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Original Research Article

A PROSPECTIVE COMPARATIVE STUDY ON THE OUTCOMES USING TRANSVERSE VERSUS VERTICAL INCISION IN ELECTIVE VENTRAL HERNIA REPAIR

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ABSTRACT

Background: Open ventral hernia mesh repair can be performed through transverse or vertical midline incisions, but the optimal incision for minimising postoperative wound complications, pain, hospital stay, and scar morbidity remains uncertain. **Objectives:** To compare the relative merits and demerits and outcomes among patients with ventral hernia who have undergone open mesh repair through a transverse incision or a vertical incision. **Materials and Methods:** "This single-centre prospective comparative study included 90 adults undergoing elective open midline ventral hernia mesh repair (defect 4–8 cm) and compared outcomes between transverse and vertical incision groups (45 each). Postoperative complications (Southampton SSI grading, flap necrosis and dehiscence), pain (VAS), length of stay, and scar quality (Vancouver Scar Scale at 1 month) were assessed and analysed in SPSS v27. **Results:** Baseline characteristics were comparable, including age (45.2±9.9 vs 48.4±8.8 years; p=0.110), male proportion (62.2% vs 51.1%; p=0.395), BMI (24.5±2.4 vs 24.6±2.2 kg/m²; p=0.799), hernia site, and defect size (5.7±0.7 vs 5.8±1.0 cm; p=0.689). Operative time and blood loss were similar (79 vs 80 minutes; 98 vs 103 mL). Postoperatively, the transverse incision had lower SSI (any SSI: 4.4% vs 22.2%; p=0.027; clinically significant SSI 2.2% vs 13.3%; p=0.031) and less flap necrosis (8.9% vs 26.7%; p=0.041), with no wound dehiscence in either group. Pain scores were lower with transverse incision early (VAS POD1 4.0 vs 4.9; p<0.001) and at discharge (1.6 vs 2.5; p<0.001). The hospital stay was shorter (4.0±0.9 vs 5.5±1.3 days; p<0.001), and scars were better at 1 month (VSS total 4.0 vs 6.0; p<0.001). **Conclusion:** Transverse incision open mesh repair was associated with significantly lower wound morbidity and early pain, a shorter hospital stay, and better short-term scar outcomes compared with vertical incision repair.

INTRODUCTION

Ventral hernias, encompassing primary defects (such as epigastric and umbilical hernias) and incisional hernias, are among the most frequent conditions managed by general surgeons and account for a substantial proportion of elective abdominal wall operations.[1,2] Beyond the visible abdominal bulge, ventral hernias can cause pain, activity restriction, cosmetic concerns, and impaired health-related quality of life, and they may progress to incarceration or strangulation, thereby increasing the likelihood of emergency surgery and complications.[2] Although mesh-based repair has improved durability compared with suture repair alone, postoperative morbidity remains clinically important in ventral hernia surgery, particularly wound-related complications.[3,4] Surgical site infection (SSI) is especially relevant in open mesh repair because it can prolong hospital stay, increase costs, impair patient experience, and, in severe cases, compromise the prosthesis and necessitate reintervention.[3] Reported mesh-related infection rates vary across settings and case-mix, but open ventral hernia mesh repairs have been associated with higher infection ranges than minimally invasive approaches in González De Godos et al. (2025), Hatewar et al. (2024), and Joliat et al. (2025),[5-7] reinforcing the importance of meticulous wound strategy and risk mitigation. In addition to SSI, skin and subcutaneous flap complications (including edge ischaemia and flap necrosis), wound disruption/dehiscence, seroma

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formation, and postoperative pain are key drivers of delayed recovery and patient dissatisfaction after open ventral hernia repair.[4]

Incision choice is a potentially modifiable operative factor that may influence wound perfusion, tissue tension, pain, and subsequent healing. In midline ventral hernias repaired through open surgery, surgeons commonly employ either a vertical (midline/longitudinal) incision or a transverse incision tailored to the hernia location and planned dissection.

Evidence from broader abdominal surgery suggests that incision orientation affects early and late wound outcomes; a systematic review comparing vertical and transverse laparotomy reported lower postoperative pain and fewer pulmonary complications with transverse incisions, while vertical incisions were easier to extend and often had shorter operative times.[8] Importantly, Grantcharov & Rosenberg (2001) indicated higher odds of major wound failure ('burst abdomen') with vertical incisions (pooled odds ratio 2.86, 95% CI 1.72–4.73) and a higher risk of late incisional hernia (pooled odds ratio 1.68, 95% CI 1.10–2.57).[8] Consistent with this, randomised data in open upper abdominal surgery, Halm et al. (2009),demonstrated significantly fewer incisional hernias after transverse incision compared with midline incision (2% vs 14%; p=0.017) , alongside lower early postoperative pain.[9]

While these incision-orientation findings are biologically plausible- given differences in fascial fibre direction, distribution of tension across the wound, and potential effects on perfusion-their applicability to elective open ventral hernia repair (where wide flap dissection, mesh placement, and drain use are common) is not fully established across diverse patient populations and surgical settings.[4] Moreover, modern ventral/incisional hernia care increasingly emphasises outcomes beyond recurrence alone, including standardised assessment of wound infection severity, pain trajectories, length of stay, and patient-valued measures such as scar quality.[10,11] Against this background, the objectives of the present study were to compare postoperative complications–surgical site infection, flap necrosis, wound disruption, and postoperative pain–between transverse and vertical incisions following ventral hernia repair and to compare the average length of hospital stay and scar formation between the two incision approaches.

MATERIALS AND METHODS

This was a single-centre, hospital-based, prospective, comparative study conducted in the Department of General Surgery, Aarupadai Veedu Medical College and Hospital, Puducherry, India, for a duration of 18 months between March 2024 and September 2025. The study was approved by the Institutional Human Ethics Committee (IHEC) with reference number AV/IHEC/01/2024/054 dated 07/06/2024. The participants were given the Participant Information Sheet (PIS) in their native language, and its contents were verbally explained to ensure their understanding and satisfaction. Eligible participants were adults aged 18–69 years of either gender with a midline ventral hernia located between the xiphisternum and umbilicus and a defect size >4 cm and <8 cm, scheduled for elective open repair, without comorbidities such as type 2 diabetes mellitus, hypertension, or coronary artery disease, and willing to provide written informed consent. Patients were excluded if they had a body mass index <18.5 or >29.9 kg/m², a laparoscopic port-site hernia, planned laparoscopic repair, intraoperative bowel content spillage, an emergency presentation (obstructed/strangulated hernia), prior abdominal surgery, current immunosuppressive therapy (corticosteroids >40 mg/day or azathioprine), chemotherapy within the preceding 4 weeks, or abdominal radiotherapy within the preceding 8 weeks.

The sample size was calculated using the standard formula for comparing two independent proportions, assuming a two-sided α of 0.05 ($Z\alpha/2=1.96$) and 80% power ($Z\beta=0.84$). Based on the reference study by Renganathan et al. (2023),[12] expected event proportions were taken as p1=0.16 and p2=0.34, which yielded a required sample size of approximately 87 participants per group; for feasibility and adequate power, the total sample size was fixed at 90 participants (45 per group). Participants were enrolled using a non-probability purposive sampling approach with consecutive enumeration. Baseline data were collected using a structured proforma. This included sociodemographic details, relevant clinical history, and a focused clinical examination as part of routine preoperative assessment, with documentation of vital signs and pertinent clinical findings. Hernia characteristics (site, type, and clinically assessed defect size) were recorded. As part of the standard preoperative work-up, investigations were documented, including complete blood count, urine routine examination and microscopy, serum urea, serum electrolytes, serum creatinine, liver function tests, and ultrasonography of the abdomen and pelvis. Participants were then allocated into two comparison groups based on the incision used for open mesh repair: Group A comprised patients who underwent ventral hernia repair through a transverse incision, and Group B comprised patients who underwent repair through a vertical incision (45 patients in each group). The operative details – particularly the incision type and any intraoperative events – were recorded from the operative notes.

Postoperative outcomes were assessed systematically. The primary outcomes included postoperative complications – SSI, flap necrosis, wound disruption/dehiscence, and postoperative pain – and the secondary outcomes included length of hospital stay and scar formation. SSI was evaluated

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by direct wound inspection using the Southampton wound grading system (POD 3, 7, 14, and 21) to capture early and evolving wound morbidity. Flap necrosis and wound disruption were assessed clinically, with documentation of presence/absence and extent (where applicable). Postoperative pain was assessed using the Visual Analogue Scale (VAS) (0–10), along with the need for rescue analgesia if administered. The duration of postoperative hospitalisation was recorded for each participant as length of stay (days) from the day of surgery to the day of discharge. After discharge, participants were followed up once every two weeks for one month and wound evaluation findings were recorded at each visit. The scar outcome was assessed after wound healing using the Vancouver Scar Scale.

Statistical Analysis: Data were entered in Microsoft Excel and analysed using IBM SPSS Statistics for Windows, Version 27.0 (IBM Corp., Armonk, NY, USA). Continuous variables were assessed for distribution using visual inspection of histograms and the Shapiro–Wilk test. Normally distributed continuous variables were summarised as mean ± standard deviation (SD) and compared between the transverse and vertical incision groups using the independent-samples 't' test; non-normally distributed continuous variables were summarised as median (interquartile range [IQR]) and compared using the Mann–Whitney U test.

Categorical variables were presented as frequency (n) and percentage (%) and compared using the Chi-square test; Fisher's exact test was applied when expected cell counts were <5. Repeated postoperative categorical outcomes across time points (Southampton SSI grades on POD 3/7/14/21) were compared between groups at each time point using Chi-square/Fisher's exact tests. Pain scores (VAS) measured at predefined time points were compared between groups at each time point using independent-samples 't' test (or Mann–Whitney U test, where appropriate). All tests were two-tailed, and a p value <0.05 was considered statistically significant.

RESULTS

Among the 90 participants (45 per group), baseline characteristics were comparable between the transverse and vertical incision groups. The mean age was 45.2 ± 9.9 years in the transverse group and 48.4 ± 8.8 years in the vertical group (p=0.110), and mean BMI was similar (24.5 ± 2.4 vs 24.6 ± 2.2 kg/m²; p = 0.799)." Males constituted 62.2% (28/45) of the transverse group and 51.1% (23/45) of the vertical group (p = 0.395). Hernia site distribution did not differ significantly (p = 0.326), with epigastric hernias being most common in both groups (48.9% each). "Mean defect size was comparable (5.7 ± 0.7 vs 5.8 ± 1.0 cm; p = 0.689), and the majority had defects sized 4.0–5.9 cm (53.3% vs 55.6%; p = 1.000).

Symptom duration was similar (19.0 ± 10.6 vs 21.2 ± 11.0 months; p = 0.334), as were risk factors such as smoking (22.2% vs 17.8%; p=0.792), chronic cough (24.4% vs 26.7%; p=1.000), heavy lifting (31.1% vs 35.6%; p=0.823), and family history of hernia (8.9% vs 15.6%; p=0.520). Reducibility was identical across groups, with 86.7% reducible and 13.3% partially reducible in both (p=1.000). Overall, no baseline variable showed a statistically significant difference (all p>0.05).

Mean heart rate (76.6 ± 8.1 vs 78.4 ± 7.8 beats/min; p = 0.290), systolic blood pressure (126.9 ± 13.8 vs 128.2 ± 9.6 mmHg; p = 0.537), and SpO_2 (98.1 ± 0.9% vs 98.0 ± 1.0%; p = 0.707) were similar. Most patients were ASA I (73.3% vs 68.9%; p = 0.816), and tenderness was uncommon (6.7% vs 2.2%; p=0.616) with cough impulse present in 97.8% in both groups (p = 1.000). Laboratory values showed no meaningful differences, including haemoglobin (13.2 ± 1.2 vs 12.9 ± 1.0 g/dL; p=0.157), total leukocyte count (7.3 ± 1.7 vs 7.6 ± 1.4 ×10³/µL; p = 0.354), platelet count (258.4 ± 49.2 vs 249.5 ± 45.4 ×10³/µL; p=0.162), serum creatinine (0.8 ± 0.1 vs 0.9 ± 0.1 mg/dL; p=0.144), and liver enzymes (AST 25.3 ± 7.1 vs 26.2 ± 7.7 U/L; p=0.549). Urinalysis profiles and ultrasound findings were also comparable (USG normal: 62.2% vs 57.8%; p = 0.830), with incidental mild fatty liver and asymptomatic cholelithiasis observed in small proportions across both groups.

All patients received polypropylene mesh (100% in both groups). The mesh was most commonly placed in the retrorectus (sublay) position (80.0% vs 73.3%), with the remainder placed as onlay, without a significant difference (p = 0.619). Mesh size distribution was similar (p = 1.000), with 15×15 cm used in 55.6% of the transverse group versus 40.0% of the vertical group and 15×20 cm in 28.9% versus 44.4%, respectively; 20×20 cm was used in 15.6% in both. Closed-suction drains were used in 86.7% of patients in each group (p = 1.000). Mean operative time (78.9 ± 17.9 vs 80.1 ± 16.6 minutes; p = 0.722) and estimated blood loss (98.3 ± 30.6 vs 103.0 ± 36.4 mL; p = 0.509) were comparable. Intraoperative adverse events were infrequent, with no bowel injury/spillage in either group; a serosal tear occurred in one patient in the vertical group (2.2%; p = 1.000), and significant bleeding requiring additional haemostasis occurred in 6.7% (3/45) of the transverse group versus none in the vertical group (p = 0.242).

SSI was less frequent with the transverse incision, with any SSI occurring in 4.4% (2/45) compared with 22.2% (10/45) in the vertical incision group (p = 0.027), and clinically significant SSI (Southampton grade ≥2) in 2.2% versus 13.3%, respectively (p = 0.031). Flap necrosis was also lower in the transverse group (8.9% vs 26.7%; p = 0.041); most cases were minor edge necrosis (<2 cm) (6.7% vs 20.0%), while full-thickness necrosis (>5 cm) was seen only in the vertical group (4.4%), although severity distribution was not statistically different (p = 0.728). Management was predominantly conservative or

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debridement with dressings in both groups, with occasional advanced procedures in the vertical group (p=0.769). No wound disruption or dehiscence occurred in either group (p = 1.000). Length of hospital stay was significantly shorter after transverse incision (4.0 ± 0.9 vs 5.5 ± 1.3 days; p<0.001), with 73.3% discharged within ≤4 days compared with 17.8% in the vertical group, and 22.2% in the vertical group requiring ≥7 days of stay (p < 0.001).

Postoperative pain scores were consistently lower in the transverse incision group during the early postoperative period. The mean VAS was 4.5 ± 1.2 versus 5.3 ± 1.3 on POD0 (p=0.004) and 4.0 ± 1.0 versus 4.9 ± 1.2 on POD1 (p<0.001), with the difference persisting through POD2 (3.3 ± 1.1 vs 3.9 ± 1.0; p = 0.004) and POD3 (2.8 ± 1.0 vs 3.4 ± 1.1; p=0.005). At discharge, pain remained significantly lower after transverse incision (1.6 ± 0.8 vs 2.5 ± 0.9; p<0.001), while scores were comparable by POD14 (1.1 ± 0.5 vs 1.4 ± 0.7; p=0.052) and POD21 (0.7 ± 0.5 vs 0.8 ± 0.5; p=0.212). At 1 month, scar assessment using the Vancouver Scar Scale favoured the transverse incision group, with significantly better vascularity (1.0 ± 0.5 vs 1.5 ± 0.6; p<0.001), pliability (1.4 ± 0.7 vs 2.5 ± 1.1; p<0.001), and height (0.7 ± 0.5 vs 1.1 ± 0.6; p=0.003), resulting in a lower total VSS score (4.0 ± 1.2 vs 6.0 ± 1.5; p<0.001); pigmentation scores were similar between groups (0.8 ± 0.4 vs 0.9 ± 0.4; p=0.218).

Table 1: Baseline Demographic and Clinical Characteristics of Participants by Incision Type (Transverse vs Vertical) (N = 90)

Variable		Transverse incision (n=45)	Vertical incision (n=45)	P value
Age (years), mean ± SD		45.2 ± 9.9	48.4 ± 8.8	0.110
Gender, n (%)	Male	28 (62.2)	23 (51.1)	0.395
	Female	17 (37.8)	22 (48.9)	
Body mass index (kg/m²), mean ± SD		24.5 ± 2.4	24.6 ± 2.2	0.799
Hernia site, n (%)	Epigastric	22 (48.9)	22 (48.9)	0.326
	Supraumbilical	11 (24.4)	16 (35.6)	
	Umbilical	12 (26.7)	7 (15.6)	
Defect size (cm), mean ± SD		5.7 ± 0.7	5.8 ± 1.0	0.689
Defect size (cm), n (%)	4.0–5.9	24 (53.3)	25 (55.6)	1.000
	6.0–7.9	21 (46.7)	20 (44.4)	
Duration of symptoms (months), mean ± SD		19.0 ± 10.6	21.2 ± 11.0	0.334
Smoking (current), n (%)		10 (22.2)	8 (17.8)	0.792
History of chronic cough, n (%)		11 (24.4)	12 (26.7)	1.000
History of constipation/straining, n (%)		8 (17.8)	14 (31.1)	0.220
History of heavy lifting/occupational strain, n (%)		14 (31.1)	16 (35.6)	0.823
Family history of hernia, n (%)		4 (8.9)	7 (15.6)	0.520
Reducibility, n (%)	Reducible	39 (86.7)	39 (86.7)	1.000
	Partially reducible	6 (13.3)	6 (13.3)	
*Statistically significant at p < 0.05				

Table 2: Comparison of Preoperative Vitals, Clinical Examination, and Laboratory/Imaging Parameters Between Transverse and Vertical Incision Groups (N = 90)

Variable		Transverse incision (n=45)	Vertical incision (n=45)	P Value
Vitals and examination				
Heart rate (beats/min) : Mean ± SD		76.6 ± 8.1	78.4 ± 7.8	0.290
Systolic blood pressure (mmHg), mean ± SD		126.9 ± 13.8	128.2 ± 9.6	0.537
Diastolic blood pressure (mmHg), mean ± SD		78.7 ± 7.7	77.5 ± 6.8	0.458
Respiratory rate (breaths/min), Mean ± SD		16.9 ± 1.6	16.8 ± 1.5	0.608
SpO_2 (%), Mean ± SD		98.1 ± 0.9	98.0 ± 1.0	0.707
Axillary temperature (°C), Mean ± SD		36.7 ± 0.3	36.8 ± 0.3	0.459
ASA physical status, n (%)	ASA I	33 (73.3)	31 (68.9)	0.816
	ASA II	12 (26.7)	14 (31.1)	
Tenderness on examination, n (%)	Absent	42 (93.3)	44 (97.8)	0.616
	Present	3 (6.7)	1 (2.2)	
Cough impulse, n (%)	Present	44 (97.8)	44 (97.8)	1.000
	Absent	1 (2.2)	1 (2.2)	
Preoperative laboratory and imaging				
Hemoglobin (g/dL), Mean ± SD		13.2 ± 1.2	12.9 ± 1.0	0.157
Total leukocyte count (×10³/µL), Mean ± SD		7.3 ± 1.7	7.6 ± 1.4	0.354
Platelet count (×10³/µL), Mean ± SD		258.4 ± 49.2	249.5 ± 45.4	0.162
Blood urea (mg/dL), Mean ± SD		25.1 ± 6.3	26.3 ± 5.8	0.376
Serum creatinine (mg/dL), Mean ± SD		0.8 ± 0.1	0.9 ± 0.1	0.144
Serum sodium (mEq/L), Mean ± SD		139.4 ± 2.4	139.0 ± 2.4	0.361
Serum potassium (mEq/L), Mean ± SD		4.1 ± 0.3	4.1 ± 0.3	0.307
Total bilirubin (mg/dL), Mean ± SD		0.8 ± 0.2	0.7 ± 0.2	0.244
AST (U/L), Mean ± SD		25.3 ± 7.1	26.2 ± 7.7	0.549

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ALT (U/L), Mean ± SD		29.3 ± 7.2	29.0 ± 8.4	0.851
Serum albumin (g/dL), Mean ± SD		4.1 ± 0.3	4.2 ± 0.3	0.273
Urine albumin: Trace, n (%)		1 (2.2)	2 (4.4)	1.000
Urine sugar: Trace, n (%)		1 (2.2)	4 (8.9)	0.361
Pus cells, n (%)	0–2/HPF	36 (80.0)	35 (77.8)	1.000
	3–5/HPF	7 (15.6)	9 (20.0)	
	>5/HPF	2 (4.4)	1 (2.2)	
RBCs, n (%)	0–2/HPF	37 (82.2)	41 (91.1)	0.353
	3–5/HPF	7 (15.6)	4 (8.9)	
	>5/HPF	1 (2.2)	0 (0.0)	
USG abdomen/pelvis, n (%)	Normal study	28 (62.2)	26 (57.8)	0.830
	Mild fatty liver	10 (22.2)	7 (15.6)	
	Cholelithiasis (asymptomatic)	5 (11.1)	11 (24.4)	
	Renal cyst (simple, incidental)	2 (4.4)	1 (2.2)	
*Statistically significant at p<0.05				

Table 3: Comparison of Intraoperative Characteristics Between Transverse and Vertical Incision Groups (N = 90)

Variable		Transverse incision (n=45)	Vertical incision (n=45)	P value
Mesh type, n (%)		Polypropylene mesh: 45 (100.0)	Polypropylene mesh: 45 (100.0)	NA
Mesh position, n (%)	Retrorectus (sublay)	36 (80.0)	33 (73.3)	0.619
	Onlay	9 (20.0)	12 (26.7)	
Mesh size, n (%)	15×15 cm	25 (55.6)	18 (40.0)	1.000
	15×20 cm	13 (28.9)	20 (44.4)	
	20×20 cm	7 (15.6)	7 (15.6)	
Closed-suction drain used (Yes), n (%)		39 (86.7)	39 (86.7)	1.000
Operative time (minutes), Mean ± SD		78.9 ± 17.9	80.1 ± 16.6	0.722
Estimated blood loss (mL), Mean ± SD		98.3 ± 30.6	103.0 ± 36.4	0.509
Serosal tear (Yes), n (%)		0 (0.0)	1 (2.2)	1.000
Significant bleeding requiring additional hemostasis (Yes), n (%)		3 (6.7)	0 (0.0)	0.242
Bowel injury/spillage (Yes), n (%)		0 (0.0)	0 (0.0)	NA
*Statistically significant at p<0.05				

Table 4: Comparison of Postoperative Wound Complications and Length of Hospital Stay Between Transverse and Vertical Incision Groups (N = 90)

Variable		Transverse incision (n=45)	Vertical incision (n=45)	P value
Any SSI (Southampton grade ≥1 at any assessment), n (%)		2 (4.4)	10 (22.2)	0.027*
Clinically significant SSI (Southampton grade ≥2 at any assessment), n (%)		1 (2.2)	6 (13.3)	0.031*
Flap necrosis (any), n (%)		4 (8.9)	12 (26.7)	0.041*
Severity, n (%)	Minor edge (<2 cm)	3 (6.7)	9 (20.0)	0.728
	Partial thickness (2–5 cm)	1 (2.2)	1 (2.2)	
	Full thickness (>5 cm)	0 (0.0)	2 (4.4)	
Management among flap necrosis cases, n (%)	Conservative/dressings	2 (50.0)	7 (58.3)	0.769
	Debridement + dressings	2 (50.0)	3 (25.0)	
	Secondary suturing	0 (0.0)	0 (0.0)	
	Debridement + secondary suturing	0 (0.0)	1 (8.3)	
	Flap/skin graft	0 (0.0)	1 (8.3)	
Wound disruption/dehiscence (any), n (%)		0 (0.0)	0 (0.0)	1.000
Length of hospital stay (days), Mean ± SD		4.0 ± 0.9	5.5 ± 1.3	<0.001*
Length of stay, n (%)	≤4 days	33 (73.3)	8 (17.8)	<0.001*
	5–6 days	12 (26.7)	27 (60.0)	
	≥7 days	0 (0.0)	10 (22.2)	
*Statistically significant at p<0.05				

Table 5: Scar assessment (Vancouver Scar Scale) at 1 month by study group (N=90)

Variable	Transverse incision (n=45)	Vertical incision (n=45)	P value
VSS vascularity (0–3), Mean ± SD	1.0 ± 0.5	1.5 ± 0.6	<0.001*
VSS pigmentation (0–2), Mean ± SD	0.8 ± 0.4	0.9 ± 0.4	0.218
VSS pliability (0–5), Mean ± SD	1.4 ± 0.7	2.5 ± 1.1	<0.001*
VSS height (0–3), Mean ± SD	0.7 ± 0.5	1.1 ± 0.6	0.003*
Vancouver Scar Scale (VSS) total (0–13), Mean ± SD	4.0 ± 1.2	6.0 ± 1.5	<0.001*
*Statistically significant at p<0.05			

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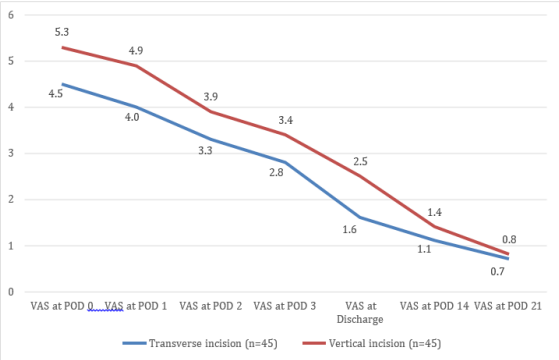

Figure 1: Postoperative pain (VAS score) at predefined time points by study group (N=90)

DISCUSSION

The present findings should be interpreted in the context of a well-balanced cohort: age, sex distribution, BMI, hernia site mix, defect size, symptom duration, and common risk factors (smoking, cough, constipation/straining and heavy lifting) were comparable between the transverse and vertical incision groups, reducing the likelihood that baseline imbalance explained postoperative differences. Similar preoperative vitals and laboratory profiles further support that the two groups entered surgery with broadly similar physiological reserves and perioperative risk, which is important because wound morbidity after open ventral/incisional hernia repair is strongly influenced by patient factors and baseline risk (e.g., obesity, diabetes, smoking, and physiologic stress) rather than incision choice alone; as noted by Lindmark et al. (2018), Wilson & Farooque (2022), and Wouters et al. (2022).[3,13,14]

Intraoperatively, both groups underwent open mesh repair with polypropylene mesh, and the majority in each arm received retrorectus (sublay/retromuscular) placement, with no significant differences in mesh position, drain usage, operative time, or blood loss. This similarity matters because mesh plane and operative complexity can affect surgical-site occurrences (SSOs) such as seroma, wound complications, and SSI; retromuscular repair is commonly used and has been associated with favourable pooled outcomes in systematic reviews of retro-rectus (Rives–Stoppa) techniques; as noted by Den Hartog et al. (2022).(15) A key observation in this study is that overall SSI was significantly lower in the transverse incision group (any SSI 4.4% vs 22.2%; clinically significant SSI 2.2% vs 13.3%). Open ventral hernia operations are particularly prone to wound-related morbidity (often framed as SSOs), which include SSI as well as skin/flap necrosis, haematoma, seroma, and dehiscence; therefore, Talpai et al. (2024) added that even moderate absolute reductions in SSI are clinically meaningful because they can lead to fewer dressing needs, reduced antibiotic exposure, fewer procedures (e.g., drainage/debridement), and smoother recovery.[16]

This direction of effect is biologically plausible and broadly consistent with the literature, including Brown & Goodfellow (2005) and Theodorou et al. (2022), suggesting transverse incisions may reduce certain wound failures (including burst abdomen) and late incisional hernia risk compared with vertical/midline approaches, likely through differences in tissue mechanics and fascial loading.[17,18] That said, not all randomised data align uniformly with 'transverse is always better' for infection; for example, Seiler and colleagues (equivalence RCT) reported more wound infections in the transverse group (15 vs 5; p=0.02), underscoring that infection outcomes depend on procedure type, perioperative pathways, wound classification, and local factors beyond incision orientation alone.[19] In the present study's context – elective midline ventral hernias with controlled BMI range and exclusion of major comorbidities – the transverse approach may have conferred a practical advantage by limiting high-tension closure vectors and reducing tissue ischaemia at wound edges, thereby lowering susceptibility to bacterial proliferation and breakdown.[20]

The longitudinal Southampton grading pattern is also instructive. Most wounds were Grade 0 at each time point in both arms, but the transverse group repeatedly showed a higher proportion of Grade 0 healing early (POD 3/7/14), while differences narrowed by POD 21.

This suggests that the transverse incision primarily improved the early inflammatory/healing trajectory rather than eliminating infection risk entirely – consistent with a mechanism of less early tissue trauma and improved wound-edge perfusion translating into fewer low-grade changes that might otherwise progress; in corroboration with Ellis et al. (1984) and Grąt et al. (2021).[21,22] Bailey (2006) and Wilson (1995) added that the Southampton system is widely used to grade wound healing/infection severity over time, enabling differentiation of mild erythema/bruising from clinically meaningful discharge or deep infection, which strengthens interpretation beyond a simple 'SSI yes/no' endpoint.[23,24]

Flap necrosis was also significantly lower with transverse incision (8.9% vs 26.7%). Skin/flap necrosis is a recognised component of SSOs in ventral hernia surgery and is mechanistically linked to undermining, disruption of perforators, and closure under tension – factors that can be influenced by incision design and orientation.[13,16] The predominance of minor edge necrosis in both arms supports a pattern of marginal perfusion compromise rather than catastrophic tissue loss; nevertheless, the higher necrosis frequency in the vertical group may reflect greater longitudinal traction and poorer distribution of closing forces along the incision line. From a reconstructive/scar biology perspective, Fearmonti et al. (2010) and Gorad et al. (2021) added that transverse incisions that align more closely with relaxed skin

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tension lines can reduce wound-edge stress and may improve vascularity at the margin, which plausibly reduces edge necrosis and improves subsequent scar quality.[11,25] Notably, wound disruption/dehiscence was absent in both groups. This likely reflects a relatively 'lower-risk' elective cohort (restricted BMI, no diabetes/hypertension/CAD, controlled operative conditions, and standardised mesh repair), because dehiscence is uncommon when major risk amplifiers are minimised, as noted by Bleier & Resnick (2009).[26]

The pain findings strongly favour the transverse approach in the early postoperative window (significantly lower VAS on POD 0–3 and at discharge), with convergence by POD 14 and POD 21. This temporal pattern is consistent with incision-related nociception being most influential early, while later pain becomes dominated by healing, activity resumption, and individual pain modulation. Evidence syntheses in abdominal surgery, Brown & Goodfellow (2005) and Theodorou et al. (2022) have found transverse incisions to be associated with reduced postoperative pain and fewer pulmonary complications compared with midline/vertical incisions, supporting the plausibility of the present observations.[17,18] However, randomised evidence is mixed on pain equivalence depending on operation type; Seiler et al. reported broadly similar analgesic requirements and no major differences in several recovery endpoints, again emphasising that context matters.[19] In ventral hernia repair specifically, less early pain with transverse incision may translate into earlier mobilisation, improved cough effort, and better participation in breathing exercises – factors that can indirectly reduce complications and support timely discharge.

Length of stay was substantially shorter in the transverse group (mean 4.0 vs 5.5 days, with a far higher proportion discharged by day 4). This is consistent with the combined downstream effects of fewer clinically meaningful wound events and lower early pain burden. SSI is repeatedly associated with additional resource use and prolonged hospitalisation across surgical populations, so an incision strategy that reduces SSI/SSO burden can plausibly shorten admission even when operative time and blood loss are similar.[13,27] Finally, scar outcomes at 1 month favoured transverse incision on Vancouver Scar Scale components (vascularity, pliability, height) and total score, with no difference in pigmentation. The VSS is among the most commonly used clinical scar assessment tools, incorporating vascularity, pigmentation, pliability, and height to reflect early scar quality and maturation trajectory. The pattern here – better vascularity/pliability/height but similar pigmentation – fits with the concept that incision orientation influences mechanical tension and collagen remodelling (affecting thickness and pliability) more than melanocyte activity (pigmentation), particularly at an early 1-month time point. The improved scar profile also aligns with Den Hartog et al. (2022) noting superior cosmetic appearance and shorter incisions in transverse approaches in selected settings, although cosmetic outcomes can vary by operation and extraction site.[15]

The present study has certain limitations. Being a single-centre prospective comparative study with a relatively modest sample size (90 participants), the findings may have limited generalisability to other settings and patient populations. Allocation was based on the incision used rather than true randomisation, and therefore surgeon preference and unmeasured intraoperative factors could have introduced selection and performance bias, despite baseline comparability between groups. Blinding was not feasible, and some key outcomes – particularly postoperative pain (VAS) and scar assessment (Vancouver Scar Scale) – are partly subjective and may be influenced by observer or participant expectations. Follow-up was short (up to 1 month for scar assessment), which precludes evaluation of long-term outcomes such as incisional hernia recurrence, chronic pain, and late scar maturation; similarly, wound outcomes were assessed clinically without detailed microbiological correlation in all cases. Finally, the strict inclusion criteria (restricted BMI range and exclusion of major comorbidities) improve internal validity but reduce applicability to higher-risk real-world ventral hernia populations, where wound morbidity is often greatest.

CONCLUSION

In this prospective comparative study of 90 patients undergoing elective open ventral hernia mesh repair, transverse and vertical incision groups were well matched at baseline and had similar intraoperative profiles, including mesh material, operative time, blood loss, and drain usage. However, the transverse incision approach demonstrated superior short-term postoperative outcomes, with significantly lower overall and clinically significant surgical site infection rates (4.4% vs 22.2% and 2.2% vs 13.3%), a significantly lower incidence of flap necrosis (8.9% vs 26.7%), and consistently lower postoperative pain scores during the early recovery period and at discharge." Patients in the transverse group also had a significantly shorter hospital stay (4.0 ± 0.9 vs 5.5 ± 1.3 days) and more favourable scar outcomes at one month, with lower Vancouver Scar Scale total scores and better vascularity, pliability, and height components. Wound disruption/dehiscence was not observed in either group. Overall, within the specified inclusion criteria and follow-up period, transverse incision open mesh repair appeared to offer meaningful advantages over vertical incision in terms of wound morbidity, early pain, recovery time, and scar quality.

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