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Original Research Article

Comparison of Continuous versus Interrupted Abdominal Wall Closure Techniques after Emergency Midline Laparotomy: A Randomized Controlled Trial

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Abstract:

Background: This research aims to compare the outcomes of continuous and interrupted abdominal wall closure techniques in emergency midline laparotomy, specifically focusing on the incidence of incisional hernia and ruptured abdomen as the key endpoints.

Aim: Comparison of continuous and interrupted abdominal wall repair techniques after emergency midline laparotomy.

Material and Methods: Patients who had undergone laparotomy in the past and were scheduled for a second look procedure were not included in the study. However, patients who had undergone minor laparoscopic surgery in the past were included. The 100 patients were evenly split into two groups, with 50 patients in each group. Both groups were required to maintain a maximum stitch spacing of 1.5 cm and a minimum distance of 2 cm from the border of the fascia. The patients in the continuous suture group had their abdomen closed using a continuous, all-layer suture technique.

Results: The average length of hospitalization was comparable across the two groups (C: 17.45 ± 14.58 days, I: 18.94 ± 14.12 days). 8.21% of patients had laparostomy, resulting in their exclusion from further investigation of hernia/dehiscence. The incidence of burst abdomen after 30 days or incisional hernia after 12 months did not vary between the continuous and interrupted groups. In the continuous group, 16% had burst abdomen or incisional hernia, whereas in the interrupted group, 22% experienced these complications. The total mortality, regardless of the reason, was 34 individuals. There was no significant difference in mortality between the groups, with 10 individuals (16.9%) in both the control group (C) and the intervention group (I). The p-value for this comparison was 0.24. The duration required for fascial closure was much shorter in the continuous group compared to the interrupted group (C: 13.66 ± 5.10 min versus 18.14 ± 5.96 min; $p < 0.001$).

Conclusion: This randomized controlled trial (RCT) demonstrated that there was no discernible difference in the occurrence of postoperative burst abdomen and incisional hernia after one year when comparing the use of continuous sutures with slowly absorbable sutures with interrupted sutures with fast absorbable sutures in main emergency midline laparotomy.

Keywords: Continuous, Interrupted, Abdominal wall repair, Laparotomy.

Introduction

Laparotomy is a significant surgical intervention [1]. The selection of the surgical incision for accessing the abdominal cavity is determined by factors such as the patient's condition, the surgeon's preference, and the healthcare system in place. The primary considerations for surgeons, in addition to achieving the best possible view of the surgical area, are the duration of the abdominal opening and closing, the occurrence of a ruptured abdomen, wound infection, incisional hernia, and suture sinus. The midline laparotomy is the prevailing method for accessing the abdominal cavity in both urgent and planned situations due to its simplicity, ability to give sufficient visibility of all four quadrants, and ability to quickly expose the area with minimum blood loss. If necessary, we have the capability to lengthen the surgical cut. A midline laparotomy involves incising the linea alba, which is a vulnerable and tendinous area. The vulnerability of the linea alba is increased when its fibres are vertically cut to reach the peritoneal cavity. Therefore, while suturing the linea alba, these fibres experience the stress caused by the mechanical forces acting on them [2]. Historically, laparotomy

wounds have been healed using many techniques, including continuous or interrupted closure, single layer or mass closure, and absorbable or non-absorbable sutures. An ideal approach to wound closure would involve a method that offers sufficient tensile strength to the incision until the wound heals, brings the tissue together in a manner that allows for normal healing under optimal conditions, remains secure even in the presence of local or systemic infection, ensures that the suture material is well tolerated in the short and long term, and can be performed quickly. The continuous suture has the benefit of equally distributing tension throughout the suture line and being more efficient. One drawback is that it relies on a single stitch to secure the whole fascia. The numerous interrupted suture techniques have been shown to be effective for a considerable period of time. However, it is time-consuming to execute and restricts tension to each individual stitch, which is a drawback [3, 4]. Potential problems that may occur after fascial closure include wound dehiscence, wound infection, incisional hernia, and suture sinus development. The occurrence of these complications might be attributed to a combination of variables such as inadequate surgical skill, improper selection of suture material, and patient-related factors. However, the primary causes are mostly attributed to substandard surgical technique, sustained elevated intra-abdominal pressure, and localised tissue death caused by infection [3, 4]. Wound dehiscence is a frequent and significant complication that may occur after midline laparotomy closure. It is a leading source of postoperative morbidity. Furthermore, there has been a rise in the expenses associated with medical care and an increase in the duration of hospitalization. Wound dehiscence refers to the untimely rupture, opening, or separation along the natural or surgical suture lines. It often occurs as a result of inadequate wound healing. Common risk factors for complications include the presence of diabetes, being of advanced age, being obese, and experiencing trauma during the post-surgical period [5]. In impoverished nations such as India, patients who arrive in emergency situations often have inadequate nutritional conditions, which is a significant contributing factor to wound dehiscence. Wound infection is often identified as a common cause of wound dehiscence. Wound dehiscence refers to the occurrence of the abdominal wound bursting open and the internal organs protruding, often between the 6th and 8th days following surgery. The disruption of the wound often happens a few days before and at the time when the sutures holding together the deep layers (such as the peritoneum and posterior rectus sheath) rupture or come undone.

Aims and Objectives: The present study was conducted to compare continuous versus interrupted abdominal wall repair techniques after an emergency midline laparotomy.

Material and Methods

The present comparative randomised controlled trial (RCT) clinical trial included 100 patients of both genders. All patients admitted to the general surgical ward or unit, either through OPD or emergency, who underwent emergency midline laparotomies were included.

The study was conducted at the Department of Surgery, Government Medical College, Bettiah, West Champaran, Bihar, India. All were informed regarding the study, and their written consent was obtained. The Institutional Ethics Committee gave the study its approval. The duration of the of the study was one year (January 2023–December 2023). Data such as name, age, etc. was recorded.

Inclusion Criteria

- Patients are to give written informed consent.
- Patient's age between 18 and 60 years, having perforation peritonitis, intestinal obstruction, who were operated on through midline laparotomy
- Available for follow-up.

Exclusion Criteria:

- Patients do not give written informed consent.
- Patients who had undergone previous laparotomies through a midline incision
- laparotomy in the past and were scheduled for a second look procedure.
- Patients with pre-existing severe co-morbid conditions: severe renal and liver disease, anaemia, diabetes mellitus, and ischemic heart disease
- Those unable to attend follow-up

Methodology

The 100 patients were evenly split into two groups, with 50 patients in each group. Both groups were required to maintain a maximum stitch spacing of 1.5 cm and a minimum distance of 2 cm from the border of the fascia. The patients in the continuous suture group (control group) had their abdomen closed using a continuous, all-layer suture technique. This included utilising two polydioxanone No. 1 sutures (0.4 mm diameter) with 150 cm loops, which are constructed of a slowly absorbable monofilament material. Two sutures were initiated at the borders of the wound, and they needed to be secured at the top and bottom of the incision. Additionally, the sutures had to overlap in the centre for a minimum of 2 cm. The interrupted suture group (study group) used Vicryl© USP 2 (0.5 mm diameter) absorbable sutures measuring 45 cm in length. These sutures were applied from the cranial end to the centre of

the incision and then from the caudal pole, with stitches anchored both cranially and caudally to the incision. The sutures were secured after all the stitches had been completed. The subcutaneous tissue was left unsutured, and no subcutaneous drainage was used during the skin closure, which was done using clips. Antibiotic prophylaxis and treatment were administered in accordance with the local protocols. The procedure included the use of electric cautery to precisely incise the skin, subcutaneous tissue, abdominal fascia, and peritoneum, while taking care to prevent any harm to the umbilicus. The peritoneum was incised using scissors. At the conclusion of the procedure, abdominal drains were inserted. The composite main outcome was defined as the occurrence of a ruptured abdomen within 30 days or an incisional hernia within 12 months. Burst abdomen is characterised by the absence of abdominal fascia continuity following surgery, along with wound dehiscence and/or the need for a second operation within 30 days due to fascial dehiscence.

The presence of an incisional hernia was evaluated 12 months after the surgery using both a physical examination and abdominal ultrasound. An incisional hernia was defined as a breach in the fascia and a bulging hernia sac, as shown on ultrasound or confirmed by a clinical examination consistent with a hernia. Ultrasound screening was not required for instances of hernia that were verified by a surgical intervention within 12 months following the first procedure.

The secondary outcome measures encompassed the following: the length of the skin and fascia incision, the time required for fascial closure, the incidence of re-operation due to burst abdomen and for any reason, the frequency of abdominal reinterventions, postoperative pulmonary infection, the duration of artificial respiration, and postoperative hemodialysis. Additionally, the study assessed the incidence of wound infection, the length of time for vacuum treatment and wound healing, the time it took for the first bowel movement, the duration of abdominal drainage via drains installed during surgery, and the duration of closed abdominal lavage. Ultimately, we evaluated the length of hospital stay (LOS), duration of intensive care unit (ICU) stay, quality of life (measured using the standardised form SF 36), and overall mortality. Patients from both groups were observed for 6-7 days. In the post-operative period, the frequency of burst abdomens was assessed by consultant surgeons.

Statistical Analysis: Statistical analysis was performed on the obtained data using SPSS version 25.0 and Microsoft 19. A P value < 0.05 was considered significant. A P value < 0.05 was considered significant.

Results

There were a total of 170 patients who were randomised randomly to either the therapeutic group or the control group at the beginning of the study. Out of the total number of patients, 5 individuals in the continuous suture group and 6 individuals in the interrupted suture group did not undergo the intended treatment. Due to missing data, the one-year postoperative data for 32 and 27 patients were not available. However, there were 35 and 40 patients who reached the one-year follow-up, respectively. However, by using ICA-r imputation, the final analytic dataset regarding the primary endpoint was 50 patients for continuous suture and 50 patients for the interrupted suture groups for the main outcome.

Table 1: Baseline characteristics of patients in both groups

characteristics	Continuous suture group (Control group)		Interrupted suture group (Study group)		P value
	Number (N = 50)	Percentage (%)	Number (N = 50)	Percentage (%)	
Gender					
Male	34	68	31	62	0.82
Female	16	32	19	38	
Age (years)	39.94 ± 15.53		44.87 ± 14.21		0.01
Body mass index (kg/m^2)	25.22 ± 6.32		26.65 ± 10.03		0.75
Mean duration of hospital stay (in days)	17.45 ± 14.58		18.94 ± 14.12		0.04

In the present study, the mean age in Group I was 39.94 years and 44.87 years in Group II. The majority of the patients were male, i.e., 65 out of 100 (65%). Out of which, Group I had 34/50 (68%) males, while Group II had 31/50 (62%) males. The average length of hospitalisation was comparable across the two groups [continuous suture (C): 17.45 ± 14.58 days, interrupted suture group (I): 18.94 ± 14.12 days].

Table 2: ASA classification and Comorbidities of patients in both groups

ASA classification	Continuous suture		Interrupted suture	
	Number (N = 50)	Percentage (%)	Number (N = 50)	Percentage (%)
I (normal healthy patient)	4	8	3	6
II (mild systemic disease)	15	30	17	34
III (severe systemic disease)	22	44	21	42
IV (constant threat to life)	9	18	8	16
V (moribund state)	0	0	1	2
Reason for operation				
Suspected diverticular abscess with perforation	11	22	17	34
Suspected stomach/duodenal perforation	15	30	9	18
Suspected ischemia	6	12	7	14
Other	18	36	17	34
Comorbidities				
Diabetes mellitus	7	14	6	12
Chronic pulmonary disease	10	20	7	14
Current immunosuppressive therapy	6	12	4	8
Current smoker	16	32	14	28
Previous smoker	11	22	16	32
Current smoker years	26.2 ± 12.1		38.9 ± 12.1	
Ongoing malignancy at time of surgery	7	14	4	8
Previous minor abdominal incisions	10	20	12	24

Table 3 : Primary endpoint results

Types of Primary endpoint	Continuous suture		Interrupted suture		*p*-value
	Number (N = 50)	Percentage (%)	Number (N = 50)	Percentage (%)	
Burst abdomen until day 30 or incisional hernia until month 12 (ITT)	8/50	16	11/50	22	0.25
Composite endpoint with ICA-r imputation (ITT)	14/50	28	16/50	32	0.14
Composite Endpoint (PP)	10/35	28.57	13/40	32.5	0.25
Composite endpoint with ICA-r imputation (PP)	14/50	28	16/50	32	0.24
Primary endpoint (ITT)	Ref = 1		OR: 1.04 (95% CI: 0.31-3.43)		0.45
Primary endpoint (PP)	Ref = 1		OR: 1.19 (95% CI: 0.28-5.04)		0.36

Primary endpoint

The incidence of burst abdomen after 30 days or incisional hernia after 12 months did not vary between the continuous and interrupted groups. In the continuous group, 16% (n = 8/50) had burst abdomen or incisional hernia, whereas in the interrupted group, 22% (n = 11/50) experienced these complications with no statistical difference between the 2 groups. The patient, who had a complete fascial burst, was managed by the application of a Bagota bag under general anaesthesia, followed by secondary wound healing. On the other hand, both patients who had localised fascial wound bursts were managed by daily aseptic dressing followed by secondary suturing (Table 3, Figure 1). One patient in each group had a protruding hernia sac on day 30, with a p-value of 0.14. A logistic regression analysis was conducted to examine the relationship between BMI, age, and the occurrence of fascial dehiscence based on prior research results. Age was not shown to have a meaningful correlation with the main outcome in both the ITT and PP set analyses. In contrast, the Body Mass Index (BMI) showed an odds ratio

(OR) of 1.17 with a 95% confidence interval (CI) ranging from 1.04 to 1.32.

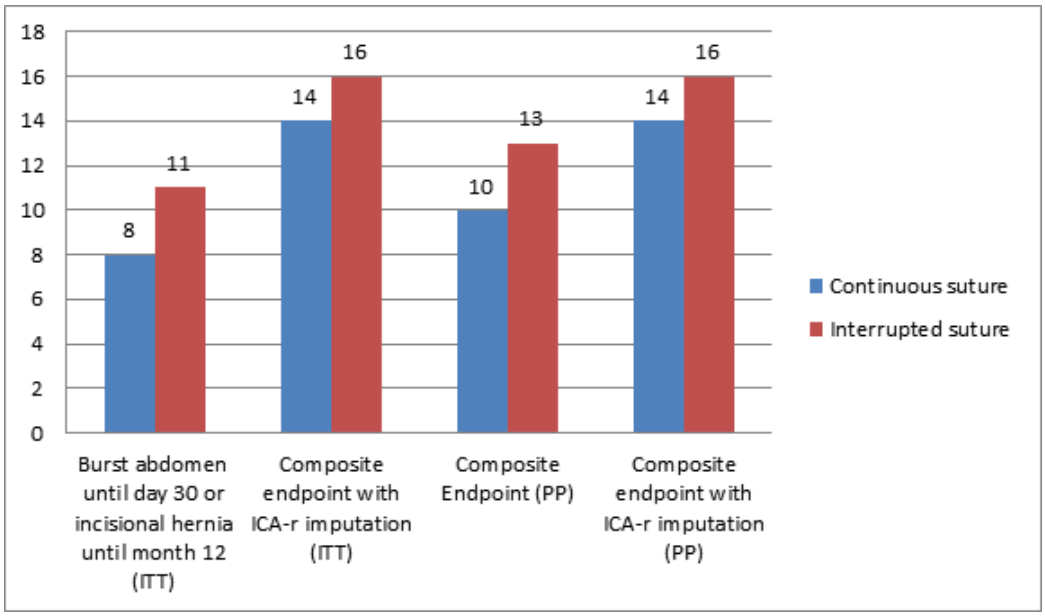

Figure 1: primary end point result

Table 4: Evaluation of hernia/ burst abdomen

parameters	Continuous suture		Interrupted suture		p value
	Number (N = 50)	Percentage (%)	Number (N = 50)	Percentage (%)	
Bulging hernial sac on day 30 (telephone interview)	1	2	2	4	0.27
Unclear	4	8	1	2	
Missing	18		16		
Palpable fascia gap on day 30 (telephone interview)	1	2	2	4	0.16
Unclear	3	6	1	2	
Missing	18		16		
Bulging hernial sac at 12 months (clinical examination)	7	14	4	8	0.13
Missing	40		33		
Palpable fascia gap at 12 months (clinical examination)	2	4	7	14	0.31
Missing	40		33		
Bulging hernial sac at 12 months (ultrasound examination)	4	8	0	0	0.12
Missing	46		40		
Palpable fascia gap at 12 months (ultrasound examination)	0	0	9	18	0.08
Missing	46		40		
Re-operation due to burst abdomen	4	8	2	4	0.21
Re-operation due to hernia	2	4	6	12	0.15
Completed the trial regularly according to the protocol	24	48	28	56	0.16
Reason for early trial termination					
Withdrawal of informed consent	6	12	4	8	0.32

Lost to follow up	15	30	16	32	
Death	16	32	18	36	
Other	14	28	13	26	

Table 5: Secondary endpoint result

Secondary endpoint	Continuous suture		Interrupted suture		*p* value
	Number (N = 50)	Percent-age (%)	Number (N = 50)	Per-centage (%)	
Mortality/death due to any cause—yes	9	18	8	16	1.00
Length of skin incision [cm]	21.25 ± 6.12		23.41 ± 6.33		0.14
Length of fascial incision [cm]	21.87 ± 5.55		25.20 ± 7.36		0.14
Time needed for fascial closure [min]	13.66 ± 5.10		18.14 ± 5.96		< 0.001
Re-operation due to other reason than hernia/burst abdomen	13	26	14	28	0.33
Puncture of the abdominal cavity for any reason	0	0	3	6	0.08
Postoperative pulmonary infection	8	16	4	8	0.22
Duration of artificial respiration [days]	2.32 ± 8.85		1.58 ± 3.97		0.19
Duration of postoperative hemodialy-sis [days]	1.11 ± 4.56		1.37 ± 3.20		0.43
Wound infection	17	34	25	50	0.22
Duration of vacuum therapy [days]	1.89 ± 4.32		1.63 ± 6.10		0.13
Duration of wound healing in patients with secondary wound healing [days]	46.86 ± 33.74		38.54 ± 19.97		0.38
Time to first bowel movement [days]	3.12 ± 2.10		3.31 ± 2.81		0.27
Duration of abdominal drainage [days]	7.11 ± 5.94		7.41 ± 7.32		0.31
Duration of closed abdominal lavage [days]	0.10 ± 1.52		0.98 ± 3.21		0.21
Postoperative duration of hospital stay [days]	17.84 ± 14.23		18.64 ± 13.36		0.15
Postoperative duration of intensive care unit stays [days]	6.84 ± 12.21		6.84 ± 9.31		0.18

Secondary Endpoints

Table 5 displays the secondary endpoints. The total mortality, regardless of the reason, was 34 individuals. There was no significant difference in mortality between the groups, with 10 individuals (16.9%) in both the control group (C) and the intervention group (I). The p-value for this comparison was 0.24. The duration required for fascial closure was much shorter in the continuous group compared to the interrupted group (C: 13.66 ± 5.10 min versus 18.14 ± 5.96 min; $p < 0.001$). During the experiment, 42% of patients had a wound infection, mostly affecting the superficial tissue.

The safety analysis conducted on the as-treated population showed comparable rates of patients experiencing at least one serious adverse event (SAE) in both groups. In the control group, 28 patients (56%) had at least one SAE, while in the intervention group, 31 patients (62%) had at least one SAE. The difference in rates between the two groups was not statistically significant ($p = 0.27$). The incidence, severity, and result of serious adverse events (SAEs) did not show any significant changes. Additionally, there were no notable differences in the association between SAEs and the trial intervention, as shown in Table 4. The SF36 was used to assess the quality of life (QoL) after 30 days and 12 months following an emergency laparotomy. Patients had a decline in quality of life (QoL) 30 days following surgery, although there was an improvement at 12 months after the operation. However, more than 18% of the patients reported significantly poorer QoL compared to their preoperative values. No significant change was seen in the other secondary endpoints.

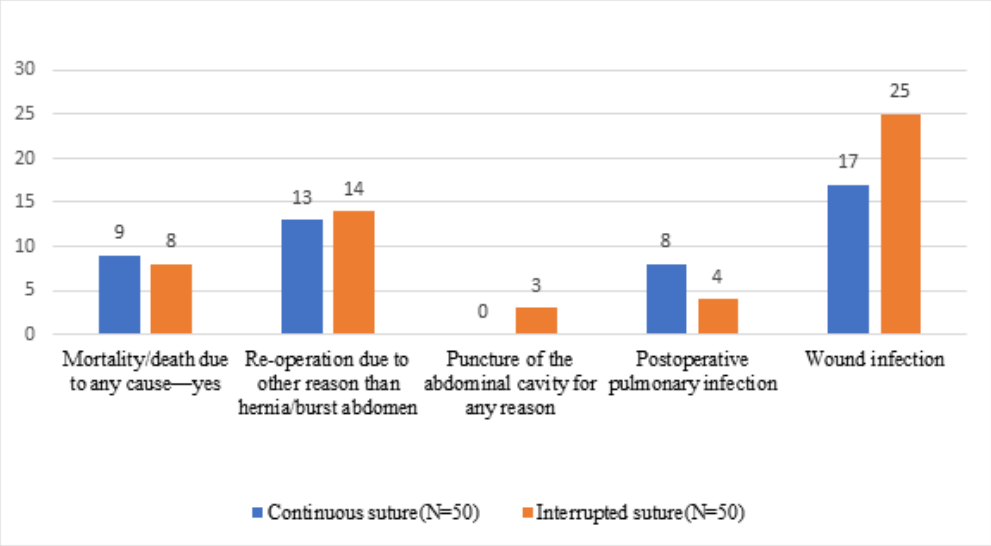

Figure 2: Secondary endpoint result

Discussion

This research aims to compare the outcomes of continuous and interrupted abdominal wall closure techniques in emergency midline laparotomy, specifically focusing on the incidence of incisional hernia and ruptured abdomen as the key endpoints. There was no notable difference between continuous and interrupted closure methods in relation to the main outcome measure or any additional problems after surgery. Our data did not support the previously claimed advantage of interrupted closure. The INLINE comprehensive review and meta-analysis evaluated the incidence of incisional hernia in patients undergoing elective and emergency surgery. The study indicated that continuous closure resulted in an 11.3% incidence of incisional hernia, whereas interrupted closure had a 7.9% incidence. In our study, we observed a higher occurrence of the composite endpoint, with rates of 27.1% and 30% for continuous and interrupted closure, respectively [7]. While the studies included in this systematic review had a similar duration of follow-up (12 months), they did not adhere to the same stringent standards as CONTINT in terms of including clinical and ultrasound examinations as part of the assessment process. An alternative explanation for this difference might be attributed to the limited duration of prior studies. This is evident in the publication of the 3-year follow-up of the INSECT trial participants, where the incidence of incisional hernia rose from 12.3% at the end of the first year to 23.2% after three years [6].

A comparative trial conducted in the United States found that the use of slowly absorbable interrupted polydioxanone sutures resulted in a significantly lower occurrence of early fascial dehiscence (excluding reoperations for burst abdomens) in emergency situations. However, both interrupted and continuous sutures had similar rates of incisional hernias after one year, with 13.5% for interrupted sutures and 22.0% for continuous sutures. Despite the results of major randomised controlled trials (RCTs) in elective procedures, which reported rates of 12.6% in the INSECT trial and 21% in the STITCH trial, substantial rates of complications still occur following emergency midline incisions [8–10]. The incidence of reoperation owing to burst abdomen in our ITT dataset is 6.6%, which aligns with current data that does not use the small-bites approach advocated by the EHS in 2015. A single-centre, one-arm experiment demonstrated a decrease in postoperative fascial dehiscence from 6.6% to 3.8% when the institutional norm was changed to this approach, as compared to historical data [11].

Our study found that BMI was a significant risk factor for the existence of an incisional hernia or ruptured abdomen, which supports the results of earlier retrospective investigations [12]. However, this did not apply to the age of the patients. Additional risk variables such as chronic obstructive pulmonary disease (COPD), anaemia, and catecholamine treatment were not subjected to additional analysis.

In the present study, the mean time taken for closure of the rectus sheath in Group I (13.66 minutes) was significantly less than in Group II (18.14 minutes). When comparing both methods, continuous suturing showed a much higher speed compared to interrupted sutures. the difference being statistically highly significant ($p< 0.001$). This can be attributed to the fact that interrupted suturing requires multiple knots, whereas in continuous suturing, we place a single Aberdeen knot at the end of the fascial wound. This element might be especially important in emergency laparotomy closure since time is crucial.

This was similar to the study by Shashikala et al. [13]. The mean time taken for closure of the rectus sheath in group A (continuous) was 13.9±2.9, and that for group B (interrupted) was 28.9±3.4.6. The mean time taken for closure in the continuous technique was less as compared to the interrupted group, the difference being statistically highly significant ($p< 0.05$). McNeill et al. [14], in their prospective study, found the mean closure time to be 43 minutes in the interrupted group and 21 minutes in the continuous group.

In our study, the mean duration of hospital stays in Group I was 17.45 days and 18.94 days in Group II. It compares well with the findings of Richards [15], who noted hospital stays of 12.9 in the interrupted group and 19.5 in the continuous group.

In the present study, 16% of patients in the continuous group developed burst abdomens, while 22% of patients in the interrupted group developed burst abdomens, with no statistically significant difference between them. McNeill et al. [14], observed that 12.96% of patients in the continuous group developed wound dehiscence, while 15.65% of patients in the interrupted group developed wound dehiscence.

We observed a death rate of 34% in both groups; the death rate in the continuous group was 18%, whereas in the interrupted group it was 16%. Havens JM, et al. [16] Comparing emergency general surgery (EGS) to non-EGS (NEGS), there is a disproportionate burden of risk associated with medical errors, complications, and death with EGS. Death rates were 2.66% for NEGS patients and 12.50% for EGS patients ($p < 0.0001$). Significant issues happened in 12.74% of NEGS patients and 32.80% of EGS patients ($p < 0.0001$). EGS was independently associated with mortality (odds ratio: 1.39; $p = 0.029$) and major complications (odds ratio: 1.31; $p = 0.001$) when preoperative variables and procedure type were taken into consideration.

During a subgroup analysis, we discovered that the group of patients who were lost during follow-up had a higher prevalence of persisting malignancy at the beginning and preoperative pneumonia. Our research also indicates that the impact of an emergency laparotomy on quality of life should not be underestimated, which aligns with previous studies [17]. The research has notable strengths. Our results are considered clinically meaningful primarily due to the utilisation of the composite endpoint. In addition, a thorough assessment of hernia reduces the likelihood of reporting bias.

Limitation of the study

The shortcoming of the study is the small sample size and the short duration of the study.

Conclusion

This randomised controlled trial (RCT) demonstrated that there was no discernible difference in the occurrence of postoperative burst abdomen and incisional hernia after one year when comparing the use of continuous sutures with slowly absorbable sutures with interrupted sutures with fast absorbable sutures in the main emergency midline laparotomy. Wound dehiscence is a major complication of emergency laparotomy that increases costs, lengthens hospital stays, and increases morbidity. We used both continuous and interrupted PDS sutures in our study and found that, although it requires more time, the interrupted suturing approach of abdominal wall closure is better.

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