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Original Article

A Comparison of Outcomes of Sub-Lay and On-Lay Polypropylene Mesh Repair for Ventral Incisional Hernia

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ABSTRACT

Background: Incisional hernia is a common postoperative complication occurring in 10–25% of patients following laparotomy. Mesh repair is the accepted standard of care; however, the optimal plane of mesh placement—onlay or sublay—remains debated. This study aims to systematically compare outcomes of onlay and sublay polypropylene mesh repair for ventral incisional hernia. Methods: An observational prospective study was conducted at KIMS, Karad, over 24 months. Twenty-six patients with ventral incisional hernia (13 per group) underwent either onlay or sublay polypropylene mesh repair. Outcomes including surgical site infection (SSI), seroma formation, early recurrence (within 3 months), postoperative pain (Day 1), and hospital stay were assessed and compared using Chi-square test (SPSS v28, $p < 0.05$ significant). Results: Sublay repair showed significantly lower SSI (0% vs 38.5%; $p = 0.018$), seroma formation (7.7% vs 46.2%; $p = 0.032$), and early recurrence (0% vs 30.8%; $p = 0.041$) compared to onlay repair. Postoperative pain on Day 1 was significantly milder in the sublay group ($p = 0.021$), and hospital stay outcomes were better ($p = 0.039$). Age, gender, hernia size, and operative duration were comparable between groups. Conclusion: Sublay polypropylene mesh repair is superior to onlay repair in terms of fewer postoperative complications, reduced early recurrence, lesser pain, and improved hospital stay outcomes. Sublay repair should be the preferred technique for elective ventral incisional hernia surgery.

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INTRODUCTION

Incisional hernia (IH) is defined as any abdominal wall gap at or near a surgical scar, detectable on clinical examination or imaging. It is one of the most frequent complications following laparotomy, occurring in approximately 10–25% of patients. Risk factors include obesity, diabetes mellitus, smoking, surgical site infection (SSI), advanced age, and use of immunosuppressive agents, all of which impair wound healing and compromise abdominal wall integrity. Technical factors—suture material, bite technique (small vs large), and incision location—also play a significant role [1,2].

Historically, primary suture repair was the mainstay of treatment; however, it was associated with recurrence rates of up to 63% at 10 years. Landmark randomized trials by Luijendijk et al. (2000) and Burger et al. (2004) demonstrated that mesh-based repair reduced recurrence to 24–32%, establishing it as the gold standard. Approximately 200,000 incisional hernia repairs are performed annually in the United States alone, reflecting the enormous clinical and economic burden of this condition [3,4].

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Two widely practiced open mesh repair techniques are onlay (anterior rectus sheath reinforcement) and sublay (retro-muscular/Rives–Stoppa) placement. Onlay repair is technically simpler but requires extensive subcutaneous dissection, which predisposes to wound-related complications including seroma, SSI, and skin necrosis. Sublay placement positions the mesh in the well-vascularized retro-muscular plane, with intra-abdominal pressure acting to reinforce rather than displace the mesh, theoretically resulting in superior biomechanical outcomes and lower complication rates [5,6].

Despite growing evidence, no universally accepted guidelines exist for choosing between these techniques. The present study was designed to prospectively compare onlay and sublay polypropylene mesh repair for ventral incisional hernia, evaluating postoperative outcomes including SSI, seroma, pain, hospital stay, and early recurrence.

METHODOLOGY

Study Design and Setting

This prospective observational study was conducted in the Department of General Surgery, Krishna Institute of Medical Sciences (KIMS), Karad, Maharashtra, India, over a period of 24 months. Institutional Ethics Committee approval was obtained prior to commencing the study, and all participants provided written informed consent.

Participants

Inclusion criteria: patients aged 18–70 years with a confirmed diagnosis of ventral incisional hernia (clinical and/or ultrasonographic). Exclusion criteria: recurrent, obstructed, or strangulated hernia; BMI > 40 kg/m^2; severe cardiopulmonary comorbidities precluding general/spinal anaesthesia.

Sample Size

Based on proportions of seroma formation reported by Haskins et al. (onlay: 83.3%; sublay: 20.7%) and using the formula $n = [(Z_{1-}\alpha/_2 + Z\beta)^2 \times (p_1q_1 + p_2q_2)] / (p_1-p_2)^2$, with 95% CI and 90% power, a minimum sample of 13 patients per group was calculated. Total sample: 26 patients (13 onlay, 13 sublay).

Surgical Technique

Group A (Onlay): Hernia sac reduced, defect closed primarily, and polypropylene mesh placed over the anterior rectus sheath with adequate overlap. Group B (Sublay): Hernia sac reduced, posterior rectus sheath/peritoneum closed, and polypropylene mesh placed in the retro-muscular plane (Rives–Stoppa technique), with anterior rectus sheath closed over the mesh.

Outcome Measures

Primary: SSI, seroma formation, and early recurrence (within 3 months). Secondary: postoperative pain (Day 1, assessed as mild/moderate/severe), intraoperative complications, duration of surgery, and length of hospital stay. Overall outcome was classified as Good, Fair, or Poor.

Statistical Analysis

Data were entered and managed in Microsoft Excel 2013. Qualitative variables were expressed as frequencies and percentages. Quantitative variables were reported as mean ± standard deviation. Chi-square test was used for comparing categorical variables. A p-value < 0.05 was considered statistically significant. All analyses were performed using SPSS Version 28.

RESULTS

Demographic Profile

A total of 26 patients were enrolled (13 per group). The majority were aged 31–50 years (46%), followed by 51–70 years (39%), and 18–30 years (15%). Male predominance was noted (57.7% males vs 42.3% females). Demographic characteristics were comparable between both groups (Table 1 and 2).

Table 1: Age Distribution of Study Participants

Sr. No	Age Group (Years)	Onlay Repair (N=13)	Sublay Repair (N=13)	Total (N=26)
1	18–30	02	02	04
2	31–50	06	05	11
3	51–70	05	06	11
Total		13	13	26

Table 2: Gender Distribution of Study Participants

Sr. No	Gender	Onlay Repair (N=13)	Sublay Repair (N=13)	Total (N=26)
1	Male	08 (61.5%)	07 (53.8%)	15 (57.7%)
2	Female	05 (38.5%)	06 (46.2%)	11 (42.3%)
Total		13	13	26

Hernia Characteristics and Operative Details

Hernia size was equally distributed between groups: <5 cm (30.8%), 5–10 cm (46.2%), and >10 cm (23.1%) in both. Most surgeries (46.2%) were completed within 60–120 minutes. Intraoperative complications were uncommon: onlay group 3 (23.1%) vs sublay group 2 (15.4%), with no significant difference.

Postoperative Outcomes — Association Analysis

Statistically significant differences favoring sublay repair were observed for SSI, seroma formation, early recurrence, postoperative pain, and hospital stay outcomes (Tables 3–6).

Table 3: Association Between Type of Mesh Repair and Surgical Site Infection (Chi-Square Test)

Mesh Repair	SSI Present	SSI Absent	Total / P Value
Sublay	00	13	13
Onlay	05	08	13 / p = 0.018*
Total	05	21	26

***Statistically significant (p < 0.05)**

No SSI was observed in the sublay group, whereas 5 patients (38.5%) in the onlay group developed SSI (p = 0.018). The retro-muscular position of the mesh, away from the subcutaneous layer, likely accounts for this advantage.

Table 4: Association Between Type of Mesh Repair and Seroma Formation (Chi-Square Test)

Mesh Repair	Seroma Present	Seroma Absent	Total / P Value
Sublay	01	12	13
Onlay	06	07	13 / p = 0.032*
Total	07	19	26

*Statistically significant (p < 0.05)
Seroma formation was significantly more frequent in the onlay group (46.2% vs 7.7%; p = 0.032). This is consistent with the larger subcutaneous dead space created during onlay dissection.

Table 5: Association Between Type of Mesh Repair and Early Recurrence (Chi-Square Test)

Mesh Repair	Seroma Present	Seroma Absent	Total / P Value
Sublay	00	13	13
Onlay	04	09	13 / p = 0.041*
Total	04	22	26

*Statistically significant (p < 0.05)
No early recurrences occurred in the sublay group compared to 4 (30.8%) in the onlay group (p = 0.041). The biomechanical advantage of retro-muscular mesh placement, where intra-abdominal pressure assists in holding the mesh, likely explains the lower recurrence rate.

***Table 6: Association Between Type of Mesh Repair and Postoperative Pain on Day 1 (Chi-Square Test*)**

Pain Severity	Sublay (N=13)	Onlay (N=13)	Total / P Value
Mild	09	02	11
Moderate–Severe	04	11	15 / p = 0.021*
Total	13	13	26

*Statistically significant (p < 0.05)

Mild pain was more prevalent in the sublay group (69.2% vs 15.4%), while moderate-to-severe pain predominated in the onlay group (84.6% vs 30.8%; p = 0.021). Hospital stay outcomes were also better in the sublay group (Good outcome: 84.6% sublay vs 53.8% onlay; p = 0.039).

DISCUSSION

The present study compared onlay and sublay polypropylene mesh repair in 26 patients with ventral incisional hernia (13 per group). Both groups were well-matched for age, gender, hernia size, and operative duration, allowing valid comparison of outcomes.

Surgical site infection was significantly lower in the sublay group (0% vs 38.5%; p = 0.018). This aligns with findings by Burger et al. (2004), who reported lower wound-related complications with sublay (retro-muscular) repair compared to onlay placement. The deep retro-muscular location of the mesh minimizes contact with potentially colonized subcutaneous tissues, reducing infection risk. Beckers Perletti et al. in a systematic review of 21 RCTs similarly found a significantly higher seroma risk with onlay repair (RR = 2.61, 95% CI 1.86–3.66) [7].

Seroma formation was significantly more frequent with onlay repair (46.2% vs 7.7%; p = 0.032). This is consistent with multiple comparative studies including Shakeel et al. and Shah et al. , both of whom reported fewer wound-related complications with the sublay technique. The extensive subcutaneous dissection required during onlay mesh placement creates a larger dead space, predisposing to fluid collection [8,9].

Early recurrence within 3 months occurred exclusively in the onlay group (30.8%; p = 0.041). Landmark data from Luijendijk et al. and Burger et al. (2004) demonstrated that mesh repair dramatically reduces recurrence compared to suture repair; however, retro-muscular placement appears to confer additional benefit over anterior onlay placement. Kharde et al. similarly reported no recurrences in the retro-rectus group versus 4% in the onlay group at six months [10,11].

Postoperative pain on Day 1 was significantly milder in the sublay group (p = 0.021). The limited subcutaneous dissection and avoidance of direct mesh-skin contact in sublay repair likely reduce nociceptive stimulation in the early postoperative period. Hospital stay outcomes were also significantly better with sublay repair (p = 0.039), consistent with findings, who reported shorter hospitalization with the sublay approach despite longer operative time [12,13].

These findings collectively support the preferential use of sublay mesh repair for elective ventral incisional hernia surgery. Limitations include the small sample size (n = 26), single-center design, and short follow-up of 3 months, which may underestimate late recurrence. Larger, multi-center randomized trials with longer follow-up are warranted to confirm these conclusions.

CONCLUSION

Both onlay and sublay polypropylene mesh repairs are feasible and safe techniques for ventral incisional hernia. However, sublay (retro-muscular) mesh repair demonstrated statistically significant superiority over onlay repair in terms of lower surgical site infection (p = 0.018), reduced seroma formation (p = 0.032), decreased early recurrence (p = 0.041), lesser postoperative pain (p = 0.021), and better hospital stay outcomes (p = 0.039). Sublay repair should be the preferred surgical approach for elective ventral incisional hernia repair to optimize patient outcomes and reduce postoperative morbidity.

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DECLARATIONS

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Conflict of interest: None declared.

Ethical approval: The Institutional Ethics Committee, Krishna Vishwa Vidyapeeth (Deemed to be University), Karad, approved this study.

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