Abstract: Background. The use of negative pressure in the dressing of split-thickness skin grafts has been shown to promote healing by a variety of mechanisms, including a decrease in interstitial edema, an increase in perfusion, and a decrease in bacterial colonization. Methods. An observational study was performed on 52 patients at the Department of Plastic Surgery, University of Perugia in Perugia, Italy, undergoing split-thickness skin grafting for acute wounds after trauma and for chronic wounds, such as pressure ulcers and diabetic wounds. The dressing used consisted of a single foam sheet, a conventional disposable closed-system suction drain, and an adhesive dressing. Results. In all patients, there was a 95% take of the graft, with 5% of partial loss. There were no significant complications encountered. Conclusions. Negative pressure wound therapy is an innovative and commercially successful concept for the management of difficult-to-treat wounds of nearly every etiology, and the authors’ technique is an alternative to commercially available negative pressure dressings.

Key words: negative pressure skin graft, wound closure

Acute and chronic wounds affect at least 1% of the population. Regardless of etiology, wounds are difficult to treat if coexisting factors such as infection or diabetes mellitus prevent regular wound healing. Modern wound-healing concepts include different types of moist dressings and topical agents, although only a few of these treatments have convincingly been shown to give higher wound closure rates compared with traditional wound dressings. Over the past 50 years, clinicians have described how certain wounds respond to subatmospheric pressure used within a closed dynamic delivery system. The vacuum-assisted closure device has revolutionized wound care since its first introduction in 1997. This relatively new technique, developed by Argenta and Morykwas to expedite wound healing by secondary intention, is based on the principle of application of controlled negative pressure wound therapy (NPWT), often called topical negative pressure (TNP). It is effective for treating acute, chronic, and infected wounds, to prepare a wound for skin grafting, and to promote subsequent graft adherence. It has been reported to increase local vascularity and the rate of formation of granulation tissue, and a reduction in interstitial edema and bacterial contamination, ensuring intimate

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contact between foam dressing, graft, and recipient wound bed. However, such techniques require surgical skill and experience to make the skin graft adhere securely to the grafting site, and it does not always provide satisfactory results in some difficult body areas, with poor skin graft-taking as an outcome. Several companies are now able to offer devices that deliver NPWT, giving greater choice to health care authority decision-makers.

Materials and Methods

Between January 2007 and February 2012 at the Department of Plastic, Reconstructive and Aesthetic Surgery, University of Perugia, Perugia, Italy, 52 patients received wound management with NPWT after a split-thickness skin graft. Their medical records were evaluated and efficacy was assessed using the following primary outcome measures: wound-healing time, granulation rate, change in wound surface and volume (calculated with the Xakellis and Frantz method), pain, bacterial clearance, total costs, and time of nursing staff involvement. Secondary outcome measures included adverse effects and comfort. Exclusion criteria were the use of steroid drugs, deep fistulas, sepsis, underlying osteomyelitis, active bleeding, patients younger than 18 years, and psychiatric patients. All patients gave written informed consent.

Skin grafts were managed with the use of a soft polyurethane sponge as a compressive tool and a staple fixation technique for skin grafts. This had several advantages over a traditional tie-over dressing including quick application, good adaptation, and the ability to more evenly distribute pressure across the wound.

A paraffin gauze was individually trimmed and shaped to make close contact with all wound surfaces and placed over the wound or skin graft, then a sterile porous latex foam dressing was applied. A second foam dressing containing a wound drainage tube (Medinorm, Quierschied, Germany) was then added. The drainage tube was inserted into the foam using a trocar; all drainage holes were positioned to lie within the foam (Figure 1). The wound was then covered with a semiocclusive dressing (Opsite, Smith and Nephew, Hull, UK) (Figure 2a-b). The drainage tubing was placed over a gauze swab and within the semiocclusive dressing to ensure a good seal and to avoid ischemic necrosis of the skin. Any hair at the wound site was shaved to facilitate subsequent removal of the dressing. A continuous negative pressure of 50-100 mmHg was applied using a low-pressure suction pump or wall suction with a pressure-reducing valve (Figure 3). A standard vacuum drainage bottle can be used once the patient is mobile (Figure 4). It is important that an airtight peripheral seal be maintained. Small leaks may be patched with further semiocclusive dressing. Wounds being prepared for grafting should have the dressing changed, by doctors or trained nurses, every 48 hours, as granulation tissue may penetrate into the pores of the foam dressing. If the wound is infected, the dressing should be changed every 12 hours. A dressing over a skin graft should be left for 5 days.
before the first inspection. In the author’s practice, this technique has proved effective for short-term inpatient management. It is important to examine the tubing system regularly because it may be obstructed by blood clots.

Results

Fifty-two patients (40 males and 12 females), mean age 42 years, were managed with this method after a skin graft. In the 41 patients with traumatic defects and with diabetic wounds, the skin grafts survived completely with no troubles. The skin-graft survival in the 11 burned patients was almost complete; there were some small areas of vascular insufficiency that finally healed completely. There were no cases of infection or hematoma. One disadvantage of this method was the increased difficulty of flap monitoring when the flap was completely covered by the NPWT device. In 7 patients, the authors performed flap monitoring by handheld Doppler examination of the pedicle, which was tunneled subcutaneously from the anastomotic site to the muscle flap. Often, arterial and venous signals can be differentiated from each other. Care must be taken to confirm, intraoperatively, that the pulsations noted are from the flap pedicle rather than an adjacent in situ blood vessel. An implantable flap monitoring device, such as the Cook-Swartz implantable Doppler (Cook Vascular Inc, Vandergrift, PA), was also used where handheld Doppler examination was not practical, or the signal could not easily be confirmed. The authors considered leaving a window in the center of the black foam, but the flap would still need to be covered with a nonadherent dressing to prevent sticking of the plastic dressing to the skin graft, which would interfere with physical examination of the flap. No superficial skin reaction to latex or polyurethane were observed in these patients, only minor skin reactions due to the adhesive drape.

Discussion

During the past decade, NPWT has become a common treatment of acute and chronic wounds. The granulation tissue formed with this technique is high quality, rich in capillaries, and totally suitable to manage a skin graft. In the authors’ opinion, it should be noted that NPWT may have striking benefits in the treatment of some diseases (ie, complex reconstructions in plastic surgery), for which it may be impossible to conduct other treatments.14-20 Moreover, NPWT is an innovative and commercially successful concept for the management of difficult-to-treat wounds of nearly every etiology. In addition to worldwide marketing, the authors believe that the most important reasons for the success of NPWT are its assumed safety and the facilitation of wound care. In their experience NPWT has yielded significantly lower nursing staff costs and less time involvement, patients are more comfortable, and there is less risk of cross-infection than treatment with modern wound dressings.13 In addition, the technique used in this case series is based on the same principles as the expensive, commercially available vacuum-assisted closure systems.11-13 Therapy price per day for a commercially available NPWT system (V.A.C. ATS Therapy System, KCI, San Antonio, TX) is 70 €, including rental of the pump (42 €). The total price of the equipment used for 1 dressing change in the method used in this study is approximately 16 €. If dressings are changed twice weekly, the daily cost becomes less than 5 €, making the commercial method more than 10 times as expensive to use. When the study technique is used to promote graft take, according to literature, the authors have noted excellent results by day 3 and the dressing can usually then be discontinued, decreasing the time of immobilization and shortening the patients’ hospital course.17 The authors have also used this method to improve graft take at acute wounds, such as the free tissue donor sites of
the radius and the fibula, both of which are susceptible to delayed healing and wound breakdown. As advocated by Morykwas et al, the only contraindication to the use of this technique is the limited possibility of performing an intermittent treatment. However, the importance of this has not been clarified in clinical studies, and intermittent treatment can often lead to increased pain.

**Conclusion**

The authors think this technique represents a major advance in wound care and recommend its use, although more research is needed to confirm results since there are contrasting opinions in the literature. The disadvantage of this system is that it can only be used for hospitalized patients, and it should, therefore, be reserved for patients confined to the hospital for reasons other than wound treatment alone. In summary, this study of 52 patients with different kinds of wounds showed the authors’ NPWT technique is an efficient alternative to the commercially available, branded systems and, as already demonstrated in the literature, is safe, efficient, and more convenient-to-use than conventional treatments for healing split-thickness skin grafts.

**References**