024 to March 2025. A total of 168 children aged between 5 and 15 years who presented with clinical suspicion of acute appendicitis were enrolled through non-probability consecutive sampling. Diagnosis was supported by laboratory workup and ultrasound findings. After meeting eligibility criteria and obtaining informed written consent from parents/guardians, patients were assigned to one of two groups based on the operative approach performed: Group A underwent open appendectomy, while Group B underwent laparoscopic appendectomy.

Inclusion Criteria

Age 5–15 years

Diagnosis of acute appendicitis (clinical + ultrasound)

Undergoing open or laparoscopic appendectomy

Written informed consent from parents/guardians

Exclusion Criteria

Previous abdominal surgery

Generalized peritonitis requiring alternate surgical procedure

Immunocompromised patients

Refusal/withdrawal of consent

Data Collection Procedure

After approval from the Institutional Ethics Committee, eligible patients were enrolled. A structured proforma was used to record demographics, clinical findings, operative details, and postoperative outcomes. All surgeries were performed under general anesthesia following standard hospital protocols. Patients were followed for 30 days postoperatively to document

complications and recovery parameters. The variables studied included baseline demographic characteristics, type of appendicitis (simple or complicated), operative time, intraoperative findings, pain scores, wound infection, intra-abdominal abscess formation, length of hospital stay, time to resume oral intake, and time to return to normal daily activities.

4. DATA ANALYSIS

Data were entered and analyzed using SPSS version 26. Continuous variables such as age, operative time, and hospital stay were expressed as mean ± standard deviation and compared using an independent t-test. Categorical variables such as gender, type of appendicitis, and postoperative complications were presented as frequency and percentage, and analyzed using chi-square or Fisher's exact test as appropriate. A p-value ≤ 0.05 was considered statistically significant.

5. RESULTS

A total of 168 children diagnosed with acute appendicitis were included in the study. Among 168 children, 94 (56%) underwent open appendectomy and 74 (44%) laparoscopic. The mean age was 10.8 ± 2.9 years, similar between groups (11.0 ± 3.0 in open vs. 10.6 ± 2.7 in laparoscopic). Males constituted 61.3% overall (59 in open, 44 in laparoscopic). Simple appendicitis was present in 112 (66.7%) cases, while 56 (33.3%) had complicated disease, with no notable difference in distribution between groups.

Table 1. Baseline Demographic and Clinical Characteristics (N = 168)

Variable	Total (N=168)	Open (n=94)	Laparoscopic (n=74)
Age (years), mean ± SD	10.8 ± 2.9	11.0 ± 3.0	10.6 ± 2.7
Gender — Male	103 (61.3%)	59 (62.8%)	44 (59.5%)
Gender — Female	65 (38.7%)	35 (37.2%)	30 (40.5%)
Type of appendicitis — Simple	112 (66.7%)	60 (63.8%)	52 (70.3%)
Type of appendicitis — Complicated	56 (33.3%)	34 (36.2%)	22 (29.7%)

Mean operative time was significantly longer in the laparoscopic group (68.4 ± 12.6 min) than the open group (54.9 ± 10.8 min). Pain scores at 24 hours were lower after laparoscopy (3.1 ± 0.9 vs. 5.2 ± 1.1; p<0.001). Surgical site infections were more frequent in open cases (13.8% vs. 5.4%). Intra-abdominal abscess occurred in 7.0% of laparoscopic cases vs. 3.2% in open cases. Hospital stay was shorter after laparoscopy (2.4 ± 0.9 vs. 4.1 ± 1.4 days), and patients regained normal activity faster (6.2 ± 2.1 vs. 10.8 ± 3.3 days). No mortality occurred.

Table 2. Intraoperative and Postoperative Outcomes

Outcome	Open (n=94)	Laparoscopic (n=74)	p-value
Operative time (min), mean ± SD	54.9 ± 10.8	68.4 ± 12.6	<0.001
Pain score at 24h (VAS), mean ± SD	5.2 ± 1.1	3.1 ± 0.9	<0.001
Surgical site infection	13 (13.8%)	4 (5.4%)	0.049
Intra-abdominal abscess	3 (3.2%)	5 (7.0%)	0.27
Length of hospital stay (days), mean ± SD	4.1 ± 1.4	2.4 ± 0.9	<0.001
Return to normal activity (days), mean ± SD	10.8 ± 3.3	6.2 ± 2.1	<0.001
30-day mortality	0	0	—

Complicated appendicitis was associated with higher rates of adverse outcomes: surgical site infection occurred in 19.6% of complicated cases vs. 5.4% in simple cases (p=0.006), and intra-abdominal abscess in 12.5% vs. 0.9% respectively (p<0.001). Re-intervention (5.4% vs. 0.9%) and readmission within 30 days (8.9% vs. 1.8%) were also more frequent in complicated appendicitis.

Table 3. Complications Stratified by Type of Appendicitis (N = 168)

Complication	Simple Appendicitis (n=112)	Complicated Appendicitis (n=56)	p-value
Surgical site infection	6 (5.4%)	11 (19.6%)	0.006
Intra-abdominal abscess	1 (0.9%)	7 (12.5%)	<0.001
Re-intervention required	1 (0.9%)	3 (5.4%)	0.08
Readmission within 30 days	2 (1.8%)	5 (8.9%)	0.03

Laparoscopic patients required fewer days of IV antibiotics (2.5 ± 1.1 vs. 3.8 ± 1.3) and tolerated oral intake earlier (14.2 ± 5.1 vs. 29.6 ± 8.4 hours) compared with open surgery. Hospital stay was significantly shorter after laparoscopy (2.4 ± 0.9 vs. 4.1 ± 1.4 days), and return to school was earlier (7.0 ± 2.5 vs. 12.3 ± 4.1 days), indicating markedly faster recovery.

Table 4. Resource Utilization and Recovery Metrics Between Groups

Parameter	Open (n=94)	Laparoscopic (n=74)	p-value
IV antibiotics duration (days), mean ± SD	3.8 ± 1.3	2.5 ± 1.1	<0.001
Time to oral intake (hours), mean ± SD	29.6 ± 8.4	14.2 ± 5.1	<0.001
Length of hospital stay (days), mean ± SD	4.1 ± 1.4	2.4 ± 0.9	<0.001
Return to school (days), mean ± SD	12.3 ± 4.1	7.0 ± 2.5	<0.001

6. DISCUSSION

This comparative study evaluated clinical outcomes of open versus laparoscopic appendectomy in children with acute appendicitis in a local tertiary care setting. The findings of this study demonstrated that although laparoscopic appendectomy required a longer operative time, it provided superior postoperative outcomes compared with the open technique in terms of pain control, wound infection, hospital stay, and return to normal activity. The longer operative duration noted in the laparoscopic group is consistent with previously published regional data, which attributes this observation to the learning curve and technical expertise required for minimally invasive procedures in low- and middle-income countries. However, despite this, the advantages seen in postoperative recovery parameters justify the extended operative time. Similar patterns have been reported in multicenter Pakistani studies where laparoscopy, once mastered, yielded more rapid postoperative rehabilitation [12].

Postoperative surgical site infection was markedly higher in the open group, most likely due to larger incisions and increased exposure of tissues, whereas laparoscopic surgery with smaller ports minimized infection exposure risk. These findings align with international as well as Pakistani literature reporting consistently lower surgical site infection rates following minimally invasive pediatric surgeries [13]. Interestingly, intra-abdominal abscess was slightly more common in the laparoscopic group, especially in complicated appendicitis. This trend has been widely debated in existing literature, with some attributing it to the technical limitation of peritoneal lavage through trocars and potential aerosolization of infected fluid during pneumoperitoneum. Nonetheless, the difference in our study was not statistically significant and was confined mainly to perforated cases [14]. Hospital stay and time to return to school were significantly shorter in the laparoscopic group, reflecting early mobilization and less postoperative discomfort. These findings are particularly relevant in the pediatric population where prolonged hospitalization impacts psychosocial well-being, parental finances, and school attendance [15-17]. Such outcome benefits emphasize the need for broader adoption of laparoscopy in the pediatric setting in Pakistan, provided trained personnel and equipment are available. From a contextual standpoint, despite the clinical superiority observed in several outcomes with laparoscopy, open appendectomy remains more frequently performed in many Pakistani hospitals due to cost constraints, limited equipment availability, and surgeon preference shaped by years

of training in conventional methods [18-20]. Therefore, the choice of surgical method in Pakistan is still significantly influenced by system-level factors rather than solely by patient outcomes. Overall, the results of this study reinforce existing evidence that laparoscopic appendectomy is a safe and effective alternative to the open technique in children, offering faster recovery and lower wound morbidity. However, its benefits can only be fully realized if infrastructure, equipment, and surgeon training are strengthened across pediatric surgical centers in Pakistan.

7. CONCLUSION

It is concluded that laparoscopic appendectomy offers favorable postoperative outcomes in pediatric patients when compared with the conventional open approach. Although the laparoscopic technique was associated with a relatively longer operative time, it resulted in significantly lower postoperative pain, fewer wound infections, shorter hospital stay, and earlier return to normal activities. These advantages are particularly valuable in the pediatric population where recovery time, cosmetic results, and reduced hospitalization have broader social and psychological implications. Despite these benefits, open appendectomy continues to be practiced more commonly in Pakistan due to resource limitations and variability in surgeon expertise. Expanding access to minimally invasive surgical training and equipment may further enhance the quality of pediatric surgical care and support a gradual shift toward laparoscopic appendectomy as the preferred approach in suitable cases.

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