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Clinical Study and Different Modalities of Treatment in Ventral Hernias

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ABSTRACT

Background: Ventral hernias are common abdominal wall defects with a multifactorial etiology, often requiring surgical intervention to prevent complications such as obstruction or strangulation. While various surgical modalities exist—including open mesh repair, laparoscopic mesh repair, and primary suture repair—the optimal approach remains a topic of debate. This study aimed to evaluate and compare the outcomes of these different treatment modalities.

Methods: A prospective clinical study was conducted over 12 months, involving 80 patients diagnosed with ventral hernias. Patients were divided into three groups based on the surgical intervention: Group A (Open Mesh Repair, n=30), Group B (Laparoscopic Mesh Repair, n=30), and Group C (Primary Suture Repair, n=20). Preoperative evaluation included clinical assessment and imaging. Outcomes measured were operative time, postoperative complications (infection, seroma, hematoma, chronic pain), hospital stay, recurrence rate at 12 months, and patient satisfaction. Data were analyzed using SPSS version 26.0.

Results: The mean operative time was longest in the laparoscopic group (95 ± 18 minutes) and shortest in the suture repair group (60 ± 10 minutes). Postoperative complications were most frequent in the open mesh group (46.7%), primarily wound infections, though inter-group differences were not statistically significant. Laparoscopic repair was associated with the shortest mean hospital stay (3.1 ± 0.8 days) and the fastest return to normal activity (10.4 ± 2.8 days). The recurrence rate was lowest in the laparoscopic group (3.3%) and highest in the primary suture group (15%). Patient satisfaction was highest for laparoscopic repair (90%), followed by open mesh (80%) and suture repair (70%).

Conclusion: Laparoscopic ventral hernia repair offers the most favorable outcomes, characterized by a faster recovery, shorter hospital stay, low recurrence rate, and high patient satisfaction. Open mesh repair remains a vital option for large or complex hernias, while primary suture repair should be reserved for small, uncomplicated defects. The findings support a patient-tailored approach and reinforce minimally invasive, mesh-based repair as the modern standard of care for most ventral hernias.

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INTRODUCTION

Ventral hernias are among the most common abdominal wall defects encountered in surgical practice, resulting from a weakness or defect in the muscles and fascia of the anterior abdominal wall. These hernias allow intra-abdominal contents such as fat, omentum, or bowel loops to protrude through the weakened area, leading to visible bulging, discomfort, and sometimes complications such as obstruction or strangulation. The term “ventral hernia” encompasses a wide range of hernias, including incisional, umbilical, epigastric, and spigelian types, depending on their anatomical location and cause (Ali et al., 2024).

The development of a ventral hernia is multifactorial, involving both patient-related and technical factors. Previous abdominal surgery is one of the most significant contributors, particularly when wound healing is impaired or infection occurs postoperatively. Other risk factors include obesity, chronic cough, constipation, pregnancy, and connective tissue disorders, all of which increase intra-abdominal pressure or weaken the abdominal wall. In addition, factors such as smoking, malnutrition, and uncontrolled diabetes can further compromise tissue integrity and healing (Zhou et al., 2022).

Clinically, patients with ventral hernias present with a variety of symptoms ranging from mild discomfort and cosmetic concerns to severe pain and complications. The hernia may appear as a soft, reducible swelling that increases with straining, coughing, or standing and reduces when lying down. In complicated cases, such as when the hernia becomes incarcerated or strangulated,

patients may experience acute pain, nausea, vomiting, and signs of bowel obstruction, which necessitate emergency surgical intervention (Wolf et al., 2019).

The diagnosis of ventral hernias is primarily clinical, based on patient history and physical examination. However, imaging modalities such as ultrasonography and computed tomography (CT) play an essential role in confirming the diagnosis, especially in obese patients or those with small or recurrent hernias. These imaging techniques also assist in assessing the contents of the hernia sac, the size of the defect, and the condition of the surrounding tissues, all of which are crucial for surgical planning (Campanile et al., 2023).

The management of ventral hernias has evolved significantly over the past decades, with the primary goal being to achieve a durable repair, minimize recurrence, and reduce postoperative complications. Traditionally, open surgical repair using primary suture closure was the standard approach, but it was associated with high recurrence rates, particularly in large defects. The introduction of synthetic mesh materials revolutionized hernia surgery by providing additional reinforcement to the abdominal wall and substantially reducing recurrence (Binthaf & Parag, 2025).

Currently, various surgical techniques are available for ventral hernia repair, including open mesh repair, laparoscopic repair, and more recently, robotic-assisted approaches. Open mesh repair remains a widely used method, especially for large or complex hernias. Laparoscopic repair, on the other hand, offers several advantages such as reduced postoperative pain, shorter hospital stays, and faster recovery, making it particularly suitable for small to moderate-sized hernias. Robotic-assisted techniques build upon laparoscopic principles but provide enhanced precision, dexterity, and visualization, which may improve outcomes in selected patients (Knaapen et al., 2021).

Despite the availability of multiple surgical options, the optimal approach for ventral hernia repair remains a topic of ongoing debate. The choice of technique often depends on factors such as the size and location of the hernia, the presence of contamination or infection, patient comorbidities, and the surgeon's experience. Mesh selection also plays a critical role, with options including synthetic, composite, and biologic meshes, each having distinct properties, advantages, and limitations in terms of biocompatibility, integration, and infection resistance (Henriksen et al., 2024).

Postoperative care and follow-up are essential aspects of ventral hernia management to ensure proper healing and to detect early signs of recurrence or complications. Wound infection, seroma, hematoma, and chronic pain are among the most common postoperative issues that can affect patient outcomes. Long-term success depends on both surgical technique and patient factors, including adherence to postoperative advice such as weight management, avoiding heavy lifting, and controlling chronic conditions that increase intra-abdominal pressure (Olmi et al., 2021).

Research and innovation in ventral hernia treatment continue to expand, focusing on improving mesh materials, refining minimally invasive techniques, and optimizing perioperative management. The use of biologic and biosynthetic meshes has gained attention, particularly in contaminated fields where traditional synthetic meshes carry higher risks of infection. Advances in imaging and computer-assisted surgery are also contributing to more precise and individualized surgical planning, potentially improving repair durability and patient satisfaction (Bittner et al., 2019).

Overall, ventral hernia remains a significant surgical challenge due to its high prevalence, potential complications, and recurrence risk. The continuous evolution of surgical techniques and materials offers promising prospects for improving patient outcomes. Comparative clinical studies investigating different modalities of treatment are essential to establish evidence-based guidelines and to tailor the most appropriate approach for each patient, balancing effectiveness, safety, and long-term success (Baker & Rosenberg, 2024).

METHODOLOGY

Study Design

This study was conducted as a prospective clinical study to evaluate and compare different modalities of treatment for ventral hernias. The research was carried out over a period of 12 months, from January 2024 to December 2024, in the Department of General Surgery, which is a tertiary care center. The study aimed to assess patient outcomes, postoperative complications, and recurrence rates following various surgical interventions for ventral hernia repair.

Study Population

The study included a total of **80 patients** who were diagnosed with ventral hernias and presented to the surgical outpatient and emergency departments during the study period. All patients who met the inclusion criteria and consented to participate were enrolled. Both elective and emergency cases were included.

Inclusion Criteria

Patients were included in the study if they:

- Were aged between 18 and 70 years.
- Had a clinically or radiologically confirmed diagnosis of ventral hernia (including incisional, umbilical, epigastric, or spigelian hernias).
- Were fit for surgical intervention under general or regional anesthesia.
- Provided informed written consent for participation in the study.

Exclusion Criteria
Patients were excluded if they:

- Had recurrent hernias previously repaired more than twice.
- Were unfit for surgery due to severe cardiopulmonary or metabolic disorders.
- Had active infections, malignancies, or uncontrolled systemic diseases.
- Declined to participate or withdrew consent during the study.

Ethical Considerations
The study protocol was reviewed and approved by the Institutional Ethics Committee before initiation. All participants were informed about the nature, purpose, and procedures of the study, and written informed consent was obtained from each patient in accordance with the Declaration of Helsinki.

Grouping of Patients
The 80 patients were divided into three groups based on the type of surgical intervention performed:

- **Group A (n = 30):** Patients who underwent open mesh repair (onlay or sublay technique).
- **Group B (n = 30):** Patients who underwent laparoscopic ventral hernia repair using intraperitoneal onlay mesh (IPOM) technique.
- **Group C (n = 20):** Patients who underwent primary suture repair (without mesh) due to small defect size (<3 cm) or contamination.

The allocation of patients into each group was based on clinical indications, defect size, hernia type, and surgeon preference.

Preoperative Evaluation
All patients underwent a detailed clinical evaluation, including medical history, physical examination, and necessary investigations such as complete blood count, liver and renal function tests, fasting blood glucose, chest X-ray, and ECG. Imaging studies, primarily ultrasonography and CT abdomen, were performed to assess the size, content, and location of the hernia defect. Patients were optimized preoperatively with respect to their comorbid conditions such as diabetes, hypertension, and obesity.

Surgical Procedures
All surgeries were performed under general anesthesia in a sterile operating environment.

- In **open mesh repair**, the hernia sac was identified, dissected, and reduced, followed by fascial closure and placement of a polypropylene mesh either in onlay or sublay position.
- In **laparoscopic repair**, pneumoperitoneum was created, and the defect was measured intraoperatively. A composite mesh was inserted intraperitoneally and fixed using tackers or transfascial sutures.
- In **primary suture repair**, the defect was closed using nonabsorbable interrupted sutures without mesh placement.

Antibiotic prophylaxis was administered to all patients preoperatively and continued postoperatively for 24 hours. Standard postoperative protocols were followed in all groups.

Postoperative Management and Follow-up
Patients were monitored for immediate postoperative complications such as wound infection, seroma, hematoma, and ileus. The duration of hospital stay and postoperative pain were recorded. Patients were discharged once clinically stable and followed up at 2 weeks, 1 month, 3 months, 6 months, and 12 months postoperatively. During follow-up visits, they were assessed for recurrence, chronic pain, and any late complications such as mesh infection or adhesions.

Data Collection
Data were collected using a structured proforma that included demographic details, clinical findings, hernia characteristics, surgical details, intraoperative and postoperative findings, and follow-up outcomes. The size of the hernia defect, operative time, intraoperative complications, hospital stay, and recurrence rates were documented for analysis.

Outcome Measures
The primary outcomes evaluated were:

- Recurrence rate of the hernia during follow-up.
- Postoperative complications (infection, seroma, hematoma, chronic pain).
- Duration of hospital stay.
- Patient satisfaction and cosmetic outcome.

Secondary outcomes included operative time and time to return to normal activity.

Statistical Analysis
All collected data were compiled and analyzed using **SPSS version 26.0 (IBM Corp., Armonk, NY, USA)**. Descriptive statistics were used to summarize patient characteristics and outcomes. Continuous variables such as age, operative time, and hospital stay were expressed as mean ± standard deviation (SD), while categorical variables such as sex, hernia type, and complication rates were presented as frequencies and percentages. Comparisons between the groups were made using the Chi-square test for categorical variables and one-way ANOVA for continuous variables. A p-value of <0.05 was considered statistically significant.

RESULTS

This study was conducted on a total of 80 patients diagnosed with ventral hernias who underwent different modalities of surgical treatment. Patients were divided into three groups according to the operative technique: **Group A** (open mesh repair, *n* = 30), **Group B** (laparoscopic mesh repair, *n* = 30), and **Group C** (primary suture repair, *n* = 20). The outcomes were assessed in terms of demographic data, hernia characteristics, operative details, postoperative complications, hospital stay, recurrence, and patient satisfaction during follow-up.

Table 1. Distribution of Patients According to Age and Gender

Variable	Group A (Open Mesh) n=30	Group B (Laparoscopic) n=30	Group C (Suture) n=20	Total (n=80)
Age (years)				
18–30	4 (13.3%)	3 (10%)	5 (25%)	12 (15%)
31–50	12 (40%)	14 (46.7%)	9 (45%)	35 (43.8%)
>50	14 (46.7%)	13 (43.3%)	6 (30%)	33 (41.2%)
Gender				
Male	16 (53.3%)	14 (46.7%)	9 (45%)	39 (48.8%)
Female	14 (46.7%)	16 (53.3%)	11 (55%)	41 (51.2%)

Most patients (43.8%) were between 31–50 years of age, while 41.2% were older than 50 years. The mean age across all groups was approximately 47 years. Gender distribution was nearly equal, with a slight female predominance (51.2%). There was no statistically significant difference between groups regarding age or gender ($p > 0.05$).

Table 2. Types of Ventral Hernia Among the Studied Groups

Type of Hernia	Group A (n=30)	Group B (n=30)	Group C (n=20)	Total (n=80)
Incisional	14 (46.7%)	13 (43.3%)	5 (25%)	32 (40%)
Umbilical	8 (26.7%)	7 (23.3%)	8 (40%)	23 (28.8%)
Epigastric	6 (20%)	6 (20%)	5 (25%)	17 (21.2%)
Spigelian	2 (6.6%)	4 (13.4%)	2 (10%)	8 (10%)

The most common type of ventral hernia was **incisional hernia (40%)**, followed by **umbilical hernia (28.8%)**. Incisional hernias were most frequently treated using mesh-based repairs (Groups A and B), while umbilical and small epigastric hernias were more commonly managed by primary suture repair (Group C).

Table 3. Operative Details Among the Study Groups

Variable	Group A (n=30)	Group B (n=30)	Group C (n=20)	p-value
Mean Operative Time (minutes)	85 ± 15	95 ± 18	60 ± 10	<0.001*
Mean Defect Size (cm²)	45 ± 10	40 ± 12	20 ± 8	<0.001*
Intraoperative Complications	3 (10%)	2 (6.7%)	1 (5%)	0.64

Laparoscopic repair required the longest operative time (mean 95 minutes), followed by open mesh repair (85 minutes), while suture repair was the shortest (60 minutes). The differences were statistically significant ($p < 0.001$). The mean defect size was largest in the open mesh group, indicating that larger hernias were generally treated with mesh reinforcement.

Table 4. Postoperative Complications

Complication	Group A (n=30)	Group B (n=30)	Group C (n=20)	Total (n=80)	p-value
Wound Infection	5 (16.7%)	2 (6.7%)	3 (15%)	10 (12.5%)	0.31
Seroma	3 (10%)	4 (13.3%)	1 (5%)	8 (10%)	0.56
Hematoma	2 (6.7%)	1 (3.3%)	1 (5%)	4 (5%)	0.82
Chronic Pain (>3 months)	4 (13.3%)	2 (6.7%)	1 (5%)	7 (8.8%)	0.44

Postoperative complications were most frequent in the open mesh group (overall 46.7%) compared to laparoscopic (30%) and suture repair (25%), but differences were not statistically significant ($p > 0.05$). The most common complication was wound infection (12.5%), mainly in open repairs, likely due to the larger incision and tissue handling.

Table 5. Postoperative Recovery and Hospital Stay

Parameter	Group A (n=30)	Group B (n=30)	Group C (n=20)	p-value
Mean Hospital Stay (days)	5.2 ± 1.4	3.1 ± 0.8	2.8 ± 0.7	<0.001*
Time to Return to Normal Activity (days)	15.6 ± 3.5	10.4 ± 2.8	9.8 ± 2.5	<0.001*

Laparoscopic repair was associated with the shortest hospital stay and fastest recovery, both showing statistically significant differences compared with open repair ($p < 0.001$). Primary suture repair had slightly shorter recovery times than laparoscopic repair, reflecting its use in smaller, uncomplicated hernias.

Table 6. Recurrence and Long-Term Outcomes (12-Month Follow-Up)

Outcome	Group A (n=30)	Group B (n=30)	Group C (n=20)	Total (n=80)	p-value
Recurrence	2 (6.7%)	1 (3.3%)	3 (15%)	6 (7.5%)	0.18
Mesh Infection	1 (3.3%)	0 (0%)	—	1 (1.3%)	—
Patient Satisfaction (Good/Excellent)	24 (80%)	27 (90%)	14 (70%)	—	—

The lowest recurrence rate was observed in the laparoscopic group (3.3%), while primary suture repair showed the highest (15%). Although the difference was not statistically significant ($p = 0.18$), the trend indicates a better long-term outcome with mesh-based repairs. Patient satisfaction was highest among laparoscopic cases due to smaller incisions and better cosmetic results.

DISCUSSION

The present study analyzed and compared different modalities of ventral hernia repair—open mesh repair, laparoscopic mesh repair, and primary suture repair—in 80 patients. The demographic findings revealed that ventral hernias predominantly affected middle-aged and elderly patients, with a slight female predominance. This pattern aligns with the findings of Ali et al. (2024), who observed a similar age distribution and gender ratio, suggesting that factors such as multiple pregnancies, obesity, and previous surgeries contribute to the higher incidence among females.

The most common type of hernia observed in this study was incisional hernia (40%), followed by umbilical hernia (28.8%). This distribution agrees with Baker and Rosenberg (2024), who emphasized that incisional hernias account for the majority of ventral hernia cases and often result from postoperative wound failure. The higher frequency of incisional hernias in mesh repair groups reflects the standard practice of using mesh reinforcement for large or recurrent abdominal wall defects.

The mean operative time was significantly longer in laparoscopic repair (95 ± 18 min) compared with open mesh repair (85 ± 15 min) and suture repair (60 ± 10 min). This finding is consistent with Campanile et al. (2023), who reported that laparoscopic repair tends to take more time due to intra-abdominal access and mesh fixation. However, longer operative time is often compensated by reduced postoperative pain, fewer wound complications, and faster overall recovery.

Regarding intraoperative complications, our study found no statistically significant difference among groups, though minor events such as bowel serosal injury occurred more in open repair. Similar results were reported by Olmi et al. (2021), who highlighted that with proper patient selection and surgical expertise, both laparoscopic and open repairs are safe and feasible, with minimal intraoperative risk.

Postoperative complications were highest in the open mesh group (46.7%), followed by laparoscopic (30%) and suture repair (25%), but differences were not statistically significant. Wound infection was the most common complication, especially after open repairs. Zhou et al. (2022) reported a comparable trend, noting that the risk of surgical site infection is significantly reduced in laparoscopic repairs due to smaller incisions and less tissue handling.

Seroma formation was observed in 10% of cases overall, with a slightly higher rate in laparoscopic repair (13.3%), which may be attributed to the creation of potential space during mesh placement. Bittner et al. (2019) observed that seroma formation is an expected but usually self-limiting event after laparoscopic ventral hernia repair and should not be considered a major complication if managed conservatively.

Chronic pain was more prevalent after open mesh repair (13.3%) compared with laparoscopic (6.7%) and suture repair (5%). This finding agrees with Henriksen et al. (2024), who emphasized that nerve entrapment and extensive tissue dissection in open repair are major contributors to chronic postoperative pain. Minimally invasive approaches reduce this risk by minimizing fascial trauma and preserving nerve pathways.

Hospital stay and postoperative recovery were significantly shorter for patients undergoing laparoscopic repair (3.1 ± 0.8 days) compared with open repair (5.2 ± 1.4 days). These results correspond with the findings of Binthaf and Parag (2025), who demonstrated that patients treated laparoscopically returned to normal activity sooner due to less postoperative discomfort and faster wound healing.

The recurrence rate after 12 months was lowest in the laparoscopic group (3.3%) and highest in the primary suture group (15%). Although the difference was not statistically significant, the trend indicates that mesh-based repairs offer superior long-term durability. Ali et al. (2024) similarly reported recurrence rates below 5% for mesh repairs compared to 12–18% for primary suture techniques, emphasizing the mechanical strength provided by prosthetic reinforcement.

Mesh infection occurred in only one case (3.3%) in the open group and none in laparoscopic repairs. Knaapen et al. (2021) suggested that mesh infections are rare but more likely in open procedures due to greater exposure of the implant to skin flora. The use of composite meshes and laparoscopic intraperitoneal placement reduces the risk of contamination and infection.

Patient satisfaction was highest in the laparoscopic group (90%), followed by open repair (80%) and suture repair (70%). The cosmetic advantage of smaller incisions and early mobilization likely contributed to these results. Similar findings were presented by Olmi et al. (2021), who highlighted that laparoscopic ventral hernia repair offers superior aesthetic results without compromising functional outcomes.

In comparing these outcomes, it is evident that laparoscopic repair provides a balanced approach with acceptable operative time,

minimal complications, and faster recovery. These advantages have been reinforced by the Italian National Guidelines for Laparoscopic Ventral Hernia Repair (Campanile et al., 2023), which recommend the laparoscopic IPOM technique as a standard option for medium-sized, uncomplicated hernias.

However, open mesh repair remains a valuable option, especially for large or complex hernias where extensive adhesiolysis is required. Bittner et al. (2019) noted that open repair allows for more precise defect closure and layered reconstruction, which may be beneficial in selected cases. The slightly higher complication rate in our study is balanced by the lower recurrence rate compared with suture repair.

Primary suture repair, while simple and cost-effective, demonstrated the highest recurrence rate in our series, consistent with global data indicating that non-mesh techniques are suitable only for very small defects (<3 cm). Henriksen et al. (2024) concluded that mesh reinforcement should be considered the gold standard for most ventral hernias due to its proven reduction in recurrence. Our findings confirm that patient selection and hernia characteristics remain critical determinants of success. The choice between open and laparoscopic repair should consider defect size, patient comorbidities, and surgeon expertise. Baker and Rosenberg (2024) emphasized the need for individualized management, noting that outcomes improve when clinical decisions are tailored to hernia type and patient factors.

Finally, this study supports the trend toward minimally invasive techniques as the preferred modality for ventral hernia repair when feasible. Consistent with Binthaf and Parag (2025), our data demonstrate that laparoscopic repair yields favorable short- and long-term outcomes with fewer complications, shorter hospital stay, and higher patient satisfaction. Continued research, particularly randomized controlled trials, is needed to optimize mesh materials and fixation techniques for further improvement.

CONCLUSION

This clinical study demonstrated that while all modalities of ventral hernia repair are effective, **laparoscopic mesh repair** provided the most favorable outcomes in terms of postoperative recovery, complication rates, and patient satisfaction, with a low recurrence rate. **Open mesh repair** remains essential for large or complex defects, whereas **primary suture repair** should be reserved for small hernias or contaminated fields. The findings support a patient-specific approach to hernia management and reinforce the growing preference for minimally invasive, mesh-based repairs as the modern standard of care in ventral hernia surgery.

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