Takefumi Mori,[1,2] Shinichi Sato,[1,2] Ikuko Oba-Yabana,[1,2] Takuo Hirose,[1] Satoshi Kinugasa,[1] Yoshikazu Muroya,[1] Kohei Ota,[1] Shingo Nakayama,[1] Hannah Nakamura,[1] Junichi Tani,[1] Chika Takahashi,[1,2] Sadayoshi Ito[2]

Better Healing of the Exit Site with Negative-Pressure Wound Therapy

Exit-site infection poses a risk for peritonitis and can shorten peritoneal dialysis (PD) vintage. A loose fit of the skin around the catheter at the exit site can push bacteria surrounding the catheter into the subcutaneous tunnel. Negative-pressure wound therapy (NPWT) has been used to hasten healing of the wound after an operation or to treat pressure ulcers. We hypothesized that NPWT could speed the healing of the exit site and tighten the fit of the skin around the catheter. Using a V.A.C. Therapy system [vacuum-assisted closure (KCI, San Antonio, TX, U.S.A.)], NPWT was therefore applied in 9 patients for 1 – 2 weeks after the PD catheter insertion operation. Results in those patients were compared with results in patients who did not receive NPWT.

The healed exit site was classified as either tightly fitted (when the skin was tightly connected around the PD catheter) or loosely fitted (when the skin was not tightly connected around the catheter). The relevant data were retrieved from the medical record and analyzed retrospectively.

Patients who received NPWT had a tight exit site after 1 – 2 weeks. Those who did not receive NPWT did not have a tight exit site after 1 – 2 weeks. No bleeding was observed in patients receiving NPWT. Bleeding from the exit site after the catheter insertion operation was observed in 3 patients not receiving NPWT.

Because we use a fine trocar to make the subcutaneous catheter tunnel, bleeding from the vasculature can often be observed. That bleeding could be minimized with the application of NPWT. Negative pressure could also hasten wound healing and result in a tight fit of the skin around the catheter within in 1 – 2 weeks compared with the 1 month typically required with the use of conventional film dressings.

Negative-pressure wound therapy is beneficial for creating a tight fit of the skin to the catheter within 1 – 2 weeks and might reduce the number of exit-site and tunnel infections, which could result in a reduction in the peritonitis rate.

Key words
Exit site, wound therapy, negative pressure

Introduction

Peritoneal dialysis (PD) is a home-based dialysis therapy that enables continuous dialysis with self-care by the patient. However, certain pitfalls can make PD difficult to continue. Exit-site infection is a common complication that appears as redness at the exit site and in the subcutaneous tunnel surrounding the PD catheter. If the infection around the catheter progresses toward the peritoneal cavity, the PD patients can experience an episode of peritonitis. Thus, exit-site infection is a risk for peritonitis and could shorten the patient's duration on PD (1).

Although various mechanisms are involved in the pathogenesis of exit-site and tunnel infections, loose fit of the skin surrounding the exit site is a common reason for exit-site infection. Loose fit of the skin around the catheter at the exit site can push bacteria surrounding the catheter into the subcutaneous tunnel (2). To create a tight fit of the skin around the catheter, tight bandaging is required for several weeks or months. We have been using film-type dressings over the catheter from two sides for a month after catheter placement surgery. However, patients sometimes complain that the bandage irritates the skin.

Negative-pressure wound therapy (NPWT) is a well-established technique used to hasten healing of the wound after an operation or to treat pressure ulcers (3). The negative pressure applied to

From: [1]Division of Nephrology and Endocrinology, Tohoku Medical and Pharmaceutical University, Sendai, Japan; [2]Division of Nephrology, Endocrinology, and Vascular Medicine, and [3]Division of Integrated Renal Replacement Therapy, Tohoku University Graduate School of Medicine, Sendai, Japan.

the wound, which is covered with sponge material, protects the wound from bacteria, removes exudate and infectious waste, promotes formation of granulation tissue, and results in progression of wound healing (4).

Because we use a fine trocar to make the subcutaneous catheter tunnel, bleeding from the vasculature can often occur. We hypothesized that NPWT might shorten the healing of the exit site and result in a tight fit of the skin surrounding the catheter. Here, we report a series of 9 patients in whom we used NPWT for rapid creation of a tight exit site.

Methods

Patients

Our observational study included 12 patients who were introduced to PD at Tohoku Medical and Pharmaceutical University Hospital or Tohoku University Hospital. All patients used neutral glucose-based PD solution or icodextrin, or both. No patients used acidic glucose-based PD solution. Patients in whom NPWT had to be discontinued because of severe leakage of PD fluid through the tunnel or re-operation because of catheter obstruction was excluded. No patient experienced peritonitis during the study period.

All human studies were performed according to the principles of the Declaration of Helsinki, and all protocols were approved by the institutional ethics committee.

Use of NPWT

After a PD catheter insertion surgery or a change in the exit site because of a tunnel infection, NPWT was applied using a V.A.C. Therapy system [vacuum-assisted closure (KCI, San Antonio, TX, U.S.A.)] (5). As shown in Figure 1, the surgical wound and the exit site were covered with a sponge and tightly sealed with transparent film. Negative pressure was then applied through a hole in the film by tubing running from a V.A.C. therapy machine. The V.A.C. system was applied for 1 – 2 weeks, and the system was changed every week (Figure 1).

The exit site was classified, as established Twardowski *et al.* (5), as tightly fitted (when the skin was tightly connected around the PD catheter) or loosely fitted (when the skin was not tightly connected around the catheter). Patient data were retrieved from the medical record and analyzed retrospectively.

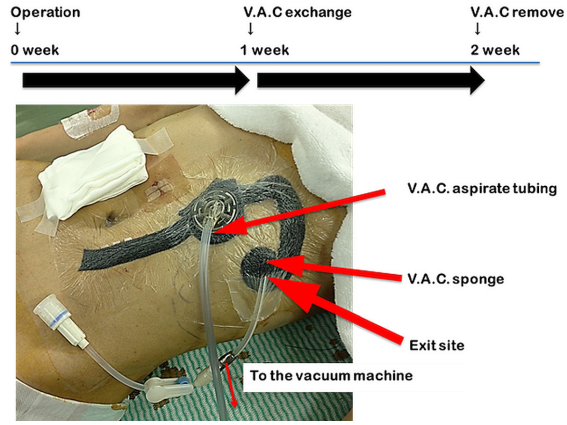

FIGURE 1 Negative-pressure wound therapy using a V.A.C. Therapy system [vacuum assisted closure (KCI, San Antonio, TX, U.S.A.)]. The catheter insertion and exit-site wounds were covered with a sponge and tightly sealed with transparent film. Negative pressure to the sponge was applied through the aspiration tubing attached to the vacuum machine. The sponge was exchanged at 1 week and removed at 2 weeks after the operation.

Statistical analysis

Statistical significance was determined by the Fisher exact test in the JMP software application (version 12: SAS Institute, Cary, NC, U.S.A.).

Results

Characteristics of the patients

Table I summarizes the characteristics of the patients and their catheter placement surgeries. The 6 men and 3 women who agreed to receive NPWT (4 with diabetes) had an average age of 57.1 ± 6 years. Of those 9 patients, 6 were undergoing PD catheter insertion; 2 were having an exit site change; and 1 patient was undergoing catheter re-insertion after a tunnel infection.

Rapid creation by NPWT of a tight exit site was observed in 7 of 9 patients at 1 week and in all patients at 2 weeks. Compared with patients who did not receive NPWT, those who received NPWT had a tight exit site after 1 – 2 weeks ($p < 0.05$). Those who did not receive NPWT did not have a tight exit site after 1 – 2 weeks. Bleeding from the exit site was observed in patients who did not receive NPWT, but not in patients who received NPWT. No difference between the groups in exit-site score as established by Twardowski *et al.* was observed ($p = 1.00$).

TABLE I Characteristics of the study patients and their operations

Patient received negative-pressure wound therapy?	*Sex*	*Age (years)*	*Diabetes*	*Operation*	*VAC duration (weeks)*	*Bleeding*	*Leak*	*Exit site assessment [score (status)]*			
								Day 0	*Week 1*	*Week 2*	*Month 1*
Yes											
1	M	80	Yes	Catheter insertion	2	No	No	0 (loose)	1 (tight)	0 (tight)	0 (tight)
2	F	57	No	Exit-site change	2	No	No	0 (loose)	1 (tight)	0 (tight)	0 (tight)
3	M	77	No	Catheter insertion	2	No	No	0 (loose)	1 (tight)	0 (tight)	0 (tight)
4	F	40	No	Exit-site change	2	No	No	0 (loose)	1 (tight)	0 (tight)	1 (loose)
5	M	54	No	Catheter insertion	2	No	No	0 (loose)	1 (tight)	0 (tight)	0 (tight)
6	M	56	Yes	Catheter insertion	2	No	Yes	0 (loose)	3 (loose)	1 (tight)	0 (loose)
7	F	62	Yes	Catheter insertion	2	No	No	0 (loose)	2 (loose)	0 (tight)	0 (tight)
8	M	37	Yes	Catheter re-insertion	2	No	Yes	0 (loose)	1 (tight)	0 (tight)	0 (tight)
9	M	51	No	Catheter insertion	2	No	No	0 (loose)	1 (tight)	0 (tight)	0 (tight)
No											
1	M	69	Yes	Exit-site change	—	Yes	No	0 (loose)	1 (loose)	0 (loose)	0 (tight)
2	M	62	Yes	Exit-site change	—	Yes	No	0 (loose)	1 (loose)	0 (loose)	0 (loose)
3	M	48	Yes	Catheter insertion	—	Yes	No	0 (loose)	1 (loose)	2 (loose)	3 (loose)

VAC = vacuum-assisted closure; M = male; F = female.

As Figure 2 shows, the skin and subcutaneous tissue of the tunnel and exit site followed the catheter when the PD catheter was pulled. Significant improvements in exit-site classification ($p < 0.05$ compared with the score at day 0) and tightness of the exit site ($p < 0.05$) were observed (Table I).

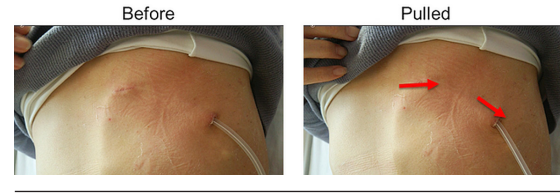

FIGURE 2 Tight exit site after 1 week of negative-pressure wound therapy using a vacuum-assisted closure system. The skin and subcutaneous tissue around the catheter is tightly connected and remains connected when the catheter is pulled.

Discussion

In the present study, we set out to determine whether NPWT is beneficial for creation of a tight PD catheter exit site. With NPWT, a tight exit site was observed as soon as 1 week after catheter placement surgery. Our study demonstrates for the first time that NPWT can hasten wound healing by applying V.A.C. Therapy to the wound around the exit site and that it could be beneficial for exit-site creation not only for PD catheter placement, but also for an exit-site change.

Mechanism of NPWT

Application of NPWT has been used in many types of wounds, such as surgical incisions (6), open abdomen (7), pressure ulcers (8), skin grafts (9), diabetic ulcers (10), and venous leg ulcers (11). The beneficial effect of NPWT has been considered to be produced by various mechanisms (12). Based on earlier studies, Figure 3 summarizes the proposed mechanisms for the benefit seen in exit-site creation. First, the wound is protected from bacteria by the sponge covering and removal of bacteria by the negative pressure. Second, negative pressure also removes exudate and infectious waste. Third, the pressure is also compressing the small vessels and thus controlling bleeding after surgery. Third, tight attachment of the catheter to the tissue hastens wound healing, resulting in a tight fit of the skin surrounding the catheter within 1 – 2 weeks. The same result takes nearly 1 month when the exit site is covered with a conventional film dressing. The leaks of PD fluid that are sometimes observed within 1 week of PD catheter insertion might also be reduced with NPWT.

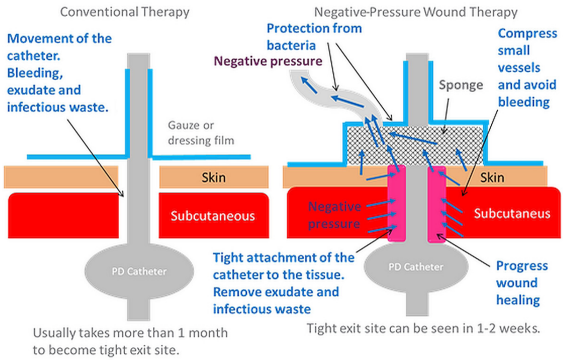

FIGURE 3 Mechanism of negative-pressure wound therapy in the creation of a tight exit site. The sponge over the exit site protect it from bacteria, and negative pressure applied to the sponge removes exudate and infectious waste and compresses small vessels, thus avoiding bleeding. The tissue is thus tightly attached to the catheter, and wound healing is hastened.

Cost effects of NPWT

Although the cost of NPWT cannot be neglected, the technique has been reported to be cost-effective in hernia operations (13). We therefore believe that V.A.C. Therapy is a cost-effective therapy in exit-site creation, because the costs for future admissions to the hospital for patients who experience severe exit-site or tunnel infection and peritonitis could be much greater. Although there is a direct cost of NPWT during wound healing, the technique has the potential to increase a patient's duration on PD and might save the cost of a switch to hemodialysis.

Limitations and future directions

Although we have demonstrated that NPWT is beneficial for the creation of a tight exit site, the present study was observational only, not a randomized controlled trial. Future study into whether creation of a tight exit site with NPWT indeed reduces the rate of exit-site or tunnel infections and of peritonitis is required.

Conclusions

Negative-pressure wound therapy is beneficial for tightly fitting the skin around the catheter within 1 – 2 weeks and might reduce the number of exit-site and tunnel infections, which could result in a reduction of the peritonitis rate.

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Disclosures

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Corresponding author:
Takefumi Mori, MD PhD, Division of Nephrology and Endocrinology, Tohoku Medical and Pharmaceutical University, 1-15-1 Fukumuro, Miyagino-ku, Sendai 983-8536 Japan.
E-mail:
tmori@tohoku-mpu.ac.jp