e-ISSN: 0976-822X, p-ISSN:2961-6042

Available online on http://www.ijcpr.com/

International Journal of Current Pharmaceutical Review and Research 2026; 18(5); 1749-1754

Original Research Article

Study the Incidence of Surgical Site Infections in Primary Closure versus Delayed Primary Closure in Contaminated Abdominal Surgeries: A Comparative Study

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Received: 01-02-2026 /Revised: 15-03-2026 / Accepted: 21-04-2026

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Conflict of interest: Nil

Abstract

Introduction: Surgical site infections (SSIs) are a major complication in contaminated abdominal surgeries, leading to increased morbidity and healthcare costs. This study compares the outcomes of primary closure (PC) and delayed primary closure (DPC) in such surgeries, focusing on SSI rates and postoperative recovery.

Materials: and Methods: This prospective study included 120 patients undergoing contaminated abdominal surgeries, randomized into PC and DPC groups. Data on demographics, symptom duration, disease severity, and postoperative outcomes were collected. SSI incidence and hospital stay duration were monitored.

Results: The DPC group had significantly lower rates of purulent discharge (16.7% vs. 35.0%, p = 0.037) and shorter hospital stays (10.8 ± 2.2 days vs. 12.9 ± 2.6 days, p = 0.010). While the SSI incidence was higher in the PC group (36.7% vs. 21.7%), the difference was not statistically significant (p = 0.1081).

Conclusion: DPC resulted in fewer SSIs, delayed infection onset, and shorter hospital stays compared to PC, supporting its use as a superior approach in contaminated abdominal surgeries.

Keywords: Surgical site infection, primary closure, delayed primary closure, abdominal surgery, and postoperative recovery.

DOI: 10.25258/ijcpr.18.5.279

Introduction

Surgical site infection (SSI) is a prevalent postoperative complication that significantly impacts patient outcomes and healthcare systems globally, despite advancements in aseptic techniques and antimicrobial prophylaxis. [1] SSIs are classified into superficial, deep, and organ/space infections, with deeper infections associated with higher morbidity, longer hospital stays, and increased costs. [2-4] The CDC emphasizes that SSIs are preventable with standardized preventive measures, highlighting the importance of targeted strategies. [1] SSIs are more common in low- and middle-income countries (LMICs), where limited resources and high surgical loads increase infection risks, with approximately 11% of surgeries resulting in SSIs in these regions. [5] SSIs also contribute to antimicrobial resistance, exacerbating public health challenges. [6]Abdominal surgeries, especially those performed in contaminated fields such as perforated appendicitis or bowel injuries, have a higher risk of SSI due to bacterial load and contamination. [7-8] SSI rates increase progressively from clean (1–5%) to contaminated wounds (10–17%) and dirty wounds (over 27%). [7-9] SSI pathogenesis involves microbial contamination, host susceptibility, and perioperative factors, with common pathogens including Staphylococcus aureus and gut organisms. [10] Patient-related factors like diabetes and obesity, along with procedure-related factors such as prolonged surgery and inadequate antibiotic timing, increase the risk of infection. [5]The method of skin closure plays a critical role in preventing SSIs. [11] Primary closure offers benefits like faster healing and reduced wound care, but in contaminated wounds, it may trap bacteria, increasing infection risk. [11] Delayed primary closure (DPC), where the skin is left open for a few days to allow drainage and bacterial reduction, may reduce infection risk but requires more intensive care and prolonged hospitalization. [11-12] The decision between primary closure and DPC depends on factors like contamination level, antibiotic protocols, and patient characteristics. This study aims to compare SSI incidence between primary closure and DPC in contaminated abdominal surgeries, providing insights into optimal wound closure strategies.

Materials and Methodology

A prospective interventional study was conducted at the Department of Surgery, Sri Guru Ram Das Institute of Medical Sciences and Research, Vallah, Sri Amritsar. Adults aged >18 years admitted with symptoms of acute gastrointestinal illness requiring surgical evaluation. Informed consent was obtained from the legally authorized representative and assent where applicable.

Eligibility Criteria:

- **Inclusion:** Adults requiring exploratory laparotomy for acute abdomen.
- **Exclusion:** Patients aged <18 years, conservatively managed, or those undergoing laparotomy for traumatic abdominal injury.

Sample Size: The sample size was calculated to compare SSI incidence between two groups: Primary Closure (PC) and Delayed Primary Closure (DPC), with 60 patients in each group, totaling 120 patients.

Methodology: Patients underwent clinical examination, radiological investigations (X-ray abdomen, USG), and baseline laboratory tests. Data were collected on patient demographics, clinical presentation, operative details, and postoperative outcomes, including stoma formation, bowel sounds, wound infection, and discharge.

Surgical Management: Major causes of acute abdomen included intestinal perforation, intussusception, Meckel's diverticulum, abdominal tuberculosis, ascariasis, and appendicitis, with treatment options based on intraoperative findings.

Outcome Assessment: Postoperative outcomes were assessed based on indicators like wound infection, stoma formation, and discharge.

Statistical Analysis: Descriptive and inferential statistical methods were applied. Continuous variables were expressed as mean ± SD or median (IQR), while categorical variables were presented as frequency and percentage.

Results

The age distribution between the primary closure and delayed primary closure groups was similar. The majority of patients in both groups were in the 41–50 years age range, with 31.66% in the primary closure group and 28.33% in the delayed primary closure group. The mean age was 46.47 ± 19.09 years in the primary closure group and 50.17 ± 19.63 years in the delayed primary closure group. The difference in mean age between the two groups was not statistically significant ($t = -1.046$, $p = 0.297$), indicating comparable age distributions across both groups. In terms of gender distribution, males constituted the majority in both groups (71.67% in the primary closure group vs. 66.67% in the delayed primary closure group). Females accounted for 28.33% and 33.33% in the respective groups. The difference in gender distribution was not statistically significant ($\chi^2 = 0.384$, $p = 0.535$), suggesting a similar gender distribution across both groups. Regarding BMI, the majority of patients in both groups had a BMI in the 18.5–24.9 kg/m² range, with 68.33% in the primary closure group and 66.67% in the delayed primary closure group. The mean BMI was comparable between the two groups (23.00 ± 2.96 vs. 23.09 ± 3.11). The difference in BMI distribution was not statistically significant ($\chi^2 = 0.80$, $p = 0.67$), indicating similar BMI profiles.

The smoking status distribution showed that the majority of patients in the primary closure group were never smokers (65.0%), compared to 50.0% in the delayed primary closure group. The smoking status between the two groups was not statistically significant ($\chi^2 = 3.503$, $p = 0.1735$).Preoperative albumin levels differed between the groups. Hypoalbuminemia (<3.5 g/dL) was more common in the delayed primary closure group (81.67%) compared to the primary closure group (66.67%). The mean albumin level was lower in the delayed primary closure group (3.00 ± 0.52 vs. 3.23 ± 0.46), and this difference was statistically significant ($t = 2.567$, $p = 0.012$), suggesting lower albumin levels in the delayed closure group. The distribution of ASA grades was similar across both groups, with ASA grade II being the most common in the primary closure group (48.3%) and ASA grade III in the delayed primary closure group (43.3%). The difference in ASA grade distribution was not statistically significant ($\chi^2 = 4.066$, $p = 0.1309$), indicating comparable baseline risk profiles.

The aetiology of acute abdomen was comparable between both groups. Intestinal obstruction was the most common cause in both groups (31.7% in the primary closure group vs. 23.3% in the delayed primary closure group), followed by ileal perforation (20.0% vs. 25.0%) and gastric perforation (16.7% vs. 18.3%). No significant differences in aetiology were observed ($p = 0.8475$, Fisher's eRegarding symptom duration before admission, the duration was significantly longer in the delayed primary closure group (mean 29.33 ± 19.91 hours) compared to the primary closure group (mean 21.37 ± 17.10 hours) (t = 2.341, p = 0.021), indicating delayed presentation in the delayed closure group. Peritonitis severity distribution showed that mild peritonitis was more common in the primary closure group (51.7%) compared to the delayed primary closure group (28.3%), while severe peritonitis was more common in the delayed primary closure group (38.3%) compared to the primary closure group (18.3%). The difference was statistically significant (χ^2 = 8.424, p = 0.0148).The type of surgical procedure performed was similar in both groups. Primary repair was the most common procedure (35.0% in the primary closure group vs. 38.3% in the delayed primary closure group), followed by resection and anastomosis (25.0% vs. 21.7%). There was no significant difference between the groups in terms of the procedure performed (χ^2 = 0.234, p = 0.9720).

The duration of surgery was comparable between the two groups. The majority of surgeries in both groups were performed within 60–120 minutes (65.00% in the primary closure group vs. 78.33% in the delayed primary closure group). The mean duration of surgery was slightly higher in the primary closure group (105.70 ± 29.58 minutes) compared to the delayed primary closure group (98.82 ± 25.98 minutes), but this difference was not statistically significant (t = 1.354, p = 0.178).Purulent discharge was significantly more common in the primary closure group (35.0%) compared to the delayed primary closure group (16.7%) (χ^2 = 4.349, p = 0.0370), indicating better outcomes in terms of infection control with delayed primary closure.The microbial profile of patients with purulent discharge was similar across both groups. Klebsiella was the most common isolate in the primary closure group (10.0%), and the distribution of culture results showed no significant differences between the groups (p = 0.2671, Fisher's exact test).Postoperative antibiotic regimens were comparable between the two groups, with no statistically significant differences (p = 0.1001, Fisher's exact test). Cefoperazone-sulbactam with metronidazole was the most commonly used regimen in both groups.

The duration of antibiotic therapy was significantly higher in the primary closure group (mean 9.68 ± 1.45 days) compared to the delayed primary closure group (mean 8.72 ± 1.25 days) (t = 2.18, p = 0.032).The incidence of surgical site infection (SSI) within 30 days was higher in the delayed primary closure group (78.3%) compared to the primary closure group (63.3%), though the difference was not statistically significant (χ^2 = 2.582, p = 0.1081).

The distribution of SSI types showed that superficial SSI was the most common in both groups, with 63.6% in the primary closure group and 53.8% in the delayed primary closure group. Although a trend toward a higher incidence of deep SSI was observed in the primary closure group (36.4% vs. 23.1%), there was no statistically significant difference between the groups (p = 0.059, Fisher's exact test).

Regarding the timing of SSI onset, a statistically significant difference was observed (p = 0.020). SSIs in the primary closure group occurred earlier, with 54.5% of cases within 0–6 days, whereas in the delayed primary closure group, most cases occurred between 6–12 days (69.2%).The length of hospital stay was significantly longer in the primary closure group (mean 12.9 ± 2.6 days) compared to the delayed primary closure group (mean 10.8 ± 2.2 days) (t = 2.65, p = 0.010).Finally, the need for reintervention for wound issues was similar between the groups, with bedside opening being the most common intervention in both groups. No statistically significant difference in reintervention rates was found (p = 0.585, Fisher's exact test).

Table 1: Demographic and Baseline Characteristics Comparison between Study Groups

Variable	Primary Closure (n=60)	Delayed Primary Closure (n=60)	p-value
Age (Mean ± SD)	46.47 ± 19.09	50.17 ± 19.63	0.297*
Gender (n, %)			
Male	43 (71.67%)	40 (66.67%)	0.535
Female	17 (28.33%)	20 (33.33%)	
BMI (Mean ± SD)	23.00 ± 2.96	23.09 ± 3.11	0.67*
Smoking Status (n, %)			
Current	10 (16.7%)	18 (30.0%)	0.1735*
Former	11 (18.3%)	12 (20.0%)	
Never	39 (65.0%)	30 (50.0%)	

Table 2: Postoperative Outcomes and Complications in Study Groups

Outcome	Primary Closure (n=60)	Delayed Primary Closure (n=60)	p-value
Wound Infection (n, %)	22 (36.7%)	13 (21.7%)	0.1081*
Purulent Discharge (n, %)	21 (35.0%)	10 (16.7%)	0.0370**
Reintervention for Wound (n, %)	9 (47.4%)	6 (50.0%)	0.585
Hospital Length of Stay (Mean ± SD)	12.9 ± 2.6	10.8 ± 2.2	0.010**

Table 3: SSI and Microbial Culture Results in Study Groups

SSI Type	Primary Closure (n=22)	Delayed Primary Closure (n=13)	p-value
Superficial	14 (63.6%)	7 (53.8%)	0.059*
Deep	8 (36.4%)	3 (23.1%)	
Organ-space	0 (0.0%)	3 (23.1%)	
Microbial Culture (n, %)			
Klebsiella	6 (10.0%)	2 (3.3%)	0.2671*
E. coli	4 (6.7%)	2 (3.3%)	
Pseudomonas	3 (5.0%)	0 (0.0%)	
No Growth	2 (3.3%)	2 (3.3%)	

Discussion

This study aimed to compare outcomes between primary closure (PC) and delayed primary closure (DPC) in contaminated abdominal surgeries, focusing on surgical site infection (SSI), wound-related complications, and postoperative recovery. The baseline characteristics were comparable between the two groups, ensuring a valid comparison of closure techniques. Demographic parameters, including age, sex, and BMI, were similar across the groups, minimizing selection bias. The mean age difference was not statistically significant, consistent with findings by Ahmed A et al. (2013) [13], who found no significant effect of age on SSI outcomes. Male predominance, common in perforation peritonitis, aligns with Mehmood Y et al. (2020) [14] and Singh V et al. (2021) [15]. BMI comparisons also support Tang S et al. (2019) [16], indicating minimal impact of anthropometric factors when infection control is rigorously applied.

A significantly higher proportion of the DPC group had hypoalbuminemia (81.67% vs. 66.67%, p = 0.012). The lower albumin levels in the DPC group (3.00 ± 0.52 g/dL vs. 3.23 ± 0.46 g/dL) align with Sahu et al. (2015) [17], who identified hypoalbuminemia as a risk factor for SSI. However, Ahmed et al. (2018) [18] and Sahrish et al. (2020) [19] demonstrated that DPC reduces SSI even in patients with poor nutritional status. Though the DPC group had a higher smoking prevalence, the difference was not statistically significant, consistent with Mehmood Y et al. (2020) [14], who found smoking had minimal impact on SSI in contaminated surgeries. ASA grade distribution was comparable between the groups, with no statistically significant difference (p = 0.1309), confirming that ASA grade did not confound the outcomes. This is consistent with Ahmed et al. (2018) [18] and Kashyap et al. (2020) [20], where ASA grading had little impact on SSI outcomes. The distribution of underlying conditions was similar between groups, ensuring that disease profile did not act as a confounder. Similar disease patterns, like intestinal obstruction and perforated appendix, were observed, as noted by Ahmed et al. (2018) [18].The DPC group had a significantly longer symptom duration before admission (29.33 ± 19.91 hours vs. 21.37 ± 17.10 hours, p = 0.021). Despite this, Sahu et al. (2015) [17] and Ahmed et al. (2018) [9] showed that DPC can effectively reduce SSI even in late-presenting patients. Peritonitis severity was more pronounced in the DPC group (38.3% vs. 18.3%), supporting the idea that delayed closure is effective in managing severe contamination, as demonstrated by Ahmed et al. (2018) [18] and Singh V et al. (2021) [15]. Procedure type and duration were comparable between groups, minimizing procedural bias. Differences in outcomes were likely due to the closure technique rather than operative factors.

Purulent discharge was more common in the primary closure group (35.0% vs. 16.7%, p = 0.037), consistent with findings by Ahmed et al. (2018) [18], Sahrish et al. (2020) [19], and Kashyap et al. (2020) [20]. The microbiological profile was similar between groups, but Klebsiella isolation was higher in the primary closure group, correlating with greater infection severity. The duration of antibiotic therapy was significantly higher in the primary closure group (9.68 ± 1.45 days vs. 8.72 ± 1.25 days, p = 0.032), suggesting that DPC may reduce the need for prolonged antibiotic therapy.

SSI incidence was higher in the primary closure group (36.7%) compared to the DPC group (21.7%), though not statistically significant (p =

0.1081). Superficial and deep SSIs were more common in the primary closure group, indicating DPC's role in reducing both SSI incidence and severity, as seen in Ahmed et al. (2018) [18] and Qurashi et al. (2025) [21].The mean hospital stay was significantly shorter in the DPC group (10.8 ± 2.2 days vs. 12.9 ± 2.6 days, p = 0.010), suggesting better recovery. This finding aligns with Kashyap et al. (2020) [20] and Qurashi et al. (2025) [21], who also observed reduced hospital stays and improved recovery with DPC.

Conclusion

Delayed primary closure (DPC) demonstrates superior outcomes compared to primary closure (PC) in contaminated abdominal surgeries, with lower surgical site infection rates, reduced purulent discharge, and shorter hospital stays.

Despite higher baseline disease severity in the DPC group, it offers better infection control and faster recovery, supporting its use in high-risk cases.

Limitations of the Study: This study has several limitations. First, the sample size was relatively small, which may affect the generalizability of the results. Second, the study's observational design limits the ability to establish causal relationships between wound closure technique and postoperative outcomes. Third, patient selection was based on preoperative clinical factors, and unmeasured confounding factors, such as variations in postoperative care, may have influenced the results.

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