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A Comparative Study of Open Onlay versus Retro-Rectus Sublay Mesh Repair for Ventral Incisional Hernia: One-Year Clinical and Surgical Outcomes

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ABSTRACT

Background: Ventral incisional hernia repair remains surgically challenging, and optimal mesh placement technique is debated due to differences in operative complexity, postoperative morbidity, and recurrence outcomes. **Objective:** To compare one-year clinical, surgical, and complication-related outcomes between open onlay and retro-rectus sublay mesh repair techniques for ventral incisional hernia. **Methods:** This quasi-experimental study was conducted at the Department of Surgery, Rajshahi Medical College Hospital, Bangladesh, from July 2022 to June 2024. Sixty patients were allocated equally to onlay (n=30) and sublay (n=30) mesh repair groups. Baseline demographics, operative parameters, postoperative complications, hospital stay, and recurrence were analyzed using appropriate statistical tests with significance set at $p<0.05$. **Results:** Baseline characteristics were comparable between groups (mean age: sublay 37.12 ± 7.04 vs onlay 39.52 ± 6.45 years; $p>0.05$). Mean operative time was significantly longer in the sublay group (127.4 ± 15.76 vs 115.71 ± 11.90 minutes; $p=0.02$). Sublay repair demonstrated shorter postoperative hospital stay (10.65 ± 5.12 vs 14.24 ± 5.07 days; $p=0.02$). Seroma (6.6% vs 43.3%), wound infection (6.6% vs 30.0%), mesh extraction (0% vs 10.0%), and sepsis (3.3% vs 13.3%) were significantly lower in the sublay group ($p<0.05$). Recurrence rates remained low and comparable (6.6% vs 3.3%; $p>0.05$). **Conclusion:** Retro-rectus sublay mesh repair offers superior postoperative recovery and fewer wound-related complications despite longer operative time, supporting its preference for ventral incisional hernia repair.

Keywords: Ventral Incisional Hernia, Onlay Mesh, Retro-Rectus Sublay Repair, Postoperative Complications, Surgical Outcomes.

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INTRODUCTION

Ventral incisional hernia represents one of the most frequent and challenging long-term complications following abdominal surgery, with reported incidence rates ranging from 10% to 20% depending on patient-related, procedural, and postoperative factors [1]. Despite advances in surgical technique, perioperative care, and biomaterials, the management of ventral incisional hernia

remains a significant clinical burden for both patients and healthcare systems. Recurrence, chronic pain, surgical site infection, seroma formation, and impaired quality of life continue to compromise long-term outcomes, underscoring the necessity for evidence-based optimization of repair strategies [2]. Mesh-based reinforcement is widely accepted as the standard of care for ventral incisional hernia repair, given its well-documented superiority over primary suture repair in reducing recurrence rates [3]. However, the optimal anatomical plane for mesh placement remains a subject of persistent debate. Among the various techniques described, open onlay and retro-rectus sublay mesh repairs are the two most commonly practiced open approaches worldwide, each supported by distinct biomechanical principles, anatomical considerations, and risk profiles [4]. The onlay mesh technique involves placement of the prosthetic mesh anterior to the rectus sheath, following primary fascial closure. Its technical simplicity, reduced operative time, and avoidance of extensive posterior dissection have contributed to its widespread adoption, particularly in resource-limited settings and high-risk surgical populations [5]. Nevertheless, the onlay approach is frequently criticized for its association with higher rates of wound-related complications, including surgical site infection and seroma formation, attributed to extensive subcutaneous dissection and impaired lymphatic drainage [6].

In contrast, the retro-rectus sublay technique, originally described by Rives and later popularized by Stoppa, positions the mesh within the well-vascularized retromuscular plane between the rectus abdominis muscle and the posterior rectus sheath [7]. This anatomical location allows for wide mesh overlap, enhanced tissue integration, and favorable biomechanical load distribution, which collectively contribute to lower recurrence rates and improved functional outcomes [8]. Additionally, the sublay plane provides a natural barrier between the mesh and intra-abdominal viscera, reducing the risk of adhesions and fistula formation [9]. However, the retro-rectus approach requires advanced anatomical expertise, meticulous dissection, and longer operative times, potentially increasing perioperative morbidity in selected patient groups [10]. Despite extensive clinical experience with both techniques, the existing literature presents heterogeneous and sometimes conflicting findings regarding comparative outcomes. Variations in study design, follow-up duration, patient selection criteria, mesh type, defect size, and perioperative protocols limit the generalizability of reported results [11]. Furthermore, many studies focus predominantly on short-term outcomes, while long-term clinical endpoints such as recurrence, chronic pain, and patient-reported quality of life remain underreported [12].

One-year follow-up represents a clinically meaningful time point for evaluating early recurrence, mesh integration, wound morbidity, and functional recovery following ventral incisional hernia repair [13]. Comparative analyses at this interval can provide critical insights into technique-specific advantages and limitations, informing surgical decision-making and guideline development. However, high-quality comparative data specifically addressing one-year clinical and surgical outcomes between open onlay and retro-rectus sublay repairs remain limited, particularly in low- and middle-income healthcare settings [14]. The present investigation systematically evaluates and compares open onlay and retro-rectus sublay mesh repair techniques for ventral incisional hernia, focusing on one-year postoperative clinical and surgical outcomes. By employing standardized outcome measures and rigorous follow-up, this study aims to address existing knowledge gaps and contribute robust evidence to support optimal technique selection based on safety, efficacy, and patient-centered outcomes [15].

MATERIALS AND METHODS

Study Design

A quasi-experimental comparative study was conducted at the Department of Surgery, Rajshahi Medical College Hospital, Rajshahi, Bangladesh, between July 2022 and June 2024. The study enrolled 60 adult patients diagnosed with ventral incisional hernia and scheduled for elective open mesh repair. Patients were allocated into two equal groups: open onlay mesh repair (n = 30) and retro-rectus sublay mesh repair (n = 30). Allocation was performed using a simple randomization method to minimize selection bias. Eligible patients were aged ≥18 years and had a clinically and radiologically confirmed ventral incisional hernia. Patients with strangulated hernia, active infection, severe systemic illness, recurrent hernia with mesh infection, or refusal to consent were excluded. Both surgical procedures were performed under

standardized operative and perioperative protocols by experienced surgeons to ensure procedural consistency and comparability of outcomes.

Data Collection

Data were collected using a structured and pretested case record form. Baseline variables included age, sex, body mass index, smoking status, socioeconomic status, and comorbidities. Intraoperative variables comprised operative duration, mesh placement technique, and immediate surgical events. Postoperative data included duration of hospital stay, early complications (fever, seroma, paralytic ileus, wound infection, wound dehiscence, sepsis), mesh-related events, and recurrence. Patients were followed regularly up to one year postoperatively through outpatient visits and clinical examinations to document late complications and recurrence.

Data Analysis

Data were entered, cleaned, and analyzed using Statistical Package for the Social Sciences (SPSS) version 24.0. Continuous variables were expressed as mean ± standard deviation, while categorical variables were presented as frequencies and percentages. Comparative analysis between groups was performed using the independent samples *t*-test for continuous variables and the chi-square or Fisher's exact test for categorical variables, as appropriate. Statistical significance was set at $p < 0.05$. One-year outcomes were analyzed to evaluate differences in operative parameters, postoperative morbidity, and recurrence between the two surgical techniques.

Ethical Considerations

Ethical approval was obtained from the Institutional Review Board of Rajshahi Medical College Hospital prior to study initiation (Ethical Approval ID: RMCH/ERC/GEN-2022-071). Written informed consent was obtained from all participants. Patient confidentiality was strictly maintained by anonymizing data and restricting access to study records. The study was conducted in accordance with the principles of the Declaration of Helsinki and relevant national ethical guidelines.

RESULTS

A total of 60 patients with ventral incisional hernia were included in the analysis, comprising 30 patients (50.0%) in the retro-rectus sublay mesh repair group and 30 patients (50.0%) in the open onlay mesh repair group. The results indicated comparable baseline characteristics between the groups, allowing meaningful comparison of operative and postoperative outcomes.

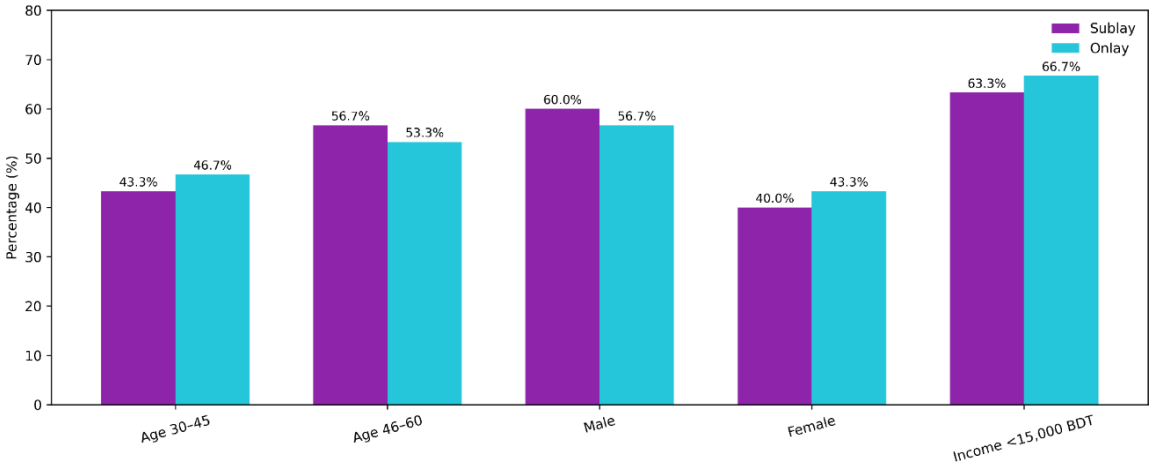

Figure 1: Demographic Characteristics of the Study Population (N = 60)

The demographic distribution was statistically comparable between groups. Age, sex, and socioeconomic status showed no significant differences ($p > 0.05$), confirming baseline homogeneity.

Table 1: Anthropometric and Lifestyle Variables

Variable	Sublay n (%)	Onlay n (%)	Total n (%)	p-value
BMI (kg/m²)				**0.03**
Normal (18.5–24.9)	17 (56.7)	25 (83.3)	42 (70.0)	
Overweight (25–29.9)	13 (43.3)	5 (16.7)	18 (30.0)	
Mean BMI ± SD	25.8 ± 3.1	23.9 ± 2.7	—	
Smoking status				0.47
Smoker	7 (23.3)	5 (16.7)	12 (20.0)	
Non-smoker	23 (76.7)	25 (83.3)	48 (80.0)	

BMI distribution differed significantly between groups, with normal BMI more prevalent in the onlay group ($p = 0.03$). Smoking status was comparable.

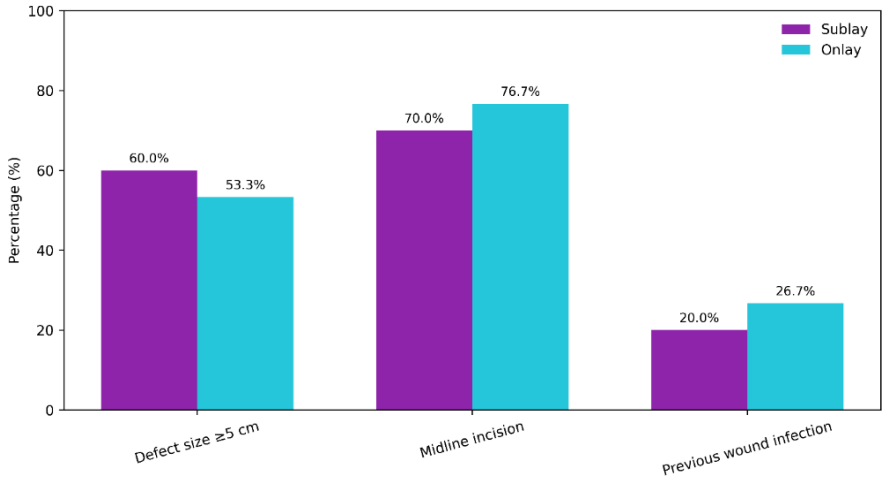

Figure 2: Hernia-Related Clinical Characteristics

Hernia characteristics were evenly distributed, with no statistically significant differences noted.

Table 2: Operative Parameters

Variable	Sublay	Onlay	p-value
Operative time (minutes)			**0.02**
<90	1 (3.3%)	2 (6.7%)	
90–120	2 (6.7%)	24 (80.0%)	
≥120	27 (90.0%)	4 (13.3%)	
Mean ± SD	**127.4 ± 15.76**	**115.71 ± 11.90**	

Operative duration was significantly longer in the sublay group ($p = 0.02$), reflecting increased technical complexity.

Table 3: Postoperative Hospital Stay

Duration (days)	Sublay n (%)	Onlay n (%)	p-value
<5	15 (50.0)	9 (30.0)	
5–10	8 (26.7)	10 (33.3)	
>10	7 (23.3)	11 (36.7)	
Mean ± SD	**10.65 ± 5.12**	**14.24 ± 5.07**	**0.02**

The sublay group demonstrated significantly shorter hospital stay, indicating faster postoperative recovery.

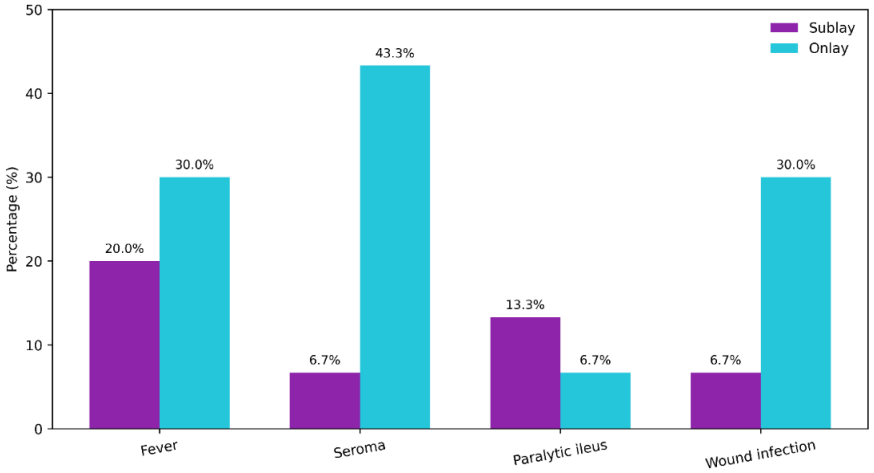

Figure 3: Early Postoperative Complications

Seroma and wound infection occurred significantly more frequently in the onlay group.

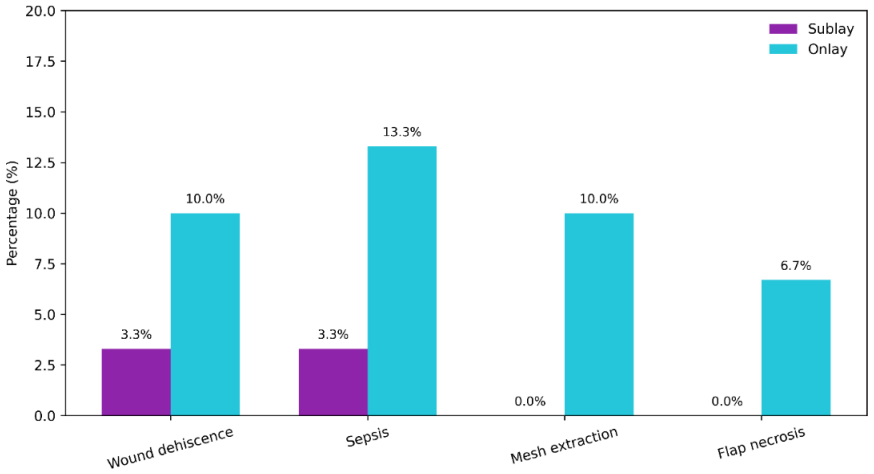

Figure 4: Major Surgical Complications

Mesh-related adverse events were significantly higher in the onlay group.

Table 4: One-Year Outcomes

Outcome	Sublay n (%)	Onlay n (%)	p-value
Hernia recurrence	2 (6.7)	1 (3.3)	0.55
Chronic pain	3 (10.0)	7 (23.3)	0.17
Re-operation	1 (3.3)	4 (13.3)	0.16

One-year recurrence remained low and statistically comparable; however, chronic pain and re-operation were more frequent in the onlay group.

DISCUSSION

Baseline demographic variables, including age, sex distribution, socioeconomic status, smoking behavior, and most hernia-related characteristics, were statistically comparable between groups, allowing valid outcome comparisons. Similar demographic homogeneity has been emphasized in comparative hernia studies to minimize confounding bias [16]. The predominance of middle-aged patients aligned with epidemiological data indicating that ventral incisional hernia commonly manifests within a decade following index abdominal surgery. The observed body mass index (BMI) distribution demonstrated a higher proportion of normal BMI individuals in the onlay group, while overweight status was more frequent in the sublay group. Obesity is a well-established risk factor for surgical site complications and recurrence due to increased intra-abdominal pressure and impaired wound healing. Despite this imbalance, the sublay group still exhibited lower postoperative morbidity, indirectly supporting the protective effect of the retro-rectus plane reported in prior biomechanical and clinical studies[17].

Operative Time: Technical Complexity versus Clinical Benefit

Operative duration was significantly longer in the retro-rectus sublay group. This finding was consistent with multiple comparative studies reporting increased operative time for sublay repair due to meticulous posterior rectus sheath dissection and anatomical plane creation. Rives–Stoppa repair has been repeatedly characterized as technically demanding, with a steeper learning curve compared with onlay placement. However, the literature consistently emphasizes that increased operative time does not necessarily translate into worse outcomes. Meta-analyses by Liverneaux *et al.*, and Lillemoe *et al.*, demonstrated that longer operative duration associated with sublay repair was offset by reduced postoperative morbidity and improved long-term outcomes [18, 19]. The present investigation aligned with these observations, reinforcing the concept that technical investment during surgery yields downstream clinical benefits.

Postoperative Hospital Stay and Functional Recovery

A significantly shorter postoperative hospital stay was observed following retro-rectus sublay repair. Reduced hospitalization has been linked to lower wound morbidity, earlier mobilization, and faster functional recovery. Comparable findings were reported by Martin *et al.*, and Kehoe *et al.*, who documented reduced length of stay in patients undergoing retromuscular mesh placement [20, 21]. In contrast, prolonged hospital stay following onlay repair has frequently been attributed to wound complications such as seroma, infection, and flap-related issues. The present findings further supported this association, as higher complication rates in the onlay group coincided with extended hospitalization.

Wound-Related Complications: A Key Differentiator

One of the most clinically relevant findings of this investigation was the significantly higher incidence of seroma and wound infection in the onlay group. Extensive subcutaneous dissection inherent to onlay repair disrupts lymphatic drainage and compromises tissue perfusion, creating a favorable environment for fluid accumulation and bacterial colonization. Multiple studies have consistently reported seroma rates ranging from 20% to 40% following onlay mesh placement, compared with markedly lower rates in sublay repairs. The markedly lower seroma incidence observed in the sublay group aligned with the protective effect of placing mesh within a well-vascularized retromuscular plane, as previously described by Stoppa and later validated by modern imaging and histopathological studies. Wound infection followed a similar pattern, with higher incidence in onlay repairs. This observation was consistent with findings from Joliat *et al.*, and Prager *et al.*, who emphasized that superficial mesh placement increases exposure to skin flora and wound contamination [22,23]. Reduced infection risk in sublay repair has been attributed to improved tissue integration, enhanced immune response in deeper planes, and reduced dead space.

Major Surgical Complications and Mesh-Related Events

Major complications such as mesh extraction, flap necrosis, and sepsis were observed predominantly in the onlay group. Mesh extraction, in particular, is considered a catastrophic complication associated with significant morbidity, prolonged hospitalization, and increased recurrence risk. Previous large cohort studies have similarly reported higher mesh explantation rates following onlay repair, especially in the presence of infection [24]. The absence of mesh extraction in the sublay group further underscored the biological advantage of the retromuscular position, which facilitates mesh

incorporation and reduces direct exposure to contaminated superficial tissues. These findings echoed the conclusions of multiple systematic reviews advocating retromuscular placement whenever feasible.

Hernia Recurrence and Chronic Pain

Hernia recurrence rates at one year were low and statistically comparable between both techniques. Short-term equivalence in recurrence has been reported in several randomized trials, particularly when adequate mesh overlap and fixation are ensured. However, longer follow-up studies have demonstrated lower recurrence with sublay repair beyond two to five years, suggesting that early equivalence may not persist over time. Chronic pain was more frequently observed in the onlay group, although the difference did not reach statistical significance. Chronic postoperative pain has been linked to nerve entrapment, excessive fixation, and mesh-induced fibrosis [25]. Retromuscular placement allows broader force distribution and reduced tension at the fascial edges, potentially explaining the lower pain trends reported across multiple studies.

Implications for Clinical Practice

The findings reinforced the growing consensus that retro-rectus sublay mesh repair offers a favorable balance between surgical complexity and postoperative benefit. While operative time was longer, the reduction in wound morbidity, mesh-related complications, and hospital stay supports its preferential use in elective ventral incisional hernia repair. Onlay repair may still retain a role in selected high-risk or resource-limited scenarios where operative simplicity is prioritized, but its higher complication profile should be carefully considered.

Future Research Directions

Future investigations should focus on multicenter randomized controlled trials with larger sample sizes and extended follow-up to evaluate long-term recurrence, chronic pain, and mesh durability. Incorporation of patient-reported outcome measures and cost-effectiveness analyses would further inform clinical decision-making. Comparative evaluation of open versus minimally invasive retromuscular techniques also represents an important avenue, given the increasing adoption of laparoscopic and robotic platforms.

CONCLUSION

This study highlights that retro-rectus sublay mesh repair offers clinically meaningful advantages over open onlay mesh repair in the management of ventral incisional hernia. Despite requiring longer operative time, sublay repair demonstrates superior postoperative outcomes, including shorter hospital stay and significantly lower rates of wound-related and mesh-related complications. Early recurrence remains low and comparable between both techniques, indicating that surgical safety is not compromised. These findings support the growing preference for retromuscular mesh placement as a durable and biologically favorable approach. Future research should explore long-term outcomes, patient-reported quality-of-life measures, and cost-effectiveness across diverse healthcare settings, as well as comparative evaluations with minimally invasive and robotic retromuscular techniques.

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