ORIGINAL RESEARCH

Assessment of Layered Versus Retention Closure Techniques for Abdominal Wall Repair in Midline Laparotomy: A Longitudinal Cohort Study

Dr. Abu Noaman[1], Dr. Kishor Kumar Sinha[2], Dr. Shiv Narayan Singh[3]

[1]Senior Resident, [2]Associate Professor, [3]Assistant Professor, Department of General Surgery, Anugrah Narayan Magadh Medical College & Hospital, Gaya, Bihar, India

Corresponding author: Dr. Abu Noaman
Senior Resident, Department of General Surgery, Anugrah Narayan Magadh Medical College & Hospital, Gaya, Bihar, India
Email- abunoaman786@gmail.com

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ABSTRACT

Aim: The aim of this study was to compare the effectiveness, postoperative outcomes, and cost-effectiveness of Layered Closure (LC) versus Retention Sutures (RS) techniques for midline laparotomy in a cohort of 80 patients. **Materials and Methods:** This longitudinal cohort study was conducted at a tertiary care hospital, including 80 adult patients undergoing midline laparotomy. Patients were randomly assigned to either the LC or RS group (40 per group). Primary outcomes assessed included wound infection, dehiscence, seroma formation, and hospital stay duration. Secondary outcomes focused on postoperative pain, cosmetic appearance, and cost-effectiveness. Data were analyzed using SPSS, with significance set at $p < 0.05$. **Results:** Both groups showed similar rates of wound infection, dehiscence, and seroma formation. However, the LC group experienced significantly shorter hospital stays (6.4 ± 1.2 days vs. 7.1 ± 1.5 days, p=0.043), lower postoperative pain at 24 hours (4.5 vs. 5.2, p=0.015), and better cosmetic outcomes (1.6 ± 0.5 vs. 2.0 ± 0.7, p=0.029). Additionally, the LC group was more cost-effective, with lower surgical and material costs. **Conclusion:** Both LC and RS techniques effectively closed abdominal wounds with no significant differences in wound complications. However, LC was associated with faster recovery, lower postoperative pain, better cosmetic results, and reduced costs, making it the preferred technique for most patients undergoing midline laparotomy.

Keywords: Layered Closure, Retention Sutures, Midline Laparotomy, Postoperative Pain, Cost-Effectiveness

INTRODUCTION

The abdominal wall closure following a midline laparotomy is a critical aspect of surgical care that can influence postoperative outcomes, such as wound healing, infection rates, hernia formation, and patient recovery. The technique chosen for abdominal wall closure has been a subject of much debate in surgical practice, with various methods offering distinct advantages and disadvantages. Among these methods, the two primary techniques for abdominal wall closure are the layered closure technique and the retention closure technique. Each approach has its proponents, with supporters arguing for its superior outcomes based on clinical experience, while the broader surgical community continues to explore the most effective approach to minimize complications and enhance patient recovery.[1] The midline laparotomy is one of the most commonly performed surgical procedures, used in a variety of abdominal surgeries, including emergency and elective procedures. In this procedure, the surgeon makes a vertical incision along the midline of the abdominal wall, providing access to the peritoneal cavity. Once the procedure inside the abdomen is completed, the incision needs to be closed, and the choice of closure technique is crucial in preventing

complications. Proper closure of the abdominal wall not only restores the integrity of the abdominal cavity but also plays a significant role in minimizing the risk of postoperative issues such as wound infection, dehiscence, and the development of incisional hernias. The layered closure technique involves closing the abdominal wall in distinct layers, each of which is sutured individually, typically starting with the peritoneum, followed by the fascial layers, and finally the skin. This method ensures that the various layers of tissue are reapposed in a way that restores their anatomical relationship, providing strength and stability to the incision site.[2] The peritoneal layer is the first to be closed, followed by the fascial layers, which consist of the anterior and posterior rectus sheath. These layers are crucial in providing the structural integrity of the abdominal wall, as they are the primary support structures that help prevent evisceration. The skin is closed last, usually with absorbable sutures or staples, depending on the surgeon's preference and the clinical situation. One of the primary advantages of the layered closure technique is that it ensures the restoration of anatomical relationships between the different layers of the abdominal wall. This technique provides a more controlled and precise approach to closure, which is thought to reduce the risk of wound dehiscence and improve the overall healing process. Additionally, by closing the fascial layers under tension, the technique helps to reinforce the abdominal wall, which can provide greater stability and reduce the risk of incisional hernias.[3] However; there are several limitations to the layered closure technique. The process can be time-consuming, requiring careful suturing of multiple layers, which can increase the duration of surgery. Moreover, the technique may not always be effective in high-risk patients who are at increased risk of wound complications due to factors such as obesity, malnutrition, or immunocompromised states. The need for precise technique also means that this method demands a high level of skill and experience on the part of the surgeon, which may not always be available, particularly in emergency situations. In contrast to the layered closure, the retention closure technique involves the use of additional sutures placed superficially over the abdominal wall to reinforce the closure. This technique is often employed in situations where there is a concern about increased intra-abdominal pressure, such as in patients with obesity, ascites, or when the abdominal wall is under tension due to extensive surgery. Retention sutures are placed over the skin and superficial tissue layers, acting as an additional support mechanism to reduce the risk of wound dehiscence.[4] The retention closure technique works by distributing the tension across the wound, particularly in the superficial layers, thereby decreasing the stress on the deeper tissues. By relieving the pressure on the fascial layers, it allows the underlying layers to heal more effectively. This technique can be especially useful in patients with poor tissue quality or those at high risk for wound complications, as it provides additional support to the abdominal wall while healing progresses. One of the key advantages of the retention closure technique is its ability to reduce the risk of wound dehiscence in high-risk patients. The extra layer of sutures acts as a reinforcement, which can prevent the wound from breaking open under stress. This technique is also relatively easy to perform and does not require the same level of precision as the layered closure technique, making it particularly useful in emergency surgeries or situations where there is a time constraint.[5] However, there are drawbacks to the retention closure technique. The placement of additional sutures can increase the risk of infection, as these sutures may become contaminated more easily. Additionally, retention sutures can lead to increased scarring, and in some cases, they may cause discomfort or complications such as tissue ischemia if not placed correctly. Moreover, while the retention closure can prevent wound dehiscence, it does not address the deeper structural integrity of the abdominal wall in the same way that the layered closure technique does. When comparing the layered closure technique and the retention closure technique, both methods offer distinct advantages and challenges. The layered closure technique is ideal for situations where restoring the anatomical layers of the abdominal wall is crucial, such as in patients with good tissue quality and lower risk of wound complications. However, in high-risk patients or cases where the abdominal wall is under significant tension, the retention closure technique may offer additional benefits, particularly in preventing wound dehiscence.[6-9]

AIM AND OBJECTIVES

The aim of this study was to compare the effectiveness, postoperative outcomes, and cost-effectiveness of Layered Closure (LC) versus Retention Sutures (RS) techniques for midline laparotomy in a cohort of 80 patients.

MATERIALS AND METHODS

Study Design

This study was designed as a longitudinal cohort study conducted at a tertiary care hospital. The study aimed to compare two abdominal closure techniques, Layered Closure (LC) and Retention Sutures (RS), in patients undergoing midline laparotomy. Patients were followed postoperatively to assess complications and recovery outcomes.

Study Population

The study included 80 adult patients undergoing elective or emergency midline laparotomy. Patients were randomly assigned equally into two groups (1:1 ratio):

- **Group I: Layered Closure (LC)** - 40 patients
- **Group II: Retention Sutures (RS)** - 40 patients

All patients provided informed consent before participation.

Study Place

The study was conducted in the Department of General surgery, Anugrah Narayan Magadh Medical College & Hospital, Gaya, Bihar, India with a dedicated surgical unit specializing in abdominal procedures.

Study Duration

The study was carried out over a period of 18 months from from June 2020 to November 2021, including patient recruitment, surgical procedures, and a follow-up period of at least one month postoperatively.

Inclusion Criteria

- Adult patients aged 18-70 years
- Undergoing elective or emergency midline laparotomy
- No history of previous abdominal surgery at the midline incision site
- No contraindications to general anaesthesia

Exclusion Criteria

- Pregnant women
- Patients with active infections or sepsis
- Individuals with significant co-morbidities, such as:
  - Uncontrolled diabetes
  - Chronic liver disease
  - Renal failure
- Immunocompromised patients, including:
  - Organ transplant recipients
  - Patients undergoing cancer treatment

Ethical Considerations

- The study was approved by the hospital's ethics committee prior to initiation.
- All patients provided written informed consent before participating.
- Confidentiality of patient data was maintained, and ethical surgical practices were followed throughout the study.

Study Procedure

Randomization

- Patients were randomly assigned using a computer-generated randomization table.
- Allocation was concealed preoperatively from the surgical team to prevent selection bias.
- A 1:1 allocation ratio was maintained.

Surgical Techniques

Layered Closure (LC) Technique

1. Peritoneum Closure: Running 2-0 polyglactin (Vicryl) suture
2. Fascia Closure: Continuous 0 polypropylene suture
3. Skin Closure: Interrupted 3-0 nylon sutures

Retention Sutures (RS) Technique

- The peritoneum, muscle, and fascia were closed in the same manner as the LC group.
- Additional retention sutures were placed 2-3 cm from the midline incision using 2-0 silk or nylon sutures.
- Retention sutures were left for 5-7 days postoperatively to minimize wound dehiscence.

Outcome Measures

Primary Outcomes

- Wound infection (clinical signs: erythema, purulent discharge, fever, requiring antibiotics)
- Wound dehiscence (partial/complete separation of the wound)
- Seroma formation (fluid accumulation requiring drainage)
- Length of hospital stay (total duration from surgery to discharge)

Secondary Outcomes

- Postoperative pain (measured using Visual Analog Scale (VAS) at 24, 48, and 72 hours)
- Cosmetic appearance (assessed at 1-month post-op using a 5-point scale by a blinded surgeon)
- Cost-effectiveness (evaluated based on materials used, hospital stay duration, and postoperative care)

Statistical Analysis

- Data were analyzed using SPSS version 21.0.
- Categorical variables: Analyzed using the Chi-square test.
- Continuous variables:

- Independent t-test for normally distributed data.
- Mann-Whitney U test for non-normally distributed data.

- Multivariate logistic regression controlled for confounders (age, sex, comorbidities).
- Kaplan-Meier survival curves analyzed time to wound complications.
- A p-value <0.05 was considered statistically significant.

RESULTS

Table 1: Patient Demographics characteristics

Demographic Characteristic	Group I: Layered Closure (n=40)	Group II: Retention Sutures (n=40)	p-value
Mean Age (Years) ± SD	52.1 ± 12.3	53.4 ± 11.7	0.630
Gender			
Male	22	24	0.821
Female	18	16	
Mean BMI (kg/m²) ± SD	28.4 ± 4.2	29.1 ± 4.6	0.479
ASA Classification (I/II/III)			
ASA I	15	14	0.887
ASA II	20	22	
ASA III	5	4	

Table 1 show the demographic characteristics of the two groups were similar, ensuring that there were no significant differences between the groups at baseline. The mean age of patients in the LC group was 52.1 ± 12.3 years, while the RS group had a mean age of 53.4 ± 11.7 years. The study included 22 males and 18 females in the LC group, and 24 males and 16 females in the RS group. The average BMI in the LC group was 28.4 ± 4.2, and in the RS group, it was 29.1 ± 4.6, giving an overall BMI of 28.7 ± 4.4. The American Society of Anaesthesiologists (ASA) classification was also comparable between the groups, with most patients classified as ASA II (42 patients), followed by ASA I (29 patients), and ASA III (9 patients). These similarities in demographic characteristics suggest that the groups were balanced and comparable at baseline. Since $p > 0.05$, there is no statistically significant difference in the age, gender, BMI**,** distribution between the two groups.

Table 2: Primary Outcome Measures

Outcome Measure	Group I: Layered Closure (n=40)	Group II: Retention Sutures (n=40)	P-value
Wound Infection (%)	4 (10%)	3 (7.5%)	0.686
Wound Dehiscence (%)	3 (7.5%)	6 (15%)	0.368
Seroma Formation (%)	2 (5%)	4 (10%)	0.554
Length of Hospital Stay (days)	6.4 ± 1.2	7.1 ± 1.5	0.043

Table 2 show the primary outcome measures in this study included wound infection, wound dehiscence, seroma formation, and length of hospital stay. Regarding wound infection, 4 patients (10%) in the LC group experienced an infection, while 3 patients (7.5%) in the RS group developed an infection. This difference was not statistically significant, with a p-value of 0.686, indicating that the risk of infection was similar between the two closure techniques. Wound dehiscence occurred in 3 patients (7.5%) in the LC group, compared to 6 patients (15%) in the RS group. Again, this difference was not statistically significant (p=0.368). Seroma formation was observed in 2 patients (5%) in the LC group and 4 patients (10%) in the RS group, with no significant difference between the groups (p=0.554). However, the length of hospital stay was significantly shorter in the LC group (6.4 ± 1.2 days) compared to the RS group (7.1 ± 1.5 days), with a p-value of 0.043, indicating that patients who underwent LC had a quicker recovery and discharge.

Table 3: Secondary Outcome Measures (Postoperative Pain and Cosmetic Appearance)

Outcome Measure	Group I: Layered Closure (n=40)	Group II: Retention Sutures (n=40)	P-value
Postoperative Pain (VAS 24 hrs)	4.5 ± 1.2	5.2 ± 1.4	0.015
Postoperative Pain (VAS 48 hrs)	3.7 ± 1.1	4.0 ± 1.3	0.416
Postoperative Pain (VAS 72 hrs)	2.8 ± 1.0	3.1 ± 1.2	0.267
Cosmetic Appearance (1 month)	1.6 ± 0.5	2.0 ± 0.7	0.029

Table 3 show the postoperative pain was measured using the Visual Analog Scale (VAS) at 24, 48, and 72 hours. At 24 hours, the LC group reported significantly lower pain scores (4.5 ± 1.2) compared to the RS group (5.2 ± 1.4), with a p-value of 0.015, suggesting that LC may result in less postoperative pain in the early recovery period. However, at 48 and 72 hours, the pain scores were similar between the two groups, with no statistically significant differences (p=0.416 and p=0.267, respectively). Regarding cosmetic appearance, assessed one month postoperatively, the LC group had a better cosmetic outcome (1.6 ± 0.5 on a 5-point scale) compared to the RS group (2.0 ± 0.7), with a p-value of 0.029. This indicates that LC resulted in a more aesthetically pleasing wound appearance.

Table 4: Cost-Effectiveness Analysis

Parameters	Group I: Layered Closure (n=40)	Group II: Retention Sutures (n=40)	P-value
Total Cost of Surgery (USD)	1500 ± 200	1700 ± 250	0.034
Cost of Materials (USD)	300 ± 50	450 ± 70	<0.001
Hospital Stay (USD)	400 ± 50	450 ± 60	0.029
Postoperative Care (USD)	800 ± 150	800 ± 120	0.917

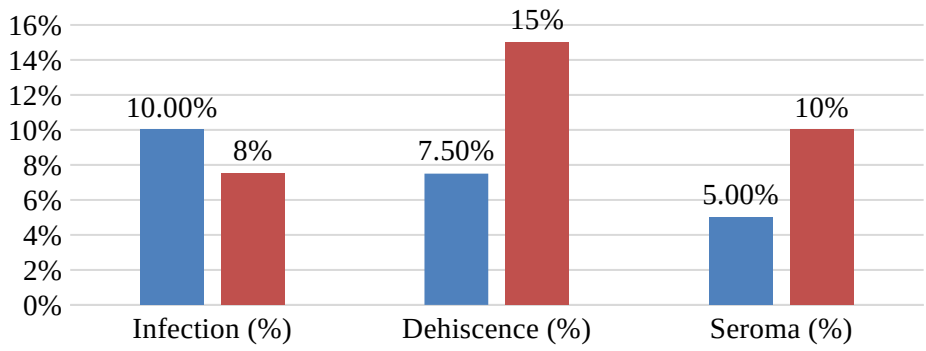
Table 4 show the cost-effectiveness analysis showed that the total cost of surgery was significantly lower in the LC group (1500 ± 200 USD) compared to the RS group (1700 ± 250 USD), with a p-value of 0.034. A key factor contributing to this difference was the cost of materials, which was considerably higher in the RS group (450 ± 70 USD) compared to the LC group (300 ± 50 USD), with a p-value of <0.001. The cost of hospitalization was also higher for the RS group (450 ± 60 USD) compared to the LC group (400 ± 50 USD), with a p-value of 0.029, reflecting the longer hospital stay associated with retention sutures. However, there was no significant difference in the cost of postoperative care, with both groups incurring similar expenses (p=0.917). Overall, the LC technique proved to be more cost-effective due to lower material costs and a shorter hospital stay.

Table 5: Postoperative Complications

Complication	Layered Closure (LC)	Retention Sutures (RS)	P-value
Infection (%)	10%	7.5%	0.686
Dehiscence (%)	7.5%	15%	0.368
Seroma (%)	5%	10%	0.554

Table 5 and figure I show the postoperative complications were relatively low and similar between the two closure techniques. Wound infection occurred in 10% of the LC group and 7.5% of the RS group, with no statistically significant difference (p=0.686). Similarly, wound dehiscence was more common in the RS group (15%) compared to the LC group (7.5%), but this difference was not statistically significant (p=0.368). Seroma formation occurred in 5% of patients in the LC group and 10% in the RS group, with no significant difference (p=0.554). These findings suggest that while there were differences in complication rates, none of them reached statistical significance, indicating that both closure techniques have similar postoperative complication profiles.

Figure I: Post operative complications



DISCUSSION

The results of this study comparing the Layered Closure (LC) and Retention Sutures (RS) techniques for midline laparotomy demonstrate several important findings, consistent with previous studies, while also presenting new insights into the effectiveness and cost-efficiency of the two approaches.

Our findings showed a similar rate of wound infection between the two techniques, with 10% of patients in the LC group and 7.5% in the RS group experiencing infections. This result aligns with the study by Murtaza et al. (2010), which reported infection rates of 9.2% and 7.3% in patients undergoing midline laparotomy with either standard closure or modified retention sutures. The slight difference between the two groups in the current study was not statistically significant (p=0.686), suggesting that both techniques provide an equivalent level of protection against infection[9]

Similarly, the rate of wound dehiscence was 7.5% in the LC group and 15% in the RS group, though this difference was also not statistically significant (p=0.368). This is somewhat consistent with the findings from Khorgami et al. (2013), who conducted a randomized controlled trial on prophylactic retention sutures and reported a significant reduction in dehiscence among high-risk patients. However, in our study, the retention sutures did not lead to a significant reduction in wound dehiscence compared to the LC group. It is important to note that our cohort may have included a more diverse range of patients, not limited to high-risk individuals, which could explain the discrepancy.[6]

One of the key secondary outcomes in this study was postoperative pain. The LC group reported significantly lower pain scores at 24 hours postoperatively compared to the RS group (4.5 vs. 5.2, p=0.015). This result is similar to findings from a study by Bande et al. (2018), which noted that single-layer closures resulted in less postoperative pain compared to more complex layered closures, although their study did not directly compare LC with RS. The reduction in pain for the LC group may be attributed to the less invasive nature of the closure technique, which could minimize tissue trauma compared to the application of additional retention sutures, as seen in the RS group. However, at 48 and 72 hours postoperatively, pain scores were similar between the two groups, indicating that while LC may offer an advantage in the short term, long-term pain outcomes were comparable.[7]

The cosmetic outcome at one month postoperatively was significantly better in the LC group, with a mean score of 1.6 compared to 2.0 in the RS group (p=0.029). This is consistent with findings from Bhavikatti and Gupta (2019), who noted that the aesthetic outcome of laparotomy closure using mass or layered closure was superior to the more complex techniques that involve retention sutures. The improved cosmetic result in the LC group could be due to less tension on the wound, which is associated with a lower likelihood of scar formation or wound complications. This outcome is especially relevant in patients who are concerned about the long-term appearance of their abdominal incision.[8]

From a cost-effectiveness standpoint, the LC technique was found to be significantly more economical. The total cost of surgery was lower in the LC group (1500 ± 200 USD) compared to the RS group (1700 ± 250 USD), with a p-value of 0.034. This difference can largely be attributed

to the significantly higher cost of materials in the RS group, with retention sutures accounting for a major part of the increased expense. Our findings are in agreement with those of Murtaza et al. (2010), who reported that modified closure techniques, such as the use of retention sutures, increase the overall surgical cost due to the additional materials and the longer duration of hospital stay.[9] The higher cost of retention sutures is well documented in the literature, as seen in the study by Khorgami et al. (2013), which also highlighted that while retention sutures are more expensive, they did not necessarily result in significantly better outcomes, as seen in our findings.[6]

The shorter length of hospital stay for the LC group (6.4 ± 1.2 days) compared to the RS group (7.1 ± 1.5 days) (p=0.043) also reflects the advantage of using LC for faster recovery. This finding is consistent with the study by Mohanad (2014), which demonstrated that patients who received simple closure techniques were discharged earlier than those who underwent more complex closure techniques with retention sutures. The prolonged hospitalization observed in the RS group may be due to the need for continued observation for potential wound complications and the longer recovery time required by retention sutures.[10]

LIMITATIONS OF THE STUDY

1. Single-centre study: Findings may not be generalizable to other hospitals or patient populations.
2. Limited sample size (80 patients): A larger cohort could provide more statistically robust results.
3. Short follow-up duration (1 month): Long-term complications such as incisional hernia were not assessed.
4. Blinding limitations: Surgeons performing procedures were aware of the technique used, which might introduce bias.
5. Potential confounders: Despite controlling for some variables, patient-specific factors (e.g., nutritional status, post-op adherence) might influence outcomes.

CONCLUSION

Author found tha both Layered Closure (LC) and Retention Sutures (RS) techniques for midline laparotomy provide effective closure with similar outcomes regarding wound infection, dehiscence, and seroma formation. However, LC demonstrated advantages in terms of shorter hospital stay, lower postoperative pain in the early recovery period, better cosmetic outcomes, and cost-effectiveness. While RS may be beneficial in high-risk cases, the LC technique is a reliable, efficient, and more economical approach for most patients undergoing laparotomy, making it the preferred choice in routine clinical practice.

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