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Vertical mesh-mediated fascial traction is associated with higher fascial closure rates than vacuum-assisted wound closure with mesh-mediated traction in open abdomen therapy

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Open abdomen treatment (OAT) is a critical surgical strategy for managing severe intra-abdominal conditions. Early definitive fascial closure (DFC) reduces complications and mortality. While the vacuum-assisted wound closure with mesh-mediated fascial traction (VAWCM) technique is considered the current standard, novel methods such as vertical mesh-mediated fascial traction (VMMFT) with devices like Fasciotens® Abdomen offer a promising alternative. This retrospective, registry-based, propensity score–matched cohort study compared fascial closure outcomes between VAWCM and VMMFT in patients undergoing OAT, utilizing data from the European Hernia Society Open Abdomen Registry (2015–2024). Patients were matched based on sepsis at OAT initiation and initial fascial defect width. Statistical analyses included descriptive statistics, Chi-square and Mann–Whitney U tests, and logistic regression. Of 1119 OAT cases, 39 (3.5%) received VMMFT and 675 (60.3%) VAWCM. After matching, each cohort included 28 patients. In the matched cohorts, higher DFC rates were observed with VMMFT than with VAWCM in both the ITT-like (89.3% vs. 60.7%; p = .01) and PP-like analyses (100.0% vs. 69.6%; p = .01). Logistic regression in the matched cohort showed an association between VMMFT and higher odds of fascial closure (OR 5.39, 95% CI 1.31–22.25; p = .02), although the confidence interval was wide. ICU stay and ventilation duration were longer in the VMMFT group, while enteroatmospheric fistula occurred in 0% versus 10.7% of patients, respectively (p = .08). In this retrospective registry-based analysis, VMMFT was associated with higher fascial closure rates compared with VAWCM. Given the limited number of VMMFT cases, wide confidence intervals, and residual imbalance after propensity-score matching, these findings should be interpreted as observational, exploratory, and hypothesis-generating rather than confirmatory. Larger prospective studies using standardized treatment protocols are required to confirm this association. Trial registration: German Clinical Trials Register (DRKS00037753), registered on 2 June 2026.

Keywords Open abdomen, Fascial traction, Vacuum-assisted wound closure and mesh-mediated fascial traction, Vertical traction device, Vertical mesh-mediated fascial traction, Fascial closure

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Abbreviations

ACS	Abdominal compartment syndrome
DFC	Definitive fascial closure
FT	Fascial traction
ICU	Intensive-care unit
NPWT	Negative-pressure wound therapy
OAT	Open abdomen therapy
PS	Propensity score
VAWCM	Vacuum-assisted wound closure and mesh-mediated fascial traction
VMMFT	Vertical mesh-mediated fascial traction

Background

Open abdomen treatment (OAT), defined as the intentional non-closure of the fascia after laparotomy, is employed in critically ill patients with severe intra-abdominal pathologies such as secondary peritonitis, abdominal trauma, or abdominal compartment syndrome (ACS)(1–7).

Since its introduction, OAT has become an established strategy to minimize initial surgical trauma (damage control), enable temporary tension-free closure, and facilitate second-look procedures(2–4, 8). This approach can reduce morbidity and mortality in patients with exhausted physiological reserves(2, 8).

Once intra-abdominal control is achieved, early definitive fascial closure (DFC) becomes the primary goal, as delayed fascial closure increases complications and mortality(9–11). Failure to achieve DFC often results in (planned) giant ventral hernias, necessitating complex reconstruction and significantly impairing postoperative quality of life(12–15).

Combining techniques such as negative-pressure wound therapy (NPWT), a visceral protective layer to prevent adhesions with the abdominal wall, and dynamic fascial traction offers the highest DFC rates—up to 85%—by promoting edema reduction and gradual fascial approximation(2, 6, 11). Vacuum-assisted wound closure and mesh-mediated fascial traction (VAWCM)—in which a mesh is sutured to both fascial edges and progressively tightened during subsequent operations while negative pressure therapy is applied—is currently regarded as the gold standard, outperforming techniques without mechanical traction, which achieve only up to 60%(2, 11, 16–18)closure rates. Accordingly, the European Hernia Society recommends dynamic closure techniques, though current evidence remains limited(4).

The introduction of a vertical traction device for OAT (Fasciotens® Abdomen; Fasciotens, Essen, Germany), represents a novel approach to addressing the limitations of current techniques(19). Like traditional horizontal mesh-based traction methods, vertical mesh-mediated fascial traction (VMMFT) aims to prevent abdominal wall retraction and facilitate earlier primary fascial closure by pulling the fascial edges upwards. Initial studies have shown promising results(19, 20).

Given these considerations, there is a clear need to evaluate whether vertical fascial traction offers advantages over traditional horizontal mesh-based techniques in terms of fascial closure rates. This study aims to compare the fascial closure rates between the VAWCM (horizontal fascial traction) and VMMFT approaches (vertical fascial traction) in OAT.

Materials and methods

The Registry

In May 2015 the EHS (European Hernia Society) open abdomen registry was implemented and is available at www.ehs-openabdomen.com since 2021 in an updated version. The registry of OAT management includes nine categories of data collection, including information on hospitals and patient-specific factors, comorbidities, risk factors for complications (immunosuppression and/or anticoagulants), indication and management of OAT, fascial closure, discharge and follow-ups(21, 22).

Data collection

All data is pseudonymized when a case is entered into the registry, allowing only the hospital responsible to re-identify patients. Additionally, a case-related identification number is allocated to each patient upon registration. All cases from the EHS Open Abdomen Registry since its establishment on May 1st, 2015 till Dec 4th, 2024, were enrolled in this study.

The registry's inclusion criteria included all indications and underlying diseases, all types of OAT-related surgical techniques, and a minimum survival of more than 24 h after the initiation of OAT if it was the initial surgical intervention. Informed consent from the patient or legal representative was obtained. Conversely, subjects who did not provide informed consent were excluded from the study. Figure 1 provides an overview of the collected data.

Study design

This retrospective observational cohort study used data from the EHS Open Abdomen Registry to compare outcomes between patients treated with VMMFT and VAWCM. Treatment decisions were made by the treating clinical teams independently of the present study; no intervention was prospectively assigned by the study protocol. The study is reported in accordance with the STROBE guidelines.

VAWCM represents the conventional horizontal fascial traction technique in which a mesh is sutured to the fascial margins and gradually tightened during re-operations. Propensity score matching was used to reduce potential confounding.

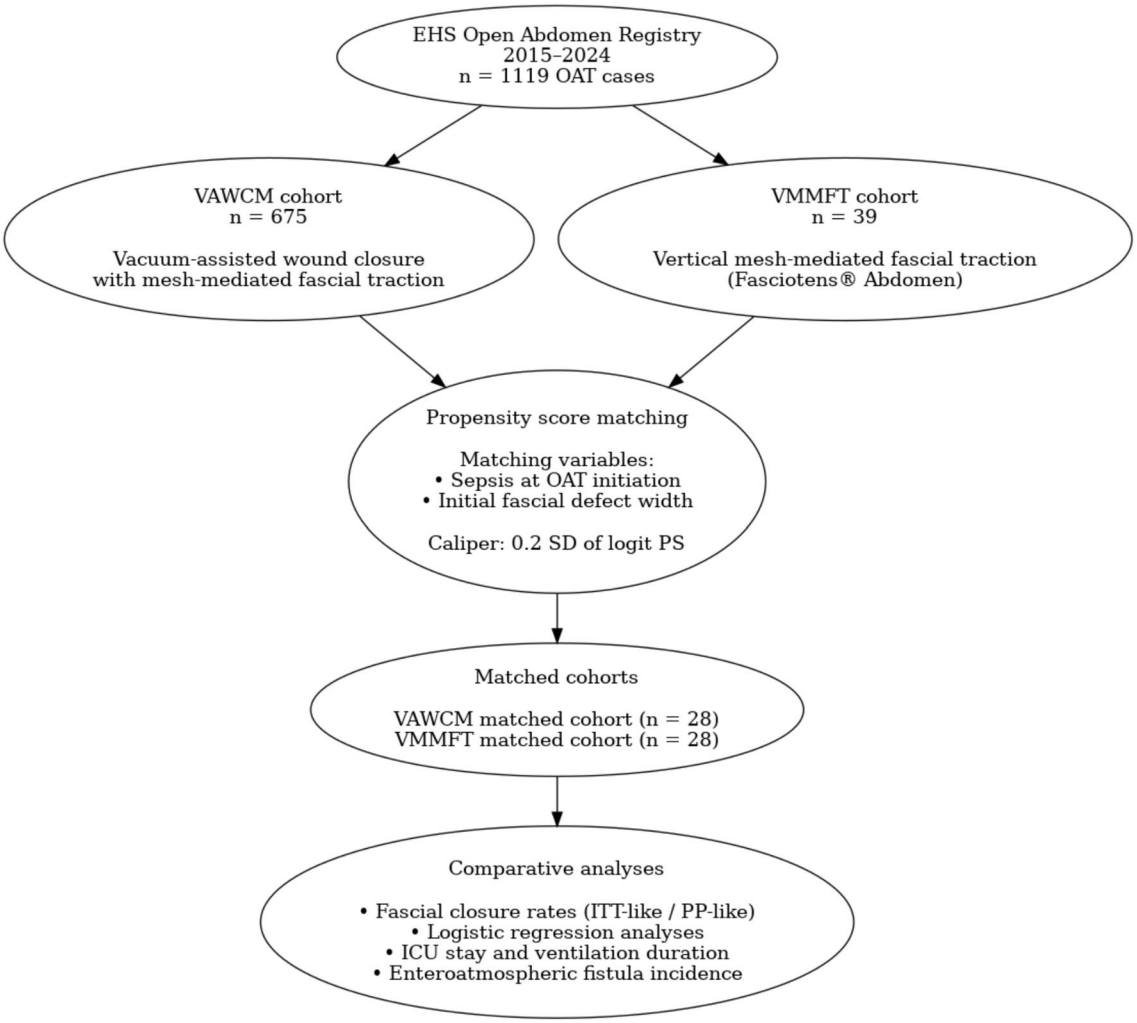


Fig. 1. Flowchart of patient selection and propensity score matching. From 1119 open abdomen therapy (OAT) cases included in the EHS Open Abdomen Registry between 2015 and 2024, patients treated with vacuum-assisted wound closure with mesh-mediated fascial traction (VAWCM) and vertical mesh-mediated fascial traction (VMMFT) were identified. Propensity score matching based on sepsis at OAT initiation and initial fascial defect width resulted in two matched cohorts of 28 patients each for comparative outcome analyses.

The selection of matching variables was based on clinical relevance and descriptive evaluation of the registry data. Two variables were identified as the most relevant baseline determinants of successful fascial closure: the presence of sepsis at the initiation of OAT and the initial horizontal width of the fascial defect.

Propensity score matching was therefore performed using these two covariates. A caliper width of 0.2 standard deviations of the logit of the propensity score was applied.

Because the number of VMMFT cases available in the registry was limited (n = 39), a parsimonious propensity score model was intentionally chosen to avoid model overfitting and to preserve matching feasibility. The selected covariates represent the two most relevant baseline determinants of fascial closure identified in previous registry analyses and clinical studies.

Covariate balance before and after matching was assessed using standardized mean differences (SMD), with an absolute SMD < 0.10 considered indicative of acceptable balance. A Love plot illustrating covariate balance is provided in the Supplementary Material. Additional baseline variables were evaluated descriptively, and their balance before and after matching is also reported using SMD.

This study was reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines. The completed STROBE checklist is provided in the Supplementary Material.

Data analysis

Data was analyzed using descriptive statistical methods. Metric variables are given with the mean ± standard deviation.

Missing data were handled using available-case analysis. Each analysis included only patients with available data for the variables required for that analysis. No imputation was performed. Variable-specific sample sizes are reported in the tables where data were incomplete.

All included open abdomen treatment episodes and index hospitalizations had been completed at the time of database analysis. Outcomes were assessed during open abdomen therapy and the index hospitalization; no post-discharge follow-up outcomes were analyzed in the present study.

Fascial closure rates were reported using both intention-to-treat (ITT-like) and per-protocol (PP-like) descriptive analyses. In the ITT-like analysis, all patients initially treated with the respective fascial traction strategy were included in the denominator, irrespective of survival until potential fascial closure. In the PP-like analysis, patients who died before a definitive fascial closure attempt became technically feasible were excluded.

These analyses were not intended to reflect the methodological framework of randomized controlled trials but were performed descriptively to allow transparent reporting and comparability with previous open abdomen studies, in which both reporting approaches are commonly used.

In the context of open abdomen therapy, death prior to closure represents a competing event that may preclude fascial closure independently of the applied traction technique. Because both reporting strategies are present in the published literature and may lead to substantially different closure rates, both were reported to ensure transparency and comparability.

The terms ITT and PPA are used here descriptively for reporting purposes and not in the strict methodological sense of randomized controlled trials.

Continuous variables were assessed for normality using the Shapiro–Wilk test and visual inspection (histograms/Q–Q plots). Because normality could not be assumed for several variables and the matched cohorts were small, continuous variables were compared using the Mann–Whitney U test. Normally distributed continuous variables are reported as mean ± standard deviation, whereas non-normally distributed variables are presented as median (interquartile range). Categorical variables were compared using the chi-square test or Fisher's exact test, as appropriate. A p value < 0.05 was considered statistically significant.

Logistic regression analysis was done to identify the influence of the fascial traction methods on the target variable (fascial closure rate). The achievement of fascial closure at the end of OAT was defined as the dependent variable (i.e., target variable). In contrast, the potential influencing factor (method of fascial closure) was defined as the independent variable. The regression model was formed through the "inclusion" method, i.e., all selected independent variables were adopted. The coefficient of determination (pseudo-R^2 by Nagelkerke) and odds ratios (OR) were statistically considered to examine the regression model.

Data was processed and analyzed with Excel (vs. 365, Microsoft, Redmont, USA), XLSTAT (Addinsoft, Paris, France) and SPSS (vs. 26, IBM, Armonk, USA).

Ethics and study registration

All methods were carried out in accordance with relevant guidelines and regulations. The Ethics Committee of the State Chambers of Medicine in Rhineland-Palatinate, responsible for the current study, approved (approval number: 837.534.13 (9219-F)), and the patients or their legal representatives provided their informed consent. This retrospective observational study was registered in the German Clinical Trials Register (DRKS00037753) on 2 June 2026. No intervention was prospectively assigned by the study protocol.

Results

A total of 1119 open abdomen cases were included in the registry at the cut-off date. Of these cases, VMMFT was utilized in 39/1119 (3.5%) cases, and VAWCM in 675/1119 (60.3%) cases. The propensity score matching for sepsis and fascial dehiscence width at the beginning of OAT yielded two equally sized cohorts (n = 28, respectively).

Table 1 shows the descriptive data of patient characteristics and comorbidities of the study and the matching cohorts. No differences were observed between the cohorts in age, gender distribution, and BMI. The unmatched cohorts showed some differences. The VMMFT cohort had a higher rate of smoking (35.9% vs. 14.8%, $p < 0.01$) and immunosuppression and/or anticoagulants (59.0% vs. 36.4%, $p = 0.01$) compared to the VAWCM cohort. These differences disappeared after matching; however, different rates of renal (VMMFT 1/28 cases (3.6%) vs. VAWCM 6/28 cases (21.4%), $p = 0.04$) and cardiac disease (VMMFT 4/28 (14.3%) vs. VAWCM 15/28 (53.6%), $p = 0.04$) remained.

Data describing the surgical therapy is given in Table 2. The OAT was initiated in an emergency index operation in 62.5% of the VAWCM cohort and was less frequent in the VMMFT cohort (30.8%); however, this was not statistically significant ($p = 0.89$). The difference was less pronounced after matching. A septic condition was present more often in the VMMFT cohort before matching (76.9% vs. 41.3%, $p < 0.01$). As PS-scores were calculated for that variable, the distribution was equal in the matched cohort with 71.4% each.

The OA indications distribution showed minor and not statistically significant differences between the study cohorts. The indications for open abdomen were mainly peritonitis (43%) and abdominal compartment syndrome (43%). The Björck classification showed some differences between the unmatched cohorts, with the VMMFT cohort comprising more contaminated cases (IC or IIC). Still, this different distribution persisted after matching without remaining significant.

After matching, the horizontal fascial width at the beginning of OAT was 13.5 ± 4.9 cm in both groups. Despite being reported in ACS cases only, the intra-abdominal pressure in the cohorts before the initiation of OAT ranged between 24 and 29 mmHg. The OAT duration was 18.0 ± 25.7 days overall, with a non-significant trend towards shorter values in the VMMFT cohort (17.8 ± 15.5 vs. 22.5 ± 18.6; $p = 0.17$).

A detailed overview of outcome parameters is provided in Table 3. The overall fascial closure rate in the registry was 67.7% on an intention-to-treat basis and 80.0% on a per-protocol basis. Fascial traction by any

Patient characteristics								
		Unmatched population				PS-matched population		
		All	VMMFT	VAWCM	p	VMMFT	VAWCM	p
N		1119	39 (3.5%)	675 (60.3%)		28	28	
Sex	m	716 (64.0%)	22 (56.4%)	434 (64.3%)	0.31	15 (53.6%)	20 (71.4%)	0.11
	f	376 (33.6%)	17 (43.6%)	239 (35.4%)		13 (46.4%)	8 (28.6%)	
Age [years]		59.9 ± 16.3 63.0 (51.0–72.0)	59.3 ± 16.3 58.5 (44.8–67.5)	60.4 ± 16.1 64.0 (52.0–72.0)	0.09	56.6 ± 16.2 58.5 (46.0–66.0)	60.2 ± 18.3 66.0 (55.5–73.5)	0.20
BMI [kg/m^2]		27.4 ± 6.5 26.3 (23.2–30.5)	28.2 ± 6.1 26.0 (24. 2–30.9)	27.3 ± 6.7 26.2 (23.2–30.2)	0.38	28.3 ± 6.5 25.8 (24.2–30.9)	27.5 ± 7.5 26.3 (23.8–30.0)	0.56
Comorbidities		804 (71.8%)	28 (71.8%)	507 (75.1%)	0.64	22 (78.6%)	23 (82.1%)	0.74
Arterial hypertension		386 (34.5%)	13 (33.3%)	238 (35.3%)	0.81	10 (35.7%)	15 (53.6%)	0.18
Malign disease		228 (20.4%)	6 (15.4%)	150 (22.2%)	0.32	6 (21.4%)	6 (21.4%)	0.99
Renal disease		164 (14.7%)	4 (10.3%)	86 (12.7%)	0.65	1 (3.6%)	6 (21.4%)	0.04
Cardiac disease		316 (28.2%)	7 (17.9%)	200 (29.6%)	0.12	4 (14.3%)	15 (53.6%)	0.04
Pulmonary disease		165 (14.7%)	6 (15.4%)	114 (16.9%)	0.81	3 (10.7%)	9 (32.1%)	0.05
Diabetes (type 1 or 2)		156 (13.9%)	6 (15.4%)	98 (8.8%)	0.74	5 (17.9%)	2 (7.1%)	0.22
Hepatic disease		44 (3.9%)	2 (5.1%)	18 (2.7%)	0.37	1 (3.6%)	1 (3.6%)	0.99
Smoking		164 (14.7%)	14 (35.9%)	100 (14.8%)	0.00	8 (28.6%)	6 (21.4%)	0.54
Risk factors (immunosuppression and/or anticoagulants)		393 (35.1%)	23 (59.0%)	246 (36.4%)	0.01	16 (57.1%)	14 (50.0%)	0.59
Anti-coagulants		270 (24.1%)	6 (15.4%)	177 (26.2%)	0.13	3 (10.7%)	8 (28.6%)	0.09

Table 1. Baseline characteristics of the study cohorts. Median (IQR) bold.

means was used in 748 cases (67.4%). VMMFT and VAWCM cohorts showed markedly higher numbers in the unmatched cohorts (VMMFT 84.6% vs. VAMCM 73.3% (intention-to-treat); p = 0.12; VMMFT 100.0% vs. VAWCM 87.4% (per-protocol); p = 0.01). After PS-matching, the difference increased significantly (VMMFT 89.3% vs. VAWCM 60.7% (intention-to-treat); p = 0.01; VMMFT 100.0% vs. 69.6% (per-protocol); p = 0.01). Figure 2 depicts the fascial closure rates. There were no statistically significant differences in the mortality rates (21.4% vs. 17.9%, p = 0.74) and the number of changes (5 vs. 5, p = 0.67). The enteroatmospheric fistula rate was lower in the VMMFT cohort before and after matching (0.0% vs. 10.7%, p = 0.08).

While the length of hospital stay was shown to be similar between the cohorts, VMMFT showed a more extended ICU stay (41.2 ± 34.8 days vs. 19.5 ± 19.9; p = < 0.01) and longer duration of mechanical ventilation (433 vs. 164 h, p < 0.01). There is a no statistically significant trend towards smaller fascial dehiscence at the end of OAT in the VMMFT cohort. Björck classification showed lower rates of contaminated conditions (fistulas/leaks) at the end of OAT in the VMMFT cohort.

Logistic regression analyses were performed separately for the unmatched and propensity score–matched cohorts (Table 4). In the unmatched cohort, univariable analysis demonstrated a trend toward a positive association between the use of VMMFT and definitive fascial closure (OR 3.26, 95% CI 0.94–11.34; p = 0.063).

In the multivariable model adjusting for sepsis at OAT initiation, initial fascial defect width, age, and BMI, VMMFT remained associated with higher odds of fascial closure, although this association did not reach statistical significance (OR 3.34, 95% CI 0.90–12.38; p = 0.071). Sepsis (OR 0.31, 95% CI 0.15–0.66; p = 0.002), increasing age (OR 0.94 per year, 95% CI 0.92–0.97; p < 0.001), and BMI (OR 0.94, 95% CI 0.88–1.00; p = 0.039) were statistically significant independent predictors of fascial closure in the adjusted model.

The model showed a Nagelkerke R^2 of 0.18. Sepsis (OR 0.31, 95% CI 0.15–0.66; p = 0.002) and increasing age (OR 0.94 per year, 95% CI 0.92–0.97; p < 0.001) were identified as independent negative predictors of fascial closure, while BMI demonstrated a modest independent association (OR 0.94, 95% CI 0.88–1.00; p = 0.039). In the propensity score–matched cohort, logistic regression analysis including treatment modality as the independent variable demonstrated a significant association between VMMFT and fascial closure (OR 5.39, 95% CI 1.31–22.25; p = 0.020), with a Nagelkerke R^2 of 0.14. Although confidence intervals were wide, reflecting the limited sample size of the matched VMMFT group, the direction and magnitude of effect remained consistent with the unmatched analysis.

Discussion

Temporary abdominal closure techniques have evolved substantially over the past decades, with vacuum-assisted wound closure combined with mesh-mediated fascial traction (VAWCM) representing the current standard approach(23, 24).

Current standard treatment approaches predominantly utilize VAWCM, which has shown promising results in achieving primary fascial closure(2, 4, 6, 11, 16, 25). Studies have reported fascial closure rates ranging from 60 to 90% with various techniques(11, 16, 26). However, even under optimal conditions, closure rates rarely exceed 85%, still leaving many patients with planned ventral hernias requiring complex reconstruction(12, 13, 15, 27). This study found an overall fascial closure rate of 67.7% for the whole registry collective, 73.3% for the

Overview of surgical variables							
	Unmatched population				PS-matched population		
	All	VMMFT	VAWCM	p	VMMFT	VAWCM	p
N	1119	39 (3.5%)	675 (60.3%)		28	28	
Emergency at index operation	654 (58.4%)	12 (30.8%)	422 (62.5%)	0.89	8 (28.6%)	10 (35.7%)	0.57
Sepsis at beginning of OAT	470 (42.0%)	30 (76.9%)	279 (41.3%)	< 0.01	20 (71.4%)	20 (71.4%)	0.99
Horizontal width of OA at beginning of OAT [cm]	14.0 ± 7.9 12.0 (9.0–18.0)	13.5 ± 4.9 12.0 (10.0–16.3)	13.3 ± 7.4 12.0 (8.0–17.0)	0.41	13.5 ± 4.9 12.0 (10.0–16.3)	13.5 ± 4.9 12.0 (10.0–17.0)	0.99
OAT was initiated at index operation	490 (43.8%)	18 (46.2%)	299 (44.3%)	0.73	14 (50.0%)	10 (35.7%)	0.33
OAT indication Peritonitis Trauma Burst abdomen/ACS Other	414 (37.0%) 97 (8.7%) 331 (29.6%) 224 (20.0%)	15 (38.5%) 1 (2.6%) 18 (46.2%) 4 (10.3%)	240 (35.6%) 54 (8.0%) 226 (33.5%) 146 (21.6%)	0.14	13 (46.4%) 1 (3.6%) 10 (35.7%) 4 (14.3%)	7 (25.0%) 1 (3.6%) 15 (53.6%) 4 (17.9%)	0.41
Initial Björck classification (2016) IA IB IC IIA IIB IIC IIIA IIIB IV	210 (18.8%) 131 (11.7%) 84 (7.5%) 187 (16.7%) 47 (4.2%) 43 (3.8%) 18 (1.6%) 11 (1.0%) 26 (2.3%)	13 (33.3%) 5 (12.8%) 8 (20.5%) 3 (7.7%) 1 (2.6%) 5 (12.8%) 1 (2.6%) 2 (5.1%) 0 (0.0%)	140 (20.7%) 80 (11.9%) 4 (0.6%) 72 (10.7%) 121 (17.9%) 6 (0.9%) 9 (1.3%) 6 (0.9%) 16 (2.4%)	< 0.01	5 (17.9%) 5 (17.9%) 7 (25.0%) 4 (14.3%) 0 (0.0%) 4 (14.3%) 1 (3.6%) 2 (7.1%) 0 (0.0%)	9 (32.1%) 3 (10.7%) 0 (0.0%) 1 (3.6%) 8 (28.6%) 2 (7.1%) 2 (7.1%) 3 (10.7%) 0 (0.0%)	0.38
IAP at beginning of OAT [mmHg]	29.2 ± 7.2 27.0 (24.5–33.5)	28.8 ± 6.9 27.5 (23.5–32.3)	24.0 ± 4.0 25.0 (23.0–25.0)	0.33	23.5 ± 2.1 23.5 (22.8–24.3)	26.0 ± 4.2 26.0 (24.5–27.5)	0.99
Mannheim Peritonitis Index (MPI)	18.2 ± 10.8 17.0 (10.0–26.0)	23.1 ± 11.0 24.0 (15.0–29.5)	17.4 ± 10.9 16.0 (9.0–26.0)	0.01	24.1 ± 10.7 25.0 (17.0–30.0)	21.1 ± 11.3 21.5 (10.5–31.0)	0.41
Injury Severity Score (ISS)	38.3 ± 17.1 35.5 (25.8–50.0)	n.a	34.2 ± 13.9 34.0 (25.0–42.5)	n.a	n.a	75 (n = 1) 75.0 (75.0–75.0)	.n.a
APACHE-II Score	18.5 ± 9.1 18.0 (11.0–25.0)	14.8 ± 17.7 15.0 (8.0–20.0)	17.4 ± 8.7 17.0 (10.0–24.0)	0.19	14.9 ± 7.8 15.0 (9.0–19.5)	17.8 ± 8.2 18.0 (13.8–23.8)	0.22
Use of a visceral protective layer	622 (55.6%)	39 (100.0%)	401 (59.4%)	< 0.01	28 (100.0%)	12 (42.9%)	0.00
NPWT	928 (82.0%)	39 (100.0%)	675 (100.0%)	0.99	28 (100.0%)	28 (100.0%)	0.99
NPWT intensity [mmHg]	78.2 ± 34.2 75.0 (50.0–100.0)	86.4 ± 30.5 75.0 (75.0–125.0)	78.8 ± 37.4 75.0 (50.0–125.0)	0.26	75.0 ± 25.0 75.0 (50.0–75.0)	47.1 ± 27.7 50.0 (25.0–50.0)	0.00
OAT duration [days]	18.0 ± 25.7 10.0 (4.5–22.0)	16.6 ± 14.4 11.0 (7.0–19.0)	18.5 ± 23.1 12.0 (5.8–23.3)	0.80	17.8 ± 15.5 13.00 (6.8–23.0)	22.5 ± 18.6 14.0 (10.5–27.5)	0.17
Number of dressing changes during OAT	4.4 ± 4.2 3.0 (1.0–8.0)	4.0 ± 3.9 3.0 (2.0–4.8)	4.7 ± 4.1 3.0 (2.0–8.0)	0.54	4.7 ± 4.4 4.0 (2.0–5.0)	4.8 ± 3.3 3.5 (3.0–7.5)	0.67
Number of adhesiolyses during OAT	1.2 ± 1.7 1.0 (0.0–2.0)	1.1 ± 1.9 0.0 (0.0–2.0)	1.9 ± 2.1 1.0 (0.0–3.0)	0.06	1.3 ± 2.1 0.5 (0.0–2.0)	1.3 ± 1.2 1.0 (0.0–2.0)	0.48

Table 2. Surgical parameters compared by study cohorts. Median (IQR) bold.

VAWCM collective, and 84.6% for all VMMFT cases (p = 0.12). After matching, the difference turned out to be more pronounced with VAWCM surprisingly only 60.7% and VMMFT 89.3% (p = 0.01).

The matched collective's low VAWCM fascial closure rate warrants discussion. No differences were found in OAT duration and the number of changes; however, the NPWT intensity was lower in the matched VAWCM cohort (47.1 ± 27.7 mmHg vs. 75.0 ± 25.0 mmHg; p < 0.01). For all VMMFT cases, a visceral protective layer was used, and only for half of the VAWCM cases. Also, the proportion ACS/burst abdomen cases was higher in the VAWCM cohort after matching compared to the matched VMMFT cohort (53.6% vs. 35.7%; p = 0.41) and the unmatched VAWCM cohort (33.5%; p = 0.14). The application of proper fascial traction is complex in a horizontal direction in many ACS cases due to intestinal edema and protrusion from the abdominal cavity. The OAT was initiated in 62.5% of the VAWCM cohort during emergency index operations, compared to 30.8% in the VMMFT cohort; this difference was not statistically significant. After matching, the difference was less noticeable. A septic condition was more common in the VMMFT cohort before matching (76.9% vs. 41.3%, p < 0.01). PS-scores equalized the distribution in the matched cohort with 71.4% in each group. The matching process seems to result in a selection of very complex cases of the VAWCM cohort and the VMMFT cohort. Also, the low number of visceral protective layer applications could have resulted in adhesions of the bowels with the lateral abdominal wall, resulting in difficulties in achieving fascial closure. Put together, this might explain the low fascial closure rate of only 60.7% in the matched VAWCM cohort.

A recent meta-analysis of seven studies (n = 535) evaluated the vacuum-assisted wound closure outcomes with mesh-mediated fascial traction (VAWCM) technique in OAT. The pooled complete fascial closure rate was 80.1%, with a mean OA duration of 14.6 days and a hospital stay of 43.3 days(28). That reported fascial closure rate is comparable to an earlier EHS Open Abdomen Registry analysis(11).

The management of the open abdomen has evolved to incorporate various innovative approaches. Recent studies have demonstrated that early fascial closure is associated with significantly better outcomes, including reduced mortality (12.3% vs 24.8%) and lower complication rates(3, 10, 11, 29). In the meta-analysis by Lech

Overview of outcome variables							
	Unmatched population				PS-matched population		
	All	VMMFT	VAWCM	p	VMMFT	VAWCM	p
N	1119	39 (3.5%)	675 (60.3%)		28	28	
Fascial closure	758 (67.7%)	33 (84.6%)	495 (73.3%)	0.12	25 (89.3%)	17 (60.7%)	0.01
In-hospital mortality	308 (27.5%)	11 (28.2%)	189 (28.0%)	0.98	6 (21.4%)	5 (17.9%)	0.74
Enteroatmospheric fistula overall	73 (6.6%)	0 (0.0%)	49 (7.3%)	0.08	0 (0.0%)	3 (10.7%)	0.08
Hospital length of stay [days]	57.3 ± 64.7 43.0 (24.0–72.0)	54.5 ± 36.2 38.0 (29.0–72.0)	58.3 ± 73.2 42.0 (24.0–70.0)	0.58	54.4 ± 36.4 39.5 (30.8–69.0)	60.4 ± 57.5 47.5 (31.3–73.0)	0.81
ICU length of stay [days]	29.5 ± 30.9 19.5 (8.0–39.0)	42.8 ± 35.4 37.0 (18.5–56.0)	22.9 ± 32.4 12.0 (3.5–36.5)	< 0.01	41.2 ± 34.8 35.5 (20.3–52.8)	19.5 ± 19.9 10.0 (4.5–31.5)	< 0.01
Mechanical ventilation [hours]	237.2 ± 303.8 110.0 (16.0–356.0)	433.0 ± 329.5 388.0 (190.5–558.0)	186.9 ± 261.8 72.0 (7.5–253.5)	< 0.01	433.0 ± 329.5 388.0 (190.5–558.0)	163.9 ± 292.4 44.0 (6.3–122.5)	< 0.01
Horizontal width of OA at end of OAT [cm]	5.0 ± 7.6 2.0 (0.0–7.0)	3.8 ± 5.4 2.0 (0.0–5.0)	5.3 ± 7.6 4.0 (0.0–7.0)	0.17	4.3 ± 5.8 2.0 (0.0–5.8)	8.0 ± 11.4 3.0 (0.0–12.5)	0.43
IAP at end of OAT [mmHg]	11.4 ± 6.1 10.0 (8.0–12.8)	9.3 ± 2.7 9.0 (8.0–11.0)	10.0 ± 0.0 10.0 (10.0–10.0)	0.84	9.4 ± 2.7 9.0 (8.0–11.0)	n/a	n/a
Björck classification (2016) at end of OAT IA IB IC IIA IIB IIC IIIA IIIB IV	228 (20.4%) 34 (3.0%) 0 (0.0%) 191 (17.1%) 53 (4.7%) 8 (0.7%) 36 (3.2%) 3 (0.3%) 36 (3.2%)	15 (38.5%) 1 (2.6%) 0 (0.0%) 14 (35.9%) 1 (2.6%) 0 (0.0%) 6 (15.4%) 1 (2.6%) 1 (2.6%)	148 (21.9%) 26 (3.9%) 0 (0.0%) 109 (16.1%) 26 (3.9%) 5 (0.7%) 10 (1.5%) 1 (0.1%) 27 (4.0%)	< 0.01	11 (39.3%) 0 (0.0%) 0 (0.0%) 12 (42.9%) 1 (3.6%) 0 (0.0%) 2 (7.1%) 0 (0.0%) 1 (3.6%)	7 (25.0%) 3 (10.7%) 0 (0.0%) 5 (17.9%) 3 (10.7%) 2 (7.1%) 2 (7.1%) 0 (0.0%) 0 (0.0%)	0.03

Table 3. Outcome variables of the study cohorts. Median (IQR) bold.

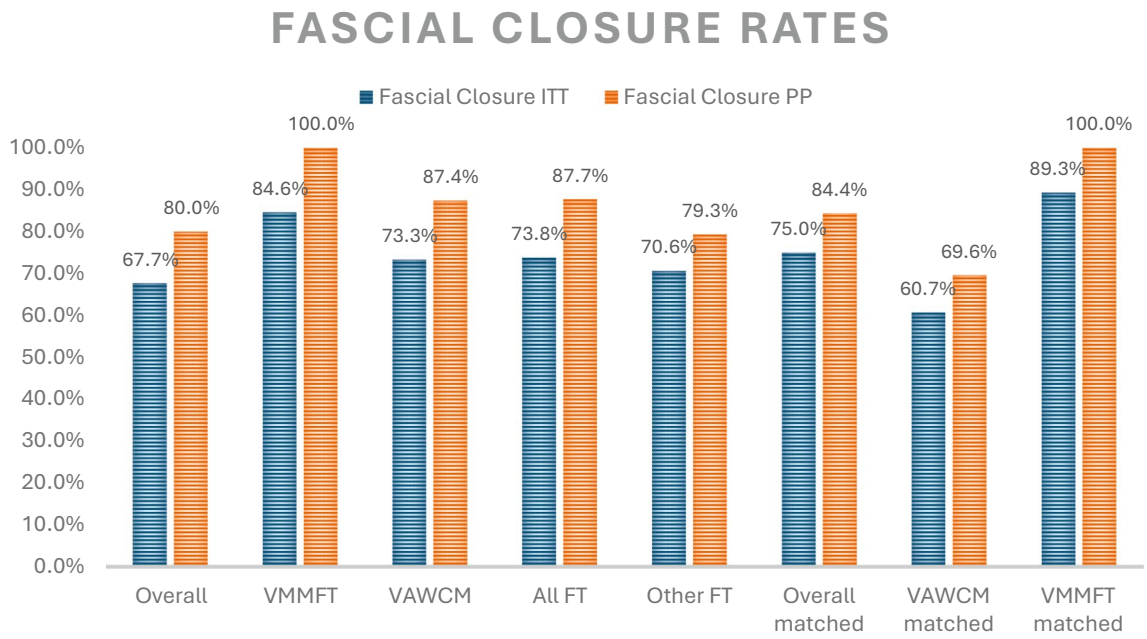


Fig. 2. Comparison of fascial closure rates across the study cohorts. VMMFT, vertical mesh-mediated fascial traction; VAWCM, vacuum-assisted wound closure and mesh-mediated fascial traction; FT, fascial traction.

et al. of 2024, the mortality rate was 33.5%, while rates of enteroatmospheric fistula and incisional hernia were 5.4% and 34.6%, respectively(28).

Recent systematic reviews and a registry analysis have highlighted the importance of active fascial traction in improving closure rates(11, 25). Combining vacuum-assisted closure with various traction methods has demonstrated superior outcomes to passive temporary closure techniques(11, 25, 30). However, depending on certain conditions (e.g., severe ACS), the optimal approach remains debatable, particularly regarding the direction and mechanism of fascial traction(20).

Variable	OR (univariate)	95% CI	p	OR (multivariate)	95% CI	p
Treatment (VMMFT)	3.26	0.94–11.34	0.063	3.34	0.90–12.38	0.071
Sepsis	0.43	0.22–0.83	0.013	0.31	0.15–0.66	0.002
SizeOAbegin	0.97	0.93–1.02	0.236	0.98	0.94–1.03	0.416
Age	0.95	0.93–0.98	< 0.001	0.94	0.92–0.97	< 0.001
BMI	0.96	0.91–1.01	0.094	0.94	0.88–1.00	0.039

Table 4. Univariable and multivariable logistic regression analyses for definitive fascial closure.

The closure timing is crucial, with evidence suggesting that delayed closure beyond specific timeframes significantly reduces the likelihood of successful primary fascial closure(3, 9). The development of complications, including enteroatmospheric fistulas and wound infections, remains a significant concern in open abdomen management(28, 31). These complications can significantly impact the possibility of achieving primary fascial closure and long-term patient outcomes(14, 28, 31, 32). Thus, the observed numerical difference in enteroatmospheric fistula rates between the matched VMMFT and VAWCM cohorts (0.0% vs. 10.7%, $p = 0.08$) is of potential clinical interest but should be interpreted cautiously. This seems to be clinically relevant, especially as the duration of OAT was not significantly different between these groups. A visceral protective layer was used in all VMMFT cases (matched and unmatched), whereas this was the case in 59.4% and 42.9% for the unmatched and matched VAWCM cohorts only ($p < 0.01$, respectively). Moreover, the Björck classification showed lower rates of contaminated conditions (fistulas/leaks) at the end of OAT in the VMMFT cohort. Since the use of a visceral protective layer has been shown to reduce the risk of enteroatmospheric fistula formation, this difference in protective strategy between the cohorts may represent an important contributing factor(31). Therefore, the observed trend toward lower fistula rates in the VMMFT group should not be attributed solely to the traction technique but may also reflect the consistent use of visceral protection.

The landscape of open abdomen management shows a trend toward more aggressive approaches to achieve primary fascial closure to prevent complications(3). However, there is limited comparative data between vertical and horizontal fascial traction techniques. Understanding these approaches' relative advantages and limitations is crucial for optimizing patient outcomes.

Concerning VMMFT as a new approach, minimal data is available. A retrospective multicenter study evaluated a novel vertical traction device (Fasciotens Abdomen) in 20 open-abdomen patients(19). The vertical traction device significantly reduced fascia-to-fascia distance within 48 h (from 15 to 10 cm, $p = 0.0081$), enabling primary fascial closure in all cases after a mean of 7 days. Outcomes were similar for septic and non-septic patients. The combination of vertical traction and NPWT appeared especially, effectively supporting vertical traction as a valuable adjunct for preventing fascial retraction and promoting early fascial closure in OAT.

Another recently published analysis showed the assessment of the vertical traction device combined with mesh-mediated fascial traction and NPWT was assessed in nine patients with an open abdomen due to impending abdominal compartment syndrome(20). Definitive fascial closure was achieved in six patients after an average of 9 days and three procedures. VMMFT use led to a 76% reduction in fascia-to-fascia distance and a marked decrease in intra-abdominal pressure (31 to 8.5 mmHg) without affecting ventilation or SAPS II scores.

Future studies need to examine some other aspects. In particular, the earliest possible application of fascial traction and further evaluation of specific indication groups should be investigated. The timing of the beginning of VMMFT or VAWCM regarding initiating OAT is critical for the outcomes. Unfortunately, the registry data does not provide insights into when the fascial traction was applied after the onset of OAT or whether there was a change in fascial traction techniques.

Also, OAT and especially VMMFT should follow a standardized protocol to ensure data comparability. Mones et al. reported a strategy of VMMFT application in their cohort(33). This case series demonstrates the feasibility and effectiveness of combining VMMFT with NPWT in the management of OAT. All patients received NPWT during the index surgery. If closure was not achievable at the second look, OAT was continued, and VMMFT was added to NPWT. Among nine patients treated for various life-threatening conditions, including septic peritonitis, ACS, and aortic rupture, definitive fascial closure was achieved in seven cases. The mean time to DFC after initiating VMMFT was 6.2 days, with no method-related complications observed. These findings suggest that a standardized approach combining VMMFT and NPWT may enhance outcomes in OA therapy and represent a promising advancement in achieving early fascial closure. Moreover, there are several case reports on applying VMMFT in OAT(34, 35). Hence, further prospective studies comparing the effects of VAWCM and VMMFT regarding time to closure, Intra-abdominal pressures, and, therefore, stabilization of these critically ill patients should be planned.

Interpretation of intra-abdominal pressure (IAP) values within the registry requires caution. Open abdomen therapy was initiated for heterogeneous indications, including abdominal compartment syndrome, septic abdomen, burst abdomen, and other emergency conditions. Moreover, IAP measurements were not collected as a standardized core registry variable, and the timing, measurement technique, and clinical context were not uniformly documented across participating centers. In clinical practice, the indication for decompressive laparotomy is not based solely on a single IAP value but also incorporates organ dysfunction, abdominal compliance, and the overall clinical condition of the patient. Consequently, registry-derived IAP values should be interpreted as descriptive real-world data rather than as a robust parameter to validate or exclude specific OAT indications such as ACS on an individual patient level.

The duration of the hospital stay was comparable between the cohorts. However, VMMFT demonstrated a more extended ICU stay (41.2 ± 34.8 days vs. 19.5 ± 19.9; $p < 0.01$) and extended hours of mechanical ventilation (433 vs. 164 h, $p < 0.01$). Answering the question of why these numbers are higher in the VMMFT cohort seems crucial. One explanation would be that a too aggressive closure regime would lead to higher intraabdominal pressure and, hence, an impaired respiratory situation. However, there is no further data to support this, and Kunst et al. emphasized possible improvements in patient physiology (e.g., respiratory parameters, urine output) under VMMFT, likely due to improved intra-abdominal pressure(34).

Another possible reason would be that VMMFT was considered the last resort strategy for patients with otherwise unmanageable conditions like long OAT due to necrotizing pancreatitis, and no other options for fascial traction were available. As with the former hypothesis, the registry data on VMMFT cases is still too sparse to answer that question. From the author's perspective, it seems also likely that the VMMFT patients were intentionally kept in sedation during the treatment.

While overall hospital length of stay was comparable between groups, ICU stay and duration of mechanical ventilation were longer in the VMMFT cohort. Baseline characteristics and disease severity parameters do not suggest that VMMFT patients were more critically ill at treatment initiation. However, the registry does not capture the specific clinical indications for prolonged ICU treatment or mechanical ventilation, limiting causal interpretation.

From a clinical perspective, many VMMFT cases likely represent early applications of the device within participating centers. Due to the initially perceived invasiveness of the vertical traction system, patients may have been managed more cautiously, including prolonged sedation or continued intensive monitoring. Importantly, VMMFT itself does not constitute an indication for prolonged mechanical ventilation or extended ICU care. The observed differences therefore most likely reflect center-specific management strategies during early implementation rather than an intrinsic effect of the traction technique.

The individual experiences of the authors in the application of VMMFT do not support a recommendation to keep patients sedated and ventilated solely due to the VMMFT treatment. The presence of a well-trained medical staff and empathic and careful instructions for the patients enables the treatment of awake patients and a regular care ward. This becomes important if the cost-effectiveness of medical devices is discussed. Kaiser et al. calculated the costs for one day in the ICU with mechanical ventilation to be about 1500€(36). Another study evaluated the cost-effectiveness of a technical device for OAT (Wittmann patch) against planned ventral hernia(37). The Wittmann patch-assisted closure strategy was more cost-efficient in managing the open abdomen than the planned ventral hernia approach. That dimension is difficult to assess but should also be addressed in future studies.

Limitations

This study has several limitations. First, its retrospective registry-based design is inherently subject to selection bias and residual confounding despite propensity score matching. Although matching improved balance in the predefined key variables, residual imbalance in certain non-matched comorbidities persisted. This reflects the targeted matching strategy focusing on the two strongest determinants of fascial closure and the limited number of VMMFT cases. Consequently, residual confounding cannot be entirely excluded. Residual imbalance after propensity score matching is not uncommon in small observational treatment cohorts and should therefore be interpreted in the context of the exploratory design of the present study.

Second, the number of VMMFT cases was relatively small, limiting statistical power and resulting in wide confidence intervals in regression analyses. Accordingly, the findings should be interpreted with appropriate caution.

Third, registry data do not capture detailed information on clinical decision-making, such as specific reasons for prolonged ICU treatment or mechanical ventilation, which restricts causal interpretation. Documentation relies on accurate data entry by participating centers. Enteroatmospheric fistula and Björck classification are recorded as independent variables within the registry. As Björck grading may be subject to interpretation, outcome analyses were based on the explicitly documented fistula variable, which directly captures clinically evident fistula events.

While some residual imbalance remained after matching, the clinical relevance of these differences for fascial closure is likely limited. Cardiovascular and renal comorbidities may influence overall morbidity but are not established independent determinants of delayed fascial closure. In contrast, the primary factors affecting closure success are local abdominal conditions—particularly fascial retraction and intra-abdominal sepsis—both of which were specifically addressed in the matching strategy. The consistency of the observed association across unmatched, adjusted, and matched analyses supports the consistency of the findings, although residual confounding remains possible and confirmation in larger prospective cohorts is warranted.

Despite these limitations, the registry provides valuable real-world data and enables comparative evaluation of different fascial traction strategies in a clinically relevant setting.

Conclusion

In this registry-based observational analysis, VMMFT may be associated with higher fascial closure rates compared with VAWCM. Given the retrospective design, limited number of VMMFT cases, wide confidence intervals, and residual imbalance after propensity-score matching, no causal inference or definitive superiority of either technique can be established. These findings should be considered exploratory and hypothesis-generating and require confirmation in larger prospective studies using standardized treatment protocols.

Data availability

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Code availability

No custom code, algorithms or computational pipelines were developed or used in this study. Statistical analyses were performed using standard functions in Microsoft Excel, XLSTAT and IBM SPSS Statistics, as specified in the Methods.

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Author contributions
SS and AW contributed to the conception and design of the study, performed the data analysis, and interpreted the registry data. They drafted the manuscript and critically revised it for important intellectual content. FB, EB, MZ, MW, OI and JD contributed to the study design and to the interpretation of the data. AW and SS provided clinical oversight during data acquisition. FB, EB and MZ contributed to the clinical interpretation of the findings and critically revised the manuscript for important intellectual content. All authors approved the final version of the manuscript and agree to be accountable for all aspects of the work, ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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Declarations

Competing interests
AW and SS declare medical consultancy with Fasciotens, Essen, Germany. All other authors declare there is no competing interest.

Ethical approval and consent to participate
The Ethics Committee of the State Chambers of Medicine in Rhineland-Palatinate, responsible for the current study, approved (approval number: 837.534.13 (9219-F)), and the patients or their legal representatives provided their informed consent.

Consent for publication
Not applicable.

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