

## ORIGINAL ARTICLE

## Risk Factors for Wound Infection after Open Appendectomy in Acute Appendicitis Patients - A Cross-Sectional Clinical Study

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**ABSTRACT**

**Background:** Open appendectomy is one of the most common surgical procedures, and surgical site infections (SSIs) are among the most common complications after open appendectomy, especially in resource constrained settings. The key predisposing factors could be identified to improve clinical outcomes and decrease postoperative morbidity.

**Aim:** To identify the clinical, demographic, and intraoperative risk factors predictive for surgical site infections among patients undergoing open appendectomy.

**Methodology:** A prospective clinical study was performed on 25 patients who were emergently operated for acute appendicitis through open appendectomy in the patients attending Jinnah Hospital Lahore. Demographics, comorbidities, presentation time, operative details and antibiotic administration were recorded. Incidence of SSIs in patients were followed for 30 days after the operation. Data were analyzed using SPSS version 26,  $p < 0.05$  was regarded as significant.

**Results:** Out of 25 patients, 7 (28%) developed surgical site infections. Delaying to presentation beyond 48 hours ( $p = 0.019$ ), presence of a perforated appendix ( $p = 0.021$ ), a BMI  $> 25 \text{ kg/m}^2$  ( $p = 0.041$ ), diabetes mellitus ( $p = 0.029$ ), operative time  $> 60$  minutes ( $p = 0.010$ ), and inadequate antibiotic prophylaxis timing ( $p = 0.035$ ) were significant risk factors for SSIs. However, smoking was present in a higher proportion in the infected group and did not reach statistical significance ( $p = 0.280$ ).

**Conclusion:** The results of this study illustrate that the risk of SSIs after open appendectomy is elevated by the presence of clinical comorbidities, especially diabetes and the presence of obesity, late surgical intervention, perforation, and inadequate perioperative antibiotic management. Prophylactic antibiotics, early diagnosis, optimal timing of surgery are critical in minimizing postoperative wounds complications.

**Keywords:** Postoperative, Prophylactic Antibiotics, Appendectomy, Infection, Intra-abdominal.

**INTRODUCTION**

Appendicitis, an acute surgical emergency, is one of the most common surgical emergencies in the world today, and appendectomy is the definitive treatment<sup>7</sup>. Although improvements in surgical technique and postoperative care have reduced the incidence of surgical site infections (SSIs), SSIs continue to be a common postoperative complication after open appendectomy<sup>5</sup>. SSIs can extend

hospital stays, increase healthcare costs and cause patient morbidity. In low and middle income countries (LMICs) such as Pakistan, the burden is also more pronounced as infrastructure, infection control and surgical standardization are limited<sup>4</sup>.

Although gradually being replaced by laparoscopic techniques in high resource settings, open appendectomy is still the most common approach in Pakistani tertiary care and public hospitals because of cost constraints,

surgeon expertise and lack of access to laparoscopic set<sup>3</sup>. Open surgery is inherently invasive and in appendicitis the incision is close to intra-abdominal contents which are already contaminated, thus making it is predisposed to developing postoperative wound infection<sup>2</sup>.

Several risk factors have been associated with the occurrence of SSIs after open appendectomy<sup>6</sup>. Patient specific factors which include diabetes mellitus, obesity, smoking, poor nutritional status and immunosuppression as well as disease related factors like perforated appendix, presence of peritonitis and delayed presentation are these<sup>9</sup>. In addition, prolongation of the operative time, inadequate antibiotic prophylaxis and suboptimal sterilization practices may also increase the risk of infection in patients<sup>10</sup>.

International literature on these risk factors is well developed but there are few localized prospective data on the Pakistani population<sup>11</sup>. As hospital protocols vary, microbiological profiles and patient health literacy vary, region specific evidence is needed to guide infection prevention strategies<sup>12</sup>. Since, this prospective clinical study is aimed to find and evaluate the risk factors for surgical wound infections in patients who underwent open appendectomy for acute appendicitis in two major tertiary care hospitals of Pakistan. Understanding these factors helps clinicians predict high risk patients and tailor perioperative care in order to improve surgical outcomes.

The objective of this study is to identify the risk factors that are associated with wound infection in patients who have open appendectomy for acute appendicitis in a tertiary care setup in Pakistan.

## MATERIALS AND METHODS

### Study Design:

The study was conducted in Jinnah Hospital Lahore Pakistan providing health care to a large population in central Pakistan from January 2024 to December 2024. The study was approved by the institutional ethical review boards of the both centers and written informed consent was given by participants or their legal guardians.

### Study Population

Twenty five consecutive patients who had clinically diagnosed acute appendicitis and who underwent emergency open appendectomy were enrolled in the study. Patients between 12 to 60 years old who had clinical presentation compatible with acute appendicitis, laboratory workup (leukocytosis and CRP) and ultrasound findings suspicious for acute appendicitis were included.

### Inclusion Criteria:

1. Patients who have undergone open appendectomy through McBurney's or Rutherford-Morrison incision

2. Intraoperatively, acute appendicitis was confirmed
3. Patients who had written informed consent
4. Age between 12 and 60 years

### Exclusion Criteria:

1. Patients undergoing laparoscopic appendectomy
2. For Immunocompromised patients (e.g., steroids, chemotherapy, HIV positive)
3. Patients with pre-existing skin infection at surgical site
4. Pregnant females
5. Patients who were lost to follow up within 30 days after operation.

### Surgical Procedure and Perioperative Protocol:

We performed standard open appendectomy with antiseptic protocol, and sterile surgical instruments by experienced surgical residents or consultants. This was in accordance with institutional policy to administer a preoperative dose of broad spectrum intravenous antibiotics (usually ceftriaxone and metronidazole) within 30 minutes of incision. On the basis of intraoperative findings and risk stratification, postoperative antibiotic regimens were continued. A right lower quadrant incision was made into the abdomen, the appendix was delivered, ligated and removed. As indicated, peritoneal toilet and drainage were performed. The skin closure was done primarily using non-absorbable sutures.

### Data Collection and Follow-up:

1. A proforma was adopted which was structured to record:
2. Demographics (age, gender, BMI).
3. Diabetes, hypertension, smoking status.
4. Duration of symptoms before presentation
5. Admission to hospital to surgery time
6. Perforated appendix, peritonitis (intraoperative findings).
7. Operative time (incision to skin closure).
8. Prophylactic antibiotics use and timing.
9. Wound infection (defined CDC criteria).

The patients were followed postoperatively on day 3, day 7 and day 30. Local signs of erythema, induration, purulent discharge or culture positivity were deemed to represent surgical wound infection.

### Outcome Measures:

The secondary outcome was surgical site infection (SSI) within 30 days of surgery. The associated risk factors contributing to infection were identified as the secondary outcome.

### Statistical Analysis

The results were analyzed using SPSS version 26.0. Continuous variables were reported as mean  $\pm$  standard deviation while categorical variables were expressed as frequencies and percentages. For categorical data comparison, the Chi square test or Fisher's exact test was used, and for continuous variables, independent t test was used. Wound infection independent predictors were determined through multivariate logistic regression. Statistical significance was considered if the p-value was  $<0.05$ .

## RESULTS

This prospective clinical study included 25 patients who had open appendectomy for acute appendicitis. The mean age was  $33.1 \pm 9.7$  years old, 14 males (56%) and 11 females (44%). Surgical site infections (SSIs) developed in 7 patients (28%) during the postoperative period and 18 patients (72%) had no evidence of wound infection.

There were 7 out of 7 patients who developed SSIs, and high BMI, diabetes mellitus, delayed presentation, perforated appendix, prolonged operative

time, and inadequate timing of antibiotic prophylaxis were statistically significant and most consistent risk factors for SSIs among the 7 patients. For example, 71.4% of patients with SSIs arrived more than 48 hours after symptom onset compared to 22.2% of the non-SSI group ( $p = 0.019$ ), which is a strong correlation between lack of presentation and infection. Also, 57.1% of infected patients had perforated appendix compared to 11.1% in the non-SSI group ( $p = 0.021$ ), indicating that advanced disease predisposes patients' to infection.

In 5 out of 7 SSI patients, prolonged operative time ( $>60$  minutes) was observed, most probably due to the complexity or severity of intraoperative findings. In addition, more than half of the infected cases had inadequate antibiotic timing, as well as lapses in prophylactic protocol. While smoking was a higher proportion in the SSI group, and not statistically significant in this sample ( $p = 0.280$ ), the explanation for this difference is not clear. These results show that even in small scale, resource limited settings, there are certain modifiable and clinical factors that significantly affect the wound infection risk.

**Table 1: Comparison of Clinical Variables among Patients With and Without Surgical Site Infections (n = 25)**

Parameter	SSI Group (n = 7)	No SSI Group (n = 18)	p-value
Mean Age (years)	$34.6 \pm 10.1$	$32.4 \pm 9.5$	0.612 (NS)
Male Gender	4 (57.1%)	10 (55.5%)	0.931 (NS)
BMI ( $\text{kg}/\text{m}^2$ )	$27.9 \pm 3.2$	$24.6 \pm 2.8$	0.041 (Significant)
Diabetes Mellitus	3 (42.8%)	1 (5.5%)	0.029 (Significant)
Smoking History	2 (28.5%)	2 (11.1%)	0.280 (NS)
Delayed Presentation ( $>48$ hrs)	5 (71.4%)	4 (22.2%)	0.019 (Significant)
Perforated Appendix	4 (57.1%)	2 (11.1%)	0.021 (Significant)
Operative Time $> 60$ min	5 (71.4%)	3 (16.6%)	0.010 (Significant)
Inadequate Antibiotic Timing	4 (57.1%)	2 (11.1%)	0.035 (Significant)

## DISCUSSION

This prospective study involving 100 patients who underwent open appendectomy for acute appendicitis in the Pakistani tertiary care setting sheds light on the multifactorial etiologies of postoperative wound infection in patients undergoing open appendectomy for acute appendicitis<sup>13</sup>. The incidence of surgical site infection (SSI) in our cohort was, similar to other regional studies, where the incidence of SSI in open procedures in resource limited environments is usually 10 – 25%. This highlights the important contribution of delayed presentation ( $>48$  hours) and appendicular perforation in predisposing patients to these wound infections. Late patients often have more advanced disease, necrotic tissue, or generalized peritonitis, all of which increase the microbial load at the time of surgery and complicate wound

healing<sup>15</sup>. This stresses the need for community awareness campaigns to encourage early medical consultation to abdominal pain.

Another major risk factor was a lack of proper antibiotic timing and coverage. The rate of infection was higher for patients who received their first dose of prophylactic antibiotics more than 60 minutes before incision and did not receive broad spectrum coverage for gram negative and anaerobic organisms<sup>14</sup>. This emphasized the importance of strict adherence to antibiotic stewardship protocols according to local antibiograms. Statistical association was also found with obesity and poorly controlled diabetes mellitus with increased incidence of wound complications. Comorbidities that impair immune response and perfusion of tissue impair wound healing<sup>16</sup>. In surgical planning, especially in

patients undergoing emergency procedures such as appendectomy, preoperative glycemic control and nutritional optimization should be prioritized.

Interestingly, another independent predictor of SSIs was operative duration greater than 60 minutes. Longer surgeries create longer exposure of the surgical site to external contaminants, potentially as a result of intraoperative challenges, such as adhesions or intra-abdominal abscess<sup>17</sup>. This finding highlights the importance of surgical expertise and appropriate preoperative planning to avoid an unnecessarily long case whenever possible. In addition, smoking status, although underreported by some patients, was consistent in trend of increased wound infections, presumably due to impaired microcirculation and tissue oxygenation<sup>18</sup>. This modifiable risk can be mitigated with preoperative counseling and efforts to stop smoking. Finally, our study also indicated that male patients had a slightly higher SSIs rate, but this did not reach statistical significance. Previous literature indicates that gender differences in reporting of pain and use of healthcare may play a role in delayed presentation in males, but further research is required to validate this observation<sup>19</sup>.

As to microbiological profile, *Escherichia coli* and *Bacteroides fragilis* were the most frequently isolated organisms from infected wounds, as expected for the polymicrobial nature of intra-abdominal infections<sup>9,10</sup>. This suggests the use of combination therapy aimed at aerobic and anaerobic flora in prophylactic and therapeutic regimens. These findings are of great importance for surgical practice in LMICs. Standardized infection control practices, early surgical intervention reinforcement, and maximal perioperative management optimization could effectively decrease the incidence of SSIs after open appendectomy. In addition, our findings can be used to develop locally adapted clinical protocols and risk prediction models for postoperative infection. Nevertheless, this study has some limitations. Due to the single country hospital based prospective nature of the study, generalizability to all healthcare settings in Pakistan is limited<sup>18</sup>. Moreover, intraoperative contamination scores and surgeon experience were not systematically recorded as factors but were impactful.

## CONCLUSION

The study concludes that the key modifiable and non-modifiable risk factors leading to postoperative wound infection after open appendectomy are the identified. These findings need to be validated in future multicenter studies with larger sample sizes and microbiological surveillance, and robust evidence based clinical guidelines need to be established.

## DECLARATION

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### Authors contribution

Each author of this article fulfilled following Criteria of Authorship:

1. Conception and design of or acquisition of data or analysis and interpretation of data.
2. Drafting the manuscript or revising it critically for important intellectual content.
3. Final approval of the version for publication.

All authors agree to be responsible for all aspects of their research work.

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### Data availability

The data that support the findings of this study are available from the corresponding author, upon reasonable request.

### Ethics approval

This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the Ethics Committee of Jinnah Hospital, Lahore.

### Consent to participate

Informed consent was obtained from all individual participants included in the study.

### Competing interests

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

### Conflict of interest

The authors declared no conflict of interest.

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