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Cosmetic

Mechanically Powered Negative Pressure Dressing Enhances Surgical Incision Cosmesis: A Randomized Trial

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Background: Cosmetic appearance of incisions remains one of the most important aspects of the patient recovery experience. Despite advances in surgery, scar prevention is the gold standard in improved results. Closed-incision negative pressure wound therapy has shown promise in decreasing surgical site infection and healing time. This study aimed to assess outcomes of primarily closed surgical incisions with mechanically powered negative pressure dressings (MP-NPDs) compared with standard dressings.

Methods: This study was a single-center, within-subjects, randomized controlled trial, in which each patient served as both the control and experimental arms. Laparoscopic/robotic port site incisions were randomized to control dressing or MP-NPD. Primary outcomes were cosmetic results at first clinic visit by blinded physicians and nonphysician observers.

Results: Forty patients with a total of 80 incisions were included in the analysis. The average scores for scar spread, erythema, dyspigmentation, scar hypertrophy, and overall impression were lower for the MP-NPD wounds. The only individual variable of the Scar Cosmesis Assessment Rating scale, in which there was no difference noted between the 2 groups, was the presence of suture marks. The average total Scar Cosmesis Assessment Rating score was significantly lower (more favorable) for the MP-NPD wounds compared with the control wounds (3.39 ± 3.18 versus 4.79 ± 3.18, respectively; $P < 0.001$).

Conclusions: The use of closed-incision negative pressure wound therapy with the application of a novel MP-NPD over surgical incisions resulted in clinical and statistically significant improvement in scar cosmesis in the early/intermediate postoperative period according to both physician and nonphysician observers.
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INTRODUCTION

Surgical incisions create tissue injuries that require careful repair at the end of the procedure. Although inherent in any surgery, the incisions create trauma and lead to a variety of scar types that can be almost invisible or hypertrophic, elevated or stretched, and can extend beyond the boundaries of the initial incisions.[1] Minimally invasive techniques have significantly improved the size of surgical incisions needed to complete complex procedures that once required large abdominal incisions. However, even small incisions can still have poor healing and cosmetic outcomes if not appropriately managed in the perioperative period. Studies have shown that patients of all ages, ethnicities, and sex are concerned about scar formation, and the vast majority prefer even small improvements in scar cosmesis, often desiring them to be less noticeable.[2] Indeed, severe scars affect patient quality of life and can lead to chronic scar–related symptoms such as itching and pain.[3–7] However, the scar severity or level of disfigurement does not necessarily correlate with patient psychosocial

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distress, and small wounds can be a significant concern for patients.[8–11]

Although many techniques and treatments have been developed for treating hypertrophic scars and/or keloids, the appearance of skin is usually unable to be returned to its prewound state, and there are limited options to prevent cutaneous scarring. As such, prevention of poor scar formation is considered the best way to obtain better cosmetic results after wound creation. In recent years, negative pressure wound therapy (NPWT), delivered through a vacuum-assisted closure device, has been used successfully to treat complex open wounds. Even more recently, NPWT has been prophylactically applied to primarily closed surgical wounds. Closed-incision NPWT (ci-NPWT) has shown promising results for a variety of surgical procedures and specialties, including decreased surgical site infection (SSI), local wound complications, and shorter healing time.[12–16] Despite the increased use of NPWT for complex wounds, the wide adoption of ci-NPWT has been slow due to high costs and complexity of use associated with standard NPWT and vacuum-assisted closure systems.[17–19] Recently, more cost effective, mechanically powered negative pressure dressings (MP-NPD), such as the NPseal (Guard Medical, Miami, FL), have been introduced. These dressings provide ci-NPWT comparable to the standard systems with potentially wider applications due to limited cost and ease of use. The prices of the device vary based on individual contract negotiations with hospitals, but they typically range from one-fourth to one-third the cost of other powered negative pressure devices. Preliminary studies have shown positive results in patient experience and reduction of superficial SSIs. From our previous SSI studies, we have incidentally found visibly noticeable better cosmetic outcomes in the incisions where MP-NPD was applied. The purpose of this study was to assess cosmetic outcomes of primarily closed surgical incisions dressed with a novel MP-NPD compared with standard dressings. This is the first study assessing cosmetic results of ci-NPWT with the use of MP-NPDs.

Takeaways

Question: Does closed-incision negative pressure wound therapy (ci-NPWT) improve the cosmetic outcome in closed surgical port site incisions when compared with standard dressings?

Findings: The use of ci-NPWT with the application of a novel mechanically powered negative pressure dressing over surgical incisions resulted in significant improvement in scar cosmesis in the early/intermediate postoperative period according to both physician and nonphysician observers through a within-subjects randomized control trial.

Meaning: Use of ci-NPWT and the novel mechanically powered negative pressure dressing have shown promise in better cosmesis in surgical incisions and should be considered for standard wound dressing applications.

MATERIALS AND METHODS

Study Design

This study was a single-center, within-subjects, randomized controlled trial, in which each patient enrolled served as both the control and experimental arms simultaneously. Participants included were adults (age > 22 y per Food and Drug Administration definition), who were undergoing elective, minimally invasive colorectal surgical procedures, in which the surgery was expected to result in 2 nonoverlapping, clean-contaminated abdominal surgical incisions. Patients included were those able to understand the study protocol and provide their own informed written consent before their surgery. Patients were excluded if they had a body mass index greater than 35 kg/m^2, were current smokers, were unable to understand or complete consent and/or follow-up surveys, had stapled wounds, were on perioperative therapeutic anticoagulation, were on dual antiplatelet therapy, or had a history of a known bleeding disorder. Patients were also excluded if they were on chronic steroids/immunosuppression, had a known allergy to the dressing or adhesives, were prison or ward patients, or were discovered before or during surgery to be unable to receive the MP-NPD.

Compliance With Ethical Standards

All procedures performed in the study involving human subjects were in accordance with the ethical standards of the institutional review committee. The study was approved by the institutional review board at the University of Southern California, and all participants provided written informed consent before study inclusion.

Study Arms

Each patient served as both the control and study arm in this within-subjects study. Incisions included in the study were laparoscopic or robotic port site incisions between 5 and 12 mm in length. All port sites were closed with interrupted 4-0 Monocryl sutures. The surgical team and perioperative staff were blinded to the randomization until the very end of the procedure after all incisions and port sites were closed in the usual standard fashion with absorbable subcuticular sutures. Study personnel selected 2 incisions of similar size and location. Using computer-generated randomization, 1 incision was selected to serve as the experimental incision, whereas the other was de facto selected as the control. The deeper fascial layers were closed with absorbable sutures for incisions greater than 10 mm in length, in addition to the superficial skin closure. At the end of the procedure, the available incisions were inspected before randomization. Incisions of comparable size and baseline appearance were selected by study personnel before dressing placement, and selected incisions were to function as the control and experimental incisions. The 2 selected incisions were then randomly assigned to function as either the control incision or the experimental incision using computer-generated randomization.

The control incision received conventional dressings after completion of skin closure. Standard dressings

consisted of a single sterile 4 × 4 gauze dressing folded once lengthwise and widthwise and placed over the incision, followed by placement of a 4 × 6 cm Tegaderm (3M, St. Paul, MN) dressing. The experimental incision was dressed with a single small (5 cm) MP-NPD. Please refer to the following section describing the MP-NPD used in this study for further details. The pump portion of the dressing was placed directly over the incision and pinched until adequate negative pressure (−75 to −125 mm Hg) was confirmed according to device and manufacturer recommendations. Before dressing placement, photographs of the control and experimental scars were taken to serve as baseline photographs, and follow-up photographs were obtained at the first clinic visit.

The Mechanically Powered Negative Pressure Dressing

The MP-NPD used in the study group was the NPseal (Guard Medical, Miami, FL), which is a Food and Drug Administration–approved self-contained MP-NPD. It features an integrated pump consisting of an inlet valve, which communicates with the dressing pad, and an outlet valve through which air exits. After placement of the dressing over the incision, the pump body is pinched until it remains collapsed, resembling an "hourglass" shape, indicating therapeutic pressure between −75 and −125 mm Hg (Fig. 1). The dressing was left in place for either 6 days postoperatively or until the date of discharge. The dressing could be changed up to 1 time by nursing staff. Although in place, the pump is monitored to determine if it remains collapsed. If it is decompressed, the pump can be pinched until it collapses again.

Study Outcomes

The primary outcomes of the study were early cosmetic results at the first clinic visit (3–6 wk postoperatively). Cosmetic results were assessed by volunteer physician and nonphysician observers using validated scar assessment scoring systems applied to a randomized set of unlabeled (blinded) scar images presented side by side. (**See figure, Supplemental Digital Content 1**, which displays representative clinic visit scar images, **http://links.lww.com/PRSGO/D867**.) Physician observers evaluated scar cosmesis using a modified version of the Scar Cosmesis Assessment Rating (SCAR) scale and the visual analog scale (VAS) scoring systems to assess scar cosmesis and preference (Figs. 2–4). Nonphysician observers also used a simplified version. Additionally, patient-reported cosmetic outcomes were assessed using the VAS at the clinic visit.

Blinded Volunteer Observers

There were 5 physician observers evaluating the incisions. These evaluators included an attending surgeon, senior general surgery residents, and junior general surgery residents. For the nonphysician evaluations, a variety of nonmedical volunteers participated after a brief explanation of the study goals and survey explanations.

Scar Scoring Systems

The modified SCAR scale used to evaluate incisions is a simplified version of the SCAR scale, which is a validated scoring system able to be used to assess photographs of scars. The variables assessed scar spread, erythema, dyspigmentation, suture marks, hypertrophy or atrophy, and overall impression. Patient questions regarding itch and pain were excluded. The total score for each scar ranged from 0 to 13, where a lower value indicates a preferable incision. Further details of the modified SCAR scale survey may be found in Figure 2.

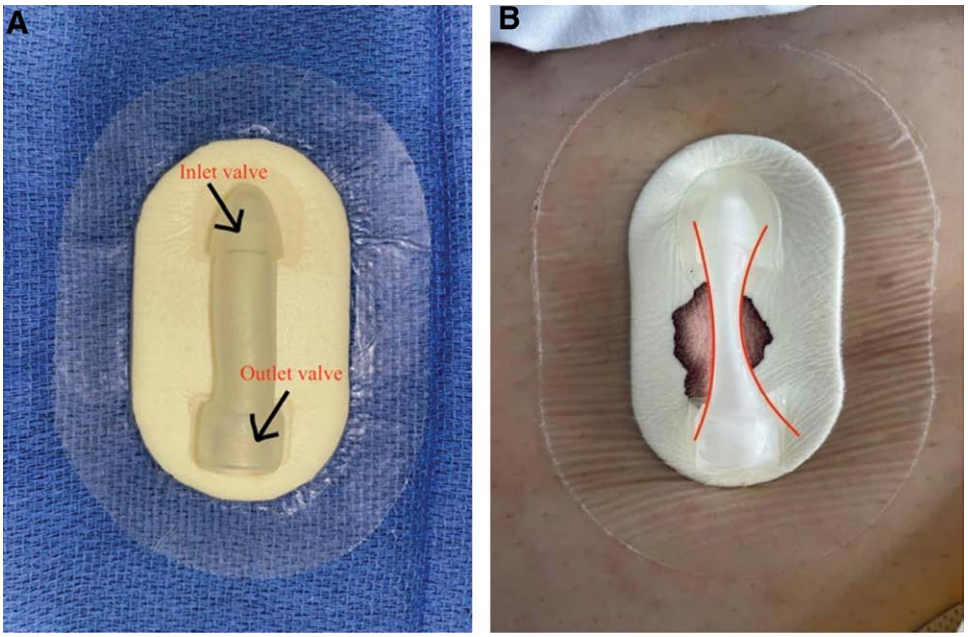

Fig. 1. Mechanically powered negative pressure dressing. Inactivated (A) and activated (B) MP-NPD dressings.

Clinician Items	Scale Ratings
Scar spread	0, None to near-invisible
	1, Pencil-thin line
	2, Mild spread, noticeable on close inspection
	3, Moderate spread, obvious scarring
	4, Severe spread
Erythema	0, None
	1, Light pink, some telangiectasias may be present
	2, Red, many telangiectasias may be present
	3, Deep red or purple
Dyspigmentation (includes hyperpigmentation or hypopigmentation)	0, Absent
	1, Present
Track marks or suture marks	0, Absent
	1, Present
Hypertrophy/atrophy	0, None
	1, Mild: palpable, barely visible hypertrophy or atrophy
	2, Moderate: clearly visible hypertrophy or atrophy
	3, Severe: marked hypertrophy or atrophy or keloid formation
Overall impression	0, Desirable scar
	1, Undesirable scar

Fig. 2. Modified SCAR scale.

The VAS is a simple scale ranging from 0 to 10 in which observers were asked to provide a subjective numerical value to each scar (Fig. 3). The scale does not utilize any specific criteria and is solely based on observer judgment. On this scale, a higher score indicates a cosmetically better incision. Additionally, nonphysician observers were asked to select which incision they felt was more "preferable" in blinded side-by-side comparisons of the control and experimental incisions for each patient. If they felt there was no appreciable difference, they reported "no difference." After the surveys were completed, a reference key identifying which images contained MP-NPD scars or control scars was used to assign values and preferences.

Statistical Analysis/Considerations

All statistical analyses were performed using the IBM SPSS Statistics software version 28.0 (SPSS, Inc., Chicago, IL). Continuous variables were described using mean and SD, depending on normality. Categorical variables were described using frequencies and percentages. To compare continuous variables between 2 groups, we used the Student *t* test. To compare differences between 2 continuous variables, a 1-sample *t* test was used, with 0 or no difference considered the baseline value. To compare categorical variables between 2 groups, we used the chi-squared test or the Fisher exact test depending on the sample size. We used a 2-tailed *P* value of less than 0.05 to define statistical significance.

RESULTS

Forty patients were enrolled, with a total of 80 incisions included in cosmetic analysis. The average age was 60.6 ± 13.5 years, the average body mass index was 26.2 ± 5.0 kg/m^2, and 21 (52.5%) patients were women. All patients were either American Society of Anesthesiologists class 2 (67.5%) or 3 (32.5%). Further details regarding demographic data and medical comorbidities can be found in Table 1. Fourteen (35.0%) patients had a history of previous abdominal surgery, and 3 (7.5%) patients reported daily low-dose aspirin use. All patients were given a preoperative prophylactic dose of subcutaneous heparin (5000 units). Thirty-seven (92.5%) patients received postoperative prophylactic dose heparin starting the same day of surgery, whereas the remaining 3 (7.5%) started postoperative heparin the day after surgery. Thirty-eight (95.0%) patients received preoperative ertapenem 1 g intravenous for antibiotic prophylaxis. For the remaining 2 patients, 1 (2.5%) received ciprofloxacin plus metronidazole, and 1 (2.5%) received levofloxacin plus metronidazole. Zero patients received further

Parameter	Descriptor	Score
Clinician questions		
Scar spread	None/near invisible	0
	Pencil-thin line	1
	Mild spread, noticeable on close inspection	2
	Moderate spread, obvious scarring	3
	Severe spread	4
Erythema	None/near invisible	0
	Light pink, some telangiectasias may be present	1
	Red, many telangiectasias may be present	2
	Deep, red, or purple	3
Dyspigmentation	Absent	0
	Present	1
Suture marks	Absent	0
	Present	1
Hypertrophy/atrophy	None	0
	Mild: palpable, barely visible hypertrophy or atrophy	1
	Moderate: clearly visible hypertrophy or atrophy	2
	Severe: marked hypertrophy or atrophy or keloid formation	3
Overall Impression	Desirable scar	0
	Undesirable scar	1
Patient questions		
Itch	No	0
	Yes	1
Pain	No	0
	Yes	1

Fig. 3. Visual analog scale.

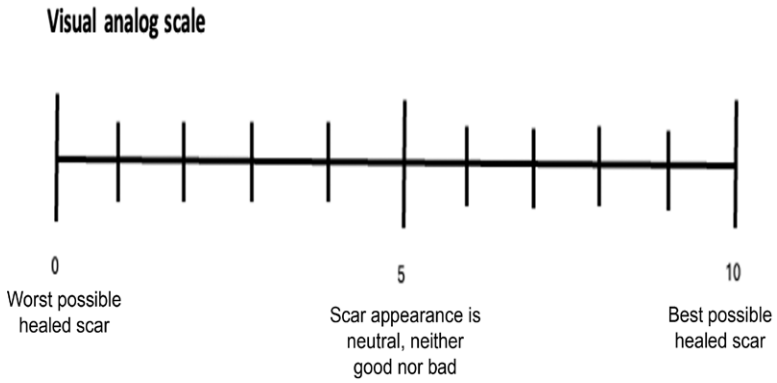

Fig. 4. SCAR scale.

antibiotics after surgery. The surgical approach used was laparoscopic in 37 (92.5%) cases, and the rest were robotic. The average incision length was 5.38 ± 1.01 mm. All incisions ranged from 5 to 8 mm in length, and none required deeper fascial sutures. Further details of demographic and perioperative data are shown in Table 1.

Primary Outcome Results

Five physician scar assessments were performed using the modified SCAR scale and VAS. Results of these evaluations found that the MP-NPD wounds had both clinically and statistically significant outcomes compared with the control incisions for most SCAR variables. The average scores for scar spread, erythema, dyspigmentation, scar

Table 1. Demographics and Perioperative Factors

	N = 40
Age, y, avg (SD)	60.6 (13.5)
BMI, kg/m^2, avg (SD)	26.2 (5.0)
Female, n (%)	21 (52.5)
Comorbid conditions, n (%)	
Hypertension	15 (37.5)
Hyperlipidemia	16 (40.0)
PAD/CAD	3 (7.5)
Prior CVA/TIA	1 (2.5)
CKD/ESRD	2 (5.0)
COPD/asthma/OSA	6 (15.0)
Diabetes	12 (30.0)
History diverticulitis	3 (7.5)
History CRC	11 (27.5)
History other cancer	2 (5.0)
Prior abdominal surgery, n (%)	14 (35.0)
Low-dose aspirin, n (%)	3 (7.5)
ASA class, n (%)	
1	0 (0)
2	27 (67.5)
3	13 (32.5)
4	0 (0)
Surgical approach, n (%)	
Laparoscopic	37 (92.5)
Robotic	3 (7.5)
Preoperative heparin, n (%)	40 (100)
DVT PPx started POD 0, n (%)	37 (92.5)
Preoperative Abx, n (%)	
Ertapenem	38 (95.0)
Ciprofloxacin plus metronidazole	1 (2.5)
Levofloxacin plus metronidazole	1 (2.5)
Continuation of postoperative Abx, n (%)	0 (0)
Length of incision, mm, avg (SD)	5.38 (1.01)

Abx, antibiotics; ASA, American Society of Anesthesiologists; Avg, average; BMI, body mass index; CAD, coronary artery disease; CKD, chronic kidney disease; COPD, chronic obstructive pulmonary disease; CRC, colorectal cancer; CVA, cerebrovascular accident; DVT, deep vein thrombosis; ESRD, end-stage renal disease; OSA, obstructive sleep apnea; PAD, peripheral arterial disease; POD, postoperative day; PPx, prophylaxis; TIA, transient ischemic attack.

hypertrophy, and overall impression were lower for the MP-NPD wounds. The only individual variable of the SCAR scale where there was no difference noted between the 2 groups was the presence of suture marks ($P = 0.325$). The average total SCAR score was significantly lower (better cosmesis) for the MP-NPD wounds compared with the control wounds (3.39 ± 3.18 versus 4.79 ± 3.18, respectively; $P < 0.001$) with an average difference of 1.37 ± 3.44 ($P < 0.001$). The MP-NPD wounds had a significantly higher average VAS score (better cosmesis) compared with the control incisions (7.02 ± 2.51 versus 6.20 ± 2.64; $P = 0.002$), with an average difference of 0.8 ± 2.59 ($P < 0.001$). Further details of all physician assessments can be found in Table 2.

There was a total of 6 nonphysician blinded side-by-side assessments completed using the side-by-side comparison and VAS for each incision. Overall, the MP-NPD wounds were preferred in 40.4% of cases and the control incision was preferred in 22.5% of cases. For the remainder of the cases (37.1%), the evaluators felt there was no difference between the paired incisions. Overall, the MP-NPD wounds were preferred or considered equivalent to the traditional dressing in 77.5% of cases. The MP-NPD wounds had a significantly higher average VAS score compared with the control incisions (6.26 ± 2.08 versus 5.83 ± 2.13; $P = 0.027$), with an average VAS difference of 0.43 ± 2.47 points higher favoring the MP-NPD wounds than the control ($P = 0.008$). Further details of the nonphysician evaluations may be found in Table 3. Patients also reported VAS for each incision at their first follow-up visit. Again, the MP-NPD wounds had a higher average VAS compared with the control wounds (9.37 ± 0.77 versus 7.87 ± 1.94, respectively; $P < 0.001$).

Discussion

The cosmetic appearance of incisions remains one of the most important aspects of the patient recovery experience after surgery. Although most small incisions heal well regardless of closure technique, patients prefer to have optimal cosmetic results with minimal hypertrophy, spread, and dyspigmentation. Multiple studies assessing patient experiences have corroborated this assertion and have consistently demonstrated patient concern regarding the visible appearance of surgical scars. These findings highlight the significant importance of cosmetic results for patients undergoing even minor procedures.[2,11] In this study, we utilized a unique study design,

Table 2. Physician Scar Assessment

	Control	MP-NPD	Overall	*P*
SCAR score, avg (SD)				
Spread	1.68 (1.07)	1.25 (1.05)	1.46 (1.08)	**<0.001**
Erythema	1.04 (0.95)	0.71 (0.81)	0.87 (0.90)	**<0.001**
Dyspigmentation	0.65 (0.48)	0.50 (0.50)	0.58 (0.50)	**0.003**
Suture marks	0.06 (0.23)	0.04 (0.19)	0.05 (0.21)	0.325
Hypertrophy	0.95 (0.89)	0.67 (0.80)	0.81 (0.86)	**0.001**
Overall impression	0.44 (0.50)	0.23 (0.42)	0.34 (0.47)	**<0.001**
Total SCAR score, avg (SD)	4.78 (3.18)	3.39 (2.93)	4.09 (3.14)	**<0.001**
SCAR score difference*	†	†	1.37 (3.44)	**<0.001**
VAS score, avg (SD)	6.20 (2.64)	7.02 (2.51)	6.61 (2.60)	**0.002**
VAS score difference‡	†	†	0.83 (2.59)	**<0.001**

Bold indicates statistically significant values.
*SCAR score difference = (control SCAR score) − (MP-NPD scar score).
†Not applicable.
‡VAS score difference = (MP-NPD VAS) − (control VAS).
Avg, average.

Table 3. Nonphysician and Patient Scar Evaluations

	Control	MP-NPD	No Difference	Overall	*P*
Nonphysician scar preference, n (%)	54 (22.5)	97 (40.4)	89 (37.1)	240 (100)	*
Nonphysician VAS, avg (SD)	5.83 (2.13)	6.26 (2.08)	*	6.05 (2.11)	**0.027**
VAS difference†	*	*	*	0.43 (2.47)	**0.008**
Patient-reported VAS, avg (SD)	7.87 (1.94)	9.37 (0.77)	*	8.62 (1.65)	**<0.001**
VAS difference †	*	*	*	1.50 (2.08)	**<0.001**

Bold indicates statistically significant values.
*Not applicable.
†Difference = MP-NPD – control.
Avg, average.

in which each patient acted as both the experimental and control arms. This approach was used to minimize potential differences inherent among different individuals, which may introduce uncontrollable factors into the groups that could affect cosmetic results. We feel that the current study design is one that can also be utilized to study incisional/wound healing outcomes for a wide variety of procedures in which multiple scars may be present postoperatively. However, this design can only be used in patients who undergo procedures that result in multiple analogous incisions. Our study examined patients who underwent laparoscopic colectomy, given it is one of the most common procedures performed by our specialty. One initial concern about our study population was whether we would be able to detect a cosmesis difference in small laparoscopic incisions analyzed. On the contrary, if significantly noticeable cosmetic improvements in small incisions were appreciated, this may translate into much better improvements in longer incisions.

A drawback of our approach in the current study is that there was limited ability by the patients to obtain unbiased scar assessments, as the patients could not be blinded to the different dressings used. Due to this concern, we elected to use blinded observer evaluations of scar images, in addition to patient-reported outcomes, in an attempt to gather more objective results. Physician assessment relied on a modified version of the SCAR scale, which is simple to use and made useful for scar assessment in this study. Physicians and nonphysicians also used the VAS to compare the incisions. This scale was used due to its simplicity and ability to be used by a variety of different evaluators regardless of clinical background, without imposing specific criteria for cosmetic assessment.

The use of nonphysician assessments was important, as the primary outcome of this study was the cosmetic appearance, which is often valued differently between surgeons and patients (ie, nonphysicians). This claim has been verified by multiple studies across a variety of specialties showing that surgeons and patients often have different perceptions of surgical cosmetic outcomes.[20–22] In fact, a large systematic review by Zhang et al,[23] reviewing 29 studies comparing patient and physician scar analyses, showed that surgeons and patients value different aspects of scar cosmesis. In particular, physicians are more likely to value pigmentation and scar relief, whereas patients are more likely to value scar depth/thickness.[23]

In our study, physician evaluations found that the MP-NPD incisions had higher (ie, preferable) modified SCAR scores. Additionally, the results of VAS assessment in this study showed that, for both physicians and nonphysicians, the MP-NPD wounds were preferable and were preferred most often in a head-to-head comparison. Specifically, the VAS was able to detect small but statistically significant cosmetic preferences for the MP-NPD incisions in physicians and nonphysicians, and an even greater difference when reported by the patients. Importantly, the patient-reported outcomes are at risk for bias, which may explain why there was a more striking difference between the 2 groups for this assessment. Importantly, in nearly half of the cases assessed by nonphysicians, the cosmetic appearance of the MP-NPD wounds was preferred when asked to simply pick the preferred wound in side-by-side comparisons. Furthermore, in more than 3 of 4 cases, the MP-NPD was considered either better or similar to the control group.

Finally, as previously stated, these incisions were small and likely would heal well regardless of the closure technique or dressings used. However, the current study showed that ci-NPWT using an MP-NPD, even for small incisions, had a positive impact on early cosmetic appearance. This suggests the potential for even greater cosmetic impact when applied to larger incisions.

The current study has several limitations. As reported previously, patients' self-reported outcomes were potentially biased, as it was not possible to blind patients to the dressing types in this within-subjects study. As such, patient-reported evaluations should be taken with caution. Another drawback of the study was the use of visual evaluation of scar cosmesis only. Although important aspects of scar cosmesis can be assessed with visual assessment, certain variables such as thickness, relief, and pliability are better assessed using in-person evaluation. However, the use of these scar assessment scales is difficult to apply to small port site incisions. Finally, as stated previously, these small incisions generally heal well, with good long-term cosmetic results making small differences difficult to appreciate. However, despite the incision size, the study showed consistent cosmetic differences as determined by physicians, nonphysicians, and patients across a variety of scar assessment scales. Another limitation of our study was the variation in image quality and display conditions. Although participants were able to zoom in during evaluations, the devices and screens they used for assessment differed, as the evaluations were conducted on their personal devices, which may have introduced inconsistencies in the interpretation of the images.

CONCLUSIONS

Cosmetic results of surgical scars are extremely important to patients. The use of ci-NPWT with the application

of a novel MP-NPD over surgical incisions resulted in significant improvement in scar cosmesis in the early/intermediate postoperative period. Although these results are promising, one of the limitations of this study was the short to intermediate perioperative follow-up, which may affect the long-term evaluation of outcomes. Large prospective studies evaluating this closure technique with larger, higher risk incisions are needed to better evaluate its effect on wound healing and cosmetic outcomes. Additionally, this unique study design provides a useful template that may be applied to future studies evaluating wound healing and cosmetic outcomes.

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DISCLOSURE

The authors have no financial interest to declare in relation to the content of this article.

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