International Surgery Journal
Hasan MT et al. Int Surg J. 2026 Dec;13(12):2428-2433
https://www.ijsurgery.com
pISSN 2349-3305 | eISSN 2349-2902

DOI: https://dx.doi.org/10.18203/2349-2902.isj20264347

Original Research Article

Role of delayed primary closure in prevention of superficial surgical site infection in laparotomy wounds of abdominal trauma: a prospective observational study

M. Tarek Hasan[1]*, M. Abdul Jabbar[1], M. Farhad Hossain[2], Sanjida Nourin Sithi[3], M. Ashraful Islam[4], Saoda Islam[5], Golam Mahfuz Khan[6], Z. M. Raihan Kabir[7]

[1]Department of Surgery, OSD, DGHS, Mohakhali, Dhaka, Bangladesh
[2]Department of Surgery, 250 bedded General Hospital, Kurigram, Bangladesh
[3]Department of Surgery, Bangladesh Medical University, Dhaka, Bangladesh
[4]Department of Surgery, Dhaka Medical College Hospital, Dhaka, Bangladesh
[5]Department of Orthopedics and Traumatology, Sher e Bangla Medical College Hospital, Barishal, Bangladesh
[6]Department of Physical Medicine and Rehabilitation, Dhaka Medical College Hospital, Dhaka, Bangladesh
[7] Department of Surgery, Kapasia Upazila Health Complex, Gazipur, Bangladesh

Received: 26 September 2026
Accepted: 04 November 2026

***Correspondence:**
Dr. M. Tarek Hasan,
E-mail: drtarekhasan4@gmail.com

Copyright: © the author(s), publisher and licensee Medip Academy. This is an open-access article distributed under the terms of the Creative Commons Attribution Non-Commercial License, which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

ABSTRACT

Background: Abdominal trauma requiring emergency laparotomy carries a high risk of postoperative wound infection due to contamination, tissue injury, emergency operative conditions, and associated physiological derangements. Delayed primary closure (DPC) involves temporarily leaving the skin open and subsequently closing it after satisfactory local wound conditions have developed. This study evaluated the association between DPC and superficial surgical site infection (SSI) following laparotomy for abdominal trauma.

Methods: This prospective observational study was conducted in the Department of Surgery, Enam Medical College and Hospital, Savar, Bangladesh, from January to December 2014. One hundred patients undergoing emergency laparotomy for abdominal trauma were enrolled using purposive sampling. Patients underwent either primary skin closure or DPC according to intraoperative wound contamination and local tissue condition. The primary outcome was superficial SSI. Secondary outcomes included wound dehiscence, secondary wound intervention, and postoperative hospital stay. Categorical variables were compared using the chi-square or Fisher's exact test, while continuous variables were analyzed using the independent-samples t-test.

Results: Of 100 patients, 50 underwent DPC and 50 primary closure. Superficial SSI occurred in 6 (12.0%) patients in the DPC group compared with 15 (30.0%) in the primary-closure group (χ^2=4.882, p=0.027). Wound dehiscence occurred in 2 (4.0%) and 5 (10.0%) patients, respectively (Fisher's exact p=0.432). Mean postoperative hospital stay was 9.2±3.1 versus 10.6±4.0 days (p=0.054). Among patients with gross contamination, SSI occurred in 4 (13.3%) DPC patients compared with 10 (40.0%) primary-closure patients (p=0.028).

Conclusions: DPC was associated with a lower frequency of superficial SSI following traumatic laparotomy. DPC may be useful in selected contaminated wounds, although the observational design precludes causal inference.

Keywords: Abdominal trauma, Delayed primary closure, Laparotomy, Surgical site infection

INTRODUCTION

Surgical site infection (SSI) is one of the most common postoperative complications and remains an important cause of morbidity, prolonged hospitalization, additional interventions, and increased healthcare expenditure.[1,2] The risk of SSI is particularly high following emergency abdominal surgery because patients may present with contamination, tissue injury, hemodynamic instability, and limited opportunity for preoperative optimization.[3]

Laparotomy for abdominal trauma represents a particularly challenging surgical situation. Hollow-viscus perforation may result in contamination of the peritoneal cavity and operative wound with gastrointestinal contents. In addition, traumatic tissue damage, hematoma, devitalized tissue, prolonged operative duration, blood transfusion, and associated injuries may contribute to postoperative wound infection.[4]

Primary wound closure involves approximation of the skin edges immediately after completion of the operation. In contrast, DPC involves temporary management of the skin wound in an open condition, followed by closure after a period of wound observation and local wound care. The theoretical advantage of DPC is that it permits drainage and observation of a potentially contaminated wound before definitive skin closure.[5]

The role of DPC in contaminated abdominal surgery remains controversial. Several systematic reviews have suggested that DPC may reduce SSI in selected contaminated wounds, although the quality and heterogeneity of the available evidence have limited definitive conclusions.[6] Randomized evidence has also produced conflicting results. A randomized trial in complicated appendicitis did not demonstrate a reduction in SSI with DPC and reported a longer hospital stay.[7]

Conversely, several observational studies involving contaminated abdominal operations and perforation peritonitis have reported lower wound infection rates following DPC.[8] These differences may reflect variations in wound contamination, patient selection, antibiotic therapy, timing of closure, and surgical technique.

Evidence specifically addressing DPC in traumatic laparotomy wounds is relatively limited, particularly in resource-constrained settings. The present study was therefore undertaken to evaluate the association between DPC and superficial SSI among patients undergoing laparotomy for abdominal trauma.

METHODS

Study design and setting

This prospective observational study was conducted in the Department of Surgery, Enam Medical College and Hospital, Savar, Bangladesh, from January 2014 to December 2014.

Participants

One hundred patients undergoing emergency laparotomy for abdominal trauma were included using purposive sampling.

Inclusion criteria

Patients were eligible if they: were adults undergoing laparotomy for abdominal trauma; required operative exploration through a laparotomy incision; and had postoperative assessment of the laparotomy wound.

Exclusion criteria

Patients were excluded if they had: pre-existing infection involving the abdominal wall; established wound infection before closure; previous laparotomy through the same incision where this substantially affected wound management; immunosuppression or other conditions judged to interfere substantially with wound healing and incomplete postoperative wound follow-up.

Wound closure

Following completion of the intra-abdominal procedure, the operative wound was assessed for contamination, tissue viability, edema, and local wound condition.

Patients with relatively clean wounds underwent primary skin closure.

For patients selected for DPC, the fascial layer was closed in the conventional manner while the skin and subcutaneous tissues were left open. The wound was covered with sterile dressings and inspected daily. Delayed skin closure was performed after 48-72 hours when there was no evidence of active infection, significant tissue necrosis, or the uncontrolled contamination.

The decision regarding closure technique was made by the operating surgeon based on the intraoperative appearance of the wound. Therefore, allocation was not randomized.

Perioperative management

All patients received standard trauma resuscitation, appropriate antimicrobial therapy, operative source control, and postoperative wound care according to institutional practice.

Study outcomes

The primary outcome was superficial SSI.

Superficial SSI was defined as infection involving the skin or subcutaneous tissues of the incision, manifested by purulent discharge, localized erythema, tenderness, swelling, wound separation associated with infection, or a clinical diagnosis requiring wound treatment.

Secondary outcomes included wound dehiscence, postoperative wound discharge, requirement for secondary wound intervention, duration of postoperative hospitalization, and mortality.

Statistical analysis

Data were analyzed using IBM SPSS Statistics version 27. Continuous variables were expressed as mean±standard deviation and categorical variables as frequency and percentage.

The chi-square test or Fisher's exact test was used to compare categorical variables. The independent-samples t-test was used for comparison of normally distributed continuous variables.

A two-sided $p<0.05$ was considered statistically significant.

No multivariable regression model was performed.

Ethical considerations

Ethical approval was obtained from Institutional Review Committee of Enam Medical College and Hospital (ERC No:126/2013). Written informed consent was obtained from participants or their legally authorized representatives.

RESULTS

A total of 100 patients were included in the study, with 50 patients undergoing DPC and 50 undergoing primary skin closure. The mean age was 37.8±12.4 years in the DPC group and 39.5±13.1 years in the primary-closure group (p=0.508). Male patients predominated in both groups, accounting for 44 (88.0%) patients in the DPC group and 42 (84.0%) patients in the primary-closure group, while female patients accounted for 6 (12.0%) and 8 (16.0%), respectively (p=0.564).

The distribution of comorbidities was broadly comparable between the two groups. Diabetes mellitus was present in 8 (16.0%) patients in the DPC group and 7 (14.0%) patients in the primary-closure group (p=1.000). Hypertension was documented in 10 (20.0%) and 9 (18.0%) patients, respectively (p=1.000). Chronic kidney disease was present in 3 (6.0%) patients receiving DPC and 2 (4.0%) patients receiving primary closure (p=1.000), while chronic liver disease was present in 2 (4.0%) and 3 (6.0%) patients, respectively (p=1.000). Current smoking was reported in 18 (36.0%) patients in the DPC group and 20 (40.0%) in the primary-closure group (p=0.837). Preoperative anemia was observed in 15 (30.0%) and 17 (34.0%) patients, respectively (p=0.830).

Blunt trauma was the predominant mechanism of injury, occurring in 38 (76.0%) patients in the DPC group and 36 (72.0%) patients in the primary-closure group (p=0.648). Penetrating trauma occurred in 12 (24.0%) and 14 (28.0%) patients, respectively. Hollow-viscus injury was identified in 34 (68.0%) patients in the DPC group and 32 (64.0%) patients in the primary-closure group (p=0.672).

Gross wound contamination was present in 30 (60.0%) patients in the DPC group and 25 (50.0%) patients in the primary-closure group (p=0.317). Blood transfusion was required in 21 (42.0%) and 19 (38.0%) patients, respectively (p=0.687), while operative duration exceeded 2 hours in 27 (54.0%) patients in the DPC group and 24 (48.0%) patients in the primary-closure group (p=0.548).

Overall, there were no statistically significant differences between the DPC and primary-closure groups with respect to age, sex, comorbidities, mechanism of trauma, hollow-viscus injury, wound contamination, blood transfusion, or operative duration.

There was no statistically significant difference between the two groups in the available baseline demographic and operative characteristics. This indicated broadly comparable distributions of the measured baseline variables before assessment of postoperative wound outcomes.

The postoperative wound outcomes are summarized in Table 2. Superficial SSI occurred in 6 (12.0%) patients in the DPC group compared with 15 (30.0%) patients in the primary-closure group. This difference was statistically significant ($\chi^2=4.882$, p=0.027).

Wound discharge was observed in 7 (14.0%) patients in the DPC group and 16 (32.0%) patients in the primary-closure group, representing a statistically significant difference ($\chi^2=4.574$, p=0.032). Wound dehiscence occurred in 2 (4.0%) patients receiving DPC and 5 (10.0%) patients receiving primary closure; however, this difference was not statistically significant (Fisher's exact p=0.432).

Secondary wound intervention was required in 5 (10.0%) patients in the DPC group compared with 12 (24.0%) in the primary-closure group. Although the frequency was lower in the DPC group, the difference did not reach statistical significance ($\chi^2=3.316$, p=0.069). Reoperation for a wound complication was required in 1 (2.0%) patient in the DPC group and 2 (4.0%) patients in the primary-closure group (Fisher's exact p>0.999).

Mortality occurred in 2 (4.0%) patients in the DPC group and 3 (6.0%) patients in the primary-closure group, with

no statistically significant difference between the groups (Fisher's exact p>0.999).

The mean postoperative hospital stay was 9.2±3.1 days in the DPC group compared with 10.6±4.0 days in the primary-closure group. Although the mean duration of hospitalization was shorter among patients undergoing DPC, the difference was not statistically significant (t=1.94, p=0.054).

A subgroup analysis was performed according to the presence of gross wound contamination (Table 3). Among patients with gross contamination, superficial SSI occurred in 4 of 30 (13.3%) patients in the DPC group compared with 10 of 25 (40.0%) patients in the primary-closure group (p=0.028).

Among patients without gross contamination, superficial SSI occurred in 2 of 20 (10.0%) patients in the DPC group and 5 of 25 (20.0%) patients in the primary-closure group; this difference was not statistically significant (p=0.416). Overall, superficial SSI occurred in 6 of 50 (12.0%) patients in the DPC group compared with 15 of 50 (30.0%) patients in primary-closure group (p=0.027).

Table 1: Baseline demographic, clinical, and operative characteristics.

Variables	DPC, (n=50) (%)	Primary closure, (n=50) (%)	P value
Age (in years), mean±SD	37.8±12.4	39.5±13.1	0.508
Sex			
Male	44 (88.0)	42 (84.0)	0.564
Female	6 (12.0)	8 (16.0)	
Comorbidities			
Diabetes mellitus	8 (16.0)	7 (14.0)	1.000
Hypertension	10 (20.0)	9 (18.0)	1.000
Chronic kidney disease	3 (6.0)	2 (4.0)	1.000
Chronic liver disease	2 (4.0)	3 (6.0)	1.000
Current smoking	18 (36.0)	20 (40.0)	0.837
Preoperative anemia	15 (30.0)	17 (34.0)	0.830
Mechanism of trauma			
Blunt trauma	38 (76.0)	36 (72.0)	0.648
Penetrating trauma	12 (24.0)	14 (28.0)	
Hollow-viscus injury	34 (68.0)	32 (64.0)	0.672
Gross contamination	30 (60.0)	25 (50.0)	0.317
Blood transfusion required	21 (42.0)	19 (38.0)	0.687
Operative duration >2 h	27 (54.0)	24 (48.0)	0.548

*DPC: delayed primary closure; SD: standard deviation.

Table 2: Postoperative wound outcomes according to closure technique.

Outcomes	DPC, (n=50) (%)	Primary closure, (n=50) (%)	Test statistic	P value
Superficial SSI	6 (12.0)	15 (30.0)	χ^2=4.882	0.027
Wound discharge	7 (14.0)	16 (32.0)	χ^2=4.574	0.032
Wound dehiscence	2 (4.0)	5 (10.0)	Fisher's exact	0.432
Secondary wound intervention	5 (10.0)	12 (24.0)	χ^2=3.316	0.069
Reoperation for wound complication	1 (2.0)	2 (4.0)	Fisher's exact	>0.999
Mortality	2 (4.0)	3 (6.0)	Fisher's exact	>0.999

*SSI: surgical site infection; DPC: delayed primary closure.

Table 3: Superficial SSI according to degree of wound contamination.

Wound contaminations	DPC, n/N (%)	Primary closure, n/N (%)	P value
Gross contamination	4/30 (13.3)	10/25 (40.0)	0.028
No gross contamination	2/20 (10.0)	5/25 (20.0)	0.416
Overall	6/50 (12.0)	15/50 (30.0)	0.027

*SSI: surgical site infection; DPC: delayed primary closure.

Overall, patients managed with DPC had a lower observed frequency of superficial SSI and wound discharge than those undergoing primary skin closure.

The differences in wound dehiscence, secondary wound intervention, reoperation for wound complications, mortality, and postoperative hospital stay were not

statistically significant. The subgroup analysis showed a statistically significant difference in superficial SSI among patients with gross contamination, whereas no statistically significant difference was observed among patients without gross contamination.

DISCUSSION

The present study evaluated the association between delayed primary closure and superficial SSI in laparotomy wounds following abdominal trauma. The observed frequency of superficial SSI was lower among patients managed with DPC than among those undergoing primary skin closure.

The rationale for DPC is based on the possibility that temporary avoidance of skin closure allows contaminated fluid to drain and permits serial assessment of the wound. In traumatic abdominal surgery, this may be particularly relevant because contamination can be substantial and the condition of the tissues may be uncertain at the end of an emergency operation.[9]

The lower SSI frequency observed with DPC is consistent with findings from several observational studies involving contaminated abdominal wounds. Pauly et al. reported lower SSI rates among patients undergoing DPC following clean-contaminated laparotomy, while other observational studies have similarly reported favorable wound outcomes with DPC.[10,11]

However, evidence is not uniformly supportive. Bhangu et al. conducted a systematic review and meta-analysis of randomized clinical trials and concluded that although DPC might have a role in contaminated and dirty abdominal wounds, the available evidence had substantial limitations.[12] Siribumrungwong et al subsequently reported that DPC did not significantly reduce superficial SSI in complicated appendicitis and was associated with longer hospitalization.[13]

These conflicting findings indicate that the effectiveness of DPC may vary according to the clinical setting. The degree of contamination, nature of the underlying pathology, tissue viability, antimicrobial therapy, patient physiological status, and timing of closure may all influence postoperative wound outcomes.

Abdominal trauma has several characteristics that may make DPC relevant. Emergency surgery may be performed before complete physiological optimization, and hollow-viscus injury can introduce enteric organisms into the operative field. Tissue crushing, hematoma, devascularization, and repeated manipulation may further compromise the local wound environment.[14]

The subgroup findings according to wound contamination suggest that DPC may be particularly useful in wounds with substantial contamination. However, because the present study was observational, this finding should be interpreted as an association rather than evidence that DPC independently prevents infection.

Selection bias is an important consideration. Surgeons may preferentially select DPC for wounds that appear heavily contaminated, while primary closure may be selected for wounds considered relatively clean. Such differences can influence the observed SSI rates.

SSI prevention is multifactorial. Appropriate antimicrobial prophylaxis, skin antisepsis, maintenance of physiological homeostasis, appropriate surgical technique, and postoperative wound care are important components of prevention.[15,16] Appropriate timing of prophylactic antibiotics and appropriate skin antisepsis have also been associated with reduced SSI risk.[17,18]

Other approaches, including wound-protection devices, negative-pressure therapy for closed incisions, and antimicrobial-coated sutures, have also been investigated.[19-21]

DPC has the practical advantage of requiring no specialized equipment and may therefore be particularly applicable in the resource-constrained surgical environments.

The principal limitation is the observational design. Patients were not randomly assigned to DPC or primary closure, allowing the possibility of selection bias and confounding. Purposive sampling also limits generalizability.

The sample size was relatively small, and the study was conducted at a single institution. If postoperative surveillance was limited to hospitalization, SSI developing after discharge may have been missed.

No multivariable analysis was performed; therefore, the observed association between closure technique and SSI cannot be interpreted as an independent effect after adjustment for other risk factors.

CONCLUSION

Delayed primary closure was associated with a lower frequency of superficial SSI than primary skin closure among patients undergoing laparotomy for abdominal trauma. The difference was particularly apparent among patients with gross wound contamination.

DPC may be considered as a wound-management option for selected contaminated traumatic laparotomy wounds. However, because of the observational design, purposive sampling, and absence of multivariable adjustment, the findings should be interpreted as an association rather than evidence of a causal preventive effect. Larger prospective comparative studies are warranted to determine the role of DPC in traumatic laparotomy wounds.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee Enam Medical College and Hospital (ERC No:126/2013).

REFERENCES

1. Berríos-Torres SI, Umscheid CA, Bratzler DW, Zeynep KN, de Jonge S, de Vries F, et al. Centers for Disease Control and Prevention guideline for the prevention of surgical site infection, 2017. JAMA Surg. 2017;152(8):784-91.
2. Allegranzi B, Zayed B, Bischoff P. New WHO recommendations on intraoperative and postoperative measures for surgical site infection prevention: an evidence-based global perspective. Lancet Infect Dis. 2016;16(12):e288-303.
3. Inyang AW, Usang UE, Talabi AO, Anyanwu LC, Sowande OA, Adejuyigbe O. Primary versus delayed primary closure of laparotomy wounds in children following typhoid ileal perforation in Ile-Ife, Nigeria. Afr J Paediatr Surg. 2017;14(4):70-3.
4. Marzoug OA, Anees A, Malik EM. Assessment of risk factors associated with surgical site infection following abdominal surgery: a systematic review. BMJ Surg Interv Health Technol. 2023;5(1):e000182.
5. Korol E, Johnston K, Waser N, Frangiscos S, Hasan SJ, Mathew L, et al. A systematic review of risk factors associated with surgical site infections among surgical patients. PLoS One. 2013;8(12):e83743.
6. Chiang RA, Chen SL, Tsai YC. Delayed primary closure versus primary closure for wound management in perforated appendicitis: a prospective randomized controlled trial. J Chin Med Assoc. 2012;75(4):156-9.
7. Baksi A, Chatterjee S, Ray U, Nilima N, Firoz Khan W, Banerjee N. A randomized trial analyzing the effects of primary versus delayed primary closure of incision on wound healing in patients with hollow viscus perforation. Turk J Surg. 2020;36(4):327-32.
8. Siribumrungwong B, Chantip A, Noorit P. Comparison of superficial surgical site infection between delayed primary versus primary wound closure in complicated appendicitis: a randomized controlled trial. Ann Surg. 2017;267(4):631-7.
9. Gupta S, Bhandari V, Dubey IB. A randomized study to evaluate wound outcome following delayed primary vs primary closure of skin in duodenal perforation peritonitis. Int Surg J. 2021;8(7):2108-13.
10. Pauly TJ, Haridas TV, Prabhakar EM, Roshan R. A comparative study on surgical site infections after primary closure and delayed primary closure in clean contaminated laparotomy cases. Int Surg J. 2019;6(3):989-92.
11. Sasikumar MN, Mammen SC. Primary versus delayed wound closure technique in laparotomy wound of perforation peritonitis. Int Surg J. 2019;6(10):3708-14.
12. Bhangu A, Singh P, Lundy J, Bowley DM. Systemic review and meta-analysis of randomized clinical trials comparing primary vs delayed primary skin closure in contaminated and dirty abdominal incisions. JAMA Surg. 2013;148(8):779-86.
13. Siribumrungwong B, Noorit P, Wilasrusmee C, Thakkinstian A. A systematic review and meta-analysis of randomised controlled trials of delayed primary wound closure in contaminated abdominal wounds. World J Emerg Surg. 2014;9:49.
14. Duttaroy DD, Jitendra J, Duttaroy B, Bansal U, Dhameja P, Patel G, Modi N. Management strategy for dirty abdominal incisions: primary or delayed primary closure? A randomized trial. Surg Infect (Larchmt). 2009;10(2):129-36.
15. O'Leary DP, Peirce C, Anglim B, et al. Prophylactic negative pressure dressing use in closed laparotomy wounds following abdominal operations: a randomized, controlled, open-label trial: the P.I.C.O. trial. Ann Surg. 2017;265(6):1082-6.
16. Di Re AM, Wright D, Toh JWT, et al. Surgical wound infection prevention using topical negative pressure therapy on closed abdominal incisions-the SWIPE IT randomized clinical trial. J Hosp Infect. 2021;110:76-83.
17. Roy A, Mondal P, Kumar R. Delayed primary closure versus subcutaneous suction drain with primary closure following contaminated laparotomy wound. Bioinformation. 2026;22(4):2640-5.
18. Zhang C, Zhou J, Sun L, Zhang D, Xia L, Zhao S, et al. Delayed primary skin closure reduce surgical site infection following surgery for gastrointestinal perforation: A systematic review and meta-analysis. Langenbecks Arch Surg. 2024;409(1):298.
19. Hawn MT, Richman JS, Vick CC. Timing of surgical antibiotic prophylaxis and the risk of surgical site infection. JAMA Surg. 2013;148(7):649-57.
20. Tang S, Hu W, Hu L, Zhou J. Primary Versus Delayed Primary Incision Closure in Contaminated Abdominal Surgery: A Meta-Analysis. J Surg Res. 2019;239:22-30.
21. Hall C, Regner J, Abernathy S, Isbell C, Isbell T, Kurek S, Smith R, Frazee R. Surgical Site Infection after Primary Closure of High-Risk Surgical Wounds in Emergency General Surgery Laparotomy and Closed Negative-Pressure Wound Therapy. J Am Coll Surg. 2019;228(4):393-7.

Cite this article as: Hasan MT, Jabbar MA, Hossain MF, Sithi SN, Islam MA, Islam S, et al. Role of delayed primary closure in prevention of superficial surgical site infection in laparotomy wounds of abdominal trauma: a prospective observational study. Int Surg J 2026;13:2428-33.