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To Comparative Study of Continuous Intermittent Crossed Versus Continuous Suturing Techniques for Linea Alba Closure in Midline Exploratory Laparotomy at a Tertiary Care Centre

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Abstract

Objective: This study evaluates intraoperative closure parameters and short-term postoperative outcomes comparing continuous intermittent crossed suturing to continuous suturing techniques for linea alba closure in midline exploratory laparotomy. ***Methods:*** This prospective randomized study total 60 patients undergoing midline exploratory laparotomy, divided into two equal groups: Group A underwent linea alba closure using continuous intermittent crossing suturing, while Group B received continuous suturing. Key metrics documented included baseline demographics, intraoperative closure duration, suture lengths, suture-to-wound length (S/W) ratio, and postoperative wound complications such as infection and dehiscence. ***Results:*** Total 60 patients 30 in each group. Male predominance in both groups, with females making up 30% in Group A and 33.33% in Group B, while males constituted 70% and 66.67%, respectively. The study compared two groups, Group A and Group B, with mean ages of 35.45± 13.54 years and 37.63± 16.77 years, respectively (p = 0.688). Group A had a slightly longer closure time averaging 24.88 ± 4.52 seconds compared to 22.38± 6.52 seconds in Group B (p = 0.68). Other parameters, including suture length, wound length, and the suture-to-wound ratio, showed no significant differences between the groups (p>0.05). Additionally, wound infection occurred in 16.67% of patients in both groups, while wound dehiscence was noted in 6.67% of patients in each cohort. ***Conclusion:*** Both wound closure methods assessed yielded similar short-term results. Continuous suturing led to slightly faster closure times, while continuous intermittent crossing suturing is also a viable choice, notably in high-risk cases. Further studies are needed to evaluate the rates of incisional hernias.

Keywords: ***Midline laparotomy, Linea alba, intermittent crossed suturing, continuous suturing, wound dehiscence.***

Introduction

Exploratory laparotomy is a surgical procedure involving an abdominal incision to investigate and treat intra-abdominal disorders when less invasive methods are inconclusive or urgent intervention is necessary. It is primarily indicated for acute abdomen, trauma with hemodynamic instability, suspected organ perforation, significant hemorrhage, peritonitis, intestinal blockage, ischemia, or cancer staging. This procedure enables definitive diagnoses and therapeutic actions in critical conditions and includes midline laparotomy for rapid access to the peritoneal cavity [1,2]. A critical aspect of this procedure is the closure of the abdominal wall, specifically at the linea alba, which is vital for ensuring adequate wound strength, preventing complications like dehiscence, and reducing postoperative issues such as incisional hernia and surgical site infections (SSI), as highlighted by Millbourn *et al*.[3]. Over the years, the techniques for closing the abdominal wall have advanced, yet there remains significant debate over the optimal suturing method, the choice of suture materials, and overall closure strategies that can lead to improved clinical outcomes [4].

The linea alba, a tendinous structure characterized by limited blood supply, is especially susceptible to impaired wound healing and tensile stress following laparotomy procedures. The effectiveness of suturing techniques plays a crucial role in determining tissue perfusion, wound strength, and the ability to withstand intra-abdominal pressure [5]. If closure techniques are not performed correctly, there could be severe complications such as wound dehiscence, evisceration, or incisional hernia. These issues

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not only increase patient morbidity but also extend hospital stays and elevate healthcare costs [6].

Continuous suturing has been popular for its ease of use, even distribution of tension, and shorter surgical duration. However, this method can lead to "purse-string" effects that may hinder blood flow and tissue healing when excessive tension is applied [7]. On the other hand, intermittent (interrupted) suturing allows for better localized control of tension and adaptability to changes in tissue edema, but it is more labor-intensive and requires greater amounts of suture material [8]. The introduction of crossed continuous suturing, or the "figure-of-eight" modification, seeks to merge the benefits of both techniques, enhancing tissue approximation, even tension distribution, and mitigating issues related to suture slippage[9].

Post-laparotomy wound dehiscence rates typically range from 1% to 3%, but some Indian centers report rates as high as 10% to 30%. This variation is due to its multifactorial causes, primarily surgical site infection (SSI), which leads to inflammation, tissue necrosis, and compromised wound integrity, thereby delaying healing [10,11]. Despite advancements in perioperative care, total wound dehiscence remains a significant complication with heightened morbidity and mortality risks. The technique used for abdominal closure, including suture material and pattern, plays a critical role, especially in high-risk emergency surgeries [12,13].

Several studies have compared different closure techniques in terms of wound complications, pain, and long-term hernia formation. Some evidence suggests that continuous suturing with a small-bite technique (4:1 suture length to wound length ratio) may result in fewer incisional hernias [14]. However, other studies emphasize that the method of suturing and tissue handling may play a more significant role than the suture material alone [15]. Despite these findings, there remains no universal consensus on the most effective suturing technique for midline closure following exploratory laparotomy, particularly in resource-limited settings where surgical expertise, suture materials, and postoperative care vary widely.

Given the high rates of postoperative wound complications in developing countries, this study compares continuous, intermittent, and crossed continuous suturing techniques for closure of the linea alba after midline exploratory laparotomy. It evaluates outcomes like wound dehiscence, infection rates, pain levels, and incisional hernia formation, aiming to identify a safe, efficient, and cost-effective technique for general surgical practice. The present study analyzed the incidences of wound infection, wound dehiscence, and intraoperative time among patients undergoing midline laparotomy. It compared two suturing techniques: intermittent crossing suture and continuous suturing of the linea alba, aiming to evaluate the outcomes associated with each method.

Methods

This prospective interventional study was conducted over twenty-four months at the Department of Surgery, Maharaja Suhel Dev Autonomous State Medical College & Mahrishi Balark Hospitals in Bahraich, Uttar Pradesh, India. This tertiary care center primarily serves socio-economically disadvantaged suburban and rural communities. The study received approval from the Institutional Ethical Committee, and written informed consent was obtained from all participants prior to 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 Maharaja Suhel Dev Autonomous State Medical College & Mahrishi Balark Hospitals, Bahraich, Uttar Pradesh, India. 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. Total 60 patients (30 in each group) included in the study. The sample size was set at 90% power, based on Roy *et al*., with postoperative wound infection rates of 40.5% for continuous suturing and 32.4% for interrupted suturing. The minimal sample size, calculated with α=5% and β=10%, was established at 30 patients per group, total 60 patients [16].

Eligible patients were assigned to two groups via the sealed envelope (SNOSE) method: Group A employed a continuous intermittent cross suture technique, while Group B used a continuous suture technique. The peritoneal cavity was thoroughly irrigated with warm normal saline until clean effluent appeared. Vicryl sutures were used for closure, and both the duration of rectus closure and total length of suture material were recorded. Pre-operative antibiotics were administered and continued post-operatively. Postoperative evaluations involved monitoring for surgical site infections (SSI) and wound dehiscence. The initial dressing was removed after 48 hours, with wound assessments made at each change. Swab cultures were sent for microbiological examination and antibiotic susceptibility testing when infection was suspected.

Statistical Analysis

Data collection and analysis were performed using SPSS (Statistical Package for Social Sciences) Version 24.0. Categorical variables were expressed in terms of frequency and percentage, and comparisons were made using the Chi-square test. A p-value of less than 0.05 was considered statistically significant.

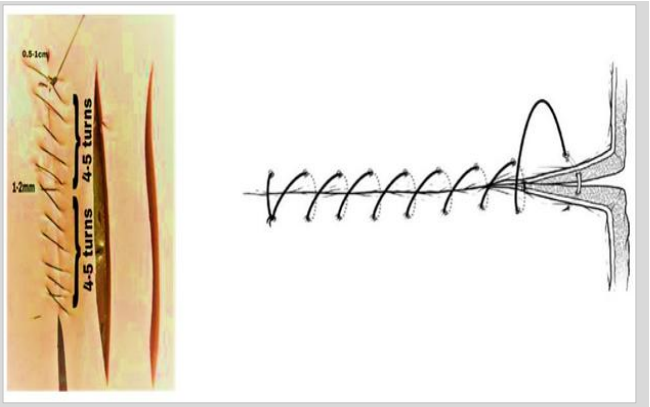

Fig. 1: Suture technique and continuous suture technique

Results

Group A (Continuous Intermittent Crossed suturing) and Group B were compared regarding baseline demographics. Group A had a mean age of 35.45 years (± 13.54), while Group B had a mean age of 37.63 years (± 16.77), with no statistically significant difference (p = 0.688). The majority of patients in both groups were aged 18–30, representing 53.33% in Group A compared to 43.0% in Group B. The next largest age group was 41–50 years. Notably, only Group B included participants aged 60 years and older, accounting for 10% of its population; however, the age distribution between the groups showed no significant difference (p = 0.189). Gender distribution revealed a predominance of males in both groups, with 70.0% in Group A and 63.3% in Group B, while females constituted 30.0% in Group A and 33.33% in Group B, also not statistically significant (p = 0.458).

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	16	53.33	13	43.0	0.189
	31-40 yrs	4	13	7	23.0	
	41-50 yrs	6	20	4	13.0	
	51-60 yrs	3	10	3	10.0	
	≥60 yrs	1	3.33	3	10.0	
	Mean±SD	35.45±13.54		37.63±16.77		0.688
Gender	Female	9	30.0	10	33.33	0.458
	Male	21	70.0	20	66.67	

In a comparison of intraoperative closure parameters between Group A (Continuous Intermittent Crossed suturing) and Group B, the mean suture timing was found to be 24.88 ± 4.52 seconds for Group A, contrasting with 22.38 ± 6.52 seconds in Group B, suggesting a tendency towards faster closure in Group B, though the difference was marginal (p = 0.068). The mean suture length in Group A was 65.80 ± 9.18 mm, while Group B's mean suture length was 64.35 ± 9.54 mm, which did not display a significant difference (p = 0.53). The wound lengths were comparable across both groups, measuring at 15.87 ± 3.53 mm for Group A and 15.39 ± 2.40 mm for Group B (p = 0.57). Additionally, the suture-to-wound length (S/W) ratio remained similar in both groups, recorded at 5.84 ± 1.21 for Group A and 4.83 ± 1.26 for Group B (p = 0.852), indicating no significant impact of the closure technique on the parameters assessed.

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.)	24.88±4.52	22.38±6.52	0.068
Suture Length (mm)	65.80±9.18	64.35±9.54	0.53
Wound Length (mm)	15.87±3.53	15.39±2.40	0.57
Suture-to-wound Ratio	5.84±1.21	4.83±1.26	0.852

The postoperative wound problems in the two study groups are summarized as follows: In Group A (Continuous Intermittent Crossed suturing), 5 patients (16.67%) developed wound infections, while 5 patients (16.67%) in Group B (Continuous suturing) also experienced infections, indicating no significant difference between the groups. Additionally, 2 patients (6.67%) in both Group A and Group B had wound dehiscence, with this change proving insignificant (p = 0.64). Overall, the frequency of postoperative wound issues was comparable in both groups, suggesting that both suturing methods effectively minimized early wound morbidity.

Table 3: Postoperative Wound Complications in the Two Study Groups

	Group A (n=30)		Group B (n=30)	
	n	%	n	%
Wound Infection	5	16.67	5	16.67
Wound Dehiscence	2	6.67	2	6.67

Discussion

In a study comparing Continuous Intermittent Crossed and Continuous Suturing Techniques for Linea Alba Closure in midline exploratory laparotomy, the Continuous Intermittent Crossed technique demonstrated superior wound strength and fewer postoperative complications due to better tension distribution along the suture line. The closure's quality impacts healing, infection risk, and abdominal wall integrity, with inadequate approximation or excessive tension leading to complications. Selecting an optimal closure technique is crucial for effective and secure outcomes.

Current best practices recommend using slowly absorbable monofilament sutures, such as polydioxanone, or non-absorbable materials like polypropylene. Key techniques include achieving an appropriate bite depth of at least 1 cm, a spacing of approximately 1 cm, and maintaining a suture length-to-wound length (SL:WL) ratio of no less than 4:1 [17].

These concepts enhance uniform tension distribution while reducing the risk of fascial breakdown. Continuous suturing is efficient and maintains consistent tension with minimal foreign body presence; however, it risks incomplete closure if a part fails. In contrast, the continuous intermittent crossing technique incorporates cross-locks intermittently, potentially increasing tensile strength, focusing failure effects, and facilitating drainage in contaminated areas [15].

This randomized trial involving 60 patients who underwent midline exploratory laparotomy revealed that baseline demographics, such as age and gender distribution, were comparable between the two groups. The mean age was 35.45 ± 13.54 years in Group A and 37.63 ± 16.77 years in Group B, with a male predominance observed in both groups. The study highlights differences in complication rates when comparing a younger cohort, whose mean age is below 45 years, to previous studies with older populations. The authors suggest that the superior tissue healing capabilities of younger patients may contribute to the observed lower complication rates in their investigation [18,19].

The closure time using the continuous intermittent crossed technique averaged 24.88 seconds (± 4.52 sec), which was longer than the continuous suturing method that averaged 22.38 seconds (± 6.52 sec). This difference was statistically borderline (p = 0.068) and exhibited limited clinical significance. Additionally, previous studies reported faster closure times associated with continuous suturing [20]. The study found that the suture length and SL:WL ratios were nearly equal among groups, differing from previous research

that indicated a greater use of sutures in crossing sutures. This discrepancy may be attributed to variations in incision length or the standardization of closure techniques [16,21].

In our study, the rates of wound infection were found to be 16.67% across both patient cohorts examined. The incidence of wound dehiscence was reported as 6.67% in one cohort and 6.7% in the other, indicating negligible difference between the groups. These results demonstrate no statistically significant differences, aligning with earlier research that similarly observed no definitive benefit of one surgical technique over another in lowering short-term complications [18,19]. Certain extensive trials suggest that interrupted-X closure in high-risk patients results in fewer instances of ruptured abdomen, indicating that this technique may offer greater benefits in contaminated or high-tension wound cases [22].

This study compares continuous, intermittent, and crossed continuous suturing techniques for linea alba closure, allowing for objective evaluation of outcomes such as dehiscence, infection, and incisional hernia. Conducted at a tertiary care center, its findings relate to diverse patient profiles. However, it faces limitations due to single-center design, small sample size, and short-term follow-up, which may not capture late complications. Future multicentric studies with larger samples and standardized protocols are recommended to enhance result validity and consistency.

The data indicate that both continuous and continuous intermittent crossing closure methods yield similar short-term outcomes concerning infection and dehiscence, with only minor differences in closure duration. Continuous closure offers slight efficiency advantages in maintaining clean surgical fields. Intermittent crossing closure is effective in scenarios of contamination or where long-term fascial integrity is essential, providing a safety net against partial suture failure. Future research should be multicentric, involve larger patient samples, consider contamination levels and comorbidities, and incorporate at least 12 months of follow-up to assess hernia rates. Additionally, standardized tracking of wound dimensions, closure duration, and SL:WL ratio is vital for meaningful comparisons between studies.

Conclusion

Both methods for midline exploratory laparotomy linea alba closure, continuous intermittent crossing and continuous suturing, exhibit comparable short-term rates of wound infection and dehiscence. The suture length and suture-to-wound length ratios remained similar across both groups; however, continuous suturing resulted in a slight reduction in closure time. These findings indicate that either surgical approach may be appropriate based on the patient's risk factors, the characteristics of the wound, and the surgeon's preference. Further research with larger samples and longer follow-up periods is essential to assess their efficacy in reducing long-term complications, including incisional hernia.

Declaration

Ethical Approval and Consent to participate

This is a Prospective study. Ethical clearance was obtained, and written informed consent was taken from all participants

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Consent for publication

Taken from all authors

Conflict of Interest

None

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Authors' Contributions

AK: initial intellectual content development, Data acquisition, and principal investigating author

BKS: Study Design, Data acquisition, initial intellectual content development and principal investigating author.

RS: Manuscript preparation, final intellectual content development and corresponding author

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