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ORIGINAL CONTRIBUTION

Closed Incisional Negative Pressure Therapy Reduces Perineal Wound Complications After Abdominoperineal Resection

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BACKGROUND: Perineal wound complications after abdominoperineal resection continue to be a significant challenge. Complications, ranging from 14% up to 60%, prolong hospitalization, increase risk of readmission and reoperation, delay the start of adjuvant therapy, and place psychological stress on the patient and family.

OBJECTIVE: This study aimed to evaluate the impact of closed incision negative pressure therapy on perineal wound healing.

DESIGN: This was a retrospective study.

SETTINGS: The study was conducted in an academic community hospital.

PATIENTS: Patients who underwent abdominoperineal resection from 2012 to 2020 were included.

MAIN OUTCOME MEASURES: Perineal wound complications within 30 and 180 days were the primary outcome measures.

RESULTS: A total of 45 patients were included in the study. Of these, 31 patients were managed with closed incision negative pressure therapy. The overall perineal wound complications were less frequent in the closed incision negative pressure therapy group (10/31; 32.2%) compared to the control group (10/14; 71.4%; $\chi^2_1 = 5.99$ [$p = 0.01$]). In the closed incision negative pressure therapy group, 2 patients (20%) did not heal within 180 days and no patient required reoperation or readmission. In the control group, 4 patients (44%) had not healed at 180 days and 1 patient required flap reconstruction. When the effect of other variables was controlled, closed incision negative pressure therapy resulted in an 85% decrease in the odds of wound complications (adjusted OR 0.15 [95% CI, 0.03–0.60]; $p = 0.01$).

LIMITATIONS: The nonrandomized nature and use of historical controls in this study are its limitations.

CONCLUSIONS: The ease of application and the overall reduction in the incidence and severity of complications may offer an option for perineal wound management and possibly obviate the need for more expensive therapies. Further prospective controlled trials are required to effectively study its efficacy. See **Video Abstract** at http://links.lww.com/DCR/B895.

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LA TERAPIA POR PRESIÓN NEGATIVA INCISIONAL CERRADA, REDUCE LAS COMPLICACIONES DE LA HERIDA PERINEAL DESPUÉS DE LA RESECCIÓN ABDOMINOPERINEAL.

ANTECEDENTES: Las complicaciones de la herida perineal, después de la resección abdominoperineal, continúan siendo un desafío importante. Las complicaciones, que van desde el 14% hasta el 60%, prolongan la hospitalización, aumentan el riesgo de reingreso y reintervención, retrasan el inicio de la terapia adyuvante y generan estrés psicológico en el paciente y su familia.

OBJETIVO: Evaluar el impacto de la terapia de presión negativa con incisión cerrada en la cicatrización de heridas perineales.

DISEÑO: Estudio retrospectivo.

ENTORNO CLINICO: Hospital comunitario académico.

PACIENTES: Se incluyeron pacientes sometidos a resección abdominoperineal entre 2012 y 2020.

PRINCIPALES MEDIDAS DE VALORACION: Las complicaciones de la herida perineal dentro de los 30 y 180 días fueron las principales medidas de valoración.

RESULTADOS: Se incluyeron en el estudio a un total de 45 pacientes. De estos, 31 pacientes fueron tratados con terapia de presión negativa con incisión cerrada. Las complicaciones generales de la herida perineal fueron menos frecuentes en el grupo de terapia de presión negativa con incisión cerrada (10/31, 32,2%) en comparación con el grupo de control (10/14, 71,4%) (X_1 ^ 2 = 5,99 [p = 0,01]). En el grupo de terapia de presión negativa con incisión cerrada, dos pacientes (20%) no cicatrizaron en 180 días y ningún paciente requirió reintervención o readmisión. En el grupo de control, cuatro pacientes (44%) no habían cicatrizado a los 180 días y un paciente requirió reconstrucción con colgajo. Cuando se controló el efecto de otras variables, la terapia de presión negativa con incisión cerrada resultó con una disminución del 85% en las probabilidades de complicaciones de la herida (OR ajustado, 0.15 [IC 95%, 0,03–0,60]; p = 0,01).

LIMITACIONES: La naturaleza no aleatoria y el uso de controles históricos en este estudio, son limitaciones.

CONCLUSIÓNES: La facilidad de aplicación, reducción general de la incidencia y gravedad de las complicaciones, pueden ofrecer una opción para el manejo de las heridas perineales y posiblemente obviar la necesidad de tratamientos más costosos. Se necesitan más ensayos controlados prospectivos para efectivamente estudiar la eficacia. Consulte **Video Resumen** en http://links.lww.com/DCR/B895. *(Traducción—Dr. Fidel Ruiz Healy)*

KEY WORDS: Abdominoperineal resection; Closed incision negative pressure therapy; Perineal wound complications.

Abdominoperineal resection (APR), first described by Miles,[1] is generally performed for distal rectal malignancies, IBD, incontinence, and pelvic malignancies and as a salvage procedure for anal canal cancer.

APR is an advanced colorectal procedure associated with high morbidity, including perineal wound complications, which occur both in the immediate postoperative period and during long-term follow-up.[2–5] Perineal wound complications soon after surgery include surgical site infection, wound separation or disruption, and formation of a draining sinus.

Many different risk factors predispose patients to perineal wound complications. Operative technique, preoperative radiation therapy, and indication for surgery (rectal cancer, anal cancer, or IBD) are strong predictors of these complications. Patient comorbidities that increase complications such as poor nutritional status, diabetes, chronic steroid use, ASA physical status score of ≥3, advanced age, obesity, and smoking have been described in the literature.[6,7]

Perineal wound management has evolved from primary closure to wound packing and open vacuum-assisted closure (VAC). Tissue transfer techniques such as omental pedicle flaps, vertical rectus abdominis, gracilis and other myocutaneous flaps have also been used. These techniques, however, have downsides. Wound packing and open wound VAC are a great inconvenience to the patient, cause severe discomfort, and often delay wound healing. Muscle and myocutaneous flaps increase the operative time, require plastic surgery expertise, are more expensive, and are associated with a significant increase in morbidity if the flap breaks down.[8]

Closed incision negative pressure therapy (CiNPT) is an alternate adjunct technique to these more complicated wound closure procedures. It was first introduced in 1997 by Argenta and Morykwas,[9] and since then, a growing body of literature has reported the benefits of CiNPT over closed surgical incisions to reduce complications. The term CiNPT refers to any type of negative pressure therapy that uses foam-based dressings over a closed incision. CiNPT holds the incision together, promotes angiogenesis, decreases tissue edema, redistributes lateral tension, and prevents wound contamination.[10,11]

To our knowledge, there are very limited data on the impact of CiNPT on perineal wound complications. Gologorsky et al[12] examined 5 studies with a total of 76 patients who were managed with CiNPT. This systematic review included studies from Chadi et al that included 27 patients and Sumerin et al that included 32 patients managed with CiNPT. The present study includes 31 patients and is one of the largest single series.

We hypothesized that CiNPT decreases the incidence and severity of perineal wound infections following APR.

PATIENTS AND METHODS

Institutional review board approval was obtained. A prospectively maintained database from November 2012 was queried. We performed a retrospective electronic medical record review of patients who had undergone APR.

All surgeries were performed by 1 surgeon. There were 45 patients identified who were divided into 2 groups: those managed with conventional care labeled as the control group (November 2012 to September 2015) and those managed with CiNPT (October 2015 to February 2020). We changed our practice in 2015 and used CiNPT on 31 consecutive patients as of February 2020.

Basic demographic information, comorbidities, neoadjuvant therapy including the dose of radiation, indication for surgery, BMI, preoperative albumin level, social history (tobacco or alcohol use), steroid use, type of surgery (laparoscopic, robotic, open), perineal wound complications, and use of CiNPT were recorded.

In the control group, 9 patients had adenocarcinoma of the rectum; 8 were candidates for neoadjuvant chemoradiation and received a standard dose of 5040 cGy. Two patients had salvage APR following treatment for anal canal cancer. Two patients had severe IBD and 1 patient with a history of schizophrenia and motor vehicle accident presented with permanent sphincter damage.

In the CiNPT group, 23 patients had adenocarcinoma of the rectum, 18 of whom were candidates for neoadjuvant chemoradiation and received a dose of 5040 cGy. One patient had an initial diagnosis of severe perianal Crohn's disease and was subsequently diagnosed with adenocarcinoma arising in a fistula. One patient underwent salvage APR for residual disease after treatment of anal canal cancer and 1 patient had a gastrointestinal stromal tumor of the rectum requiring neoadjuvant Gleevec. Another patient had giant condyloma of Buschke and Lowenstein with dysplasia and had undergone extensive soft tissue resection followed by myocutaneous flaps and skin grafts at another facility. The anal opening subsequently closed requiring a loop colostomy, and surveillance was not possible through the distal end as the rectal stump and anal canal had strictured. Five patients underwent APR for severe IBD.

In our practice, we performed standard APR for most patients. Intersphincteric dissection was performed for benign disease. Three patients underwent pelvic exenteration and 2 had extralevator APR. All patients received preoperative antibiotic prophylaxis and mechanical bowel preparation. The surgical site was prepared in a standard manner. A closed suction drain was placed through the abdomen. In all patients, perineal wounds were primarily closed in multiple layers after achieving complete hemostasis. The skin was approximated with interrupted vertical mattress nylon sutures.

The CiNPT system (Prevena) was applied in the operating room. We initially used a 13-cm peel and place dressing impregnated with 0.019% ionic silver and connected to a disposable therapy unit (Prevena Plus) that delivers a negative pressure of 125 mmHg and has a canister for the collection of fluids. In the operating room, patch strips provided in the kit help seal leaks around the dressing. At times, we had to use ostomy paste around the introitus in female patients to maintain suction. We have now transitioned to a customizable dressing that includes hydrocolloid sealing strips and an interface pad.

Patients were managed on a surgical floor by nurses trained in the management of CiNPT. Postoperatively, leaks in the seal were addressed by reinforcing the dressing with a VAC drape. In certain instances, adequate pressure was not maintained with the use of a disposable unit and required connection to the VAC Ulta. Any clogging of the tubing was addressed by replacing the interface pad. The dressing was inspected daily and any bogginess under the dressing or malfunction of the unit that could not be resolved prompted discontinuation of therapy. We did not replace the dressing in any of our patients. Most of the patients continued therapy for a minimum of 4 days until the day of discharge or to a maximum of 7 days. In 2 patients, the units malfunctioned early in the postoperative period and were discontinued after troubleshooting failed to resolve the problem. Overall, the therapy was well tolerated, and no patient required discontinuation due to pain.

Perineal wounds in the control group were covered with a simple gauze dressing in the operating room held in place by paper tape and mesh underwear. The dressing was removed 48 hours after surgery and left open to air if there was no evidence of wound infection.

All patients were followed by the authors for at least 180 days after surgery. Any wound infection requiring intervention such as removal of sutures, packing of the wound, or standard negative pressure wound therapy was documented. Dimensions of the open wound were measured and documented.

Wound complications were classified as minor or major. Minor wound complications included wounds meeting 1 or more of the following criteria: wound separation of <2 cm, wounds not requiring management with open wound VAC, wounds completely healed within 30 days of surgery, and wounds not requiring readmission or operative intervention. Criteria for major complications included separation >2 cm, perineal abscess, wounds that required reoperation, any wound that required placement of open wound VAC, or prolonged wound care for more than 30 days.

Statistical Analysis

Descriptive statistics were used: proportions were used for categorical variables and means, SDs, and medians were used for continuous variables. The Pearson correlation test was used to test the linear correlation between 2 continuous variables. The Pearson χ^2 test, Fisher exact test, and 2-sample *t* test were used to examine the demographic and clinical characteristics and the association of CiNPT

implementation with the incidence of perineal wound complications and their severity.

Logistic regression analysis was used to examine the association between CiNPT implementation and perineal wound complication. First, univariate analysis was used to explore the unadjusted association between each independent variable and the occurrence of a wound complication. Due to the small sample size, for the preliminary simple logistic regression analysis, variables that were significant at a p value of ≤0.2 were considered as exploratory variables that have an association with the incidence of wound complication. The cutoff value of 0.2 is supported in the literature.[13,14] Multiple logistic regression analysis was then used to examine the association between CiNPT implementation and perineal wound complication. To determine the final model, the backward elimination method was used including factors that were significant in simple logistic regression analysis. The association between CiNPT implementation and perineal wound complication was assessed while adjusting for preoperative IBD (model 1).

Proportional odds regression model (model 2) was used to identify the severity of wound complications in patients associated with CiNPT. The severity of wound complications had 3 ordinal levels, which were no infection, minor infection, and major infection. As for collinearity and interaction assessments, none were identified.

Analysis was performed using R statistical software, version 4.0.2.

RESULTS

A total of 45 patients who underwent APR were identified and included in the study; 31 (68.9%) were managed with CiNPT.

Table 1 provides a detailed summary of patient characteristics for the control and treatment groups. There was no statistical difference in demographic variables between the 2 groups.

Wound complications (major and minor) occurred in 20 patients (44.4%). In the CiNPT group, 10 of 31 (32.3%) patients experienced perineal wound complications, whereas in the control group, 10 of 14 (71.4%) patients did ($\chi_1^2 = 5.99$; $p = 0.01$).

Control Group

In the control group, 9 patients had major wound infections. One of these patients, undergoing rehabilitation at another facility, opted for flap reconstruction within the first few months. Seven patients who developed major wound infections were managed with open wound VAC. One patient required antibiotics and daily dressing changes with packing.

Only 1 patient had a minor wound infection that healed within 2 weeks with local wound care.

TABLE 1. Patient characteristics of the control and CiNPT groups

Characteristics	*Control (n = 14)*	*CiNPT (n = 31)*	*p*
Age (y), mean (SD)	67.9 (8.0)	61.9 (11.6)	0.05
Male	9 (64.3)	16 (51.6)	0.43
Female	5 (35.7)	15 (48.4)	
BMI (kg/m^2), mean (SD)	28.6 (8.2)	26.3 (5.0)	0.35
Albumin (g/dL), mean (SD)	3.2 (0.8)	3.2 (0.7)	0.74
Smoker			
No	5 (35.7)	11 (35.5)	0.92
Yes	4 (28.6)	7 (22.6)	
Former	5 (35.7)	13 (41.9)	
Preoperative IBD			
No	12 (85.7)	25 (80.6)	>0.99
Yes	2 (14.3)	6 (19.4)	
Diabetes			
No	10 (71.4)	24 (77.4)	0.23
Yes	4 (28.6)	7 (22.6)	
ASA			
1	0 (0.0)	0 (0.0)	
2	1 (7.1)	7 (22.6)	0.12
3	13 (92.9)	19 (61.3)	
4	0 (0.0)	5 (16.1)	
Other preoperative malignancy			
No	11 (78.6)	24 (77.4)	>0.99
Yes	3 (21.4)	7 (22.6)	
Neoadjuvant therapy			
No	6 (42.9)	13 (41.9)	0.96
Yes	8 (57.1)	18 (58.1)	
Steroid use			
No	12 (85.7)	26 (83.9)	>0.99
Yes	2 (14.3)	5 (16.1)	
Indication			
IBD	2 (14.3)	5 (16.1)	
Anal canal cancer	2 (14.3)	1 (3.2)	0.42
Rectal cancer	9 (64.3)	24 (77.4)	
Other	1 (7.1)	1 (3.2)	
Surgical technique			
Open	10 (71.4)	15 (48.4)	0.15
Minimally invasive surgery, laparoscopic/robotic	4 (28.5)	16 (51.6)	

Values expressed as n (%) unless otherwise noted.
p value denotes the Pearson χ^2 test, Fisher exact test, and 2-sample t test.
CiNPT = closed incision negative pressure therapy.

At 180-day follow-up, 4 patients with major wound infections had healed. Four required prolonged wound care. Three healed at 8 months, 10 months, and 1 year, respectively. One patient with anal canal cancer died from stage IV disease.

Closed Incision Negative Pressure Therapy Group

In the CiNPT group, 8 patients had major and 2 had minor wound complications. The 2 patients with minor wound complications required the removal of a few sutures and daily dressing changes. Their wounds healed within 2 weeks.

Among patients with major wound infections, 1 patient had a positive wound culture and was managed with daily dressing changes and oral antibiotics. The wound closed within 6 weeks of surgery. Another patient

had a 3-cm wound separation that was managed with daily dressing changes, and it closed in the second month. Another patient required enzymatic debridement and wound packing. Three patients with major wound complications were managed with an open wound VAC.

At 180-day follow-up, the perineal wounds of 6 patients had completely healed. One patient with severe fistulizing perianal disease (secondary to IBD) healed at 13-month follow-up. This patient required a combination of wound packing and open wound VAC. A second patient with locally advanced rectal cancer underwent extralevator APR, progressed to stage IV disease, and required palliative chemotherapy. This patient's wound eventually healed at 2 years.

The implementation of CiNPT was associated with the severity of infection (no infection, 21/31 [67.7%]; minor, 2/31 [6.5%]; major, 8/31 [25.8%]; $p = 0.03$; Table 2). Based on the proportional odds model results, the estimated odds of a patient with CiNPT with severe infection is about 0.19 times the odds for those managed with conventional care (model 2). That is, patients with CiNPT are less likely to have a severe infection (crude OR 0.19 [95% CI, 0.05–0.69]; $p = 0.01$).

The results of the simple logistic regression analysis using crude ORs are shown in Table 3. Preoperative diagnosis of IBD and steroid use were positively associated (OR > 1; $p < 0.20$). Additionally, the OR shows that the use of CiNPT has a negative association with wound complication occurrence. In other words, the use of CiNPT is less likely to be associated with wound complication (crude OR 0.19 [95% CI, 0.04–0.72]; $p = 0.02$).

The results of multiple logistic regression analysis demonstrated that implementation of CiNPT and preoperative IBD were significant factors that affected the risk of wound complications. Specifically, implementation of CiNPT had an 85% decrease in the odds of wound complication than conventional care when the effect of preoperative IBD was controlled (adjusted OR 0.15 [95% CI, 0.03–0.60]; $p = 0.01$; Fig. 1). Also, patients were more likely to have wound complications if they had a history of preoperative IBD (adjusted OR 7.16 [95% CI, 1.26–59.48]; $p = 0.04$) when the implementation of CiNPT was considered.

TABLE 2. Incidence and severity of wound complication for the control and CiNPT groups

Outcomes	*Control (n = 14)*	*CiNPT (n = 31)*	*p*
Perineal wound complications	10 (71.4)	10 (32.3)	0.01
Severity of wound infection			
Major infection	9 (64.3)	8 (25.8)	0.03
Minor infection	1 (7.1)	2 (6.5)	
No infection	4 (28.6)	21 (67.7)	

p value denotes the Pearson χ^2 test and Fisher exact test.
CiNPT = closed incision negative pressure therapy.

TABLE 3. Results of the simple logistic regression analysis: unadjusted ORs with 95% CI associated with the wound complication outcome

Characteristics	*Crude OR*	*95% CI*	*p*
Age (y)	1.02	0.97–1.09	0.39
Sex			
Male	Reference		0.50
Female	1.50	0.46–5.01	
BMI (kg/m^2)	1.05	0.95–1.17	0.35
Albumin (g/dL)	0.73	0.31–1.65	0.45
Smoker			
No	Reference		0.41
Yes	2.64	0.55–13.82	
Former	2.20	0.55–9.50	
Preoperative IBD			
No	Reference		0.07
Yes	4.93	0.98–36.96	
Diabetes			
No	Reference		0.27
Yes	2.44	0.52–13.42	
ASA			
2	Reference		0.68
3	1.33	0.27–7.35	
4	1.61	0.54–5.00	
Other preoperative malignancy			
No	Reference		0.69
Yes	1.33	0.32–5.62	
Neoadjuvant therapy			
No	Reference		0.35
Yes	0.56	0.17–1.85	
Steroid use			
No	Reference		0.14
Yes	3.83	0.73–29.27	
Surgical technique			
Open	Reference		0.50
Minimally invasive surgery, laparoscopic/robotic	1.5	0.46–5.01	
Use of CiNPT			
No	Reference		0.02
Yes	0.19	0.04–0.72	

p value denotes Wald test.
CiNPT = closed incision negative pressure therapy.

DISCUSSION

Perineal wound management continues to be a significant problem after APR. Wound complications are associated with increased healthcare costs, decreased quality of life, and poor survival. Hawkins et al[15] noted that the adjusted risk of death was 1.7 times higher in patients who experienced wound dehiscence than in those who did not. There is no clear consensus on how to mitigate complication rates in this patient population; however, most recent studies suggest a reduced rate of perineal wound complications with the use of CiNPT. Although several CiNPT case-controlled and prospective randomized studies have demonstrated favorable outcomes in different wound types across specialties,[16–18] there is limited literature regarding its application to perineal wounds. International multidisciplinary consensus recommendations published in the

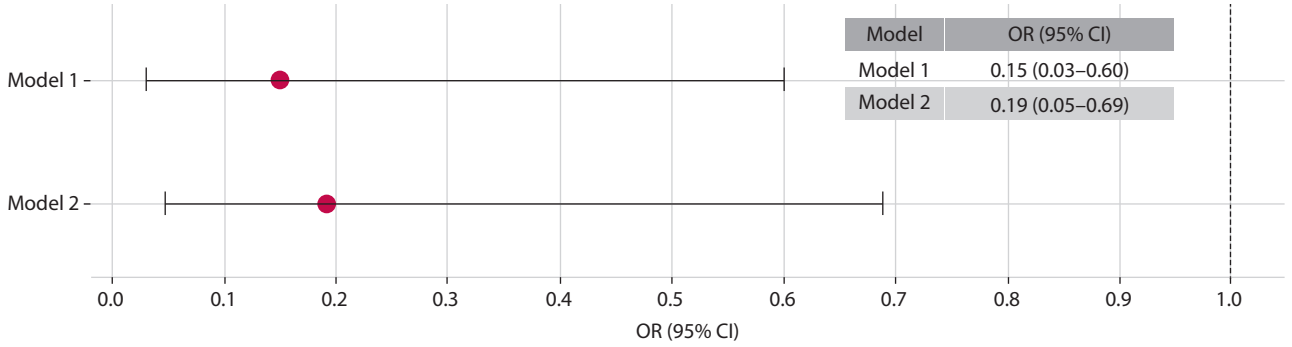

FIGURE 1. Multiple logistic model and proportional odds model. All models evaluated the association between implementation of the CiNPT and wound complication. Model 1 depicts multiple logistic regression analysis adjusted for a control variable, preoperative IBD. Model 2 depicts proportional odds model analysis of severity of wound complication with the use of CiNPT. CiNPT = closed incision negative pressure therapy.

International Wound Journal in May 2016 recommended that surgeons should consider using CiNPT for high-risk patients and procedures.[19]

Colorectal procedures, especially APR, are among the surgical interventions with the highest wound complication rates. The perineal wound is particularly vulnerable because of the large dead space created after surgery that is conducive to fluid accumulation and bacterial overgrowth. Fixed pelvic outlet and significant comorbidities in patients who undergo APR further increase the chances of wound complications. The literature suggests that negative pressure wound therapy for approximated incisions reduces wound complications because of the positive impact on wound healing.[20] CiNPT reduces hematoma or seroma formation not only through the removal of fluids but also through increased lymph clearance from the dead space.[20–22]

There is no consensus for optimal management of perineal wounds following APR. In our practice, we used primary closure of the perineal wound with a standard dressing until 2015. Our use of primary closure unassisted with negative pressure was associated with a high complication rate. Although we have included even clinically insignificant perineal wound complications, we accept that our complication rate may be higher than what would be expected. This is what led to a change in our practice with the implementation of CiNPT and was further reinforced by a large retrospective case series published by Chadi et al[23] that demonstrated a decrease in the perineal wound complications with the use of CiNPT. However, when only major wound infections are considered, our rate of wound complications is similar to those found in the literature.[3,4,8,12,24,25]

Our study includes 45 patients and is one of the largest series, given the paucity of literature. We noted decreased perineal wound complication rates with CiNPT (32.3% versus 71.4%). Implementation of CiNPT was associated with an 85% decrease in the odds of developing wound complications when the effect of other variables was controlled. The vast majority of major wound complications in the CiNPT group (6/8 patients) had completely healed at 180-day follow-up. None of these patients required readmission or reoperation. This was in contrast to the control group, in which 1 patient required reoperation and 4 patients had open wounds at 180 days requiring prolonged wound care. These results demonstrate the positive impact of CiNPT on reducing the overall incidence and severity of perineal wound complications after APR.

Even though wound complications were reduced with CiNPT, the absolute rate of wound complications is at the upper range of reported rates. However, we included all wound complications, including those that were clinically insignificant. It is also pertinent to mention that effective sealing of the system against leakage was a problem in females, which may have compromised the therapy. No such problem was encountered in male patients. Six of 8 patients with major wound complications in the CiNPT group were females. We were initially using a 13-cm peel and place dressing; however, we have more recently transitioned to a customizable dressing that provides hydrocolloid sealing strips that seem to be working better for female patients.

Several studies have reviewed the risk factors that predispose patients to perineal wound complications following APR. Christian et al[26] found that patients with IBD and anal cancer were at higher risk than those with rectal cancer. Additionally, the study found that preoperative radiation and primary closure were not associated with increased complications. Most other studies that have reviewed risk factors have specifically focused on rectal cancer; however, as demonstrated in our study, other factors can increase the risk. We analyzed the risk factors for perineal wound complications and noted that steroid use and preoperative IBD diagnosis were associated with a higher risk. Our study found IBD was a significant

independent predictor of the likelihood of developing complications. Several other factors that are traditionally linked to increased risk of perineal wound complications were not significant in our study. The number of cases in each of these subgroups is small and more patients may be required to truly evaluate the statistical significance.

The application of CiNPT is generally simple and safe with a low risk of side effects. We did not note any complications with the use of CiNPT. However, the clinical relevance of an innovation is no longer enough to justify the acquisition of a novel technique. These techniques have to be economically favorable to a value analysis committee. The initial cost of the therapy (dressing, $379; disposable pump, $350) is significantly higher than the standard gauze dressing, possibly limiting the widespread application. A cost-utility analysis performed by Chopra et al[27] demonstrated an estimated saving of $1546.52 and a gain of $0.0024 quality-adjusted life year with the use of CiNPT. We did not perform a cost-utility analysis; however, we demonstrated decreased incidence and severity of complications with the use of CiNPT, which may justify the cost of therapy. Further studies are needed to determine the cost-effectiveness.

This study has several limitations. The retrospective nature of the study is subject to selection bias. Classification of wound infections into major and minor is arbitrary. However, our study has a significant advantage of consistency of surgical technique, preoperative care, and perineal wound management given that this is a single-surgeon study.

CONCLUSION

Perineal wound complications are frequent after APR. CiNPT is a safe and effective method for the management of perineal wounds following APR. The ease of application and the overall reduction in the incidence and severity of perineal wound complications may offer an option for wound management and possibly obviate the need for more expensive therapies. Further prospective controlled trials are required to effectively study the efficacy of CiNPT.

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