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Original Research Article

A comparative study of modified Smead-Jones versus conventional continuous method in closure of the linea alba in case of emergency laparotomy

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ABSTRACT

Background: Wound dehiscence following emergency midline laparotomy is a serious postoperative complication associated with increased morbidity, prolonged hospital stay, and incisional hernia risk. The optimal method for closing the linen alba remains controversial, particularly in contaminated and emergency settings. This study aimed to compare the effectiveness of the modified Smead-Jones technique with that of the conventional continuous closure method in preventing wound dehiscence following emergency laparotomy.
Methods: This single-center, single-blind randomized controlled trial was conducted over one year in a tertiary care hospital. A total of 132 patients who underwent emergency midline laparotomy were randomized in a 1:1 ratio to either modified Smead-Jones closure (Group B) or conventional continuous closure (Group A) of the linea alba. The primary outcome was the incidence of wound dehiscence within 30 postoperative days. Secondary outcomes included surgical site infection, need for secondary suturing, duration of hospital stay, and incisional hernia during the six-month follow-up. Statistical analysis was performed using SPSS version 21.0, with $p<0.05$ considered significant.
Results: Wound dehiscence occurred significantly more frequently in the conventional closure group than in the modified Smead-Jones group (21.2% vs. 7.5%, $p=0.04$). The rates of surgical site infection, requirement for secondary suturing, and incisional hernia were also significantly higher in the conventional closure group.
Conclusions: The modified Smead-Jones technique significantly reduced the incidence of wound dehiscence and postoperative complications compared to conventional continuous closure in emergency laparotomy and should be considered a preferred method in high-risk emergency settings.

Keywords: Emergency laparotomy, Linea alba closure, Modified Smead-Jones, Wound dehiscence, Randomized controlled trial

INTRODUCTION

The sudden disruption of an abdominal laparotomy wound represents a critical complication for patients recovering from surgery and poses a significant psychological challenge for both the patient and surgeon.[1] This partial or complete postoperative separation of the abdominal wound closure is termed wound dehiscence or acute wound failure.[2] Acute wound dehiscence refers to the separation of the abdominal musculo-aponeurotic layers within 30 days post-surgery, typically requiring intervention during the same hospital stay.[2] According to the literature, the maximum incidence of wound dehiscence occurs between the 6th and 9th postoperative days.[1,3] This complication is frequently observed after emergency laparotomies, particularly in the Indian context, where many patients come from rural areas and have poor nutritional status. It may present as an early complication, such as a deep-seated surgical site infection, partial wound separation or burst abdomen with

evisceration, or as a late complication, such as an incisional hernia. Patients with this condition often require multiple dressing changes, secondary surgeries for fascial closure, and prolonged bed rest, which results in significant morbidity. The incidence of incisional hernia after wound dehiscence can reach up to 45%.[4] While the method of wound closure may not be critical for elective laparotomies in well-nourished patients without risk factors, it becomes crucial in developing countries like India. Here, many emergency cases involve patients with risk factors such as prolonged intra-abdominal sepsis and malnutrition.[5] Abdominal wound dehiscence is associated with high morbidity and mortality rates of up to 30%, extended hospital stays, and an elevated risk of incisional hernia in the long term.[6] It is also associated with higher healthcare costs due to additional treatments, surgical interventions and extended care. In such scenarios, the choice of closure technique has a significant impact on patient outcomes.

A meta-analysis by Gupta et al which reviewed 23 randomized controlled trials, revealed that using an interrupted closure method reduced the odds of wound dehiscence by half compared to the continuous closure technique.[7] Therefore, further investigation into effectiveness of interrupted methods in emergency laparotomy is warranted.

Recognizing the clinical significance of preventing wound dehiscence and the ongoing debate over the best closure technique in emergency surgery, this randomized controlled trial was conducted to compare the modified Smead-Jones closure with the conventional continuous closure of the linea alba in patients undergoing emergency midline laparotomy.

METHODS

Study design

This prospective, single-center, randomized controlled trial evaluated two methods of midline fascial closure-modified Smead-Jones closure and traditional continuous closure-in patients undergoing emergency midline laparotomy. The trial methodology adhered to the CONSORT guidelines for randomized controlled trials.[1]

Study setting and duration

The study was conducted at the Department of General Surgery, Dr. Baba Saheb Ambedkar Medical College and Hospital, Delhi, a tertiary care referral centre. Patient recruitment was conducted over a period of one year, and postoperative follow-up was performed for up to six months to assess early and late wound-related outcomes.

Inclusion criteria

Patients aged 13-70 years, patients undergoing emergency laparotomy through a midline incision and indications including: perforation peritonitis, acute intestinal obstruction, abdominal trauma, patients or legally authorized representatives providing written informed consent were included in the study.

Exclusion criteria

Patients with redo laparotomy, previous midline laparotomy, presence of burst abdomen or incisional hernia at presentation and patients requiring non-midline abdominal incisions were excluded from the study.

Sample size calculation

Sample size estimation was based on a previously published study demonstrating a reduction in wound dehiscence with Smead-Jones based closure techniques compared to continuous closure.[1] Assuming a wound dehiscence rate of approximately 15% in the conventional closure group and 5% in the modified Smead–Jones group, with a power of 80% and a two-sided alpha error of 0.05, the calculated minimum sample size was 120 patients. To compensate for potential attrition and loss to follow-up, a total of 132 patients were enrolled, with 66 patients allocated to each group.

Randomisation and allocation concealment

Eligible patients were randomized in a 1:1 ratio into two groups: Group A: Conventional continuous closure. Group B: Modified Smead-Jones closure.

Randomization was performed using a computer-generated random number sequence. Allocation concealment was ensured through the use of sealed, opaque, and sequentially numbered envelopes, which were opened intraoperatively after confirmation of eligibility and decision to close the abdomen via a midline incision.[4]

Due to the nature of the surgical intervention, blinding of the operating surgeon was not feasible. However, postoperative wound assessment was performed by a consultant surgeon who was not involved in the closure technique, thereby reducing assessment bias.

Preoperative and intraoperative management

All patients underwent standard preoperative resuscitation, including fluid optimization, correction of electrolyte imbalances, and administration of broad-spectrum intravenous antibiotics. Nasogastric decompression and urinary catheterization were performed as indicated.

All procedures were performed under general anesthesia. Intraoperative findings, degree of peritoneal contamination and indication for surgery were documented at the time of the operation.

Surgical technique

Group A-Conventional continuous closure

In group A, the linea alba was closed using a conventional continuous mass closure technique with a no. 1 polypropylene suture, as illustrated in Figure 1. Suture bites were taken approximately 2 cm from the cut edge of the linea alba, with successive bites placed at intervals of approximately 1 cm apart. Care was taken to ensure uniform tension without strangulation of the tissues.[1] A suture-to-wound length ratio of at least 4:1 was maintained, in accordance with the established abdominal wall closure principles.[8]

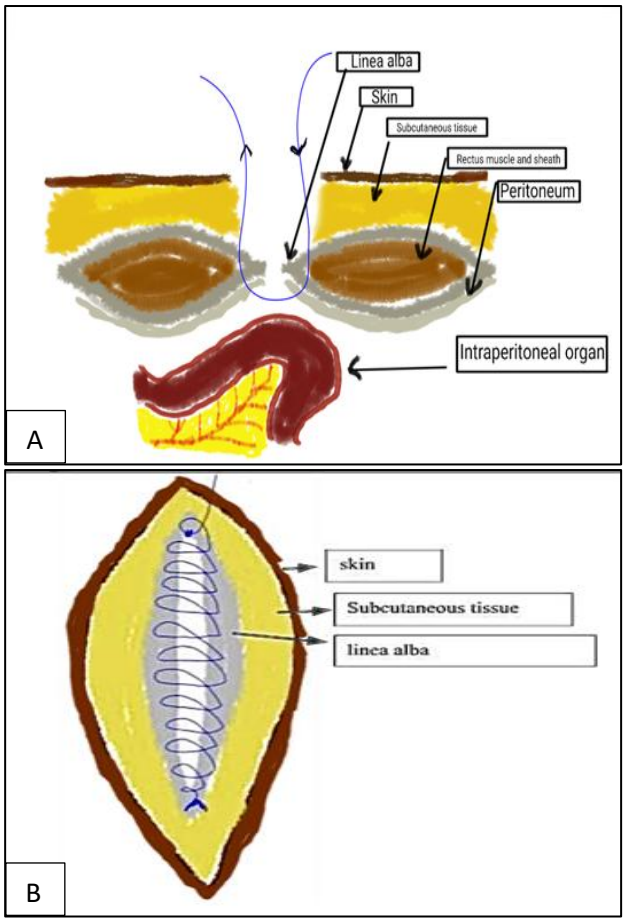

Figure 1 (A and B): Continuous approximation of the rectus sheath and linea alba in a single layer. (A) demonstrates the tangential aspect of the structure while closure (B) demonstrates the top view when closed.

Group B-Modified Smead-Jones closure

In Group B, the linea alba was closed using a modified Smead–Jones technique, performed in a continuous fashion, as illustrated in Figure 2.

This technique employs a far-near, near-far suture configuration, with far bites placed approximately 1.5 cm from the fascial edge, near bites placed approximately 0.5 cm from the fascial edge and distance between successive sutures maintained at ≤1 cm.

Closure was performed using no. 1 polypropylene suture. This modification was designed to combine the biomechanical strength of the traditional Smead-Jones technique with the efficiency of continuous suturing.[9]

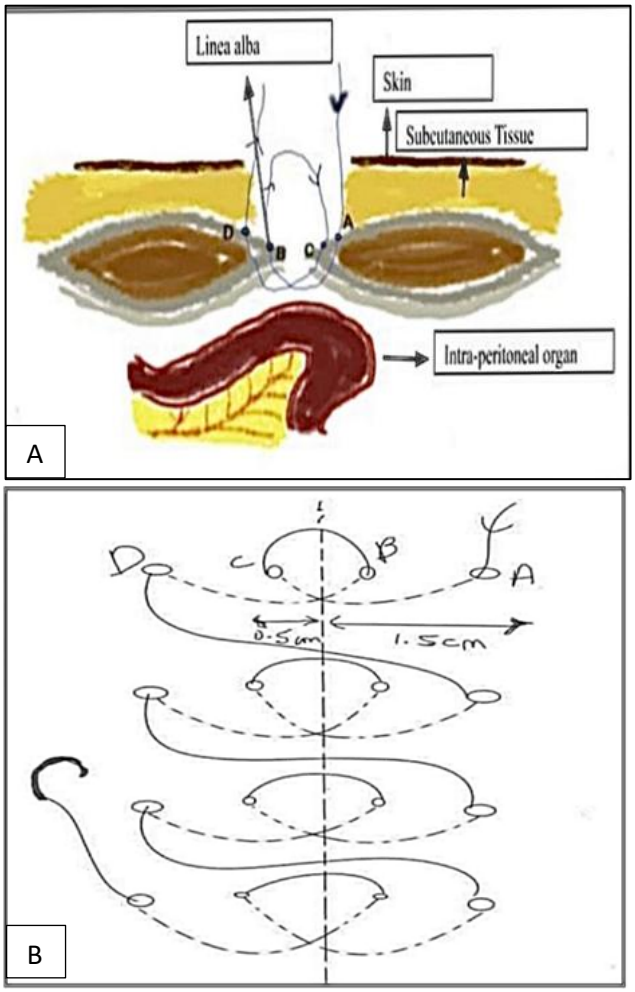

Figure 2 (A and B): Trajectory of the suture while closure of linea alba. (A) demonstrates a tangential view of the structure at closure. (B) demonstrates the top view of the closure, where point A is the first far point, point C is the first near point, point B is the second near point, and point D is the second far point.

All closures were performed by a consultant surgeon or senior resident under direct supervision, ensuring the consistency of the technique.

Postoperative care and follow-up

Postoperative management was standardized for all patients and included appropriate analgesia, antibiotics according to the institutional protocol and early mobilization as tolerated. Surgical wounds were regularly inspected for signs of infection or dehiscence.

Patients were evaluated on postoperative days 7, 15, and 30, and subsequently at six months. Follow-up assessment included clinical examination of the abdominal wound, with ultrasonography performed when an incisional hernia was suspected.

Outcome measures

Primary outcome

Wound dehiscence, defined as partial or complete separation of the musculo-aponeurotic layers of the abdominal wall occurring within 30 postoperative days.[10]

Secondary outcomes

Surgical site infection, defined according to CDC criteria.[11] Requirement for secondary suturing. Development of incisional hernia within six months of the surgery.

Statistical analysis

Data were entered into Microsoft excel and analyzed using SPSS software (version 21.0). Categorical variables were expressed as frequencies and percentages and compared using the chi-square test or Fisher's exact test, as appropriate. Continuous variables are expressed as mean±SD. Statistical significance was set at $p<0.05$.

Ethical considerations and trial registration

The study protocol was approved by the institutional ethics committee. Written informed consent was obtained from all participants or their legally authorized representatives. The trial was registered with the Clinical Trials Registry of India (CTRI) prior to commencement of study. CTRI No: CTRI/2024/02/062795.

RESULTS

Primary outcome

Wound dehiscence

Wound dehiscence within 30 postoperative days was observed in 14 patients (21.2%) in the conventional continuous closure group and 5 patients (7.5%) in the modified Smead-Jones closure group. This difference was statistically significant (p=0.04), demonstrating a significantly lower incidence of fascial dehiscence with the modified Smead-Jones technique (Table 1).

Secondary outcomes

Surgical site infection

Surgical site infection occurred more frequently in the conventional closure group, affecting 24 patients (36.3%), compared with 7 patients (10.6%) in the modified Smead–Jones group. This difference was statistically significant (p=0.03), indicating improved wound outcomes with the modified technique (Table 2).

Requirement for secondary suturing

Secondary suturing was required in 11 patients (16.6%) in the conventional closure group, whereas only five patients (7.5%) in the modified Smead-Jones group required additional suturing. The difference was statistically significant (p=0.01) (Table 2).

Incisional hernia

During follow-up, incisional hernias were observed in seven patients (10.6%) in the conventional closure group. No cases of incisional hernia were reported in the modified Smead–Jones group. This difference was statistically significant (p=0.04) (Table 2).

DISCUSSION

Study population

A total of 132 patients undergoing emergency midline laparotomy were enrolled and randomly assigned to two groups: Group A (conventional continuous closure) and group B (modified Smead-Jones closure), with 66 patients in each group. All randomized patients were included in the final analysis, and there were no losses to follow-up during the 30-day postoperative period.

Baseline demographic and clinical characteristics

Baseline demographic and clinical variables were comparable between the two groups, with no statistically significant differences observed. The majority of patients were between 31 and 50 years of age, and males predominated in both groups. The common comorbidities included diabetes mellitus, hypertension, hypothyroidism, and obesity.

The similarity of the baseline characteristics indicated adequate randomization and comparability between the study groups (Table 3).

Operative and wound characteristics

Most patients in both groups underwent surgery for contaminated or dirty wounds, reflecting the emergency nature of the procedures. The most frequent indications for emergency laparotomy were gastrointestinal perforations, including gastric, ileal, and appendicular perforations, followed by acute intestinal obstruction and abdominal trauma.

The distribution of wound classification and operative indications was similar between the two groups (Table 4).

Table 1: Comparison of primary outcome (wound dehiscence).

Outcome	Conventional closure, (n=66)	Modified Smead-Jones closure, (n=66)	P value
Wound dehiscence	14 (21.2%)	5 (7.5%)	0.04

Table 2: Secondary outcomes and postoperative complications.

Complication	Conventional closure, (n=66)	Modified Smead-Jones closure, (n=66)	P value
Surgical site infection	24 (36.3%)	7 (10.6%)	0.03
Secondary suturing required	11 (16.6%)	5 (7.5%)	0.01
Incisional hernia	7 (10.6%)	0 (0.0%)	0.04

Table 3: Baseline demographic and clinical characteristics of patients.

Characteristic	Conventional closure, (n=66)	Modified Smead-Jones closure, (n=66)
Age (in years)		
20-30	2 (3.0%)	3 (4.5%)
31-40	34 (51.5%)	31 (46.9%)
41-50	26 (39.3%)	30 (45.4%)
51-60	4 (6.0%)	2 (3.0%)
Gender		
Male	51 (77.2%)	46 (69.6%)
Female	15 (22.8%)	20 (30.4%)
Common comorbidities		
Diabetes mellitus	6 (9.0%)	5 (7.5%)
Hypertension	5 (7.5%)	7 (10.6%)
Hypothyroidism	3 (4.5%)	1 (1.5%)
Obesity (BMI ≥30 kg/m²)	3 (4.5%)	2 (3.0%)

Table 4: Operative and wound characteristics.

Variables	Conventional closure, (n=66)	Modified Smead-Jones closure, (n=66)
Clean-contaminated wound	13 (19.6%)	12 (18.1%)
Contaminated wound	10 (15.1%)	9 (13.6%)
Dirty wound	43 (65.1%)	45 (68.1%)
Gastric perforation	15 (22.7%)	12 (18.1%)
Ileal perforation	13 (19.6%)	14 (21.2%)
Appendicular perforation	11 (16.6%)	12 (18.1%)
Jejunal pathology (TB/stricture)	9 (13.6%)	10 (15.1%)
Acute intestinal obstruction	7 (10.6%)	6 (9.0%)
Abdominal trauma	7 (10.6%)	9 (13.6%)
Colonic perforation	4 (6.0%)	3 (4.5%)

Wound dehiscence within 30 postoperative days was observed in 14 patients (21.2%) in the conventional continuous closure group and 5 patients (7.5%) in the modified Smead-Jones closure group. This difference was statistically significant (p=0.04), demonstrating a significantly lower incidence of fascial dehiscence with the modified Smead-Jones technique (Table 1). Similar to our study findings, in a study conducted by Shankar et al the incidence of postoperative wound dehiscence was considerably reduced in group A (Smead-Jones technique) than in group B (Continuous closure technique) (p=0.037) in terms of postoperative results.[12] Our findings are in line with those of Aghara et al since wound dehiscence was observed in seven patients treated with B's traditional continuous closure approach and one patient treated with the modified Smead-Jones technique, with chi-square values of 4.891 and 0.027, respectively.[13] The 95% confidence interval for the relative risk of wound dehiscence was 0.0418 to 0.9059. This was also statistically significant. In another study by Nitin et al they observed that in the control group (continuous closure technique) of 45 patients, six cases (13.3%) experienced wound dehiscence, while only one case (2.2%) in the study group (Smead-Jones technique) developed this complication.[14] Surgical site infection occurred more frequently in the conventional closure group, affecting 24 patients (36.3%), compared with 7 patients (10.6%) in the modified Smead-Jones group.

This difference was statistically significant (p=0.03), indicating improved wound outcomes with the modified technique (Table 2). Suvarchala et al observed that the postoperative wound infection rate was 32.4% in group A and 12.3% in group B, with a statistically significant difference (p=0.03).[15] They concluded that the modified Smead-Jones technique using Prolene loop sutures resulted in a very low incidence of early complications and may reduce late complications. Similarly, Sringeri et al also found that the postoperative wound infection rate was significantly lower in the modified Smead-Jones group (12.3%) compared to the conventional closure group (32.4%), with a statistically significant difference (p=0.03, 95% CI: 1.083-7.326).[1] However, in another study by Dhamnaskar et al the wound infection rate was lower in the modified technique group, but the difference was not statistically significant (p>0.05).[16] In a study by Aghara et al one and six patients developed incisional hernias during the follow-up in groups A (Smead-Jones technique) and B (Conventional continuous closure), respectively, with a chi-square value of 3.840 and a p=0.05. Secondary suturing was required in 11 patients (16.6%) in the conventional closure group, whereas only five patients (7.5%) in the modified Smead-Jones group required additional suturing.[17] The difference was statistically significant (p=0.01) (Table 2).

Similar to our study findings, in a study by Metawee et al owing to dehiscence, two patients in group B (Conventional continuous closure technique) needed re-suturing with prophylactic retention sutures, whereas no patients in group A (Smead-Jones technique) required reoperation.[18] The chi-square value and p value for this study were 2.041 and 0.1531, respectively. With a 95% confidence interval of 0.00 to 1.322, the relative risk of reoperation due to wound dehiscence was 0. However, the difference was not statistically significant. During follow-up, incisional hernias were observed in seven patients (10.6%) in the conventional closure group. No cases of incisional hernia were reported in the modified Smead-Jones group. This difference was statistically significant (p=0.04) (Table 2). In a study by Aghara et al 1 and 6 patients developed incisional hernia during the follow-up in group A (Smead Jones technique) and group B (Conventional continuous closure) respectively with chi square value of 3.840 and p=0.05.[17]

Summary of outcomes

Overall, the modified Smead-Jones closure technique was associated with a significantly lower incidence of wound dehiscence and postoperative wound-related complications than conventional continuous closure in emergency laparotomy.

Limitations

Since the present study included only short-term follow-up, the true long-term incidence of incisional hernia could not be adequately evaluated. Further studies with prolonged follow-up are required for accurate assessment of long-term outcomes.

CONCLUSION

By combining the biomechanical advantages of the far-near and near-far principles with the efficiency of continuous suturing, the modified Smead-Jones technique provides a durable, reproducible, and practical method for abdominal wall closure in high-risk emergency surgical patients. Given its favorable outcomes and ease of application, this technique should be considered the preferred method for linea alba closure in emergency laparotomy, particularly in contaminated surgical fields.

Recommendations

Further multicenter studies with longer follow-ups are recommended to evaluate long-term incisional hernia rates and confirm these findings across different surgical settings.

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