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Research Article

Risk Factors for Surgical Site Complications Following Combined General and Plastic Surgical Abdominal Wall Reconstruction

Nayab Samar[1], Arooj Siddique khan[2*], Kashif Ali[3], Umair Maqsood[4], Muhammad Salman Khan[5]
[1]Consultant Plastic Surgeon, Altamash General Hospital Karachi, Surgery department.
[2*]Senior Registrar, Plastic surgery department, Bakhtawar Amin Medical and Dental College, Multan.
[3]Professor, Plastic surgery department Muhammad Medical college, Mirpur Khas, Sindh.
[4]Senior Registrar. General Surgery department, Bakhtawar Amin Medical and Dental College, Multan.
[5]Consultant, General Surgery Department.
Corresponding Author: Arooj Siddique khan
Senior Registrar. Bakhtawar Amin Medical and Dental College, Multan.
Email: [1]drnayabsamar@gmail.com, [2]arooj5565@gmail.com, [3]drkashif_64@hotmail.com, [4]drumairmaqsood555@gmail.com, [5]s4salmankhan@gmail.com
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ABSTRACT

Objective: This study aims to identify and quantify patient-specific, operative, and specialty-specific risk factors for SSOs following combined AWR.

Materials and Methods: A retrospective cohort study was conducted on 512 patients who underwent combined general and plastic surgical AWR for complex ventral hernias. Data on demographics, comorbidities, operative details, and postoperative outcomes were collected. Univariate and multivariate logistic regression analyses were performed to identify independent risk factors. A p-value of less than 0.05 was considered statistically significant.

Results: The overall SSO rate was 23.4% (n=120), with an SSOPI rate of 11.7% (n=60). Multivariate analysis revealed that a Body Mass Index (BMI) > 35 kg/m² (OR 2.84, p=0.002), active smoking (OR 2.15, p=0.011), preoperative HbA1c > 7.5% (OR 1.98, p=0.024), and operative time > 300 minutes (OR 2.45, p=0.008) were independent risk factors for SSOs. Furthermore, the use of anterior component separation (OR 3.12, p=0.004) and the absence of intraoperative indocyanine green (ICG) angiography for flap assessment (OR 2.67, p=0.015) significantly increased the risk of wound dehiscence.

Conclusion: Combined AWR is associated with a substantial risk of SSOs. Modifiable risk factors such as smoking, glycemic control, and intraoperative flap perfusion assessment must be rigorously optimized to mitigate complications in this high-risk population.

Keywords: Abdominal Wall Reconstruction, Ventral Hernia, Surgical Site Infection, Component Separation, Plastic Surgery, Risk Factors.

INTRODUCTION

Complex ventral and incisional hernias represent a significant and growing challenge in general and reconstructive surgery, characterized by high recurrence rates, substantial morbidity, and a profound impact on patients' quality of life.[1] The management of these defects has evolved dramatically over the past two decades, shifting from primary tissue repair to the widespread use of prosthetic meshes and advanced reconstructive techniques.[2] Among these techniques, abdominal wall reconstruction (AWR) utilizing component separation has become the gold standard for achieving midline fascial closure, restoring abdominal wall domain, and providing dynamic functional reconstruction.[3] However, as the complexity of the hernia defects increases, so does the complexity of the surgical intervention, often necessitating a multidisciplinary approach that combines the expertise of general surgeons and plastic surgeons.[4]

The combined general and plastic surgical approach to AWR addresses both the structural defect and the compromised soft tissue envelope. General surgeons typically manage the intra-abdominal pathology, including extensive adhesiolysis, reduction of herniated viscera, and the placement of mesh in the retrorectus or intraperitoneal plane.[5] Plastic surgeons contribute by managing the soft tissue envelope, performing extensive subcutaneous dissections, designing local or regional flaps, and ensuring tension-free skin closure, which is critical in patients with massive weight loss or previous multiple laparotomies.[6] Despite the theoretical advantages of this combined approach, it is inherently associated with a high risk of surgical site occurrences (SSOs), including surgical site infections (SSIs), seromas, hematomas, and wound dehiscence.[7]

Surgical site complications following AWR are multifactorial, arising from a complex interplay of patient-related, operative, and technical factors. Patient-related risk factors such as obesity, diabetes mellitus, malnutrition, and active smoking have been consistently identified in the literature as primary drivers of impaired wound healing and increased infection rates.[8,9] Obesity not only increases the technical difficulty of the operation but also creates a large, poorly vascularized subcutaneous dead space that is highly susceptible to fluid accumulation and subsequent infection.[10] Diabetes mellitus induces microvascular dysfunction and impairs leukocyte function, further compromising the host's ability to clear bacterial contaminants introduced during the extensive dissection required for AWR.[11]

Operative and technical factors also play a pivotal role in the development of SSOs. The use of component separation, while essential for fascial closure, requires the creation of large subcutaneous or subfascial tissue planes, which disrupts the perforating blood vessels supplying the skin and subcutaneous tissue.[12] This iatrogenic devascularization significantly increases the risk of skin flap necrosis and subsequent wound breakdown, particularly in the anterior component separation technique (ACST).[13] Furthermore, the introduction of a foreign body (the mesh) into a potentially contaminated field, combined with prolonged operative times, exponentially increases the risk of mesh infection, which often necessitates mesh explantation and leads to hernia recurrence.[14]

By isolating the variables that most significantly contribute to wound complications, surgeons can better select patients for combined procedures, optimize them preoperatively, and modify their intraoperative techniques to minimize morbidity. This includes the potential integration of adjunctive technologies, such as negative pressure wound therapy (NPWT) and intraoperative perfusion imaging, which have shown promise in other reconstructive contexts but require validation in AWR.[15]

Therefore, the primary objective of this study is to identify and quantify the patient-specific, operative, and specialty-specific risk factors for surgical site complications following combined general and plastic surgical abdominal wall reconstruction.

MATERIALS AND METHODS

This retrospective cohort study was conducted at multiple tertiary care hospitals. The study protocol was approved by the Institutional Review Board. The study was designed and reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines. We queried the institutional electronic health record (EHR) and a prospectively maintained hernia database to identify all adult patients (age ≥ 18 years) who underwent combined general and plastic surgical AWR for complex ventral or incisional hernias between January 1, 2021, and December 31, 2025. Inclusion criteria comprised patients who underwent a combined procedure where a general surgeon performed the hernia repair (including adhesiolysis, fascial release, and mesh placement) and a plastic surgeon performed the soft tissue reconstruction (including extensive subcutaneous dissection, flap elevation, and skin closure). Exclusion criteria included: (1) primary hernia repairs without the need for component separation or complex soft tissue management; (2) procedures performed by a single specialty without collaborative soft tissue management; (3) concurrent bowel resection with stoma creation (to isolate the hernia repair from enterotomy-related contamination); (4) emergency surgeries for incarcerated hernias with bowel ischemia; and (5) incomplete medical records or missing follow-up data of less than 30 days. A total of 512 patients met the inclusion criteria and were included in the final analysis. All combined procedures were performed by a dedicated multidisciplinary team comprising board-certified general surgeons and plastic surgeons. The operation commenced with a thorough exploration and extensive adhesiolysis to reduce the herniated viscera and restore abdominal domain. The rectus abdominis muscles were identified, and the posterior rectus sheath was carefully dissected. Depending on the defect size and contamination level, a mesh was placed in either the retrorectus (sublay) or intraperitoneal plane. Retrorectus mesh placement was preferred when feasible, utilizing a wide overlap of the defect (at least 5 cm in all directions). Mesh fixation was achieved using a combination of slow-absorbable barbed sutures for fascial closure and tackers or transfascial sutures for mesh fixation. When midline fascial closure could not be achieved without undue tension, a component separation was performed. Posterior component separation (transversus abdominis release, TAR) was the preferred initial approach. Following the general surgery phase, the plastic surgery team assumed responsibility for the soft tissue envelope. In patients with significant skin redundancy or previous compromised scars, extensive subcutaneous dissection was performed to elevate large skin-subcutaneous flaps. Perforator vessels were meticulously identified and preserved using loupe magnification. In cases where the skin envelope was severely compromised or deficient, local advancement flaps, dermal-fat flaps, or, rarely, free tissue transfer was utilized. Closed-suction drains were placed in the subcutaneous space bilaterally and removed according to a standardized protocol (output < 30 mL/24 hours). All patients received preoperative optimization, including smoking cessation (minimum 4 weeks prior), nutritional optimization (prealbumin > 15 mg/dL), and glycemic control (HbA1c < 8.0%). Preoperative skin preparation included chlorhexidine gluconate showers. Deep vein thrombosis (DVT) prophylaxis included sequential compression devices intraoperatively and chemical prophylaxis (subcutaneous enoxaparin) starting 12 hours postoperatively, continued until discharge. A secondary endpoint was SSO requiring procedural intervention (SSOPI), defined as any SSO that necessitated a return to the operating room, percutaneous drainage, or the opening of the wound at the bedside for packing. Additional outcomes recorded included mesh infection, hernia recurrence at 1 year, length of hospital stay, and 30-day readmission and mortality rates. Data were extracted from the EHR and the prospective hernia database by two independent trained research coordinators. Variables collected included: Demographics and Baseline Comorbidities: Age, sex, Body Mass Index (BMI), smoking status (current, former, never), diabetes mellitus (with preoperative HbA1c), hypertension, chronic obstructive pulmonary disease (COPD), and the Charlson Comorbidity Index (CCI). Operative Variables: Total operative time, estimated blood loss, hernia defect width, mesh type (synthetic, biosynthetic, biologic), mesh plane (retrorectus, intraperitoneal), type of component separation (none, TAR only, ACST only, TAR + ACST), and the use of intraoperative indocyanine green (ICG) angiography for flap perfusion assessment. Categorical variables were presented as frequencies and percentages. Univariate analyses were performed using the Student's t-test or Mann-Whitney U test for continuous variables, and the Chi-square test or Fisher's exact test for categorical variables, to compare patients with and without SSOs. Variables with a p-value < 0.10 in the univariate analysis, along with clinically relevant variables based on prior literature, were included in a multivariate logistic regression model to identify independent risk factors for SSOs and SSOPI. A two-sided p-value of < 0.05 was considered statistically significant.

RESULTS

A total of 512 patients met the inclusion criteria and underwent combined general and plastic surgical AWR.

Table 1: Patients in the SSO group were significantly older (p=0.032) and had a significantly higher mean BMI (39.8 vs 33.2 kg/m², p<0.001).

Table 1: Demographics and Baseline Comorbidities: Univariate Analysis of SSO vs. No SSO

Variable	No SSO (n=392)	SSO (n=120)	p-value
Age, years (mean ± SD)	57.8 ± 11.0	60.2 ± 11.5	0.032
Female sex, n (%)	210 (53.6%)	68 (56.7%)	0.541
BMI, kg/m² (mean ± SD)	33.2 ± 5.8	39.8 ± 6.2	<0.001
BMI > 35 kg/m², n (%)	112 (28.6%)	68 (56.7%)	<0.001
Current smoker, n (%)	98 (25.0%)	54 (45.0%)	<0.001
Diabetes Mellitus, n (%)	142 (36.2%)	70 (58.3%)	<0.001
Preoperative HbA1c > 7.5%, n (%)	45 (11.5%)	32 (26.7%)	<0.001
Hypertension, n (%)	185 (47.2%)	68 (56.7%)	0.068
COPD, n (%)	42 (10.7%)	22 (18.3%)	0.018

Charlson Comorbidity Index ≥ 2, n (%)	120 (30.6%)	58 (48.3%)	<0.001
Prealbumin < 15 mg/dL, n (%)	35 (8.9%)	24 (20.0%)	<0.001

Table 2: Prolonged operative time (> 300 minutes), increased estimated blood loss (> 300 mL), and larger hernia defect widths (> 12 cm) were all significantly associated with higher SSO rates (all p < 0.001

Table 2: Operative and Intraoperative Variables: Univariate Analysis of SSO vs. No SSO

Variable	No SSO (n=392)	SSO (n=120)	p-value
Operative time > 300 mins, n (%)	145 (37.0%)	74 (61.7%)	<0.001
Estimated blood loss > 300 mL, n (%)	65 (16.6%)	38 (31.7%)	<0.001
Hernia defect width > 12 cm, n (%)	150 (38.3%)	72 (60.0%)	<0.001
Mesh type, n (%)			0.042
- Synthetic	210 (53.6%)	52 (43.3%)	
- Biosynthetic	130 (33.2%)	48 (40.0%)	
- Biologic	52 (13.2%)	20 (16.7%)	
Mesh plane, n (%)			0.215
- Retrorectus (Sublay)	285 (72.7%)	82 (68.3%)	
- Intraperitoneal	107 (27.3%)	38 (31.7%)	
Component separation type, n (%)			<0.001
- None	85 (21.7%)	10 (8.3%)	
- TAR only	215 (54.8%)	45 (37.5%)	
- ACST only	62 (15.8%)	35 (29.2%)	
- TAR + ACST	30 (7.7%)	30 (25.0%)	
Intraoperative ICG used, n (%)	240 (61.2%)	48 (40.0%)	<0.001

Table 3: The model demonstrated good discrimination (C-statistic = 0.82) and calibration (Hosmer-Lemeshow p=0.45). Six variables remained statistically significant independent predictors of SSOs (p < 0.05).

Table 3: Multivariate Logistic Regression Analysis for Independent Risk Factors of SSO

Variable	Odds Ratio (OR)	95% Confidence Interval (CI)	p-value
BMI > 35 kg/m²	2.84	1.45 - 4.12	0.002
Active smoking	2.15	1.18 - 3.85	0.011
Preoperative HbA1c > 7.5%	1.98	1.09 - 3.52	0.024
Operative time > 300 mins	2.45	1.26 - 4.75	0.008
ACST performed (vs TAR/None)	3.12	1.42 - 6.85	0.004
Absence of ICG angiography	2.67	1.22 - 5.84	0.015
Prealbumin < 15 mg/dL	1.85	0.92 - 3.71	0.084
Defect width > 12 cm	1.62	0.88 - 2.95	0.122

Table 4: The overall SSOPI rate was 11.7%. The use of biologic mesh was associated with a significantly higher rate of SSOPI compared to synthetic mesh (25.0% vs 6.9%, OR 4.45, p<0.001), likely reflecting its use in highly contaminated fields.

Table 4: Subgroup Analysis: Impact of Mesh Type and Component Separation on SSOPI

Variable	Total N	SSOPI, n (%)	Unadjusted OR (95% CI)	p-value
Mesh Type				
- Synthetic	262	18 (6.9%)	Reference	-

- Biosynthetic	178	24 (13.5%)	2.10 (1.12 - 3.95)	0.021
- Biologic	72	18 (25.0%)	4.45 (2.15 - 9.22)	<0.001
Component Separation				
- None / TAR only	345	25 (7.2%)	Reference	-
- ACST (alone or + TAR)	167	35 (21.0%)	3.42 (1.95 - 5.98)	<0.001
Contamination Level (VHWG)				
- Grade 1 (Clean)	120	5 (4.2%)	Reference	-
- Grade 2 (Clean-Contam)	185	18 (9.7%)	2.45 (0.88 - 6.82)	0.085
- Grade 3/4 (Contam/Inf)	207	37 (17.9%)	4.95 (1.92 - 12.75)	0.001

Table 5: The extent of subcutaneous flap elevation was strongly correlated with dehiscence; elevating flaps larger than 800 cm² resulted in a 26.2% dehiscence rate compared to 5.7% for flaps < 400 cm² (OR 5.75, p<0.001).

Table 5: Impact of Plastic Surgery Specific Variables on Wound Dehiscence

Variable	Total N	Wound Dehiscence, n (%)	Unadjusted OR (95% CI)	p-value
Flap Elevation Area				
- < 400 cm²	210	12 (5.7%)	Reference	-
- 400 - 800 cm²	195	22 (11.3%)	2.10 (1.02 - 4.35)	0.044
- > 800 cm²	107	28 (26.2%)	5.75 (2.82 - 11.75)	<0.001
Intraoperative ICG Assessment				
- Used (perfusion confirmed)	288	15 (5.2%)	Reference	-
- Not used	224	47 (21.0%)	4.85 (2.62 - 8.95)	<0.001
Prophylactic iNPWT				
- Applied	315	28 (8.9%)	Reference	-
- Not applied	197	34 (17.3%)	2.14 (1.28 - 3.58)	0.004
Closure Tension				
- Tension-free	380	25 (6.6%)	Reference	-
- Moderate/High tension	132	37 (28.0%)	5.55 (3.22 - 9.55)	<0.001

DISCUSSION

The combined general and plastic surgical approach to abdominal wall reconstruction (AWR) represents the pinnacle of modern hernia management, addressing both the structural fascial defect and the compromised soft tissue envelope. However, this comprehensive approach is inherently associated with significant morbidity, primarily driven by surgical site occurrences (SSOs). In this large retrospective cohort of 512 patients, we observed an overall SSO rate of 23.4% and an SSO requiring procedural intervention (SSOPI) rate of 11.7%. These rates are consistent with, though slightly higher than, those reported in recent large-scale AWR registries, which typically cite SSO rates between 15% and 20%.[14,15]

Our study successfully identified several critical, independent risk factors for SSOs, highlighting the interplay between patient comorbidities, general surgical techniques, and plastic surgery-specific soft tissue management.

Patient-related risk factors remain the most formidable barriers to successful wound healing in AWR. Our multivariate analysis confirmed that severe obesity (BMI > 35 kg/m²), active smoking, and poor glycemic control (HbA1c > 7.5%) are independent predictors of SSOs. The pathophysiological basis for these associations is well-established.

Obesity not only increases the mechanical tension on the closure but also creates a massive, poorly vascularized subcutaneous dead space that is highly prone to seroma formation and subsequent infection.[16] Adipose tissue is relatively hypoxic, which impairs oxygen-dependent bactericidal functions of neutrophils and delays collagen synthesis.[17] Similarly, active smoking induces profound microvascular vasoconstriction and impairs tissue oxygenation, while hyperglycemia disrupts leukocyte chemotaxis and phagocytosis.[18] Smoking cessation for a minimum of 4 weeks, strict glycemic control, and nutritional optimization (targeting prealbumin > 15 mg/dL) must be mandatory prerequisites for elective combined AWR, as suggested by recent prehabilitation protocols.[19]

Operative variables, particularly the choice of component separation and operative time, significantly influenced outcomes. We found that the use of an anterior component separation technique (ACST) was a strong independent risk factor for SSOs (OR 3.12) and SSOPI (OR 3.42). This aligns with the existing literature, which demonstrates that ACST requires extensive subcutaneous dissection, severing the perforating blood vessels from the rectus muscle to the skin, thereby causing significant ischemia to the overlying skin flaps.[20] In contrast, the posterior component separation (transversus abdominis release, TAR) preserves the periumbilical perforators and keeps the subcutaneous dissection limited, resulting in significantly lower wound complication rates.[21] Furthermore, prolonged operative time (> 300 minutes) independently increased the risk of SSOs, likely due to increased tissue desiccation, prolonged exposure to potential contaminants, and greater overall surgical trauma.[22]

To mitigate this, we evaluated the use of intraoperative indocyanine green (ICG) angiography. Our results showed that the absence of ICG to confirm flap perfusion was an independent risk factor for SSOs (OR 2.67) and significantly increased wound dehiscence (OR 4.85). ICG angiography allows the surgeon to visualize real-time tissue perfusion and debride ischemic skin edges before closure, a technique that has revolutionized flap surgery but is only recently being applied to AWR.[23]

Our findings suggest that iNPWT should be considered a standard adjunct in combined AWR, particularly for patients with multiple risk factors such as obesity, smoking, or large flap elevations. Finally, the inability to achieve a tension-free closure was a massive risk factor for dehiscence (OR 5.55). When primary fascial closure results in excessive skin tension, the plastic surgeon must be prepared to utilize local advancement flaps, dermal-fat flaps, or skin grafts to ensure a tension-free skin closure, even if the fascia is closed primarily.[24]

However, study is not without limitations. Although we used multivariate modeling to adjust for confounders, unmeasured variables could not be fully accounted for. Additionally, the study was conducted at a single, high-volume tertiary care center, which may limit the generalizability of our findings to lower-volume community hospitals.

CONCLUSION

Combined general and plastic surgical abdominal wall reconstruction is associated with a significant risk of surgical site occurrences (23.4%). Independent risk factors for these complications include severe obesity, active smoking, poor glycemic control, prolonged operative time, and anterior component separation. Crucially, plastic surgery-specific factors, such as extensive flap elevation and the absence of intraoperative ICG angiography, significantly increase the risk of wound dehiscence. Mitigation strategies must include rigorous preoperative optimization, preferential use of posterior component separation, routine intraoperative perfusion assessment, and prophylactic negative-pressure wound therapy to ensure tension-free closures.

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