Journal of Surgical Sciences 2025;29(1): 37-42

https://doi.org/10.3329/jss.v29i1.91293

JOURNAL OF SURGICAL SCIENCES

Original Article

Role of Delayed Primary Closure in Reducing Superficial Surgical Site Infection in Contaminated Abdominal Wounds

Rayhan GM[1*], Sharfuzzaman AMSM[2], Hasan ASA[3], Rab JZ[4], Mahin T[5]

Abstract

Introduction: Surgical site infection (SSI) is a major postoperative complication, especially in contaminated abdominal wounds. While primary closure (PC) is common practice, delayed primary closure (DPC) is hypothesized to reduce superficial surgical site infection (SSSI) rates. To evaluate the role of DPC in reducing superficial surgical site infection (SSSI) in contaminated abdominal wounds.

Methods: A prospective observational study of 100 patients undergoing laparotomy with contaminated wounds was conducted at Sher-E-Bangla Medical College Hospital. Following fascial closure, the skin was left open and packed with saline-soaked gauze. Delayed skin closure was performed when healthy granulation tissue appeared, typically after the fifth postoperative day (POD).

Results: Only 12% of patients developed SSSI after DPC. The average length of hospital stay was 10.8 ± 2.5 days. SSSI rates varied by diagnosis: 25% for ileal perforation and 12.5% for perforated appendicitis.

Conclusion: Delayed primary closure is an effective technique for reducing SSSI in contaminated laparotomy wounds.

Introduction

The history of surgery has always been linked to the challenge of wound infection. Surgical site infections (SSIs) occur in approximately 3% of all surgical procedures and in up to 20% of laparotomies[1]. Surgical site infection (SSI) and its associated complications like wound dehiscence, incisional hernias are not only a source of discomfort for the patients but also discouraging for the surgeons[2]. Those infections contribute to significant morbidity, increased healthcare costs, and prolonged hospital stays.

Minimizing SSIs is a top priority for surgeons and hospitals to ensure the safest environment for patients undergoing surgery. Over the past decades increased attention has been focused on the risk factors both intrinsic[3], such as weight, presence of diabetes, haemoglobin values etc. and extrinsic risk factors[4], such as shaving, preoperative skin preparation, skin asepsis, operative room ventilation, inadequate sterilization of instrument, poor haemostasis, duration of operation, etc. Despite adequate systemic support and meticulous application of the principles of appropriate operation room protocol, antibiotic guidelines & wound care, certain wounds are still prone to infection.

1. Dr. Golam Mahmud Rayhan, Junior Consultant-Surgery, DGHS
2. Prof. AMSM Sharfuzzaman, Professor of Surgery, Popular Medical College Hospital
3. Dr. Ahmed Sami Al Hasan, Assistant Professor-Surgery, Kurmitola General Hospital
4. Dr. Joy Zakharia Rab, Junior Consultant-Surgery, Sher E Bangla Medical College Hospital, Barisal
5. Dr. Tasnuva Mahin, Medical Officer, Government Employees Hospital, Dhaka

***Corresponding author:** Golam Mahmud Rayhan, Junior Consultant-Surgery, DGHS, rayhan.dmc.k63@gmail.com. ORCID ID: 0009-0008-7185-0797

Closure of skin has long been debated in contaminated and dirty abdominal wounds. It is suggested that leaving skin open in presence of contamination reduces the chance wound sepsis as primary closure of skin in such circumstances creates an infected closed space and invariably lead to abscess formation and attendant sequelae.[5,6]

Delayed primary closure (DPC) involves leaving the skin open initially to reduce bacterial inoculum, improved blood flow, better oxygenation at the wound edges and increased number of functional phagocytes[1] from developing granulation tissue leading progressive increases in resistance to infections [78,9].

DPC was initially popularized by Hepburn[10] during World War-1 and its benefit in contaminated abdominal incision closure were demonstrated by Coller and Valk[11] . In 1963, the first randomized study reported that primary closure of potentially contaminated abdominal wound had a 42% incidence of infection whereas DPC was associated with only 8% incidence[12]. Since then, general and trauma surgeons have stressed the value of delayed primary closure of contaminated abdominal incision in reducing incidence of post-operative SSIs.

Though primary closure may be thought apparently thought to be easier and more convenient for patients, but in contaminated and dirty abdominal wounds delayed primary closure is advocated since it significantly lowers the rate of surgical site infection as well as fascial dehiscence and reduce the mean healing time and hospitalization.

Despite its potential benefits, there is limited clinical data regarding its effectiveness in the context of hospital settings in Bangladesh. This study aims to evaluate the role of DPC in minimizing SSSI within our clinical environment.

Materials and Methods

This prospective observational study was conducted at Sher-E-Bangla Medical College Hospital, Barisal, from March 2021 to February 2022. A total of 100 patients aged 12–60 years undergoing laparotomy with suspected wound contamination were included. Contaminated abdominal wound & surgical site infection was defined per CDC criteria[13].

All patients received prophylactic antibiotics (Ceftriaxone 1g IV) 30 minutes before surgery. Following adequate peritoneal toileting, the musculo-fascial layer was closed (fascial closure) with monofilament prolene. The skin and subcutaneous layers were left open and packed with saline-soaked gauze for 48 hours. Same antibiotic regimen (Inj. Ceftriaxone, 1gm I/V 12 hourly and Inj. Metronidazole 500mg IV 8 hourly) was prescribed to all the patients up to 5th POD.

Wounds were inspected on the 3rd POD for signs of infection, such as purulent discharge or localized inflammation. A wound swab was collected from the discharging wounds and sent for culture and sensitivity report. In positive culture cases, the antibiotic regimen was rescheduled according to the sensitivity report. Daily dressing changes were performed. Final skin closure was executed with monofilament prolene once the wound appeared healthy and discharge-free, generally from the 5th POD onwards. Patients were followed up in the outpatient department at 1 and 4 weeks post-discharge.

Results

A total of 100 patients who underwent laparotomy within the study period and had contaminated wound according to CDC criteria were included in the study. 12 patients developed wound infection after delayed primary closure. No significant difference was found between the two groups who developed SSSI and both group were similar with respect to age, gender, nutritional status, anaemia, symptom duration or operative time.

Table-I: Distribution of patients according to age group (n=100)

Age group (in years)	Frequency (%)
≤20	3
21 – 30	41
31 – 40	26
41 – 50	14
51 – 60	11
Mean age ±SD (in years)	29.78±9.67
Age range (in years)	17 – 60

The study population had a mean age of 29.78 ± 9.67 years, with a male predominance (82%).

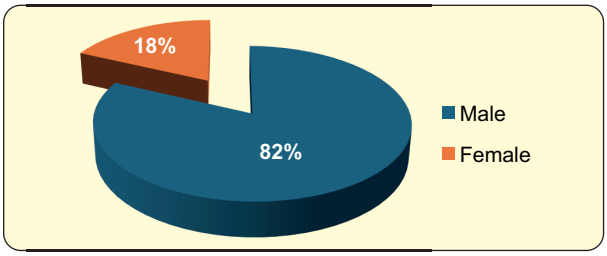

Figure-1: *Distribution of patients according to sex (n=100)*

Figure 1 shows that out of 100 patients, 82% were male and rest 18% were female. The male to female ratio was 4.55:1.

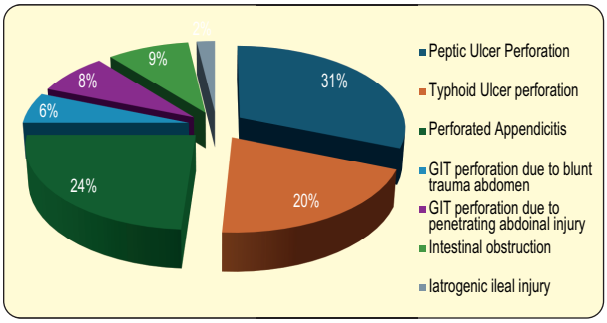

Figure-2: *Distribution of patients according to diagnosis (n=100)*

Figure-2 shows that out of 100 patients 31 patients have a diagnosis of perforated peptic ulcer, 20 patients of non-traumatic ileal perforation, 24 patients of perforated appendicitis, 6 from GIT perforation due to blunt trauma, 8 due to penetrating/gunshot injury, 9 patients due to intestinal obstruction where resection anastomosis/exteriorization was needed and two patients had ileal injury as a complication of D&C.

Incidence of Infection: Superficial SSI developed in 12 patients (12%) following DPC. Statistical analysis showed no significant correlation between SSSI development and age, gender, BMI, or operative time (p>0.05).

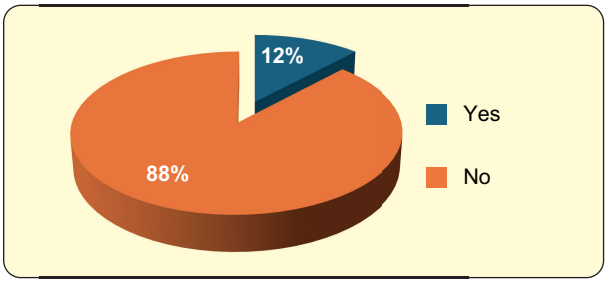

Figure-3: *Distribution of patients according to SSI in case of delayed primary closure (n=100)*

Figure-3 shows only 12 patients developed Superficial SSI after delayed primary closure.

Table-II: *Baseline characteristics of patients who underwent delayed primary closure and risk factor analysis (n=100)*

Variables	Superficial SSI		p-value
	Yes (n=12)	No (n=88)	
Age (y) (Mean±SD)	31±16	29±14	
Sex			
Male	9 (75%)	73 (82.95%)	0.501^{NS}
Female	3 (25%)	15 (17.04%)	
BMI (Kg/m^2), mean (SD)	24.5 (0.48)	23.3 (0.19)	0.23^{NS}
Anaemia (hct<30%)	3	13	$.35^{s}$
Malnutrition (albumin<2.5gm/dl)	2	12	$.140^{s}$
White blood cell count/mm^3Mean (SD)	13,654(4551)	11563(4998)	0.130^{NS}
Symptom duration (h)	32 (6-72)	24 (1-96)	0.62NS
Operative time			
≤2hr	9 (75%)	72 (82%)	0.57^{NS}
>2hr	3 (25%)	16 (18%)	
Drain placement	12 (100%)	88 (100%)	1.00^{NS}

P-values were calculated chi square test and the student's t-test, P-value was significant at <0.005,
NS: Not significant S: Significant .

Outcomes by Diagnosis:

Table-III: Distribution of superficial SSI according to Diagnosis (n=100)

Diagnosis	Superficial SSI		Percentage
	Yes (n=12)	No (n=88)	
Peptic Ulcer Perforation	1	30	3.2%
Ileal Perforation	5	15	25%
Perforated Appendicitis	3	21	12.5%
GIT perforation due to blunt abdominal trauma	1	5	1.67%
GIT perforation due to Penetrating injury	1	8	1.1%
Intestinal obstruction	0	9	-
Iatrogenic ileal perforation	1	1	50%

Out of 12 patients who were suffering from SSSI after laparotomy. SSSI was highest in ileal perforations – in iatrogenic cases (50%) and non-traumatic ileal perforations (25%), followed by perforated appendicitis (12.5%)

Table-IV: *Timing of skin closure and length of hospital stay (n=100)*

Variables	Superficial SSI	
	Yes (n=12)	No (n=88)
Timing of skin closure (Days)	8 ± 2.5	5 ± 1.3
Length of hospital stay	14.5 ± 3.5	9.3 ± 2.8

The average timing for skin closure was 5 ± 1.3 days in patients without infection, compared to 8 ± 2.5 days in those who developed SSSI.

Table-V: *Outcome of patients within 30-day period (n=100)*

Wound outcome	Number of patients
Primary Healing	88
Superficial SSI	9 (pre-closure) 3 (post-closure)
Incision Dehiscence	3
Secondary Suturing	12
Readmission	3

Figure 4 shows that out of 12 superficial SSI, 3 cases were sterile (No growth). Among 9 positive cultures, E. coli was isolated from 5 samples (41.67 %), Klebsiella-2(16.67%), Staph. Aureus-1(8.33%), P. aeruginosa-1(8.33 %).

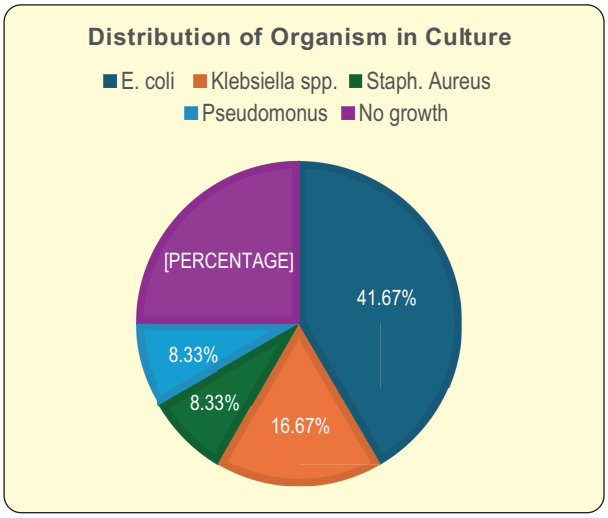

Figure 4: *Distribution of Organisms involved in post-operative superficial SSI in aerobic culture. (n=12)*

Table-VI: *Antibiotic sensitivity pattern of isolated organisms from Superficial SSI*

	E. coli (n=5)	Klebsiella (n=2)	S. aureus (n=1)	P. aeruginosa (n=1)
Ampicillin	1	1	0	0
Amoxicillin	2	0	1	0
Cefoxitin	-	-	-	-
Flucloxacillin	3	0	1	0
Gentamycin	3	1	0	0
Amikacin	5	2	1	1
Ciprofloxacin	3	1	1	1
levofloxacin	5	2	1	1
Cephradine	2	1	1	0
Cefuroxime	3	1	1	0
Cefixime	3	1	0	0
Ceftriaxone	2	0	0	0
Ceftazidime	4	1	1	1
Cefepime	4	2	1	1
Imipenem	5	2	1	1
Meropenem	3	1	1	0
Piperacillin+Tazobactum	4	1	-	1

Discussion

The incidence of SSSI is dependent upon a complex interaction between numerous factors including technique of wound closure, the nature and number of organisms contaminating the surgical site, the health of the patient and the skill and technique of the surgeon. To control this bias caused by these factors here we used a uniform protocol of preoperative preparation, similar suture materials for closure and similar antibiotic regimen. In this study, only patients with a contaminated abdominal wound were included, that enhances internal consistency and comparability with findings of other studies.

In this study of 100 people mean age of the patients was 29.78±9.67 years and male female ratio was 4.55:1. Superficial surgical site infection (SSSI) was observed in 12(12%) patients. 3 of them (25% of all SSSI patients) needed hospital readmission for superficial wound dehiscence in whom secondary closure was done after regular dressing.

After delayed primary closure, reduced incidence of SSSI to 12% in this study aligns with findings of other international studies that support delayed primary closure over primary closure for contaminated incisions. For instance, similar studies have reported SSSI rates as high as 42.5%–54% with primary closure, while DPC rates remained significantly lower at 2.7%–12%[5,7,14,15]. In a prospective randomized trial conducted to compare two wound management strategies for contaminated and dirty abdominal wounds, concluded that delayed primary closure produced a decreased (12%) SSI rate compared with primary closure (48%)[5]. In Bender study, infections in delayed primary closure group were 2.8% only[15]. A Chinese study in 2012 found SSI rate of only 2.9% in DPC compared to 38.9% in PC technique in perforated appendicitis patients[14].

In Bangladesh, a study conducted in BMU also shows delayed primary closure had significantly reduced the rate of wound infection in patients with obstructive jaundice and septic abdomen[16].

Out of 12 SSSI patients, 9 had a positive culture. E. coli was most predominant 5(41.67 %), followed by Klebsiella-2(16.67%), Staph. Aureus-1(8.33%) & P. aeruginosa-1(8.33 %). Carbapenems, Amikacin, Levofloxacin & Imipenem was found more effective and on the other hand Ampicillin, Amoxicillin & Ceftriaxone showed highest resistance. This culture & sensitivity pattern is consistent with studies

conducted in Bangladesh & India[17,18].

Though the DPC technique seems more complicated than primary closure, most of the patients were discharged within 10-12 days. The ultimate average hospital stay was comparable with other studies[7]. That helped to reduce the financial burden also.

While primary closure may seem more convenient, the risk of creating a closed infected space in contaminated cases often outweighs the ease of the procedure. Our findings suggest that DPC significantly mitigates these risks and reduces the subsequent superficial SSI.

Conclusion

Delayed primary closure is a reliable and effective technique for managing contaminated abdominal wounds. It significantly reduces the incidence of superficial surgical site infections and associated complications like wound dehiscence. DPC can be a standard protocol for laparotomies involving gross contamination to improve patient outcomes and reduce the burden on the healthcare system.

References

1. Barie PS, Eachempati SR. Surgical site infections. Surgical Clinics of North America. 2005. p. 1115–35. doi:10.1016/j.suc.2005.09.006 PubMed PMID: 16326197.
2. Haridas M, Malangoni MA. Predictive factors for surgical site infection in general surgery. Surgery. 2008 Oct;144(4):496–503. doi:10.1016/j.surg.2008.06.001
3. Nicholas RL, Barie PS, Condon RE, Fry DE, Gorbach SL. Risk factors and surveillance for surgical wound infections. Surgery. 2000 Oct;128(4):S2–13. doi:10.1067/msy.2000.110234
4. Beyea SC. Preventing surgical site infections—guiding practice with evidence. AORN J. 2000 Aug 1;72(1):305–305.
5. Cohn SM, Giannotti G, Ong AW, Varela JE, Shatz D V, Mckenney MG, et al. Prospective Randomized Trial of Two Wound Management Strategies for Dirty Abdominal Wounds. ANNALS OF SURGERY. 2000.
6. Utpal De, Battacharya P, Chakraborty BP. A prospective study of cases treated by open wound management after emergency surgery for bacterial peritonitis. Ind J Surg . 2002;64(1):52–5.
7. Duttaroy DD, Jitendra J, Duttaroy B, Bansal U, Dhameja P, Patel G, et al. Management strategy for dirty abdominal incisions: Primary or delayed primary closure? A randomized trial. Surg Infect (Larchmt). 2009 Apr 1;10(2):129–36. doi:10.1089/sur.2007.030 PubMed PMID: 19388835.
8. Garibaldi RA, Gushing D, Lerer T. Risk Factors for Postoperative Infection.
9. Alexander JW, Solomkin JS, Edwards MJ. Updated recommendations for control of surgical site infections. Annals of Surgery. 2011. p. 1082–93. doi:10.1097/SLA.0b013e31821175f8 PubMed PMID: 21587113.
10. Hepburn HH. DELAYED PRIMARY SUTURE OF WOUNDS. BMJ. 1919 Feb 15;1(3033):181–3. doi:10.1136/bmj.1.3033.181
11. Coller FA, Valk WL. THE DELAYED CLOSURE OF CONTAMINATED WOUNDS A PRELIMINARY REPORT. Ann Surg. 1940 Aug;112(2):256–70. doi:10.1097/00000658-194008000-00010
12. Bernard HR. Wound Infections Following Potentially Contaminated Operations. JAMA. 1963 Apr 27;184(4):290. doi:10.1001/jama.1963.73700170015010e
13. CDC, Ncezid, DHQP. Surgical Site Infection Event (SSI) [Internet]. 2026. Available from: https://www.cdc.gov/nhsn/pdfs/ps-analysis-resources/Importing Procedure Data.pdf.
14. Chiang RA, Chen SL, Tsai YC. Delayed primary closure versus primary closure for wound management in perforated appendicitis: A prospective randomized controlled trial. Journal of the Chinese Medical Association. 2012 Apr;75(4):156–9. doi:10.1016/j.jcma.2012.02.013 PubMed PMID: 22541143.
15. Bender JS. Factors influencing outcome in delayed primary closure of contaminated abdominal wounds: a prospective analysis of 181 consecutive patients. Am Surg 2003 Mar;69(3):252-5; discussion 255-6. 2003 Mar;69(3):255–6.
16. Das BC, Khan AS, Elahi NE, Sobhan SA, Azad AK, Matubber M, et al. Delayed primary suture prevents wound infection in patients with obstructive jaundice and septic abdomen. Mymensingh Med J. 2014 Apr;23(2):249–53.
17. Nur-E-Elahi M, Jahan I, Siddiqui O, Ahmed SU, Joarder AI, Faruque S, et al. Wound infection in surgery department in bsmmu: A study of 100 cases.
18. Golia S, B A, AR N. A study of superficial surgical site infections in a tertiary care hospital at Bangalore. Int J Res Med Sci. 2014;2(2):647. doi:10.5455/2320-6012.ijrms20140552