Negative-Pressure Wound Therapy to Reduce Wound Complications after Abdominoperineal Resection

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E-pub: 02/07/2020
https://doi.org/10.7812/TPP/19.173

ABSTRACT

Introduction: Abdominoperineal resection is associated with a high rate of wound complications. A high degree of wound tension, a common contributor to wound breakdown and complications, may be mitigated by incisional negative-pressure wound therapy (NPWT). Although NPWT has been shown to reduce complications associated with open and complex wounds, there is a paucity of data regarding its prophylactic use for incisional wounds.

Objective: To determine the effect of NPWT use on surgical wound complications of abdominoperineal resection for malignancy.

Methods: We performed a systematic review by querying the PubMed database for studies from 1990 to 2019 and included English-language studies that used incisional NPWT for closed wounds from abdominoperineal resection in malignancy cases.

Results: Five studies with a total of 76 patients were included. Their findings showed reduced rates of surgical site complications with the use of incisional NPWT. Another 2 studies describing the use of prophylactic NPWT to expedite secondary closure of the surgical wound followed by incisional wound therapy were separately categorized and included 8 patients, none of whom experienced wound wound complications.

Discussion: Additional, prospective research is needed to confirm the benefit of prophylactic incisional NPWT.

INTRODUCTION

Abdominoperineal resection (APR) is associated with a high rate of wound complications, including surgical site infection (SSI) and wound separation. The incidence of SSI alone is estimated at 30% to 60%, and the rate of wound separation or dehiscence has been reported to be up to 80%. Wound complications have a positive correlation with the risk of tumor recurrence in patients treated for malignancy, which may be secondary to delays in adjuvant therapy while wounds resolve. Failure to heal primarily also results in marked prolongation of wound healing time with a corollary increase in cost burden and decrease in quality of life. Wound healing complications after APR is hypothesized to be secondary to high wound tension in the context of a fixed pelvic outlet. Additionally, filling the empty space left by resection of the rectum and anus and potentially other pelvic structures presents a technical challenge; as the volume of empty space increases, so does the rate of wound complications. Finally, minimizing pressure on the healing wound can be difficult because healing patients spend much of their time seated or supine. Additional factors that are well known to increase the risk of wound complications include diabetes mellitus, neoadjuvant radiotherapy, and higher intraoperative blood loss.

Techniques to reduce the complication risk with APR have historically included myocutaneous rotational flap closure to reduce wound tension, use of biologic or synthetic mesh, omentoplasty to fill “dead space,” and closed-suction drainage to reduce fluid accumulation. The risk clearly varies with the indication for surgery, with malignancy and recurrence translating to a higher-risk operation than for benign disease. A greater extent of resection is also associated with higher rates of complications. Because there is no consensus as to the lowest-risk surgical strategy, there is a high variability in surgeon technique.

Negative-pressure wound therapy (NPWT) has been shown to reduce wound complications for large and deep clean wounds, open abdominal wounds, skin grafts, open fractures, pressure ulcers, and clean wounds in obese patients. For this application of enhanced healing by secondary intention, the negative pressure reduces wound tension by approximating wound margins and reducing edema. Stimulation of granulation tissue and increased blood flow are also thought to contribute, but animal models have produced conflicting results. Reduced bioburden has also been suggested but is unproven. Typically, 50 mmHg to 125 mmHg of negative pressure is used, but the risks and benefits across this pressure range are unknown.

There is increasing use of NPWT for approximated incisional wounds but with minimal prospective data. For incisional wounds, negative pressure theoretically also reduces wound tension and decreases edema, but suggestions of increased blood flow or stimulation of wound granulation are more difficult to believe. A 2019 Cochrane review of 25 studies included more than 2500 patients treated with incisional NPWT for a variety of surgeries. The results suggested a reduced SSI (risk ratio = 0.67, 95% confidence interval = 0.53 to 0.85), but the authors noted that highly biased data limited data interpretation.

The effect on hematoma development, wound separation, and reoperation rates was uncertain. Finally, NPWT for surgical incisions may be more cost-effective than conventional wound therapy, according to the same review study.

Few reports—and no randomized controlled trials, to our knowledge—describe outcomes for use of NPWT for incisional wounds, including for APR. The success of NPWT for improved healing of a variety of wounds lends hope that the technology...

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Keywords: abdominoperineal resection, incisional negative pressure wound therapy, negative pressure wound therapy, perineal wound, wound care prophylaxis
will reduce perineal wound complication rates. We performed a systematic review of the current literature to determine the effect of NPWT use on surgical site complications in oncologic APR.

METHODS

Database Query

This study was exempted by the institutional review board. We performed a literature review of the PubMed database from years 1990 to 2019 with the following search terms: perineal, abdominoperineal, wound, negative pressure, and vacuum. Studies were reviewed by 2 authors (RCG and AD) and were excluded if both authors determined them not to meet inclusion criteria. Exclusion criteria included non-English-language publications, nonhuman studies, nonsurgical studies, and reports of NPWT initiated after wound separation, dehiscence, or infection. We included reports of prophylactic use of NPWT only. There were no restrictions on the basis of patient age, geographic location of treatment, or surgical approach to APR. Figure 1 details the study selection process.

Data Collection and Analysis

Recorded factors included age, sex, indication for surgery, disease stage, surgery performed, closure technique, neoadjuvant chemoradiation therapy, NPWT prescription (pressure, duration), and complication as identified by the study authors. Important factors including comorbidities, surgical margin, time to wound healing, and measure of nutritional health were omitted from data collection because of limited reporting in the literature.

Given the heterogeneity of study protocols, patient populations, and reported data, the results of this review are descriptive in nature.

RESULTS

Eighty-nine articles met the search terms; 18 nonhuman studies were excluded, as were 14 non-English-language articles. An additional 45 studies were eliminated because they were based on an incorrect diagnosis or surgery (predominantly gynecologic procedures, Fournier gangrene, and skin grafts). Five articles were excluded because they were nonsurgical, and 1 additional article was excluded because it was a review article.

Study Characteristics

Five studies describing the use of incisional NPWT were included, totaling 76 patients. An additional 2 studies describing the use of prophylactic NPWT to expedite secondary closure of the surgical wound followed by incisional wound therapy were separately categorized and included 8 patients. All but 2 studies were retrospective in design, and there were no randomized controlled trials. Three studies included a comparator of historical control patients. When present, control groups were matched for sex, age, diagnosis, and operation but not comorbidities.

Patient Characteristics and Wound Management

The mean age of patients was approximately 65 years, and men predominated (68% of patients who underwent incisional NPWT). Body mass index was reported in only 1 study, as a mean value, and therefore was not included in this review. Most patients were treated with APR for a diagnosis of rectal cancer, although disease stage, APR approach (extrasphincteric, intrasphincteric, or extralevator abdominoperineal excision), and method of reconstruction were not consistently reported. Six of 7 studies reported primary closure with or without biologic mesh. Prescription of prophylactic antibiotics was not routinely described. Neoadjuvant chemotherapy and radiotherapy were documented as a single entity (chemoradiotherapy) in 3 studies and reported separately in the remaining 4; between 40% and 100% of patients in each study received either or both chemotherapy and radiation therapy.

The NPWT protocol was variable, with a range of 1 to 12 days of use across the included studies and a pressure prescription between -80 mmHg and -125 mmHg. The wound sponge material in all studies consisted of polyurethane foam applied to the wound with overlying occlusive tape. An absorbent barrier was specified in all but 1 study and consisted of petrolatum gauze, polyester, or...
a silicone-coated material. Only 1 study defined a control group using conventional wound dressings. Additional patient characteristics are found in Tables 1 and 2A and 2B.

**Outcomes**

The follow-up time varied from 30 days to 238 days. The time to wound healing and length of hospitalization were inconsistently documented and therefore excluded from this report. A wound complication was inconsistently defined as any wound breakdown or as wound tenderness, calor, rubor, or focal edema. The overall complication rate, excluding

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### Table 1. Comparison of peer-reviewed, published studies using incisional negative-pressure wound therapy (NPWT) after abdominoperineal resection (APR)

<table>
<thead>
<tr>
<th>Category</th>
<th>Incisional NPWT</th>
<th>Open NPWT followed by NPWT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Chadi et al.10 2014, N = 27</td>
<td>Fujino et al.14 2015, N = 2</td>
</tr>
<tr>
<td>Study design</td>
<td>Retrospective, cohort</td>
<td>Case report</td>
</tr>
<tr>
<td></td>
<td>Sumrein et al.10 2016, N = 32</td>
<td>Case report</td>
</tr>
<tr>
<td></td>
<td>Mino et al.11 2016, N = 1</td>
<td>Case series</td>
</tr>
<tr>
<td></td>
<td>van der Valk et al.12 2017, N = 10</td>
<td>Case report</td>
</tr>
<tr>
<td></td>
<td>Wiegering et al.12 2017, N = 6</td>
<td>Case report</td>
</tr>
<tr>
<td></td>
<td>Ito et al.13 2019, N = 6</td>
<td>Case series</td>
</tr>
<tr>
<td>Control/ comparator (n)</td>
<td>Historical (32)</td>
<td>Historical (25)</td>
</tr>
<tr>
<td></td>
<td>NA</td>
<td>Historical (10)</td>
</tr>
<tr>
<td>Mean age, y</td>
<td>62</td>
<td>63</td>
</tr>
<tr>
<td>Sex, M/F</td>
<td>18/9</td>
<td>54</td>
</tr>
<tr>
<td>Surgery</td>
<td>APR, APR + protocolectomy, or pelvic exenteration</td>
<td>APR + APR + vaginal wall resection</td>
</tr>
<tr>
<td></td>
<td>Extralevator APR</td>
<td>APR + exenteration</td>
</tr>
<tr>
<td>Reconstruction</td>
<td>Primary closure</td>
<td>Closed primarily 1 d after application of WV</td>
</tr>
<tr>
<td></td>
<td>Biologic mesh + primary closure</td>
<td>APR</td>
</tr>
<tr>
<td>Diagnosis</td>
<td>Rectal cancer</td>
<td>Rectal cancer</td>
</tr>
<tr>
<td></td>
<td>Rectal cancer</td>
<td>Anorectal melanoma (1), recurrent rectal cancer (1)</td>
</tr>
<tr>
<td>Chemotherapy/ RT, %</td>
<td>63/59</td>
<td>54/50</td>
</tr>
<tr>
<td>Wound dressing</td>
<td>Petrolatum gauze, stoma paste at wound margins, overlying polyurethane foam, occlusive tape</td>
<td>50/50</td>
</tr>
<tr>
<td></td>
<td>Polyurethane, occlusive tape dressing</td>
<td>17/17</td>
</tr>
<tr>
<td></td>
<td>Polyester wound barrier, silver-coated polyurethane foam (Prevena, KCI, Wiesbaden, Germany)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Silicone-coated absorbent, overlying occlusive foam layer (PICO, Smith &amp; Nephew, London, UK), occlusive tape</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Polyester wound barrier, silver-coated polyurethane foam (Prevena)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Polyester wound barrier, silver-coated polyurethane foam (Prevena)</td>
<td></td>
</tr>
<tr>
<td>Control group dressing</td>
<td>Gauze packing, mesh underwear</td>
<td>NA</td>
</tr>
<tr>
<td>Pressure, mmHg</td>
<td>-125</td>
<td>Unknown</td>
</tr>
<tr>
<td>Duration, d</td>
<td>7.7</td>
<td>5-12</td>
</tr>
<tr>
<td>Follow-up, d</td>
<td>238</td>
<td>29-36</td>
</tr>
<tr>
<td>Infection/ complication criteria</td>
<td>Wound breakdown</td>
<td>Unknown</td>
</tr>
<tr>
<td></td>
<td>Unknown</td>
<td>Unknown</td>
</tr>
<tr>
<td>SSI, %</td>
<td>15</td>
<td>0</td>
</tr>
<tr>
<td>Other wound complication</td>
<td>2/27 (7%) intra-abdominal abscess</td>
<td>0</td>
</tr>
<tr>
<td>Important findings</td>
<td>Lower SSI in NPWT group</td>
<td>2/10 (20%) wound separation</td>
</tr>
<tr>
<td></td>
<td>Longer hospital stay in NPWT group</td>
<td>1/6 (17%) wound separation</td>
</tr>
<tr>
<td></td>
<td>Lower SSI rate in NPWT vs literature</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>NA</td>
<td>0</td>
</tr>
</tbody>
</table>

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* = plus; CRT = chemoradiotherapy; F = female; M = male; NA = not applicable; RT = radiotherapy; SSI = surgical site infection; VRAM = vertical rectus abdominis myocutaneous flap; WV = wound vacuum.
the deep-wound NPWT cases, was 29% (22/76) and the SSI rate was 18% (14/76). No SSIs or other complications were reported among the 8 patients treated with deep-wound (open NPWT) followed by incisional NPWT.

**DISCUSSION**

We present a literature review of prophylactic NPWT for perineal surgical wounds after APR. All but 1 study reported rates of wound complication and infection lower for NPWT than rates associated with conventional wound care. Taken together, results of the 7 published reports described here suggest that prophylactic use of NPWT for perineal wounds deserves additional study in the form of prospective, randomized trials. However, major limitations of the reported data limit interpretation and generalization of these results.

An absence of critical data included in these reports, particularly of variables known to affect wound healing such as nutritional health and sarcopenia, prevents full understanding of wound complication risk factors. Tumor stage, margins, and time to wound healing are also critical factors related to wound healing and are inconsistently reported (Tables 2A and 2B). Incomplete documentation of comorbidities prevented true cohort matching, although most studies were reported as case series without a comparator group. A definition of wound complication or infection was inconsistent among the studies presented here, which further limits comparison of conventional wound care vs NPWT. Similarly, with considerable variation in the reported data, it is difficult to hypothesize the mechanism or mechanisms responsible for a decrease in wound complication rates.

Despite inadequate study, incisional NPWT is a logical strategy for management of APR-induced wounds given its successes with open wounds and promising early data when applied to select closed wounds. Results of early, nonrandomized studies using incisional NPWT for orthopedic surgical incisions have been promising, demonstrating possible reduction in SSI rates, as well as reduced hematoma and seroma formation—both factors that correlate with risk of wound complication. Similar studies used after open vascular and cardiothoracic operations have produced the same results, as did a small retrospective study using incisional NPWT after open colectomy. The authors of the latter study suggested that isolation of the incision from both the hospital milieu and nearby stoma, which is essentially unachievable with conventional wound dressings, may be the most important factor toward reduction of SSI frequency.

Incisional NPWT may be best suited for application to high-risk wounds, to reduce complication rates. A meta-analysis of 35 comparative studies involving patients with a variety of surgical wound types found that most studies showed decreased wound infection rates with incisional NPWT; 2 of the studies showed no difference in wound infection rate, and 1 study was halted because of skin blistering in 63% of patients receiving incisional NPWT. On the basis of these data, the authors concluded that incisional NPWT is safe and that patients with high-risk wounds and risk factors for wound complications should be considered for incisional NPWT application.

Early data for use of incisional NPWT for contaminated wounds is also promising and lends credence to its safety of use for perineal surgical wounds. A prospective, randomized trial comparing use of incisional NPWT to open-wound NPWT for patients who underwent laparotomy and who had either contaminated or dirty wounds found a markedly increased rate of wound healing in patients treated with incisional NPWT (median = 7 vs 48 days, p < 0.005), and no difference in the wound complication rate. These findings are attractive to apply to surgical wounds after APR, which suffer a high baseline wound infection rate. Further study is warranted to assess the mechanism by which wound healing is accelerated and to determine the wounds that will benefit from incisional NPWT.

Notably, the US Food and Drug Administration has issued safety guidelines for the use of NPWT and lists contraindicated wound types, rather than indications or recommendations for use. Presence of wound eschar, exposed organs or unexplored fistulae, malignancy in the wound,

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and exposed vasculature are contraindications to the use of NPWT. On the basis of interviews with 341 experts as well as a review of the literature, the US Food and Drug Administration concluded that NPWT is safe and effective at reducing wound complications for a broad variety of applications in adults.

CONCLUSION

The current body of literature reviewing the impact of NPWT on wound healing after APR is supportive. In this review article, the results of 5 studies (76 patients) showed reduced surgical site complication rates with the use of incisional NPWT compared with either rates reported in the literature or control groups. Future prospective, randomized controlled data are needed to evaluate the efficacy of NPWT for perineal wounds after APR. It is essential for future studies to include factors that strongly affect wound healing, including preoperative chemoradiation or radiation exposure, nutritional status, hemoglobin and hematocrit, and body mass index.

Disclosure Statement

The author(s) have no conflicts of interest to disclose.

Acknowledgments

Kathleen Louden, ELS, of Louden Health Communications performed a primary copy edit.

Authors’ Contributions

Rebecca Golorgorsky, MD; Shudai Arora; and Anahita Dua, MD, MS, MBA, contributed to the study design, literature review, and manuscript drafting and editing. All authors have given final approval to the manuscript.

How to Cite this Article


References


November 2020