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Ventral Hernia Repair With Onlay Placement of Biosynthetic Ovine Rumen Is Noninferior to Retrorectus Placement

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Background: Mesh placement impacts postoperative outcomes in ventral hernia repair (VHR). The retrorectus technique is associated with lower recurrence rates than the onlay technique. Hybrid meshes, combining synthetic and biologic benefits, have been introduced, but the effect of placement location on outcomes remains unclear.

Methods: We retrospectively analyzed 71 patients who underwent VHR with biosynthetic ovine rumen in either an onlay (n = 38) or retrorectus (n = 33) position. We compared demographics, comorbidities, complications, and recurrent rates. Multivariate logistic regression assessed associations between mesh placement and outcomes.

Results: Onlay patients were older (mean 62.9 versus 57.4 y, $P = 0.03$) and had larger hernias (158 versus 73.8 cm^2, $P < 0.001$). Most patients had grade 2 or 1 hernias according to the modified ventral hernia working group classification, with no significant differences in postoperative complications. Hernia recurrence occurred in 5.41% of onlay patients and 0% of retrorectus patients.

Conclusions: No significant differences in complications or recurrence rates were observed between placement techniques. These findings suggest that hybrid mesh placement in an onlay position is a safe and durable strategy for VHR. *(Plast Reconstr Surg Glob Open 2025;13:e6666; doi: 10.1097/GOX.0000000000006666; Published online 2 April 2025.)*

INTRODUCTION

Ventral hernia repair (VHR) is one of the most commonly performed surgical procedures, costing the US healthcare system approximately $9.7 billion annually.[1] The volume of VHR in the United States has almost doubled to 611,000 per year since 2006. Along with the increase in VHR, a recent study by Kenawy et al[2] showed that recurrence rates are high, with the risk almost doubling from 7.37% at year 3 to 14.74% at year 10. It has been estimated that a 1% decrease in ventral hernia recurrence or prophylactic measures to prevent ventral hernias could save the US healthcare system at least $139.9 million annually.[1]

The placement of mesh to reinforce the abdominal wall has led to a significant reduction in hernia recurrence rates and has become the standard approach for the repair of complex ventral hernias.[3] A wide range of synthetic and biologic materials have been utilized to fabricate mesh for hernia repair and are currently in clinical use.[4] Benefits of synthetic mesh include its robust strength and low cost, but this mesh type has been shown to be prone to infections, fistula formation, abdominal stiffness, and adhesions.[5] Biologic mesh was introduced to address these problems along with the aim to provide a scaffold for native regeneration of soft tissue.[6] Biologic mesh serves the purpose of supporting the abdominal wall until a stable abdominal wall has been regenerated.[6] Disadvantages of biologic mesh include its higher cost and lower strength compared with synthetic mesh.[7] Hybrid mesh has been introduced more recently with the goal of combining the benefits of synthetic and biologic mesh for VHR. By utilizing both biologic and synthetic components, hybrid mesh aims to improve biocompatibility while minimizing foreign body response and infections.[8]

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Beyond the material properties of the mesh, the plane of mesh placement has been reported to have an impact on postoperative outcomes and recurrence rates of ventral hernias. Placement of mesh in an onlay position on top of the anterior rectus sheath requires less dissection of the rectus sheath and allows for a shorter duration of surgery. However, several meta-analyses on studies using synthetic mesh for VHR demonstrated a superiority of retrorectus mesh placement when compared with the onlay repair technique.[9–14] Whether these findings also apply to biologic or hybrid mesh has not been investigated so far.[10–15] Here, we compare postoperative outcomes and recurrence rates between patients who had undergone VHR with hybrid mesh placed using a retrorectus or onlay technique.

Takeaways

Question: Are there differences in complications or recurrence rates in patients who underwent hybrid mesh placement in an onlay or retrorectus fashion?

Findings: A retrospective review of 71 patients revealed that although patients who underwent ventral hernia repair with onlay hybrid mesh were older and had larger hernia defects, this did not translate into higher complications or recurrence rates compared with patients who underwent hybrid mesh placement in a retrorectus technique.

Meaning: Hybrid mesh placement in an onlay position represents a safe and durable strategy for ventral hernia repair.

METHODS

Patients

We performed a retrospective analysis on 71 patients who underwent VHR with reinforced biosynthetic ovine rumen (RBOR, Ovitex, TELA Bio, Malvern, PA) placed in either a retrorectus (n = 33) or onlay plane (n = 38) at Stanford University Medical Center and the Indiana Hernia Center between 2016 and 2021. Patients who met the following inclusion criteria were included in the study: 18 years of age or older, open VHR performed between 2016 and 2021, and implantation of RBOR in a retrorectus or onlay technique. Exclusion criteria included the presence of umbilical hernias or multiple ventral hernias, combinations of multiple mesh types, active abdominal infection, concomitant procedures in addition to VHR, and laparoscopic repair. Institutional review board approval was obtained for the study.

Surgical Techniques

For onlay repair, fascial closure was achieved with a running barbed polydioxanone suture (Stratafix, Ethicon, Raritan, NJ), and the mesh was sutured on top of the anterior rectus sheath using a 2-0 barbed polydioxanone suture (Stratafix, Ethicon) (Fig. 1).

In patients who received retrorectus repair, the retrorectus space was dissected, and the mesh was placed behind the rectus muscles and sutured in place using 2-0 polydioxanone sutures (Ethicon) (Fig. 2). The anterior rectus sheath was closed using a 2-0 barbed polydioxanone suture (Stratafix, Ethicon). The decision to utilize an onlay or retrorectus technique for mesh implantation was dependent on surgeon preference.

Data Acquisition

Analysis of patient demographics and baseline characteristics was conducted by comparing age, sex, body mass index, smoking activity, and medical comorbidities between groups (Table 1). Modified ventral hernia working group classification, hernia defect size, and length of follow-up were also compared between the groups. Hernia defect size was calculated by measuring the greatest fascial defect diameter on the sagittal and transverse planes of preoperative computed tomography. The following postoperative complications were compared between the groups: hernia recurrence, hematoma, seroma, wound complication, abdominal infection, and enterocutaneous fistula. Wound complications included skin necrosis, prolonged wound healing (>14 d), and wound dehiscence. Surgical site occurrence was defined as the occurrence of hematoma, seroma, wound complication, or fistula. Overall complications were defined as the presence of at least 1 complication, including hematoma, seroma, wound complication, abdominal infection, fistula, or recurrence.

Statistical Analysis

Statistical analysis was performed using R (version 4.0, www.r-project.org). We utilized a Student *t* test to compare continuous variables and a chi-square test or Fisher test to compare categorical variables. The odds ratios and 95% confidence intervals were calculated using multivariate logistic regression analysis. Variables that demonstrated differences between the groups as

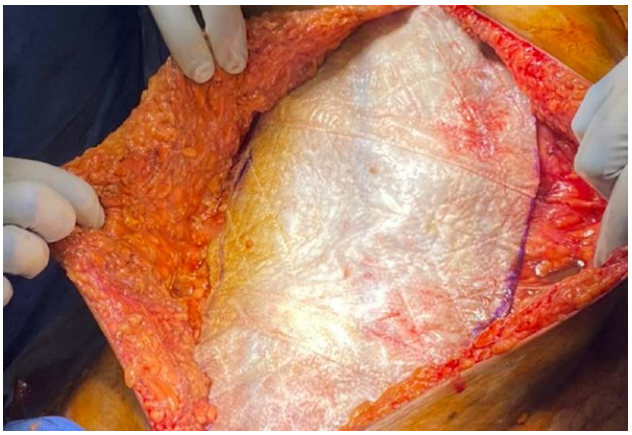

Fig. 1. A photograph of RBOR placed in an onlay position on top of the anterior rectus sheath.

Fig. 2. A photograph of retrorectus placement of RBOR before advancement of the rectus abdominis muscles and closure of the anterior rectus sheath.

indicated by a *P* value less than 0.1 in univariate analysis were included in the multivariate analysis. Statistical significance was set at a *P* value less than 0.05, and all statistical tests were 2-tailed.

RESULTS

Baseline Characteristics

A total of 71 patients met the inclusion criteria. Of these, 38 patients had undergone a VHR with onlay mesh placement, and 33 patients had undergone VHR with retrorectus mesh placement (Table 1). There were no statistically significant differences in body mass index, tobacco use, diabetes, and renal disease between the groups. However, patients who underwent VHR with an onlay technique were significantly older (mean age 62.9 versus 57.4 y, $P = 0.03$) and had a lower incidence of coronary artery disease (5.26% versus 39.4%, $P = 0.001$) compared with patients who underwent VHR with the retrorectus technique.

Most patients had grade 2 and grade 1 hernias (57.9% grade 2, 31.6% grade 1, 10.5% grade 3) in the onlay group; 54.5% grade 2 and 45.5% grade 1 in the retrorectus group ($P = 0.134$) as defined by the modified ventral hernia working group classification. Patients who received onlay mesh had significantly larger hernias compared with patients with a retrorectus repair (158 versus 73.8 cm^2, $P < 0.001$) on preoperative computed tomography. Most patients in the retrorectus group received an additional anterior component separation or transversus abdominis release (TAR). Among patients in the retrorectus group, TAR was performed in 69.7%, and anterior component separation was performed in 3.03%. Most patients in the onlay group did not receive an additional component separation. Among patients in the onlay group, TAR was performed in 10.5%, and anterior compartment separation was performed in 13.2%. Mean follow-up time was comparable between groups (27.6 versus 22.9 mo, $P = 0.542$) (Table 2).

Postoperative Complications

No significant differences in postoperative hematoma, seroma, wound complications, abdominal infections, or fistulas were found between the groups (Table 3). Hernia recurrence occurred in 5.41% of the onlay patients and 0% of the retrorectus patients without significant differences between the groups ($P = 0.49$; Table 3). To adjust for the differences in baseline characteristics and to determine the impact of the plane of mesh placement on overall

Table 1. Patient Demographics and Comorbidities

	Onlay (n = 38)	Retrorectus (n = 33)	*P*
Age, y (SD)	62.9 (10.2)	57.4 (10.9)	**0.034***
BMI, kg/m² (SD)	30.0 (4.59)	31.3 (5.64)	0.322
Tobacco use, n (%)	5 (13.2)	8 (24.2)	0.370
Diabetes, n (%)	14 (36.8)	5 (15.2)	0.073
Renal disease, n (%)	9 (23.7)	2 (6.06)	0.086
Coronary artery disease, n (%)	2 (5.26)	13 (39.4)	**0.001***
Previous pulmonary disease, n (%)	1 (2.63)	8 (24.2)	**0.010***
Previous abdominal surgery, n (%)	38 (100)	33 (100)	
Revision mesh surgery, n (%)	13 (34.2)	16 (48.5)	0.328
Incarceration, n (%)	1 (2.63)	31 (93.9)	**<0.001***
Component separation, n (%)	9 (23.7)	24 (72.7)	**<0.001***
Etiology			1.000
Abdominal surgery, n (%)	37 (97.4)	33 (100)	

*Bolded values indicate significant *P* values.
BMI, body mass index.

Table 2. Surgical Characteristics

	Onlay (n = 38)	Retrorectus (n = 33)	*P*
Modified ventral hernia working group classification, n (%)			0.134
Grade 1	12 (31.6)	15 (45.5)	
Grade 2	22 (57.9)	18 (54.5)	
Grade 3	4 (10.5)	0 (0.00)	
Component separation type, n (%)			**<0.001***
None	29 (76.3)	9 (27.3)	
Anterior	5 (13.2)	1 (3.03)	
TAR	4 (10.5)	23 (69.7)	
Defect size, cm^2			
Mean (SD)	158 (80.4)	73.8 (65.1)	**<0.001***
Mean follow-up (SD), mo (Min, max)	27.6 ± 13.7 (10.2, 50.2)	22.9 ± 11.0 (12.4, 34.3)	0.542

*Bolded values indicate significant *P* values.

Table 3. Postoperative Complications

	Onlay (n = 38)	Retrorectus (n = 33)	*P*
Overall complications, n (%)	7 (18.9)	3 (9.09)	0.315
Recurrence, n (%)	2 (5.41)	0 (0.00)	0.494
Hematoma, n (%)	1 (2.70)	1 (3.03)	1.000
Seroma, n (%)	4 (10.8)	1 (3.03)	0.361
Wound complication, n (%)	4 (10.8)	1 (3.03)	0.361
Abdominal infection, n (%)	0 (0.00)	1 (3.03)	0.471
Fistula, n (%)	2 (5.26)	1 (3.03)	1.000

Table 4. Logistic Regression for Overall Complications

	OR (95% CI)	*P*
Mesh placement		
Onlay	Ref.	Ref.
Retrorectus	0.006 (6.62×10^{6}–0.694)	0.07
Age	1.01 (0.877–1.18)	0.86
Diabetes	0.107 (1.94–2.73×10^{4})	0.17
Previous pulmonary disease	49.1 (1.94–2.73×10^{4})	0.06
Renal disease	0.256 (4.59×10^{-3}–5.33)	0.42
Incarceration	0.021 (7.09×10^{-5}–1.55)	0.20
Component separation	795 (6.01–1.87×10^{6})	**0.03***

*Bolded values indicate significant *P* values.
CI, confidence interval; OR, odds ratio.

complications and hernia recurrence, we performed a multivariate logistic regression analysis. This confirmed that the plane of mesh placement does not have a significant impact on overall complications (odds ratio: 0.006, $P = 0.07$) or hernia recurrence ($P = 1.00$) (Table 4).

DISCUSSION

There is currently no consensus on the ideal location for mesh placement in VHR, with previous studies having investigated different mesh locations and their impact on postoperative outcomes.[16,17] A systematic review and meta-analysis of 93 studies representing 12,440 patients with retrorectus repair showed superior or similar outcomes to other techniques for all outcomes except for surgical site infection.[18] Fifteen of these studies compared retrorectus repair with onlay repair and showed that retrorectus repair was associated with a lower risk for hernia recurrence, surgical site infection, and seroma.[18] All relevant studies included in this analysis only compared outcomes utilizing synthetic mesh types. Whether these findings also apply to biologic or hybrid mesh has not been investigated to date.

The RBOR mesh that was used in our study consists of ovine rumen reinforced with interwoven polypropylene with the goal of conferring increased long-term strength through the synthetic component while promoting tissue integration through the biologic backbone of the material.[19] We have previously analyzed 141 patients who underwent VHR with porcine or bovine acellular dermal matrix as well as RBOR and found that RBOR decreases abdominal complications and recurrence rates after VHR compared with biologic mesh.[20] When comparing outcomes of VHR using RBOR with synthetic mesh, we previously found that the use of RBOR reduces surgical site occurrence while providing a durable repair with low hernia recurrence rates similar to synthetic mesh (4% versus 6.8%) at 30 months follow-up.[20] The plane of mesh placement did not have a significant impact on overall complications in this prior analysis. These data indicate that the findings of large meta-analyses of

studies using synthetic mesh may not be applicable to more novel hybrid mesh products.

Here we compared postoperative outcomes among patients who had undergone VHR with RBOR using either onlay or retrorectus mesh placement. Although patients who underwent VHR with onlay hybrid mesh were older and had larger hernia defects, this did not translate into higher complications or recurrence rates compared with patients who underwent hybrid mesh placement in a retrorectus technique. Our findings were confirmed using multivariate logistic regression analysis demonstrating that the plane of mesh placement did not have a significant impact on postoperative outcomes. Potential benefits of the onlay technique include a less invasive dissection of the abdominal wall and a shorter operative time, which may be beneficial for surgical outcomes of patients with multiple comorbidities.

Limitations of our study include its retrospective nature, along with the limited sample size. To analyze postoperative outcomes and hernia recurrence with statistical robustness, differences in baseline characteristics were accounted for using logistic regression analysis. Because this is a preliminary study with a limited sample size, larger studies on patients with onlay and retrorectus mesh placement are needed to confirm our findings. As the decision to implant mesh in either an onlay or retrorectus fashion, and whether to use component separation in addition to mesh placement, was based on surgeon preference in our study, this bias must be taken into consideration in future studies as well. Nevertheless, this is the first study to compare postoperative outcomes among patients who underwent VHR with onlay or retrorectus hybrid mesh placement. Our data provide valuable information for preoperative surgical planning and counseling of patients planning to undergo VHR with hybrid mesh.

CONCLUSIONS

Our data indicate that VHR with RBOR placed in an onlay technique provides a safe and durable repair without significant differences in postoperative outcomes or hernia recurrence compared with retrorectus mesh placement. The onlay repair technique may, therefore, be a valuable alternative to a retrorectus repair in patients with multiple comorbidities that may benefit from shorter operative times.

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DISCLOSURES

Dr. Nazerali serves as a speaker/consultant/advisor to Mentor, MTF, and TELA Bio. The other authors have no financial interest to declare in relation to the content of this article.

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