Tracción fascial mediada por malla para el manejo del abdomen abierto y la prevención de hernias ventrales planificadas: una cohorte retrospectiva

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Mesh-mediated fascial traction for open abdomen management to prevent planned ventral hernias: a retrospective cohort.

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Abstract

Background: Open abdomen is indicated in some clinical scenarios, but it introduces new challenges like the development of planned incisional hernias; new management techniques for temporary closure in open abdomen such as negative pressure wound therapy and mesh-mediated fascial traction have shown an incidence reduction of this outcome. However, for successful abdominal wall closure rates, there is limited evidence evaluating the factors associated with it when mesh-mediated fascial traction is employed in the context of open abdomen.

Methods: We conducted a retrospective cohort analysis of patients managed with mesh-mediated fascial traction at Méderi Hospital Network from 2020 to 2025. Demographic data, clinical characteristics, surgical variables, and postoperative outcomes were systematically evaluated.

Results: Ninety-two patients were included, achieving a definitive abdominal wall closure success rate of 70.7%. Closure failure was significantly correlated with more than four peritoneal lavage procedures, intestinal resection, and initial fascial defects greater than 7.5 cm. Primary indications for OA management were peritonitis/sepsis (34.8%) and bowel obstruction (19.6%).

Conclusions: Mesh-mediated fascial traction is effective for definitive abdominal wall closure in a majority of patients. However, identifying those at increased risk for closure failure is vital. Utilizing a tailored decision-making algorithm based on specific predictors can optimize clinical outcomes and reduce healthcare costs.

Keywords: Open abdomen, mesh-mediated fascial traction, negative pressure wound therapy, incisional hernia, abdominal wall closure

Background

Open abdomen (OA) is indicated in some clinical scenarios including damage control surgery, major vascular surgery, peritonitis, and decompressive laparotomy for abdominal compartment syndrome, among others. Advances in devices and techniques for managing the OA have broadened its indications and improved surgical outcomes (1). Despite its utility in various conditions, the OA introduces new challenges—one of the most significant being the development of planned incisional hernias due to retraction of the rectus sheath fascia, which may ultimately preclude primary closure of the abdominal wall (2).

To address this issue, Petersson et al. introduced the technique of negative pressure wound therapy (NPWT) and mesh-mediated fascial traction for temporary closure in OA, which has been shown to increase the rate of successful abdominal wall closure and reduce the incidence of planned ventral hernias (3). Reported rates of incisional hernia without mesh-mediated fascial traction range from 63.5% to 69.5% (4), whereas the use of mesh-mediated fascial traction has been associated with significantly higher fascial closure rates, up to 80.1% and 83.5% (5,6). Based on this evidence, current guidelines increasingly support the use of mesh-mediated fascial traction in patients undergoing OA management (7,8).

Moreover, current recommendations emphasize the importance of achieving abdominal closure as early as possible, since prolonged open abdomen duration is associated with a higher risk of complications, particularly enteric fistula formation (9,10) . Therefore, it is crucial to identify which patients are most likely to benefit from additional procedures aimed at achieving complete fascial closure, and conversely, which patients are less likely to succeed and may require early planned ventral hernia closure instead (11). To date, however, there is limited evidence evaluating the factors associated with successful abdominal wall closure when mesh-mediated fascial traction is employed in the context of OA. Identifying such factors is clinically relevant, as continued use of mesh-mediated fascial traction involves significant logistical and economic considerations, including the need for multiple procedures, repeated transfers to the operating room, anesthesia exposure, and frequent dressing changes.

The aim of this study is to identify factors associated with successful mesh-mediated fascial traction for temporary closure in OA management, and to report the overall success rate of achieving definitive abdominal wall closure with this approach.

Patients and Methods

Study Design

We conducted a retrospective cohort study including all patients who underwent mesh-mediated fascial traction as part of OA management at Méderi Hospital Network between 2020 and 2025. All data were collected in an anonymized database. Upon admission, patients or their legal representatives provided written informed consent for the use of clinical information in research.

The study protocol was reviewed and approved by the institutional ethics committee (approval number CEISH-2025034). The STROCSS guidelines were followed for the reporting of this study (12).

Patients

Eligible participants were adults (≥18 years old) who underwent OA for any indication and subsequently received mesh-mediated fascial traction for temporary closure. Patients who did not provide informed consent were excluded. The timing of mesh-mediated fascial traction initiation—whether during the initial procedure or during subsequent operations—was at the discretion of the operating surgeon.

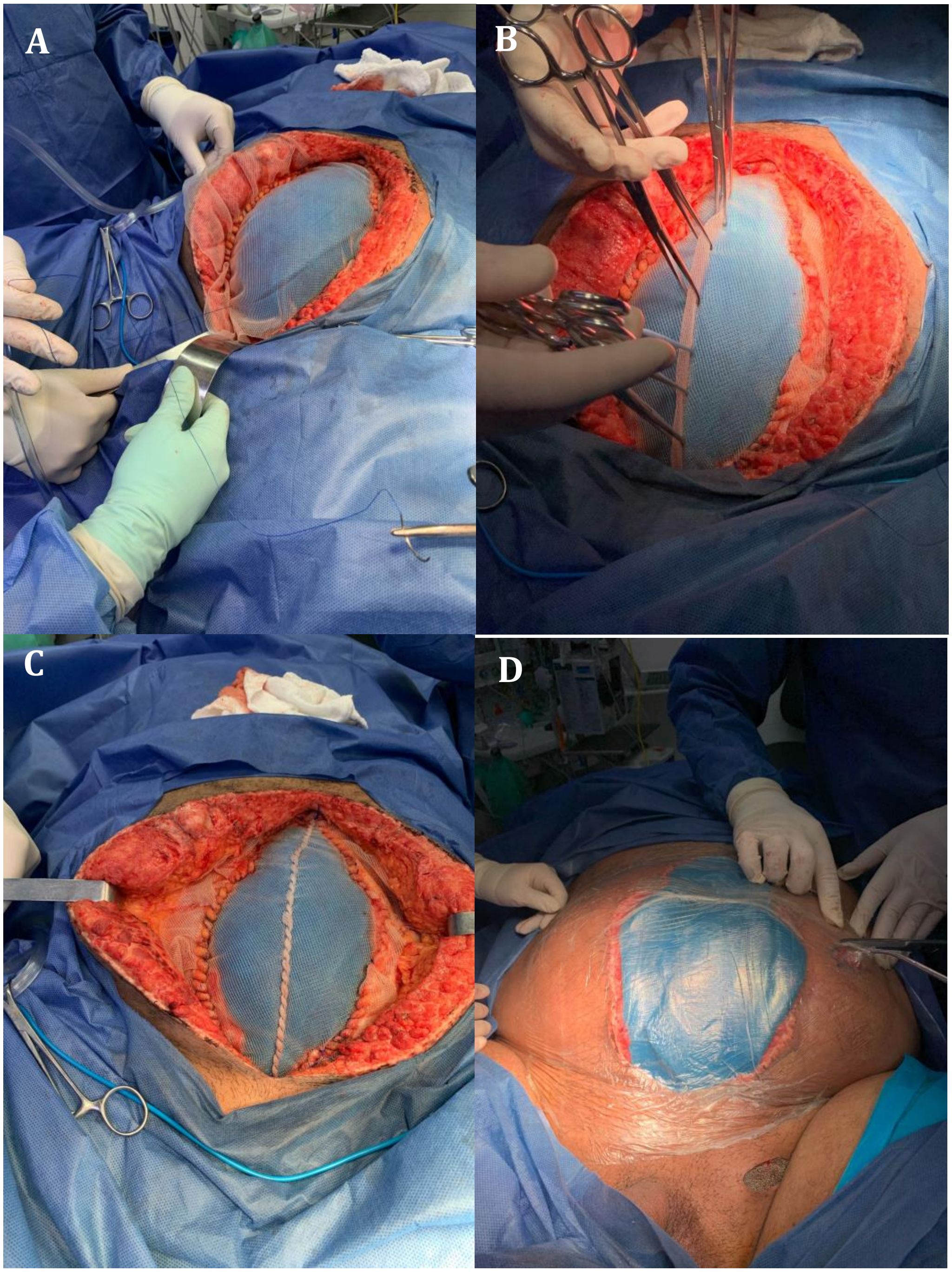
The following variables were analyzed: patient demographics, body mass index (BMI), American Society of Anesthesiologists (ASA) physical status classification, presence of comorbidities including hypertension, diabetes mellitus, chronic obstructive pulmonary disease, cardiovascular disease, and chronic kidney disease; preoperative hemoglobin level; primary diagnosis requiring OA; history and characteristics of incisional hernia; need for bowel resection, stoma formation, or intestinal anastomosis during OA; time from initial laparotomy to mesh placement; number of lavage procedures performed during OA management; use of NPWT in conjunction with mesh-mediated fascial traction; initial fascial gap size; method of definitive abdominal wall closure; development of intestinal fistula during OA; length of stay in the intensive care unit and hospital; occurrence of major complications (Clavien-Dindo grade ≥ 3); and 30-day mortality.

The outcome we were trying to evaluate was the rate of success of abdominal wall closure without the need of a planned ventral hernia.

Surgical Procedure

After appropriate management of the acute pathology and peritoneal lavage, a thorough assessment was conducted. When primary fascial closure was deemed unfeasible, mesh-mediated fascial traction was initiated. Prior to mesh placement, a visceral protection layer was applied using either a polyvinyl chloride sheet or NPWT (3M™ AbThera™ SensaT.R.A.C™ Open Abdomen Dressing Kit with the 3M™ V.A.C.® Ulta Therapy Unit), depending on the preference of the attending surgeon. In cases involving an ostomy, a radial incision was made in the protective layer to accommodate the stoma. A large, medium- or heavyweight polypropylene mesh was used. The mesh was sutured circumferentially to the edges of the fascial aponeurosis using 2-0 polypropylene sutures, avoiding muscle penetration to prevent ischemia. Any excess mesh was trimmed circumferentially. The mesh was then incised longitudinally at the midline and its edges approximated using 2-0 polypropylene sutures, thereby applying tension to gradually approximate the fascial edges. At this point, the fascial gap (distance between aponeurotic edges) was measured. If NPWT was used, the dressing was completed by placing the foam layer over the mesh followed by an occlusive dressing maintained at a pressure between 100 and 125 mmHg. Progressive closure was performed at intervals of 72 to 120 hours. Shorter intervals were permitted if the underlying pathology required more frequent surgical intervention. When NPWT was in place, it was disconnected, and the occlusive dressing and foam were removed. The midline traction sutures were resected, while the circumferential fixation sutures between the mesh and fascia were left intact. The peritoneal cavity was irrigated, and the visceral protection layer was reapplied. The mesh edges were then trimmed and re-sutured to reapply gentle tension, again using 2-0 polypropylene sutures as previously described. Definitive fascial closure was performed once the fascial edges could be approximated without undue tension. Closure technique was at the discretion of the attending surgeon and included the small-bites technique with a suture length-to-wound length ratio of 4:1, the reinforced tension line technique, or, in cases where primary fascial closure was not feasible, component separation was performed **(figure 1)** (13). At the time of final closure, no mesh was left in any of the cases.

Figure 1. Technique NPWT and mesh-mediated fascial traction for temporary closure.



Statistical analyses

A descriptive analysis of demographic, clinical, and surgical variables was conducted. Categorical variables were reported as frequencies and percentages, while continuous variables were summarized using medians and their respective interquartile ranges (IQR). To assess differences between patients with successful versus unsuccessful abdominal wall closure, a bivariate analysis was performed using the chi-square test for categorical variables and the Mann–Whitney U test for continuous variables.

To explore factors associated with abdominal wall closure failure, an exploratory binary logistic regression model was constructed using a stepwise selection method. Additionally, a classification and regression tree analysis was conducted as a complementary exploratory approach to identify the most relevant variables associated with abdominal wall closure failure using mesh-mediated fascial traction. Covariates included in the analysis were the number of lavage procedures performed, whether bowel resection was performed, and the initial fascial gap size.

A p-value < 0.05 was considered statistically significant.

All analyses were carried out using Rstudio (version 2023.12.1 + 402).

Results

A total of 92 patients were included in this study. The overall success rate of abdominal wall closure using mesh-mediated fascial traction was 70.7%. The median age of the cohort was 56.0 years (IQR: 42.5–66.0), and the majority were male (63.0%). When comparing patients according to whether abdominal wall closure was successful or not, no statistically significant differences were found in median age, median BMI, the distribution of comorbidities, use of NPWT, or the initial fascial gap size. However, significant differences were observed in the ASA physical status classification, bowel resection, intestinal anastomosis, stoma formation, number of lavage procedures, and the time from the initial surgery to mesh placement. **Table 1** summarizes the demographic, clinical, and surgical characteristics according to abdominal wall closure outcome.

Table 1. Demographic, clinical and surgical characteristics according to whether abdominal wall closure was successful or failed.

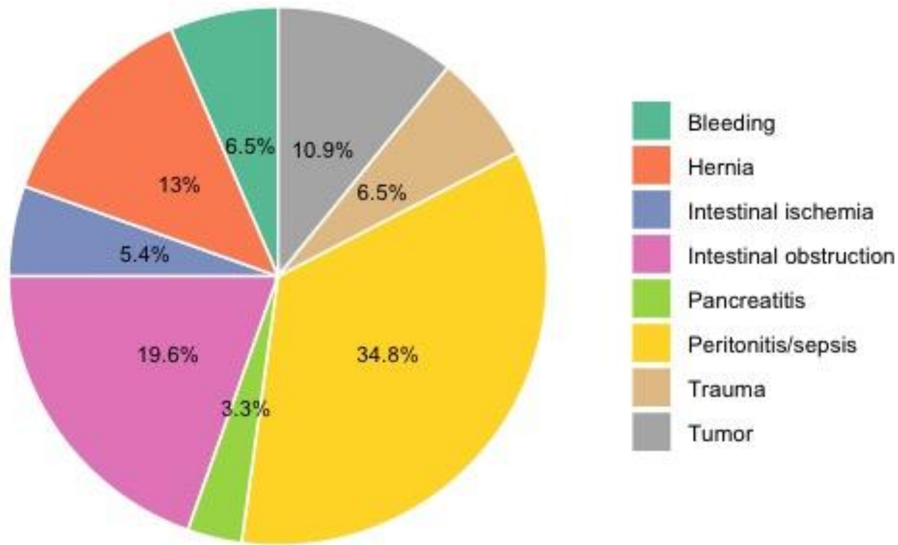
	N (%)	Successful closure (n=65)	Closure failure (n=27)	p value
Age(median)(IQR) (years)	56.00 (42.50 – 66.00)	56.00 (40.00 – 64.00)	56.00 (49.00 – 70.00)	0.375*
Sex				0.470
Female	34 (37.0)	22 (33.8)	12 (44.4)	
Male	58 (63.0)	43 (66.2)	15 (55.6)	
Body mass index (median)(IQR) (kg/m^2)	24.00 (21.15 – 28.02)	24.30 (21.20 – 28.10)	23.50 (21.05 – 26.10)	0.433*
ASA				**0.001**
I	30 (32.6)	25 (38.5)	5 (18.5)	
II	30 (32.6)	21 (32.3)	9 (33.3)	
III	21 (22.8)	16 (24.6)	5 (18.5)	
IV	9 (9.8)	1 (1.5)	8 (29.6)	
V	2 (2.2)	2 (3.1)	0 (0.0)	
Co-morbidity				
Arterial hypertension	26 (28.3)	15 (23.1)	11 (40.7)	0.145
Diabetes mellitus	14 (15.2)	9 (13.8)	5 (18.5)	0.803

Chronic obstructive pulmonary disease	5 (5.4)	4 (6.2)	1 (3.7)	1.000
Chronic kidney disease	10 (10.9)	6 (9.2)	4 (14.8)	0.678
Cardiovascular disease	14 (15.2)	8 (12.3)	6 (22.2)	0.375
Current smoker	4 (4.3)	2 (3.1)	2 (7.4)	0.714
Hemoglobin (mg/dL)	12.95 (10.22 – 15.22)	13.10 (10.70 – 15.90)	12.40 (9.70 – 14.05)	0.184*
Incisional hernia				0.906
No	76 (82.6)	53 (81.5)	23 (85.2)	
W1	0 (0.0)	0 (0.0)	0 (0.0)	
W2	1 (1.1)	0 (0.0)	1 (3.7)	
W3	15 (16.3)	12 (18.5)	3 (11.1)	
Bowel resection				**0.001**
No	46 (50.0)	40 (61.5)	6 (22.2)	
Yes	46 (50.0)	25 (38.5)	21 (77.8)	
Stoma formation	24 (26.1)	9 (13.8)	15 (55.6)	**<0.001**
Intestinal anastomosis	33 (35.9)	18 (27.7)	15 (55.6)	**0.022**
Time from the initial surgery to mesh placement (median) (IQR) (days)	2.00 (2.00 – 3.00)	2.00 (1.00 – 3.00)	3.00 (2.00 – 3.50)	**0.016***
Lavage procedures (median) (IQR) (#)	4.00 (3.00 – 5.00)	3.00 (3.00 – 4.00)	5.00 (4.00 – 7.50)	**<0.001***
NPWT				0.882
No	16 (17.6)	12 (18.8)	4 (14.8)	
Yes	75 (82.4)	52 (81.2)	23 (85.2)	
Initial fascial gap size (median) (IQR) (cm)	8.00 (6.00 – 12.00)	8.00 (5.00 – 12.00)	10.00 (8.00 – 13.50)	0.112
Type of abdominal wall closure				
Small bites technique		45 (69.2)	Not apply	
Reinforced tension line		12 (18.5)	Not apply	
Component separation		8 (12.3)	Not apply	

p values were obtained using the chi-squared test.
*p values were obtained using the Mann–Whitney test.

Regarding the etiology leading to the need for open abdomen management, the most frequent indication was peritonitis/sepsis (34.8%), followed by intestinal obstruction (19.6%). Additional causes and their respective proportions are illustrated in **Figure 2.**

Figure 2. Primary diagnosis requiring open abdomen management.



Regarding surgical outcomes, patients who achieved successful abdominal wall closure demonstrated significantly lower rates of intestinal fistula, major complications, and mortality, as well as shorter hospital and intensive care unit stays **(table 2)**.

Table 2. Surgical outcomes according to whether abdominal wall closure was successful or failed.

	N (%)	**Successful closure (n=65)**	**Closure failure (n=27)**	**p value**
Intestinal fistula				**0.009**
No	88 (95.7)	65 (100.0)	23 (85.2)	
Yes	4 (4.3)	0 (0.0)	4 (14.8)	
Intensive care unit stay (median) (IQR) (days)	3.50 (0.00 – 12.00)	0.00 (0.00 – 10.00)	8.00 (1.00 – 22.50)	**0.018**
Hospital stay (median)(IQR)(days)	23.00 (15.00 – 32.00)	20.00 (14.00 – 26.00)	29.00 (23.00 – 38.00)	**0.001**
Major complication (Clavien-Dindo ≥3)				**0.001**
No	39 (42.4)	35 (53.8)	4 (14.8)	
Yes	53 (57.6)	30 (46.2)	23 (85.2)	
30-day mortality				**0.003**
No	74 (80.4)	58 (89.7)	16 (59.3)	
Yes	18 (19.6)	7 (10.8)	11 (40.7)	

p values were obtained using the chi-squared test.
*p values were obtained using the Mann–Whitney test.

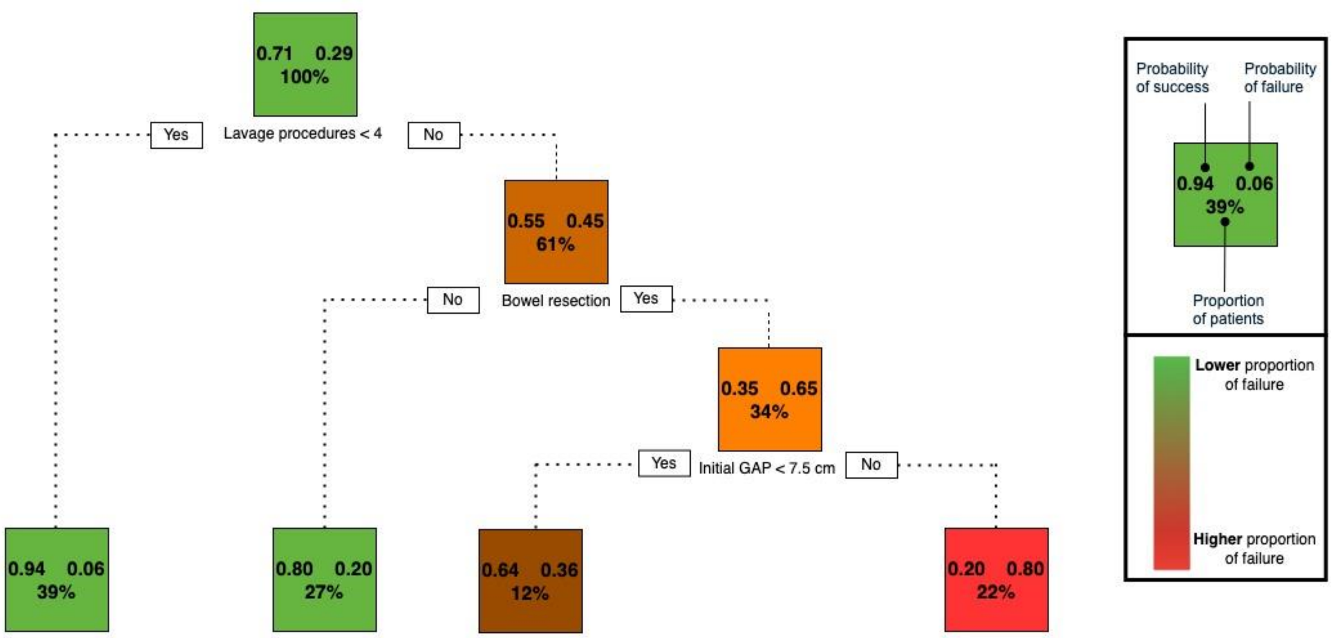
The logistic regression model with stepwise selection identified the number of lavage procedures (OR = 1.84, 95% CI: 1.36–2.68), bowel resection (OR = 14.25, 95% CI: 3.65–77.9), and initial fascial gap size (OR = 1.17, 95% CI: 1.03–1.34) as independent factors associated with an increased risk of abdominal wall closure failure **(table 3)**.

Table 3. Logistic regression to predict abdominal wall closure failure with mesh-mediated fascial traction.

	OR (95%CI)	p-value
Number lavage procedures	1.84 (1.36 – 2.68)	<0.001
Bowel resection	14.25 (3.65 – 77.9)	<0.001
Initial fascial gap size	1.17 (1.03 – 1.34)	0.014

In the complementary decision tree analysis, the most relevant variables associated with abdominal wall closure failure with mesh-mediated fascial traction are presented in **Figure 3**. Among all evaluated factors, a number of lavage procedures greater than 4, the presence of bowel resection, and an initial fascial gap larger than 7.5 cm were identified as the key determinants of closure failure.

Figure 3. Classification and regression tree model identifying key predictors of abdominal wall closure failure with mesh-mediated fascial traction.



Discussion

The current study provides robust evidence supporting mesh-mediated fascial traction combined with NPWT in the management of OA, achieving a definitive fascial closure rate of 70.7%. These findings align closely with earlier studies reporting closure rates ranging from 70% to 92%, depending on patient populations and surgical techniques employed (6,14–16). In evaluating predictors influencing abdominal closure success, our analysis identified performing more than four lavage procedures, intestinal resection, and initial fascial gaps larger than 7.5 cm as significant predictors of closure failure. This aligns partially with previous literature, where similar surgical variables have been linked to closure outcomes (1,17,18). Conversely, other studies have emphasized enteroatmospheric fistula formation as a predominant predictor of failure, demonstrating a strong association with unsuccessful closure attempts (10,11). Our study observed a relatively low fistula incidence (4%), but cases with fistulas were universally associated with closure failure.

In our study, the number of lavage procedures emerged as a factor associated with abdominal wall closure failure. The decision to maintain the abdomen open or proceed with closure was made by the operating surgeon based on intraoperative findings. These decisions were most likely related to the degree of contamination and, more importantly, to the possibility of approximating the fascial edges without generating excessive intra-abdominal pressure that could lead to compartment syndrome, which becomes the main determinant after four or more lavages. To reduce the number of lavage procedures and achieve earlier closure, different adjunctive strategies may be considered. These include the use of botulinum toxin; component separation techniques, which were performed in eight patients; or the use of vertical traction device. Although the evidence for these adjuncts remains limited in this context, they may represent potential avenues to improve outcomes. (19–21).

Concerning mesh materials, our cohort primarily utilized polypropylene meshes, as this material is economical and widely available, and its use is supported by prior institutional experience. However, recent studies have suggested superior outcomes with polyglactin meshes, indicating a need for future prospective studies directly comparing these materials for clinical efficacy and cost-effectiveness (5).

It is also essential to emphasize the significant economic burden associated with prolonged management of the open abdomen. This includes extended hospital stays, frequent surgical dressing changes, multiple operative interventions, and intensive postoperative care. These elements cumulatively drive up healthcare costs and strain institutional resources. Timely identification of patients at high risk for closure failure is therefore critical, allowing clinicians to tailor management strategies that minimize unnecessary interventions and associated costs (22).

Moreover, beyond the costs directly related to prolonged OA care, the financial impact of planned ventral hernias should not be overlooked. These hernias often require delayed complex reconstructions, long-term follow-up, and can lead to recurrent hospitalizations due to complications such as infections, chronic pain, and functional impairment. Efficient closure strategies and risk stratification protocols not only improve clinical outcomes but also contribute significantly to reducing the long-term economic burden on healthcare systems (23,24).

This research presents inherent limitations due to its retrospective design, potential selection bias, and variability in clinical practices. Additionally, the relatively small sample size might limit the generalizability and statistical robustness of certain analyses. Another important limitation is the lack of long-term follow-up, which precludes determining the true incidence of incisional hernias after successful stoma closure.

We highlight the broader challenge of conducting high-quality randomized controlled trials in the open abdomen setting, given the urgency, heterogeneity, and rarity of these cases. For this reason, we consider it important to integrate this type of data into large-scale international registries, such as the EHS Open Abdomen Registry or IROA (International Register of Open Abdomen) (25,26), to generate higher levels of evidence and strengthen external validity.

The primary strength of this study is the proposal of a practical decision tree grounded in patient-specific risk factors, facilitating informed clinical decisions regarding the continuation or cessation of mesh-mediated traction and NPWT to prevent planned ventral hernias and related complications.

In conclusion, while mesh-mediated fascial traction with NPWT demonstrates substantial efficacy for most OA patients, recognizing patients at higher risk for failure is crucial for optimizing treatment strategies, improving clinical outcomes, and reducing unnecessary healthcare expenses.

Conclusion

This study demonstrates that mesh-mediated fascial traction combined with NPWT is highly effective for achieving definitive abdominal wall closure in patients managed with an OA. However, outcomes are significantly influenced by specific factors, including the number of lavage procedures, intestinal resections, and initial fascial gap size. Recognizing these predictors early allows for tailored treatment approaches, potentially reducing closure failures and associated complications. Implementing a structured clinical decision algorithm can further optimize patient outcomes, enhance cost-effectiveness, and improve the overall quality of care in open abdomen management.

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Author contribution

Camilo Ramírez-Giraldo: Study conception and design, analysis and interpretation of data, drafting of manuscript, critical revision of manuscript.

Nicolas Rincón Nieto: Analysis and interpretation of data, acquisition of data, drafting of manuscript, critical revision of manuscript

Julián Hernández: Analysis and interpretation of data, acquisition of data, drafting of manuscript, critical revision of manuscript.

Jorge Luis Turizo Faria: Study conception and design, analysis and interpretation of data, drafting of manuscript, critical revision of manuscript.
Antonio Pesce: Drafting of manuscript, critical revision of manuscript.
Daniel Agudelo: acquisition of data, drafting of manuscript and critical revision of manuscript.
Sofia Santamaría-Forero: acquisition of data, analysis and interpretation of data, drafting of manuscript, critical revision of manuscript.
Andrés Isaza-Restrepo: Study conception and design, analysis and interpretation of data, drafting of manuscript, critical revision of manuscript.

All authors reviewed and approved the final version of the manuscript.

Ethical Standards

Ethical compliance with the Helsinki Declaration, current legislation on research Res. 008430-1993 and Res. 2378-2008 (Colombia) and the International Committee of Medical Journal Editors (ICMJE) were ensured under our Ethics and Research Institutional Committee (IRB) approval. Informed consent was filled out as required for the execution of this study.