

A clinical study of postoperative complications following mesh repair of ventral hernias and their association with patient-related risk factors and mesh position: A cross-sectional observational study

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Abstract

Background: Ventral hernias constitute one of the most frequently encountered abdominal wall hernias requiring operative intervention. Mesh repair has become the standard of care because of its lower recurrence rates compared with primary suture repair. Nevertheless, postoperative complications such as seroma formation, surgical site infection, skin necrosis, haematoma and chronic pain continue to contribute significantly to patient morbidity. Multiple patient-related factors, including obesity, diabetes mellitus, smoking, previous abdominal surgeries and the choice of mesh position, may influence postoperative outcomes. Identifying these factors is essential for optimizing surgical planning and reducing complications.

Objectives: To evaluate the incidence of early and late postoperative complications following mesh repair of ventral hernias and to determine the association of these complications with patient-related risk factors, type of ventral hernia and mesh position.

Materials and Methods: A hospital-based cross-sectional observational study was conducted in the Department of General Surgery, K.H. Patil Institute of Medical Sciences, Gadag, over a period of two years from March 2024 to February 2026. One hundred consecutive patients undergoing elective or emergency mesh repair for ventral hernias were enrolled using universal sampling. Demographic characteristics, clinical presentation, associated risk factors, type of ventral hernia, mesh position, anaesthesia and postoperative outcomes were recorded prospectively. Statistical analysis was performed using SPSS software. Associations between variables were analysed using Chi-square test, Fisher's exact test and independent t-test. A p-value <0.05 was considered statistically significant.

Results: The mean age of the study population was 46.07 ± 13.21 years, with females accounting for 63% of patients. Umbilical hernia was the commonest ventral hernia (71%), followed by incisional, paraumbilical and epigastric hernias. Obesity was the most prevalent associated risk factor (46%). Onlay mesh placement was performed in 53% of patients, while sublay and preperitoneal repairs accounted for 25% and 22%, respectively. Early postoperative complications occurred in 31% of patients, with seroma (14%) and skin necrosis (13%) being the most common complications. No late postoperative complications were observed during follow-up. Mesh position demonstrated a statistically significant association with postoperative complications ($p = 0.0009$), whereas age, gender, hernia type and associated risk factors did not show significant associations.

Conclusion: Mesh position significantly influences postoperative outcomes following ventral hernia repair. Sublay and preperitoneal mesh placement were associated with lower postoperative complication rates compared with onlay repair. Whenever technically feasible, deeper mesh placement should be preferred to minimize postoperative morbidity and improve surgical outcomes.

Keywords: Ventral hernia, mesh repair, onlay mesh, sublay mesh, preperitoneal mesh, surgical site infection, seroma, postoperative complications

Introduction

Ventral hernias represent defects in the anterior abdominal wall through which intra-abdominal or preperitoneal contents protrude. They include primary ventral hernias such as umbilical, paraumbilical, epigastric and Spigelian hernias, as well as secondary or incisional hernias developing after previous abdominal surgeries. Ventral hernias account for a substantial proportion of general surgical procedures worldwide and remain an important cause of morbidity due to pain, cosmetic deformity, bowel obstruction and impaired quality of life. ^[1, 3]

The introduction of prosthetic mesh has revolutionized ventral hernia surgery by significantly reducing recurrence rates compared with anatomical suture repair. Consequently, mesh repair has become the gold standard for most ventral

hernias. However, despite advances in prosthetic materials and operative techniques, postoperative complications remain a major concern. Early complications such as seroma, haematoma, surgical site infection, flap necrosis and wound dehiscence may prolong hospital stay, increase healthcare costs and adversely affect patient satisfaction. Chronic pain, mesh infection and recurrence may occur later and often require further surgical intervention ^[2, 6]

Several patient-related factors have been implicated in the development of postoperative complications following ventral hernia repair. Obesity, diabetes mellitus, smoking, chronic obstructive pulmonary disease, anaemia, malnutrition, previous abdominal surgeries and raised intra-abdominal pressure are recognized contributors to poor wound healing and surgical site complications. In addition,

operative factors including mesh position, tissue handling, and operative duration and wound closure techniques may influence postoperative outcomes. [7, 10]

Among the various techniques of mesh placement, onlay, sublay (retro-rectus) and preperitoneal repairs are the most commonly performed? While onlay repair is technically simpler and less time-consuming, it requires extensive subcutaneous dissection that may increase the risk of seroma formation and wound-related complications. In contrast, sublay and preperitoneal mesh placement provide superior tissue coverage, improved mesh integration and reduced wound morbidity, although they demand greater technical expertise. [4, 8, 11]

Although numerous studies have compared different mesh positions, the influence of mesh placement in relation to patient-specific risk factors remains incompletely understood, particularly in the Indian population. Furthermore, evidence from rural tertiary care centres remains limited. Understanding these associations may help surgeons identify high-risk patients, select the most appropriate operative technique and implement preventive strategies to reduce postoperative complications.

The present study was therefore undertaken to evaluate the spectrum of early and late postoperative complications following mesh repair of ventral hernias and to determine their association with patient-related risk factors, type of ventral hernia and mesh position in patients treated at a rural tertiary care teaching hospital.

Materials and Methods

Study Design and Setting

This hospital-based cross-sectional observational study was conducted in the Department of General Surgery, K.H. Patil Institute of Medical Sciences (KHPIMS), Gadag, Karnataka, India, over a period of 24 months from March 2024 to February 2026 after obtaining approval from the Institutional Ethics Committee. The study aimed to evaluate postoperative complications following mesh repair of ventral hernias and determine their association with patient-related risk factors and mesh position.

Study Population

A total of **100 consecutive patients** diagnosed with ventral hernia and undergoing mesh repair during the study period were enrolled using a universal sampling technique. Patients fulfilling the inclusion criteria and providing informed written consent were included in the study.

Inclusion Criteria

- Patients aged 18 years and above.
- Patients diagnosed with primary or incisional ventral hernia.
- Patients undergoing elective or emergency open mesh repair.
- Patients willing to participate and provide informed written consent.

Exclusion Criteria

- Patients managed conservatively.
- Patients undergoing laparoscopic ventral hernia repair.
- Patients presenting with recurrent ventral hernia.
- Patients with contaminated or dirty abdominal wounds requiring alternative reconstructive procedures.
- Patients unwilling to participate in the study.

Data Collection

Preoperative Evaluation

All patients underwent a detailed clinical evaluation including history taking and physical examination. Demographic details, body mass index (BMI), associated comorbidities, previous abdominal surgeries, smoking history, chronic cough, constipation, benign prostatic hyperplasia, diabetes mellitus, hypertension and other recognized risk factors were documented.

Routine laboratory investigations included complete blood count, renal function tests, liver function tests, random blood glucose, coagulation profile, viral serology (HBsAg and HIV), urine analysis, chest radiography and electrocardiography whenever indicated. Ultrasonography was performed in selected patients to assess the hernia defect and contents, while computed tomography of the abdomen was reserved for patients with large, recurrent or complicated ventral hernias requiring detailed anatomical assessment.

Operative Technique

All procedures were performed under strict aseptic precautions by consultant surgeons or under their direct supervision. The choice of anaesthesia (general anaesthesia or spinal anaesthesia) depended on patient fitness, hernia characteristics and anaesthetic assessment.

After exposure of the hernia sac, careful adhesiolysis was performed whenever necessary. The hernia contents were reduced into the abdominal cavity, and the sac was either excised or inverted according to intraoperative findings. Polypropylene mesh was used in all patients. Depending on the size of the defect, tissue condition and surgeon preference, mesh was placed in one of the following anatomical planes:

- Onlay
- Sublay (retro-rectus)
- Preperitoneal

The fascial defect was approximated whenever feasible before mesh placement. Closed suction drains were inserted selectively, particularly following extensive subcutaneous dissection or onlay repair. Wound closure was performed in layers using standard surgical techniques.

Postoperative Management

All patients received standardized postoperative care including intravenous antibiotics, analgesics and routine wound care according to institutional protocol. Early ambulation and respiratory physiotherapy were encouraged. Drains were removed once the output became minimal.

Patients were evaluated daily during hospitalization for evidence of postoperative complications. Following discharge, regular outpatient follow-up visits were scheduled to identify early and late postoperative complications.

Outcome Measures

The primary outcome was the incidence of postoperative complications following mesh repair.

Early Postoperative Complications Included:

- Seroma
- Surgical site infection (SSI)
- Skin flap necrosis
- Haematoma

- Wound dehiscence

Late Postoperative Complications Included:

- Chronic pain
- Mesh infection
- Mesh rejection
- Sinus formation
- Hernia recurrence

The association between postoperative complications and the following variables was analysed:

- Age
- Gender
- Type of ventral hernia
- Associated risk factors
- Type of anaesthesia
- Position of mesh

Statistical Analysis

Data were entered into Microsoft Excel and analysed using Statistical Package for the Social Sciences (SPSS) software. Continuous variables were expressed as mean $\pm$ standard deviation, whereas categorical variables were presented as frequencies and percentages.

Associations between categorical variables were analysed using the Chi-square test or Fisher's exact test whenever appropriate. Continuous variables were compared using the Independent Student's t-test. A p-value less than 0.05 was considered statistically significant.

Ethical Considerations

The study was approved by the Institutional Ethics Committee of K.H. Patil Institute of Medical Sciences, Gadag. Written informed consent was obtained from every participant before inclusion in the study. Patient confidentiality and anonymity were maintained throughout the study in accordance with the ethical principles outlined in the Declaration of Helsinki.

Results

A total of 100 patients who underwent mesh repair for ventral hernia during the study period were included in the analysis. The mean age of the study population was 46.07 ± 13.21 years (range: 20–75 years). The highest proportion of patients belonged to the 41–50 years age group, followed by the 31–40 years age group.

Females constituted the majority of the study population (63%), while males accounted for 37%, resulting in a female-to-male ratio of approximately 1.7:1.

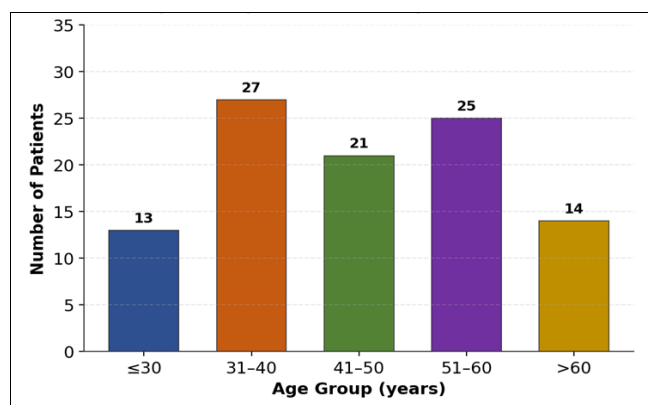


Fig 1: Demographic characteristics of study participants (N = 100)

Parameter	Value
Mean $\pm$ SD (years)	46.07 $\pm$ 13.21
Median (years)	45.0
Range (years)	22 – 80

Age Group (years)	Frequency (n)	Percentage (%)
≤30	13	13.0
31-40	27	27.0
41-50	21	21.0
51-60	25	25.0
>60	14	14.0
Total	100	100.0

Female patients constituted the majority of the study population (63.0%, n=63), with a male-to-female ratio of approximately 1:1.7. The female predominance is consistent with the known predisposing factors for ventral hernias, including previous abdominal surgeries (caesarean sections) and multiple pregnancies leading to weakened anterior abdominal wall musculature.

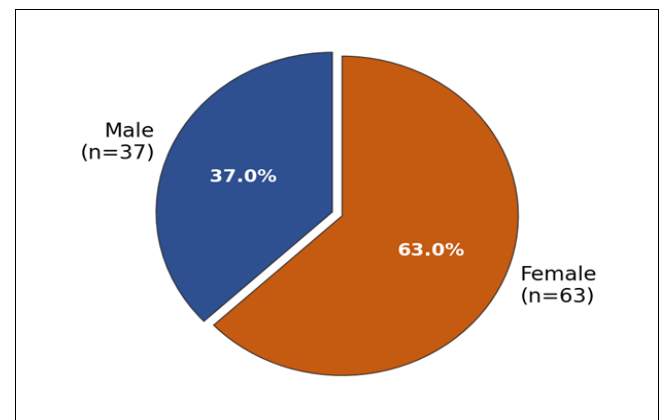


Fig 2: Gender Distribution (N = 100)

Gender	Frequency (n)	Percentage (%)
Male	37	37.0
Female	63	63.0
Total	100	100.0

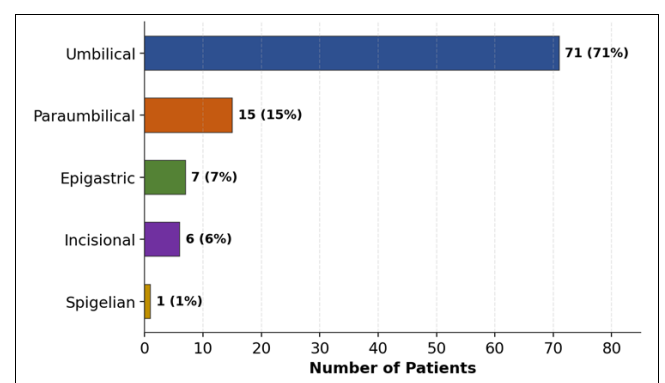


Fig 3: Distribution according to type of ventral hernia (N = 100)

Umbilical hernia was the most prevalent type of ventral hernia, accounting for 71.0% (n=71) of cases, followed by paraumbilical hernia (15.0%), epigastric hernia (7.0%), incisional hernia (6.0%), and spigelian hernia (1.0%). The high prevalence of umbilical hernias correlates with the predominance of obesity as the primary risk factor in this cohort.

Type of Ventral Hernia	Frequency (n)	Percentage (%)
Umbilical hernia	71	71.0
Paraumbilical hernia	15	15.0
Epigastric hernia	7	7.0
Incisional hernia	6	6.0
Spigelian hernia	1	1.0
Total	100	100.0

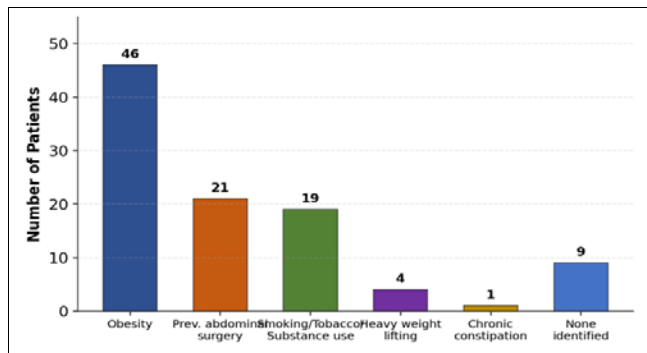


Fig 4: Distribution of associated risk factors (N = 100)

Obesity was the most common risk factor, identified in 46.0% (n=46) of patients, followed by previous abdominal surgery in 21.0% (n=21) and smoking/tobacco/substance use in 19.0% (n=19). Heavy weight lifting (4.0%) and chronic constipation (1.0%) were less frequently observed. No identifiable risk factor was documented in 9.0% of patients. These findings underscore that obesity, prior surgical history, and tobacco-related habits constitute the three major modifiable risk factors for ventral hernia development in this population.

Risk Factor	Frequency (n)	Percentage (%)
Obesity	46	46.0
Previous abdominal surgery	21	21.0
Smoking/Tobacco/Substance use	19	19.0
Heavy weight lifting	4	4.0
Chronic constipation	1	1.0
None identified	9	9.0
Total	100	100.0

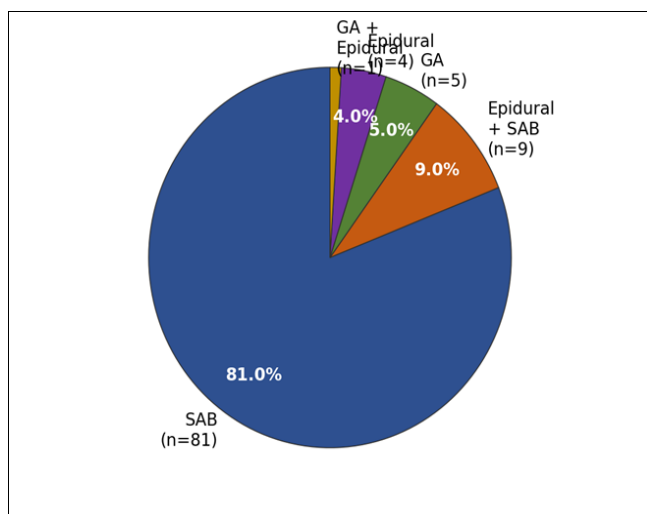


Fig 5: Distribution of patients based on type of anaesthesia (N = 100)

Spinal anaesthesia (subarachnoid block) was the most commonly employed anaesthetic technique in 81.0% (n=81) of cases, followed by combined epidural with SAB in 9.0%

(n=9), general anaesthesia in 5.0% (n=5), epidural alone in 4.0% (n=4), and combined GA with epidural in 1.0% (n=1). The preference for regional anaesthesia techniques (SAB and epidural, collectively 94.0%) reflects their suitability for ventral hernia repairs, offering advantages of reduced postoperative nausea, earlier ambulation, and superior postoperative analgesia.

Type of Anaesthesia	Frequency (n)	Percentage (%)
Spinal Anaesthesia (SAB)	81	81.0
Epidural + SAB	9	9.0
General Anaesthesia (GA)	5	5.0
Epidural	4	4.0
GA + Epidural	1	1.0
Total	100	100.0

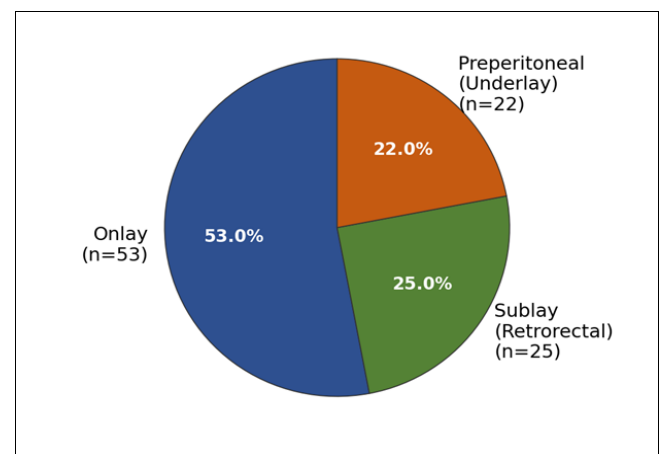


Fig 6: Distribution of patients based on position of mesh (N = 100)

Onlay mesh placement was the predominant technique employed in 53.0% (n=53) of patients, followed by sublay (retrorectal) repair in 25.0% (n=25) and preperitoneal (underlay) repair in 22.0% (n=22). The predominance of onlay technique may be attributed to its technical simplicity and familiarity among surgeons, although sublay and preperitoneal placements are increasingly recognized for their theoretical biomechanical advantages, including reduced mesh-wound interface and lower recurrence rates.

Position of Mesh	Frequency (n)	Percentage (%)
Onlay	53	53.0
Sublay (Retrorectal)	25	25.0
Preperitoneal (Underlay)	22	22.0
Total	100	100.0

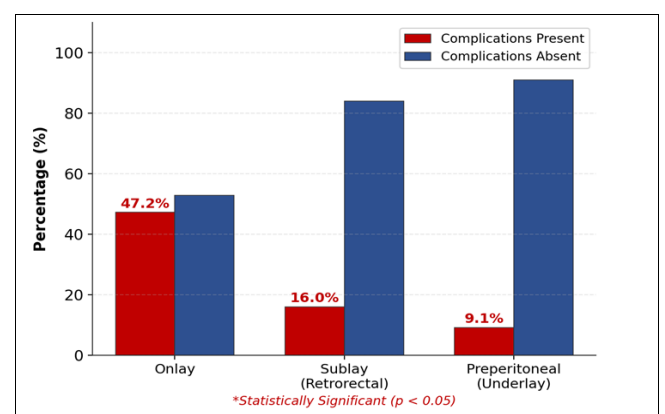


Fig 7: Incidence of early postoperative complications (N=100)

Early postoperative complications were observed in 31.0% (n=31) of patients. Seroma was the most frequent early complication, occurring in 14.0% (n=14), followed by skin necrosis in 13.0% (n=13), surgical site infection in 4.0% (n=4), and haematoma in 1.0% (n=1). No cases of sinus formation were documented. The predominance of seroma and skin necrosis as early complications is consistent with the reported literature on mesh hernioplasty, reflecting the inherent tissue response to prosthetic material and the extent of subcutaneous dissection.

Early Complication	Present n (%)	Absent n (%)
Seroma	14 (14.0)	86 (86.0)
Haematoma	1 (1.0)	99 (99.0)
Skin Necrosis	13 (13.0)	87 (87.0)
Surgical Site Infection	4 (4.0)	96 (96.0)
Sinus Formation	0 (0.0)	100 (100.0)
Any early complication	31 (31.0)	69 (69.0)

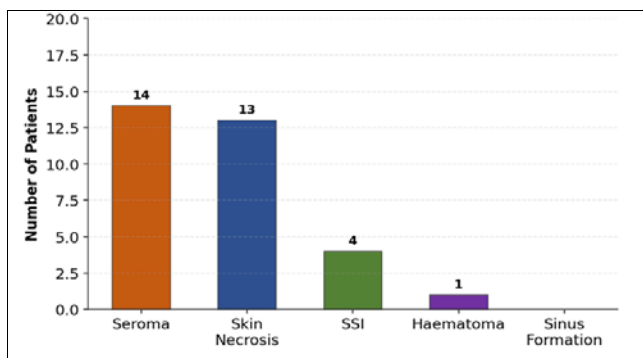


Fig 8: Association of position of mesh with postoperative complications (N=100)

Chi-Square = 14.0452, df = 2, p-value = 0.0009

A highly statistically significant association was found between the position of mesh placement and postoperative complications ($\chi^2 = 14.0452$, $p = 0.0009$). Patients who underwent onlay mesh placement demonstrated the highest complication rate at 47.2% (n=25/53), compared to 16.0% (n=4/25) in the sublay (retrorectal) group and 9.1% (n=2/22) in the preperitoneal (underlay) group. The substantially higher complication rate with onlay placement is attributable to its superficial position in the subcutaneous plane, which predisposes to increased seroma formation, skin necrosis, and wound-related complications. In contrast, sublay and preperitoneal placements benefit from deeper tissue coverage, reduced dead space, and superior mesh incorporation, thereby conferring a protective effect against early postoperative complications.

Position of Mesh	Comp. Present n (%)	Comp. Absent n (%)	Total
Onlay	25 (47.2)	28 (52.8)	53
Sublay (Retrorectal)	4 (16.0)	21 (84.0)	25
Preperitoneal (Underlay)	2 (9.1)	20 (90.9)	22
Total	31 (31.0)	69 (69.0)	100

Late Postoperative Complications

During the follow-up period, no late postoperative complications such as mesh infection, chronic sinus formation, chronic pain or recurrence were documented.

Association between Age and Postoperative Complications

Although postoperative complications were more frequent among middle-aged patients, the association between age and postoperative complications did not reach statistical significance ($p > 0.05$).

Association between Gender and Postoperative Complications

The incidence of postoperative complications was comparable between male and female patients. No statistically significant association was observed ($p > 0.05$).

Association between Risk Factors and Postoperative Complications

Patients with obesity, diabetes mellitus and previous abdominal surgery demonstrated numerically higher complication rates. However, none of the evaluated patient-related risk factors showed a statistically significant association with postoperative complications ($p > 0.05$).

Association between Type of Ventral Hernia and Postoperative Complications

The incidence of postoperative complications varied among different types of ventral hernias; however, no statistically significant association was identified ($p > 0.05$).

Summary of Major Findings

- Mean age: 46.07 ± 13.21 years
- Female predominance (63%)
- Umbilical hernia was the commonest type (71%)
- Obesity was the most frequent associated risk factor (46%)
- Onlay mesh placement was the most commonly performed procedure (53%)
- Early postoperative complications occurred in 31% of patients
- Seroma (14%) was the commonest complication
- No late postoperative complications were observed
- Mesh position was the only variable significantly associated with postoperative complications ($p = 0.0009$), with markedly lower complication rates following sublay and preperitoneal mesh placement compared with onlay repair.

Discussion

Ventral hernia repair is among the most frequently performed procedures in general surgery. Although prosthetic mesh has substantially reduced recurrence rates compared with primary suture repair, postoperative complications remain a significant source of patient morbidity. The present study evaluated the incidence of postoperative complications following open mesh repair of ventral hernias and examined their association with patient-related risk factors, ventral hernia type, and mesh position. The principal finding was that mesh position significantly influenced postoperative outcomes, whereas demographic variables and other patient-related risk factors did not demonstrate statistically significant associations.

Demographic Profile

The mean age of patients in the present study was 46.07 ± 13.21 years, with the highest incidence occurring in the fourth and fifth decades of life. This age distribution is

comparable to previous studies, which have reported that ventral hernias are predominantly diagnosed in middle-aged adults because of progressive weakening of the abdominal wall, increasing obesity, connective tissue degeneration, and the cumulative effects of raised intra-abdominal pressure. Females constituted 63% of the study population, demonstrating a clear female predominance. This observation is consistent with several Indian studies that attribute the higher incidence of ventral hernias among women to pregnancy, multiparity, obesity, and stretching of the anterior abdominal wall. Hormonal influences and reduced collagen strength following repeated pregnancies may further contribute to fascial weakness.

Distribution of Ventral Hernia Types

Umbilical hernia represented 71% of all ventral hernias in this study, making it the commonest presentation. Similar findings have been reported by several Indian authors, who observed that umbilical hernias account for the majority of primary ventral hernias encountered in surgical practice. The high prevalence may reflect increasing obesity, multiparity, and delayed presentation among adults.

Incisional hernias formed the second most common group. Previous abdominal surgery remains an important predisposing factor, particularly following emergency laparotomy, wound infection, obesity, and diabetes mellitus.

Risk Factors

Obesity emerged as the most common associated risk factor, affecting 46% of patients. Excess body weight increases intra-abdominal pressure, impairs collagen metabolism, decreases tissue perfusion, and predisposes patients to delayed wound healing and postoperative complications. Similar observations have been reported in both Indian and international studies, emphasizing obesity as one of the strongest modifiable risk factors for ventral hernia formation.

Although diabetes mellitus, smoking, and previous abdominal surgery were also identified, none demonstrated statistically significant associations with postoperative complications in the present study. This may be explained by the relatively small sample size and appropriate perioperative optimization of these conditions before surgery.

Early Postoperative Complications

The overall incidence of early postoperative complications was 31%, which falls within the range reported in previous literature.

Seroma formation was the commonest complication (14%). Seroma remains the most frequently reported complication after ventral hernia repair, particularly following extensive subcutaneous dissection associated with onlay mesh placement. Disruption of lymphatic channels, dead-space creation, and inflammatory response to prosthetic mesh all contribute to seroma formation.

Skin necrosis was observed in 13% of patients. This relatively higher incidence may be related to extensive flap elevation required during onlay repair, which compromises subdermal vascularity. Careful tissue handling, preservation of perforators, and minimizing flap dissection may reduce this complication.

Surgical site infection occurred in only 4% of patients, comparable with published rates for clean elective mesh

surgery. Strict aseptic precautions, perioperative antibiotic prophylaxis, and meticulous operative technique probably contributed to this low incidence.

Haematoma was uncommon, occurring in only 1% of patients.

Late Postoperative Outcomes

No late postoperative complications or recurrences were identified during the follow-up period. Although encouraging, this finding should be interpreted cautiously because ventral hernia recurrence may occur several years after surgery. Longer follow-up would be required to accurately assess long-term recurrence and chronic mesh-related complications.

Mesh Position and Postoperative Complications

The most important finding of the present study was the statistically significant association between mesh position and postoperative complications ($p = 0.0009$). Patients undergoing onlay mesh repair experienced the highest complication rate (47.2%), compared with 16.0% following sublay repair and 9.1% following preperitoneal repair.

These findings support the growing body of evidence favouring deeper mesh placement. Onlay repair requires extensive subcutaneous dissection, resulting in increased dead space, disruption of lymphatic drainage, and compromised flap vascularity, thereby predisposing to seroma formation, wound infection, and skin necrosis.

In contrast, sublay and preperitoneal repairs position the prosthetic mesh within a well-vascularized tissue plane, providing improved mesh incorporation, reduced dead space, lower infection rates, and superior mechanical reinforcement of the abdominal wall. Numerous contemporary studies have demonstrated lower wound morbidity and recurrence following retro-rectus or preperitoneal mesh placement compared with onlay repair.

Clinical Implications

The findings of this study have important practical implications. Although onlay repair remains technically straightforward and widely practiced, surgeons should preferentially consider sublay or preperitoneal mesh placement whenever technically feasible, particularly in obese patients or those at increased risk of wound complications.

Careful preoperative optimization of modifiable risk factors, meticulous surgical technique, adequate haemostasis, preservation of tissue vascularity, and judicious drain placement may further reduce postoperative morbidity.

Strengths of the Study

- Prospective data collection minimized recall bias.
- Uniform institutional surgical protocols reduced variability.
- Multiple patient-related and operative factors were analysed simultaneously.
- The study specifically evaluated the influence of mesh position on postoperative outcomes in an Indian rural tertiary-care setting, where published data remain limited.

Limitations

The study has certain limitations. It was conducted at a single centre with a relatively modest sample size of 100

patients, which may have reduced the power to detect associations for some variables. The duration of follow-up was insufficient to evaluate long-term outcomes such as chronic pain, mesh infection, or recurrence. Additionally, mesh position was selected based on intraoperative judgment rather than random allocation, introducing the possibility of selection bias.

Conclusion

Open mesh repair remains an effective treatment for ventral hernias. In the present study, mesh position was the only factor significantly associated with postoperative complications, with sublay and preperitoneal mesh placement demonstrating substantially lower morbidity than onlay repair. These findings support the preferential use of deeper mesh planes whenever technically feasible to reduce wound-related complications and improve patient outcomes.

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