Section: General Surgery

Original Research Article

COMPARATIVE STUDY OF CONTINUOUS INTERMITTENT CROSSED VERSUS CONTINUOUS SUTURING TECHNIQUES FOR LINEA ALBA CLOSURE IN MIDLINE EXPLORATORY LAPAROTOMY

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Received *: 28/06/2025*
Received in revised form *: 08/08/2025*
Accepted *: 30/08/2025*

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DOI: 10.70034/ijmedph.2025.3.444

Source of Support: Nil,
Conflict of Interest: None declared

Int J Med Pub Health
2025; 15 (3); 2410-2414

ABSTRACT

Background: Midline exploratory laparotomy requires optimal linea Alba closure to preserve abdominal wall integrity, prevent wound complications, and promote healing. Continuous intermittent crossing suturing may improve tensile strength and localized tension distribution, although continuous suturing is more efficient. **Objective:** Evaluate intraoperative closure parameters and short-term postoperative outcomes of continuous intermittent crossed versus continuous suturing procedures for line an Alba closure during midline exploratory laparotomy.

Materials and Methods: This prospective randomized trial had 60 adult patients undergoing midline exploratory laparotomy, who were divided into two equal groups. Group A underwent line an Alba closure via continuous intermittent crossing suturing, while Group B received continuous suturing. Baseline demographics, intraoperative closure duration, suture length, suture-to-wound length (S/W) ratio, and postoperative wound problems (infection, dehiscence) were documented. Data were analysed utilizing SPSS version 25.0, with a significance threshold set at $p<0.05$.

Results: The mean age was 34.20 ± 12.84 years in Group A and 36.93 ± 16.47 years in Group B ($p = 0.470$). The closure time in Group A was marginally longer (23.93 ± 4.22 sec) than in Group B (21.47 ± 6.44 sec; $p = 0.050$). The suture length, wound length, and suture-to-wound ratio were similar across the groups ($p>0.05$). Wound infection was observed in 13.3% of patients in both cohorts, while wound dehiscence occurred in 3.3% and 6.7%, respectively ($p = 0.554$).

Conclusion: Both methods produced comparable short-term wound results. Continuous suturing provided slightly quicker closure, whereas continuous intermittent crossing suturing remains a feasible option, especially in specific high-risk situations. Extended investigations are required to assess the incidence rates of incisional hernias.

Keywords: Linea Alba, midline laparotomy, continuous suturing, intermittent crossed suturing, wound dehiscence

INTRODUCTION

Exploratory laparotomy opens the abdominal cavity to explore and treat intra-abdominal disorders when non-invasive diagnostic methods fail or emergency action is needed. Acute abdomen, trauma (particularly hemodynamic instability), suspected perforation, haemorrhage, peritonitis, intestinal blockage, ischemia, or staging intra-abdominal cancers are the main indications.[1,2] A midline incision under general anaesthesia allows access to all abdominal organs. The liver, stomach, intestines,

and pelvic organs are examined in order.[3,4] Although invasive, exploratory laparotomy is necessary for diagnosis and treatment, especially in emergencies. The procedure can cause infection, hemorrhage, adhesions, prolonged ileus, and incisional hernias. Thus, its usage requires cautious patient selection, especially in severely ill or elderly patients.[5,6] Open exploratory laparotomies are still necessary for unstable patients or those with circumstances unsuitable for laparoscopic surgery, despite developments in imaging and minimally invasive surgery. Abdominal and gynaecological exploratory laparotomies often involve midline incisions. It allows quick and wide access to the abdominal and pelvic cavity without damaging muscles, nerves, or blood supply because they do not cross the midline.[7-9] The linea alba is essential in midline exploratory laparotomy. The fibrous, avascular plane runs vertically down the abdomen between the rectus abdominis muscles. A midline incision using the linea alba allows surgeons to explore the abdominal cavity.[10] Ideal post-surgery closures provide strength and infection protection. That goal requires a rapid, efficient, tension/ischemia-free, patient-comfortable, surgeon-friendly, and esthetic closure.[7] Wound dehiscence can range from mild disruption to full abdominal incision bursting. Burst abdomen or wound disruption is a mechanical wound healing failure. These complications cause significant morbidity and higher healthcare expenditures due to prolonged hospitalization, nursing care, and resource-intensive management. Post-laparotomy wound dehiscence is normally 1% to 3%,[11,12] however, some centres in India have reported rates of 10% to 30%.[13] This diversity highlights its multifactorial etiology, influenced by diverse pre-, intra-, and postoperative events. One of the primary causes is surgical site infection (SSI). Infection causes local inflammation, tissue necrosis, and wound edge weakening, leading to mechanical closure failure. Infection also slows wound healing and inhibits collagen synthesis, affecting wound integrity. Although perioperative optimization and critical care have improved, total wound dehiscence remains a serious and possibly life-threatening complication with increased morbidity and mortality. The abdominal closure technique, including suture material and pattern, can cause wound dehiscence.[14] These criteria may not matter in low-risk elective procedures, but they are crucial in emergency surgeries with many risk factors.[15] The present study examined wound infection, wound dehiscence, and intraoperative time in midline laparotomy patients and compared intermittent crossing suture and continuous suturing of linea alba.

MATERIALS AND METHODS

This prospective interventional study was performed in the Department of Surgery at Era's Lucknow Medical College & Hospital (ELMCH), a tertiary care facility in Lucknow primarily serving socio-economically disadvantaged suburban and rural communities. The trial lasted twenty-four months. Approval for the study was secured from the Institutional Ethical Committee, and written informed permission was collected from all individuals before enrolment. The study encompassed all patients, regardless of gender, aged 18 years and older, undergoing midline exploratory laparotomy in the Department of General Surgery at ELMCH. Patients with a history of abdominal surgery with a midline incision scar, or those with comorbidities such as renal failure, cancer, undergoing radiotherapy or chemotherapy, or collagen vascular disease were excluded. The sample size was determined at 90% power using data from Roy et al. accounting for postoperative wound infection rates of 40.5% in the continuous suturing group and 32.4% in the interrupted suturing group. The minimal sample size, calculated using standard formulas with α=5% and β=10%, was established at 30 patients each group, yielding a total of 60 patients. Eligible patients were randomized into two groups utilizing the sealed envelope (SNOSE) method: Group A (continuous intermittent cross suture technique) and Group B (continuous suture technique). In every instance, the peritoneal cavity was meticulously irrigated with warm normal saline until the effluent appeared clean. Closure was executed with Vicryl sutures, and the duration of rectus closure along with the total length of suture material utilized was documented. All patients received pre-operative antibiotics, which were maintained post-operatively. The postoperative evaluation encompassed surveillance for surgical site infection (SSI) and wound dehiscence. The initial dressing was removed after 48 hours, and the wound was examined with each dressing change. Swab cultures were dispatched for microbiological examination and antibiotic susceptibility testing in cases of suspected infection.

Statistical analysis: Data was collected and analyzed utilizing SPSS (Statistical Package for Social Sciences) Version 21.0. Categorical variables were represented as frequency and percentage, with comparisons conducted using the Chi-square test. A p-value less than 0.05 was deemed statistically significant.

RESULTS

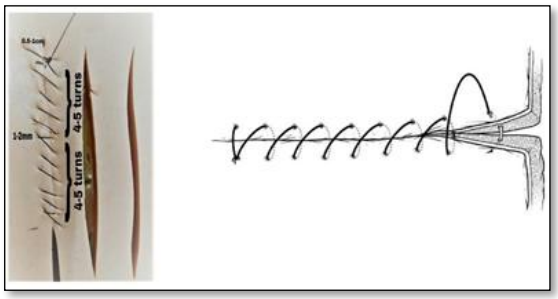

Fig. 1: Continuous intermittent crossed suturing
Fig. 2: continuous suturing technique

Table 1: Baseline Demographic Characteristics of the Study Population

		Group A (n=30)		Group B (n=30)		p-Value
		n	%	n	%	
Age	18-30 yrs	17	57	13	43	0.109
	31-40 yrs	4	13	7	23	
	41-50 yrs	6	20	4	13	
	51-60 yrs	3	10	3	10	
	≥60 yrs	0	0.0	3	10	
	Mean±SD	34.20±12.84		36.93±16.47		0.470
Gender	Female	7	23.3	11	36.7	0.405
	Male	23	76.6	19	63.3	

Table 1 shows the baseline demographics of Group A (Continuous Intermittent Crossed suturing) and Group B. Group A had a mean age of 34.20 ± 12.84 years, while Group B had 36.93 ± 16.47 years, which was not statistically significant (p = 0.470). Most patients were 18–30 years old (57% in Group A vs. 43% in Group B), followed by 41–50. Only Group B comprised participants aged ≥60 years (10%), however the age distribution did not differ significantly (p = 0.109). Males predominated in both groups (76.6% in Group A vs. 63.3% in Group B), whereas females made up 23.3% and 36.7%, respectively (p = 0.405).

Table 2: Comparison of Intraoperative Closure Parameters between Continuous Intermittent Crossed and Continuous Suturing Techniques

	Group A (n=30)		Group B (n=30)		p-Value
	Mean	±SD	Mean	±SD	
Suture Timing (sec.)	23.93	4.22	21.47	6.44	0.050
Suture Length (mm)	65.60	9.71	63.23	9.04	0.333
Wound Length (mm)	14.77	2.23	14.33	2.40	0.471
S/W Ratio	4.44	0.21	4.43	0.26	0.912

Table 2 compares intraoperative closure parameters for Group a (Continuous Intermittent Crossed suturing) with Group B. The mean suture timing was 23.93 ± 4.22 seconds in Group A and 21.47 ± 6.44 seconds in Group B, indicating a trend towards faster closure in Group B, while the difference was only marginal (p = 0.050). Group A used a mean suture length of 65.60 ± 9.71 mm, while Group B used 63.23 ± 9.04 mm, with no significant difference (p = 0.333). The wound length was similar between groups (14.77 ± 2.23 mm vs. 14.33 ± 2.40 mm; p = 0.471). The suture-to-wound length (S/W) ratio was similar in both groups (4.44 ± 0.21 vs. 4.43 ± 0.26; p = 0.912), showing no impact of closure technique.

Table 3: Postoperative Wound Complications in the Two Study Groups

	Group A (n=30)		Group B (n=30)		p-Value
	n	%	n	%	
Wound Infection	4	13.3	4	13.3	-
Wound Dehiscence	1	3.3	2	6.7	0.554

The two study groups' postoperative wound problems are shown in Table 3. Four patients (13.3%) in Group A (Continuous Intermittent Crossed suturing) and Group B (Continuous suturing) developed wound infections, suggesting no difference.One patient (3.3%) in Group A had wound dehiscence, compared to two (6.7%) in Group B. This change was insignificant (p = 0.554). The frequency of postoperative wound problems was similar across the two groups, suggesting that both closure methods prevented early wound morbidity.

DISCUSSION

The closure of the linea alba after midline exploratory laparotomy is a crucial factor affecting postoperative outcomes, including wound healing, infection risk, abdominal wall structural integrity, and aesthetic results. The linea alba, a robust fibrous formation resulting from the convergence of the abdominal wall muscle aponeuroses, provides a relatively avascular yet mechanically resilient midline access point for abdominal surgery. Nevertheless, insufficient approximation or excessive tension during closure predisposes patients to wound dehiscence, surgical site infection (SSI), and incisional hernia. The optimal closure technique must reconcile efficiency, security, and tissue preservation.

Current best practices advocate for the utilization of slowly absorbable monofilament sutures, such as polydioxanone, or non-absorbable materials like polypropylene, while providing a suitable bite depth (≥1 cm), spacing (~1 cm), and a suture length-to-wound length (SL:WL) ratio of no less than 4:1.[16]

These concepts facilitate uniform tension distribution and mitigate the likelihood of fascial breakdown. Continuous suturing provides time efficiency, consistent tension, and less foreign body burden; yet, it may jeopardize the complete closure if a section fails. Conversely, the continuous intermittent crossing technique integrates intermittent cross-locks at regular intervals, which may augment tensile strength, concentrate the effects of failure, and promote drainage in contaminated areas.[17]

This randomized trial, including 60 patients undergoing midline exploratory laparotomy, found that baseline demographics, including age (mean 34.2 ± 12.84 years in Group A versus 36.93 ± 16.47 years in Group B) and gender distribution (male predominance in both groups), were comparable. The comparatively younger cohort differs from the findings of previous studies where mean ages surpassed 45 years, potentially accounting for the reduced complication rates noted in our investigation, since younger patients typically exhibit enhanced tissue healing capabilities.[18,19]

The closure time was somewhat longer with the continuous intermittent crossed technique (23.93 ± 4.22 sec) compared to continuous suturing (21.47 ± 6.44 sec), exhibiting a borderline statistical difference ($p = 0.050$) with limited clinical significance. Similarly, a study saw expedited closure with continuous suturing.[20] The suture length and SL:WL ratios were almost comparable across groups, in contrast to the findings previous studies, they reported significantly higher suture utilization in crossing sutures—variations that may arise from changes in incision length or the standardization of closure techniques.[21,22]

In our study, the incidence of wound infection (13.3% in both cohorts) and wound dehiscence (3.3% vs. 6.7%) exhibited no statistically significant difference, similarly previous studies identified no definitive advantage of one technique over the other in mitigating short-term complications.[18,19] Conversely, certain extensive trials, a study indicated reduced incidences of ruptured abdomen with interrupted-X closure in high-risk patients, implying that advantages may be more evident in polluted or high-tension wounds.[23]

The limitation of our study is the short follow-up time, which hinders the assessment of incisional hernia—a complication that frequently develops months to years after surgery. Many comparative studies include follow-up durations of 6 to 12 months, enabling the evaluation of fascial durability. The low sample size may have reduced our ability to discern differences in very infrequent events, such as wound dehiscence. The current data indicate that both continuous and continuous intermittent crossing approaches yield similar short-term results regarding infection and dehiscence, with only a slight variation in closure duration. Continuous closure may provide slight efficiency benefits for maintaining clean surgical areas. In instances of contamination or where long-term fascial integrity is critical, intermittent crossing closure is a viable option, providing redundancy in cases of partial suture failure. Subsequent research should be multicentric, encompass bigger sample numbers, stratify patients by contamination class and comorbidities, and include a minimum of 12 months of follow-up to evaluate hernia occurrence. Moreover, standardized documentation of wound dimensions, closure duration, and SL: WL ratio is crucial for significant understudy comparability.

CONCLUSION

Both methods for midline exploratory laparotomy linea alba closure, continuous intermittent crossing and continuous suturing, had similar short-term rates of wound infection and dehiscence. Suture length and suture-to-wound length ratios were similar between groups; however, continuous suturing reduced closure time slightly. These data suggest that either approach can be used, depending on patient risk factors, wound features, and surgeon preference. Larger studies with longer follow-up are needed to determine their usefulness in reducing late complications such as incisional hernia.

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