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Effects of Delayed Skin Closure of Midline Laparotomy Incisions for Peritonitis

Liaqual Ali, Immamuddin Baloch, Javeria Memon, Ahsan Ali, Muhammad Sheeraz, Altaf Hussain

ABSTRACT

Objective: To compare outcomes of delayed versus early primary closure of midline laparotomy wounds in peritonitis.

Study Design and Setting: A randomized controlled trial was carried out during the period from 26th February, 2025 to 30th August, 2025 using consecutive sampling at the Department of Surgery, GMMMC Hospital, Sukkur.

Methodology: After getting ethical approval and consent, eighty patients aged 20-70 years (ASA I-III) were enrolled in this study, undergoing upper midline laparotomy closure for peritonitis. They were randomly placed in Group A (delayed primary closure) and Group B (early primary closure). All were taken up under one team of general anesthesia in the operating theatre. A 15-day follow-up was done for infection and dehiscence of the wound.

Results: Out of 80 patients, the overall wound infection rate was 33.8 %, which was significantly higher in Group B (45 %) compared with Group A (22.5 %); p = 0.033. The incidence of wound dehiscence was higher in Group B as compared to Group A (p = 0.019). Anemia was associated with increased complications, especially early closure. The time taken for surgery was same but blood loss was more with delayed closure (354.10 ± 42.36 ml vs. 305.25 ± 35.46 ml; p < 0.001).

Conclusion: Delayed primary closure of the wound can reduce the incidence of infection and dehiscence in case of peritonitis, although there is a slight increase in blood loss observed.

Keywords: Delayed Primary Closure, Laparotomy, Peritonitis, Wound Dehiscence, Wound Infection.

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INTRODUCTION

Peritonitis is an inflammation of the peritoneal cavity. It can occur as a result of contamination or infection. Peritonitis is a global surgical issue. At the same time, it is considered especially serious in poorer countries. For example, Pakistan suffers from a high burden of peritonitis.[1] The best surgical procedure for generalized peritonitis is midline laparotomy, which allows adequate exploration, source control, and peritoneal lavage.[2] Surgeons face a dilemma between doing the early primary skin closure and delaying it to lower or reduce the incidence of post-operative wound infection. This choice affects patient results, stay in the hospital, and the cost of health care, mainly in developing countries that can't control infection.[3]

The way this is done is through delayed primary closure (DPC) of laparotomy wounds using the deep layer as the first stage. The skin and subcutaneous tissue are open or approximated loosely to facilitate the drainage of the contaminated fluid, which helps in the removal of the bacteria.[4] The total closure of all layers that is done at the termination of the surgery is called early primary closure (EPC). There has been much debate regarding these techniques over time, because there have been contradictory results implicating that it reduces wound infection, dehiscence, and other complications.[5] Even if the EPC supports faster healing time and reduced days in hospital, it has the potential to transmit infection in the contaminated

fields. Because of DPC's potential to increase length of stay and hassle of wound care, the DPC may reduce infection rates by allowing for greater wound drainage and monitoring before closure.[6, 7]

Wound infection after midline laparotomy in cases of peritonitis is still a significant cause of morbidity and mortality in the world. Postoperative complications of 10-30 % have been reported in other studies. Surgical site infections (SSIs) in Pakistan were found at disastrous rates of 20 % to 45% after abdominal surgery due to poor healthcare infrastructure, like congested hospitals, non-sterile environment, and delayed presentations due to socio-economic reasons.[8] Many infections happen due to contaminated or dirty wounds, like peritonitis. It causes longer hospital stays, unnecessary antibiotic use, and makes healthcare costlier. Wound dehiscence is a serious complication that can lead to evisceration. This complication was also found at a significant rate. The data shows that it is commonly associated with factors like infection, poor nutritional condition, and comorbidities. It can include anemia or diabetes, which are commonly found in the community.[9]

In simpler terms, when a dirty wound is closed, a large amount of dirt, bacteria, and necrotic substance gets trapped for the most part in the wound. Thus, they promote infection. In the early phases, the wound was left open to allow it to drain, while the impending infection was treated to ultimately heal.[10] According to the wound classification system by the Centers for Disease Control and Prevention (CDC), this practice aligns with the surgical principles associated with contaminated or dirty wounds. Not all surgeons are persuaded to use DPC in all cases, which is related to the concerns of discomfort in patients.[11]

Multiple international studies have reported that altered timing of wound closure can significantly reduce postoperative infection rates in contaminated abdominal surgeries. Research in countries such as India and South Asia that enjoy a healthcare environment similar to that of Pakistan has all reported a drop in wound infections by approximately 40-50 % in cases of early closure to 15-25 % of cases in cases of delayed closure.[12] The importance of these results is largely due to the connection between the socioeconomic and environmental issues that drive the high rates of infections. In Western countries, however, the literature documents low base-level infection rates and even questions whether closure needs to be postponed, which is suggestive of the difference in the patient population in which the surgery will take place, the surgery environment, and the level of quality of the perioperative care.[13]

METHODOLOGY

A non-probability consecutive sampling technique was used to select randomized controlled trial which was carried out at the Department of Surgery, Ghulam Muhammad Mahar Medical College (GMMC) and Civil Hospital, Sukkur. The time frame was six months as between from 26th February, 2025 to 30th August, 2025. Ethical Review Committee of GMMC/Civil Hospital, Sukkur (ERC No. CMC/RER/217) gave its approval before the beginning of the study. An independent institutional ethics committee granted permission to the research to make sure that ethical standards were met in line with the Declaration of Helsinki. Informed consent was taken in written form during the enlistment of all the participants and privacy of patient information was ensured during the entire study.

Eighty patients (20 to 70 years of both genders) that underwent primary midline laparotomy repair were enrolled. The sample size was estimated with the help of the OpenEpi soft (version 3.01) considering a confidence interval of 95 percent, power of 80 percent and the anticipated rate of wound dehiscence difference between early and delayed closure methods using the published literature of the previous researches (1, 2) in the first place.

Patients, who had primary laparotomy in the midline, and experienced peritonitis as a result of appendicular rupture, perforated peptic ulcer, or bowel injury (traumatic) were included in the study. There were emergency as well as elective laparotomy cases. The participants were eligible provided that their physical status of ASA (American Society of Anesthesiologists) is I–III and they are hemodynamically stable and fit to be put under general anesthesia. Patients were eliminated when they had renal failure, diabetes mellitus, bleeding disorders, chronic liver disease, HIV/AIDS or any other immunocompromised condition, recurrent peritonitis, or were taking long-term corticosteroid treatment.

A pre-designed pro forma was used to record clinical and demographic data, such as age, sex, weight, length of peritonitis, ASA grade, smoking status, anemia, hypertension, and residential location. The lottery method was used to randomly allocate the participants to two groups of equal size (40 individuals) (Group A -Delayed Primary Closure and Group B -Early Primary Closure).

In the first group (Delayed Primary Closure), the peritoneal layer was first stitched followed by loose closure of the musculoperitoneal layer using Prolene sutures. The wound was then stuffed with povidone-iodine impregnated gauze. The tightening of sutures was done slowly on the 5th postoperative day and taken off on the 12th postoperative day.

Group B (Early Primary Closure): The musculoperitoneal layer, fascia, and skin were closed immediately using standard Prolene sutures that were removed on the 8 th postoperative day. The operations were carried out by the same surgical team in all procedures under general anesthesia to reduce the inter-operator variability. All the cases were noted in terms of the duration of operation and intraoperative blood loss. All patients were provided with standard antibiotic

therapy on the initial day of postoperative period and continued up to the time of discharge according to the hospital protocol. The postoperative assessment on the wound was done 48 hours after operation and finally up to 15 days after the surgery to determine the surgical site infections and wound dehiscence as per the hospital post-operative care protocols.

RESULTS

Out of 80 patients who underwent primary closure of the midline laparotomy for peritonitis, 47 (58.8%) were male and 33 (41.3%) were female. The average age of patients was 44.0 ± 12.37 years (Table 1). These patients were equally split into two groups of 40 each. Group A was subjected to delayed primary closure in which the musculoperitoneal layers were closed first, then the fascia and skin were loosely approximated with Prolene sutures, and povidone-iodine-soaked gauze was used to pack the wound. Group B, on the other hand, had early primary closure that was done by closing both the fascia and the skin in interrupted Prolene sutures.

A total of 54 patients (67.5%) were from urban areas, 26 (65.0%) were in the delayed closure group, and 28 (70.0%) were in the early closure group, whereas 26 patients (32.5%) were residing in rural areas, 35.0% from group A and 30.0% from Group B. About their medical history, a smoking history was present in 24 (30.0%). More patients were present in group B (15 patients, 37.5%) rather than in group A (9 Patients, 22.5%). Hypertension was common in 28 patients (35.0%) and was equally common in both groups. Seventeen patients (21.3%) were found to be anemic, more in group A (25.0%) than in group B (17.5%). Eleven patients (13.8%) had no significant past medical history. As per the American Society of Anesthesiologists (ASA) classification, 52 patients (65.0%) were ASA I (normal healthy) with 27 (67.5%) in Group A and 25 (62.5%) in Group B and remaining 28 patients (35.0%) were ASA II (mild systemic disease) including 13 (32.5%) in Group A and 15 (37.5%) in Group B. Thus the two groups were comparable in demographic and clinical characteristics and baseline factors were comparable as per table 1.

Both groups were also evaluated for the duration of peritonitis pre-surgery. The delayed closure group experienced peritonitis for a mean time of 4.53 ± 0.60 days, and the early closure group experienced peritonitis for a mean time of 4.10 ± 0.81 days, as illustrated in Table 1.

Postoperatively, a wound infection developed in 27 patients (33.8%) overall. This was significantly higher in early closure 18 (45.0%), as compared to delayed closure 9 (22.5%). According to the Pearson Chi-Square statistical analysis, the results were statistically significant with p value = 0.033 ($x^2 = 4.53$). It indicates that delayed primary closure is associated with fewer wound infections (Table 2).

The incidence of wound dehiscence, however, was seen in 14 patients (17.5%). However, the incidence was much higher in the early closure group with 11 patients (27.5%), and only 3 patients (7.5%) in the delayed closure group. This difference was also statistically significant ($x^2 = 4.53$, $p = 0.033$). Based on these findings, delayed primary closure may lower the incidence of wound infection and dehiscence in patients undergoing midline laparotomy for peritonitis. Thus, it may enable the surgeon to have an edge over early primary closure in managing contaminated surgical wounds Table 2.

The subgroup analyses showed the effect of delayed primary closure versus early primary closure on wound infection and wound dehiscence across various characteristics. The gender-wise analysis showed that in females, the rate of wound infection was significantly lower with delayed closure that is statistical significance was seen in females, i.e., $p = 0.019$. However, in males, no statistical significance was observed, i.e., $p = 0.312$. It implies that women may benefit the most from delayed closures to reduce post-operative infection. Wound dehiscence showed a similar outcome where fewer events happened in females with delayed closure ($p = 0.041$), while males did not show any significant finding, Tables 3 & 4.

Where a person lives affected their outcome, but it was not a significant difference when analyzed separately for urban and rural groups regarding wound infection. Nevertheless, the study showed that wound dehiscence rates were lower among the urban patients who had delayed closure ($p = 0.029$). Thus, it can be inferred that the urban factors may interact with closure timing to affect wound healing. In rural groups, there were no significant differences, potentially due to limitations of sample size or other contextual factors Tables 3 & 4.

Reviewing the patient's history revealed that anemia was significantly associated with a higher rate of wound infection ($p=0.034$) and also with dehiscence ($p=0.023$) for early closure. It indicates that in case of early closure, anemic patients may be at greater risk of wound complications; hence, surgeons should also consider the preoperative condition during closure techniques. In contrast, the closure groups did not show any statistically significant difference in other histories like smoking and hypertension Tables 3 & 4.

Lastly, assessment based on the American Society of Anesthesiologists (ASA) classification showed trends favoring delayed closure in reducing wound complications, especially in ASA class I patients. Although these results did not reach statistical significance in all analyses, the borderline p-values for wound dehiscence ($p = 0.050$) suggest that healthier patients might also derive benefit from delayed closure (Table 3 & 4). In addition to wound-related outcomes, operative characteristics were analyzed to assess any differences between the delayed and early closure groups.

Table 1. Baseline demographic and clinical characteristics of patients in delayed (Group A) and early (Group B) wound closure groups (n = 80)

Parameters	Total (n=80)	Group A: Delayed Closure (n = 40)	Group B: Early Closure (n = 40)
Sex			
Male	47 (58.8%)	24 (60.0%)	23 (57.5%)
Female	33 (41.3%)	16 (40.0%)	17 (42.5%)
Mean Age (years)		44.0 ± 12.37	
Residence			
Urban	54 (67.5%)	26 (65.0%)	28 (70.0%)
Rural	26 (32.5%)	14 (35.0%)	12 (30.0%)
History			
Smoking	24 (30.0%)	9 (22.5%)	15 (37.5%)
Hypertension	28 (35.0%)	14 (35.0%)	14 (35.0%)
Anemia	17 (21.3%)	10 (25.0%)	7 (17.5%)
No Medical History	11 (13.8%)	7 (17.5%)	4 (10.0%)
ASA Classification			
ASA I	52 (65.0%)	27 (67.5%)	25 (62.5%)
ASA II	28 (35.0%)	13 (32.5%)	15 (37.5%)
Duration of Peritonitis (days)		4.53 ± 0.60	4.10 ± 0.81

Table 2. Comparison of wound dehiscence and infection rates between delayed and early primary closure in midline laparotomy for peritonitis

Outcomes	Categories	Delayed Closure (n = 40)	Early Closure (n = 40)	p-value
Wound Dehiscence	Yes	3 (7.5%)	11 (27.5%)	**0.019***
	No	37 (92.5%)	29 (72.5%)	
Wound Infection	Yes	9 (22.5%)	18 (45.0%)	**0.033***
	No	31 (77.5%)	22 (55.0%)	

The mean operative time was slightly longer in the delayed closure group (123.65 ± 14.44 minutes) compared to the early closure group (121.50 ± 12.08 minutes); however, this difference was not statistically significant (p = 0.472) Table 5.

Intraoperative blood loss was significantly higher in the delayed closure group than in the early closure group. The mean blood loss was 354.10 ± 42.36 ml in the delayed closure group and 305.25 ± 35.46 ml in the early closure group (p < 0.001). This difference of nearly 49 ml suggests that delayed closure patients experienced more bleeding during surgery, which could be related to the condition of the wound or the need for additional surgical measures associated with delayed closure Table 5.

DISCUSSION

The study compared the results of delayed primary closure and early primary closure in patients who had a midline laparotomy operation to repair peritonitis, considering in terms of wound complications, operative parameters, and subgroup differences with respect to demographic and clinical characteristics. The similarities in the various characteristics of the two groups, such as age, gender, comorbidities, and ASA classification, support the internal validity of the comparative analysis.

This significantly reduced wound infection and wound dehiscence observed in the delayed closure group can be compared to a growing body of literature supporting the practice of delayed primary wound closure in dirty or potentially infectious wounds. Delayed closure provides adequate drainage, debride, and improved local infection control before definitive closure, which is perhaps the reason behind the 50% decrease in wound contamination 22.5% vs. 45.0%) and equally lower dehiscence rates (7.5% vs. 27.5%) in this study. These findings are consistent with the prior studies because it was established that delayed closure techniques of contaminated abdominal wounds lead to superior wound healing and lower infection rates.[14]

There were also some significant details provided in the subgroup analyses, including gender-specific benefits of delayed closure. This massive reduction in wound infections and dehiscence among females but not males can be explained by differences in the moods of the skin and connective tissue, hormonal, or wound healing processes that have been previously advanced in the literature.[15] These differences

Table 3. Association of wound infection with patient demographics, clinical history, and ASA classification in delayed and early primary closure groups.

	Wound Infection	Closure		Total	p-value
		Delayed	Early		
Place of Residence					
Urban	Yes	5	11	16	0.107
	N o	21	17	38	
Rural	Yes	4	7	11	0.126
	N o	10	5	15	
Gender					
Male	Yes	8	11	19	0.312
	N o	16	12	28	
Female	Yes	1	7	8	0.019*
	N o	15	10	25	
History					
Smoking	Yes	3	9	12	0.206
	N o	6	6	12	
Hypertension	Yes	3	2	5	0.622
	N o	11	12	23	
Anemia	Yes	2	5	7	0.034*
	N o	8	2	10	
Insignificant	Yes	1	2	3	0.201
	N o	6	2	8	
ASA					
I	Yes	7	12	19	0.099
	N o	20	13	33	
II	Yes	2	6	8	0.150
	N o	11	9	20	

between the genders show that patient-centered surgery is essential because females could gain more in case delayed closure is adopted in high-risk settings.

The statistically significant influence of residence on wound dehiscence was found in urban delayed wound closure patients, but not on infections. This may reflect the enhanced care after an operation and the availability of healthcare centers in the cities, which can aid in the process of identifying and controlling complications earlier.[16] Other factors, such as late presentation or poor compliance phase and environmental differences, may influence the outcome of rural patients; thus, there is a necessity to intervene with specific postoperative interventions among different populations.[17]

It is worth noting that the issue of anemia was critical enough to predispose wound complications in particular situations where early closure was performed. There were higher rates of infection and dehiscence among the anemic patients in the early closure group, which highlights the importance of systemic physiological status in wound healing of the local area. This finding is consistent with the recommendations made by the previous studies,[18,19] which stress the need to improve the patient conditions before the operation, and to use delayed closure in the at-risk population to improve the outcome.

Operative parameters showed that there was no meaningful difference in operative time in the groups, which implies that delayed closure does not add much time to the surgical time, which is a crucial fact to consider when using the resources of the operating room. Nevertheless, the intraoperative hemorrhage discharged in the delayed closure was considerably higher. It could be explained by the fact that the wound environment demands a more detailed debridement and hemostasis before the closure, or, possibly, by a long-term exposure of the tissues to the environment and their manipulation. Agrawal et al. (2017) highlighted similar results, as the risk of bleeding was higher with delayed abdominal surgery closure in case of contamination. In spite of this, the clinical importance of the difference of about 49 ml of the blood loss should be offset against the lower postoperative wound morbidity that is observed in delayed closure.[20]

The ASA trends (classification) indicated that the healthier patients (ASA I) could be helped through delayed closure,

Table 4. Association of wound dehiscence with patient demographics, clinical history, and ASA classification in delayed and early primary closure groups

	Wound Dehiscence	Closure		Total	p-value
		Delayed	Early		
Place of Residence					
Urban	Yes	1	7	8	0.029*
	No	25	21	46	
Rural	Yes	2	4	6	0.250
	No	12	8	20	
Gender					
Male	Yes	2	5	7	0.197
	No	22	18	40	
Female	Yes	1	6	7	0.041*
	No	15	11	26	
History					
Smoking	Yes	2	6	8	0.371
	No	7	9	16	
Hypertension	Yes	1	2	3	0.541
	No	13	12	25	
Anemia	Yes	0	3	3	0.023*
	No	10	4	14	
Insignificant	Yes	0	0	0	---
	No	7	4	11	
ASA					
I	Yes	2	7	9	0.050*
	No	25	18	43	
II	Yes	1	4	5	0.191
	No	12	11	23	

Table 5. Comparison of operative time and intraoperative blood loss between delayed and early primary closure groups

Variables	Groups	N	Mean ± SD	p-value
Operative Time (in minutes)	Delayed Closure	40	123.7 ± 14.4	0.472
	Early Closure	40	121.5 ± 12.1	
Blood Loss (in ml)	Delayed Closure	40	354.1 ± 42.4	0.000*
	Early Closure	40	305.3 ± 35.5	

but the statistical significance was marginal. This concurs with clinical reasoning that patients with fewer systemic comorbidities are capable of wound healing better and could therefore experience more benefit from maximized closure methods [21].

This study yields useful results; however, some limitations should be acknowledged to interpret the findings properly. The relatively limited sample size means the investigators may not be able to detect smaller but clinically important differences between the delayed primary closure and early primary closure groups. Next, the single institution study may limit the applicability of study results to other health care setups of diverse surgical skills, after-surgical protocols, and patient and public demographics. The third issue is that the follow-up period may not have been long enough to observe the late-onset complications related to the wound, for example, incisional hernias or infection of the wound, which becomes chronic. The researchers relied on clinical observation to identify wound infection instead of standard microbiological confirmation, which raised the concern of observer bias. Ultimately, although the groups were matched for demographic and clinical characteristics, unaccounted-for factors such as nutritional status, intraoperative contamination grade, and variations in antibiotic use may have influenced the results. Larger multicenter studies with standardized postoperative monitoring should be undertaken in the future to prove and strengthen these results.

CONCLUSION

The study supports the clinical benefit of delayed primary closure in the treatment of peritonitis wounds in midline laparotomy to avoid wound infections and dehiscence. The subgroup results highlight the need to assess patients individually, taking into account gender, the presence or absence of anemia, and residence, to be able to plan surgical closure. Although an unpromising delay to close could be associated with a slightly greater amount of blood loss, it is compensated with better wound healing rates, justifying its use as the solution of choice in contaminated abdominal surgery. Subsequent multicenter studies involving a larger sample size could help to explain these associations and support the best closure guidelines among varied populations of patients.

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Liaqat Ali: Conception and design of study, data collection, drafting of manuscript, final approval.
Imamuddin Baloch: Study design, supervision, methodology refinement, critical review of manuscript.
Javeria Memon: Data acquisition, literature review, initial drafting of sections.
Ahsan Ali: Methodology guidance, interpretation of results, critical revision.
Muhammad Sheeraz: Data entry, statistical analysis, preparation of tables/figures.
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