

Negative Pressure Wound Therapy Prevents Hernia Recurrence in Simultaneous Ventral Hernia Repair and Panniculectomy

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Background: Simultaneous ventral hernia repair with panniculectomy (VHR-PAN) is associated with a high rate of wound complications. Closed incision negative pressure wound therapy (ciNPWT) has been shown to lower complications in high-risk wounds. There is a debate in the literature as to whether ciNPWT is effective at preventing complications in VHR-PAN. The aim of our study was to evaluate if ciNPWT improves outcomes of VHR-PAN.

Methods: A retrospective review of patients who underwent VHR-PAN between 2009 and 2021 was conducted. Patients were divided into two groups: (1) those who received standard sterile dressings (SSD), or (2) ciNPWT. Primary outcomes were postoperative complications, including surgical site occurrences (SSO) and hernia recurrence.

Results: A total of 114 patients were identified: 57 patients each in the SSD group and ciNPWT group. The groups were similar in demographics and comorbidities. There were more smokers in the SSD group (22.8% versus 5.3%, $P = 0.013$). Hernia defect size was significantly larger in patients who received ciNPWT (202.0 versus 143.4 cm², $P = 0.010$). Overall SSO was similar between the two groups (23.2% versus 26.3%, $P = 0.663$). At a mean follow-up of 6.6 months, hernia recurrence rate was significantly higher in the SSD group compared with that in the ciNPWT group. (10.5% versus 0%, $P = 0.027$). Smoking, diabetes, component separation, mesh type, and location were not significantly associated with hernia recurrence.

Conclusions: Application of incisional NPWT is beneficial in decreasing hernia recurrence in VHR-PAN, compared with standard dressings. Larger prospective studies are warranted to further elucidate the utility of ciNPWT in abdominal wall reconstruction. (*Plast Reconstr Surg Glob Open* 2022;10:e4171; doi: 10.1097/GOX.0000000000004171; Published online 7 March 2022.)

INTRODUCTION

Ventral hernia repair (VHR) is one of the most common abdominal procedures performed in the United States.¹ Obesity is an independent risk factor for hernia development; therefore, as the prevalence of obesity continues to rise, so will the number of patients seeking concurrent VHR and panniculectomy (VHR-PAN).^{2,3}

Advantages of VHR-PAN include avoiding multiple hospitalizations, removing adiposity (which contributes to wound break-down), decreasing exposure to general anesthesia, and condensing the postoperative recovery time.⁴ Despite improved surgical exposure and increased patient satisfaction, VHR-PAN has been shown to have considerably high postoperative complications.⁵⁻⁷

Although traditionally employed to manage complex open wounds, a growing body of literature supports the use of negative pressure wound therapy (NPWT) for closed incisions. Closed incision NPWT (ciNPWT) consists of application of a negative-pressure foam-based vacuum-assisted closure (VAC) dressing over a surgical incision. Over the past two decades, prophylactic ciNPWT placement in patients at a high risk for wound complications has become increasingly common. CiNPWT lowers wound complications by reducing lateral tension, controlling edema, decreasing bacterial bioburden, and improving skin flap perfusion.⁸⁻¹¹

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The literature contains conflicting evidence on the efficacy of ciNPWT in abdominal wall reconstruction.^{12,13} There are also multiple studies that describe decreased postoperative wound complications when closed incisional NPWT are used in panniculectomies.¹⁴ However, there is a paucity of literature evaluating the utility of ciNPWT in patients undergoing VHR-PAN. The aim of this study was to evaluate how ciNPWT affects postoperative outcomes in patients undergoing VHR-PAN.

METHODS

Following institutional review board approval, we retrospectively reviewed patients who underwent VHR-PAN from February 2009 to June 2021. Patients were divided into two groups: (1) those who received standard sterile dressings (SSD), and (2) those who received ciNPWT. The ciNPWT group consisted of patients who either received a self-made incisional VAC with standard black VAC GRANUFOAM (3M+KCI, San Antonio, Tex.) or the commercially-available Prevena Incision Management System (3M+KCI, San Antonio, Tex.). All dressings were immediately placed postoperatively under sterile conditions.¹⁵ Over the 12-year period, patients were operated on by one general surgeon (PB) and four plastic surgeons (including KLF and KKE). Our institution implemented Prevena ciNPWT in November 2016; thus, at the discretion of the operating surgeon, patients who were treated before this date either received SSD or the self-made ciNPWT. All patients treated after November 2016 received Prevena incisional VAC therapy. Both the self-made and Prevena ciNPWT systems were placed intraoperatively and remained in place for 5–7 days after surgery. Mesh type consisted of Strattice biologic mesh, (LifeCell Corp., Branchburg, N.J.), Proceed composite mesh (Ethicon Inc., Somerville, N.J.), Ventralight composite mesh (C.R. Bard, Inc., Warwick, R.I.), or Vicryl synthetic mesh (Ethicon Inc., Somerville, N.J.). Mesh was applied either as an underlay (intraperitoneal), sublay (deep to the rectus muscles), or onlay (superficial to the rectus muscles).

Primary outcomes of interest were hernia recurrence and surgical site occurrence (SSO). As defined by Baucom et al, SSO includes development of a surgical site infection (SSI), cellulitis, necrosis, dehiscence, seroma, or hematoma.¹⁶ Patient demographics, hernia characteristics, surgical factors, postoperative complications, and follow-up were analyzed using Mann-Whitney U test for continuous variables, and Pearson chi-square test or Fisher exact test for categorical variables. Univariate analysis was also performed to identify potential confounding factors for hernia recurrence; however, the small patient population in this study precluded multivariate regression. All analyses were conducted using Statistical Analysis System software, version 9.4 (SAS Institute Inc., Cary, N.C.). Statistical significance was set at a *P* value less than 0.05.

RESULTS

A total of 114 patients were identified: 57 patients in the SSD group and 57 patients in the ciNPWT group (14 self-made and 43 Prevena ciNPWT). The groups were

Takeaways

Question: Is closed incision negative pressure wound therapy (ciNPWT) effective in decreasing wound complications and hernia recurrence in patients undergoing ventral hernia repair with panniculectomy (VHR-PAN)?

Findings: Overall surgical site occurrence was similar between the patients who received standard sterile dressings (SSD) and those who received ciNPWT (23.2% versus 26.3%, *P* = 0.663). Hernia recurrence rate was significantly higher in the SSD group (10.5% versus 0%, *P* = 0.027).

Meaning: Application of incisional NPWT is beneficial in decreasing the proportion of hernia recurrences in VHR-PAN, compared with standard dressings.

similar in age, gender, BMI, and diabetes mellitus. There were more smokers in the SSD group compared with the ciNPWT group (22.8% versus 5.3%, *P* = 0.013). Hospital length of stay (LOS) was significantly higher in the ciNPWT group (5.2 versus 3.9 days, *P* = 0.030). Mean follow-up durations for the SSD group and ciNPWT group were 7.9 months and 5.5 months, respectively. Hernia defect size was significantly larger in patients who received ciNPWT compared with those received SSD (202.0 versus 143.4 cm², *P* = 0.010). There was a significantly higher percentage of component separation technique (CST) in the ciNPWT group compared with that in the SSD group (54.4% versus 33.3%, *P* = 0.024). There were no significant differences in mesh type, mesh location, recurrent hernias, prior abdominal surgeries, or intestinal violation between the two cohorts. [Table 1](#) summarizes patient, hernia and operative characteristics of each group.

The rates of SSO were similar among the two cohorts (23.2% versus 26.3%, *P* = 0.663). Rate of hernia recurrence (*n* = 6) was significantly higher in the SSD group compared with that in the ciNPWT group (10.5% versus 0%, *P* = 0.027). All hernia recurrences occurred in the SSD group. [Table 2](#) describes the rates of complications between the two groups. Statistical analysis comparing the two ciNPWT groups was also conducted; however, there were no significant differences among them. Univariate analysis of risk factors for hernia recurrence revealed only ciNPWT was associated with preventing hernia recurrence (*P* = 0.012). Higher BMI was associated with hernia recurrence, approaching statistical significance (*P* = 0.059). Smoking, diabetes, component separation, mesh type, and location were not significantly associated with hernia recurrence ([Table 3](#)).

DISCUSSION

Patients undergoing VHR-PAN are at high risk for postoperative complications, including seroma, hematoma, wound dehiscence, and hernia recurrence. A meta-analysis evaluating simultaneous VHR-PAN found that the overall rate of SSO was 27.9%, with superficial SSI having an incidence of 15.8%.⁴ The mean hernia recurrence rate was 4.9% at a mean follow-up duration of 17.8 months.⁴ Other studies have reported that VHR-PAN has up to a

Table 1. Patient, Hernia, and Operative Characteristics

Variable	Total (n = 114)	SSD (n = 57)	ciNPWT (n = 57)	P
Patient Characteristics				
Age (y)	53.9±11.7	52.9±11.0	55.0±12.4	0.344
Women	103 (90.4%)	51 (89.5%)	52 (91.2%)	1.000
BMI (kg/m ²)	36.3±9.5	36.2±8.4	36.4±10.5	0.834
Diabetes	36 (31.6%)	18 (31.6%)	18 (31.6%)	1.000
Smoking	16 (14.0%)	13 (22.8%)	3 (5.3%)	0.013
Prior abdominal surgeries	101 (88.6%)	49 (86.0%)	52 (91.2%)	0.557
Hernia characteristics				
Recurrent ventral hernia	49 (43.0%)	23 (40.4%)	26 (45.6%)	0.570
Hernia defect size (cm ²)*	188.1±273.1	143.4±319.6	202.0±259.8	0.010
Operative characteristics				
Component separation	50 (43.9%)	19 (33.3%)	31 (54.4%)	0.024
Unilateral	5	3	2	
Bilateral	45	16	29	
Mesh type				
Biologic (Strattice)	54 (71.1%)	23 (71.9%)	31 (70.5%)	0.893
Composite†	21 (27.6%)	8 (25.0%)	13 (29.5%)	0.662
Synthetic (Vicryl)	1 (1.3%)	1 (3.1%)	0 (0%)	0.421
Mesh location‡				
Underlay (intraperitoneal)	66 (86.8%)	29 (90.6%)	37 (84.1%)	0.405
Sublay (retrorectus)	9 (11.8%)	2 (6.3%)	7 (15.9%)	0.288
Onlay	1 (1.3%)	0 (0%)	1 (2.3%)	0.421
Violation of intestine	31 (27.2%)	12 (21.1%)	19 (33.3%)	0.141
Hospital LOS (d)	4.6±5.2	3.9±4.6	5.2±5.6	0.030
Follow-up duration (mo)	6.64±10.5	7.9±12.5	5.5±8.4	0.502

Values in bold signify statistically significant *P* values.

*Only 55 patients had hernia defect size reported in their medical record.

†Ten patients received Ethicon Proceed composite mesh, and 11 patients received Bard Ventralight composite mesh.

‡76 patients had mesh placed at the time of VHR-PAN. % reflects percentage of patients in each cohort who had mesh placed during VHR-PAN.

BMI: body mass index; ciNPWT: closed incision negative pressure wound therapy; LOS: length of stay; SSD: standard sterile dressing; VHR: ventral hernia repair

70% SSO rate.^{17–19} Thus, providing proper postoperative incision care is of utmost importance to limit abdominal wall morbidity (Fig. 1).

The use of negative pressure over a closed incision was described as early as 1997 in a porcine model.²⁰ Since then, a growing body of literature supports the use of ciNPWT to decrease postoperative complications in many surgical specialties.^{10,21–29} Studies comparing ciNPWT to SSD in ventral hernia incisions have had conflicting results.^{10,11,30–32} Conde-Green et al compared SSD with ciNPWT in patients undergoing VHR and found a decrease in SSO in the ciNPWT group (22.0% versus 64.0%, *P* = 0.02) but no difference in SSI (4.3% versus 6%, *P* > 0.05).¹⁰ Vargo et al studied 30 patients who underwent abdominal wall reconstruction with NPWT, and found that the overall wound complication rate was 6% (n = 2 of 30); both patients developed seromas that required percutaneous drainage.³²

To our knowledge, only one other study (Diaconu et al) has compared ciNPWT with SSD in patients undergoing

simultaneous VHR-PAN.³³ In the 104 patients they evaluated, there were fewer total complications (57% versus 83%, *P* = 0.004) and less SSO (47% versus 69%, *P* = 0.025) in the ciNPWT group (n = 62) compared with those in the SSD group (n = 42), respectively. However, hernia recurrence was similar between both cohorts. In contrast, this study found decreased rates of hernia recurrence in patients who received ciNPWT (regardless of type) but similar rates of SSO. Hernia recurrence only occurred in patients who received standard dressings.

Obesity, smoking, and large fascial defects have been associated with hernia recurrence, whereas component separation has been shown to decrease risk of hernia recurrence.^{34–37} The present study found only ciNPWT to be associated with decreasing risk of hernia recurrence. Smoking, hernia defect size, and CST were not statistically significant, but higher BMI approached statistical significance in the hernia recurrence group. These findings suggest that ciNPWT may aid in preventing hernia recurrence.

Table 2. Complications

	Total (n = 114)	SSD (n = 57)	ciNPWT (n = 57)	P
Overall SSO	28 (24.6%)	13 (23.2%)	15 (26.3%)	0.663
SSI	10 (8.9%)	3 (5.6%)	7 (12.3%)	0.321
Wound dehiscence	16 (14.0%)	8 (14.6%)	8 (14.6%)	1.000
Seroma	7 (6.1%)	3 (5.5%)	4 (7.0%)	1.000
Hematoma	5 (4.4%)	4 (7.3%)	1 (1.8%)	0.364
Hernia recurrence	6 (5.3%)	6 (10.5%)	0 (0%)	0.027
90-day reoperation rate	8 (7.0%)	2 (3.5%)	6 (10.5%)	0.271

Values in bold signify statistically significant *P* values.

ciNPWT, closed incision negative pressure wound therapy; SSD, standard sterile dressing; SSI, surgical site infection; SSO, surgical site occurrence.

Table 3. Univariate Analysis of Risk Factors for Hernia Recurrence

Variable	No Hernia Recurrence (n = 108)	Hernia Recurrence (n = 6)	P
BMI (kg/m ²)	36.0±9.4	42.9±8.6	0.059
Diabetes	35 (32.4%)	1 (16.7%)	0.663
Smoking	15 (13.9%)	1 (16.7%)	1.000
Recurrence ventral hernia	46 (42.6%)	3 (50.0%)	1.000
Hernia defect size (cm ²)*	192.4±277.3	75.0±49.5	0.472
Component separation	48 (44.4%)	2 (33.3%)	0.694
Mesh type†			1.000
Biologic (Strattice)	51 (70.8%)	3 (75%)	
Composite	10 (13.9%)	0 (0%)	
Synthetic (Vicryl)	1 (1.4%)	0 (0%)	
Mesh location‡			1.000
Underlay	62 (86.1%)	4 (100.0%)	
Sublay	9 (12.5%)	0 (0%)	
Onlay	1 (1.4%)	0 (0%)	
Violation of intestine	30 (27.8%)	1 (16.7%)	1.000
ciNPWT	57 (52.8%)	0 (0%)	0.012
Hospital LOS (d)	4.6±5.2	3.0±3.0	0.594
Follow-up duration (mo)	6.10±10.3	17.4±10.0	0.005

*Only 55 patients had hernia defect size reported in their medical record.

†Hernia recurrence occurred in 4 of the 76 patients who had mesh placed at the time of VHR-PAN. % reflects percentage of patients in each cohort who had mesh placed during VHR-PAN.

BMI, body mass index; ciNPWT, closed incision negative pressure wound therapy; CST, component separation technique; LOS, length of stay.

Although SSI was higher in the ciNPWT group, this finding was not significant and could be attributed to chance alone. Furthermore, the increased hospital LOS in the ciNPWT group can be attributed to the increased proportion of intestinal violation that occurred in patients who received ciNPWT. When bowel has been violated during VHR (ie, bowel resection, serosal repair), patients are admitted postoperatively to await return of bowel function.

This study was underpowered given the small patient population. Another inherent limitation of this study was its retrospective design, which relies heavily on quality of electronic medical records. As such, potential confounding factors (such as hernia size, panniculectomy incision type, and pannus weight) were not recorded for all patients. The ciNPWT consisted of two different designs, but no statistically significant differences were identified. This study included patients treated over a 12-year period by four plastic surgeons; as such, surgeon technique and experience could potentially influence our results. However, because the hernia surgeon stayed constant throughout

the study period, the difference in hernia recurrence is likely attributable to the use of ciNPWT rather than surgeon experience. Lastly, because the follow-up duration was significantly shorter in the ciNPWT group, it is possible that adequate time has not passed for hernia recurrences to occur in this group. Our finding that application of ciNPWT in patients undergoing VHR-PAN reduces hernia recurrence rate is notable, but should be confirmed with larger prospective studies that can account for the possible confounding factors we did not evaluate.

CONCLUSIONS

The application of ciNPWT in VHR-PAN is associated with beneficial outcomes. Our study suggests that ciNPWT reduces the proportion of hernia recurrences following VHR-PAN, compared with standard dressings. These findings are consistent with the robust body of evidence supporting the use of NPWT on closed incisions. Our favorable findings warrant larger prospective studies to

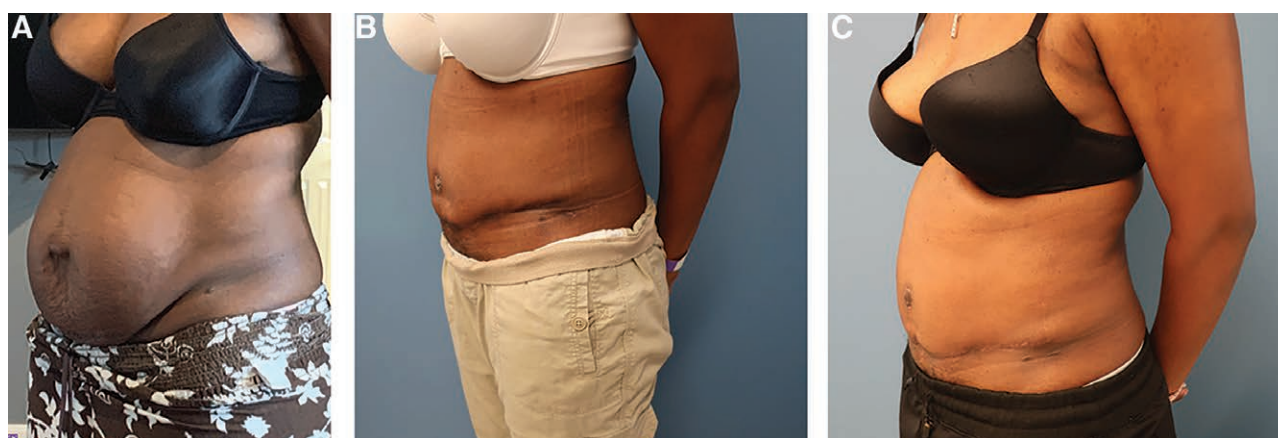


Fig. 1. Ventral hernia with pannus. A, A 54-year-old woman with large ventral hernia and pannus who underwent VHR-PAN with incisional NPWT application. B, At 1.5-month follow-up, incisions were healed. C, Four-month follow-up.

further elucidate the utility of ciNPWT in abdominal wall reconstruction.

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