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An Overlooked but Effective Wound Care Methodology: Hydromechanical Therapy Revisited

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Summary: Chronic wounds are frequently difficult, expensive to treat, and pose a significant burden on both the patient's quality of life and health care system. Their recalcitrance to treatment stems from multiple factors, particularly the presence of bacterial biofilms within the wound bed. However, a commonly overlooked modality in the field of wound care, pressurized irrigation, offers an inexpensive mechanical debridement force capable of dislodging these biofilms that contribute to delayed healing of chronic wounds. We present here a single clinical case of a difficult nonhealing wound that had previously failed 3 months of negative-pressure wound therapy, a much more expensive modality. This chronic plantar foot wound was treated with daily application of hydromechanical therapy using tap water at home. It achieved a stable granulation surface, and with a small skin graft, healing with no recurrence seen at 15-month follow-up. We speculate that a combination of tissue stimulation and disruption of the wound surface biofilm contribute to improved healing, supporting a reevaluation for the use of pressurized irrigation in the treatment of chronic wounds. *(Plast Reconstr Surg Glob Open 2018;6:e1883; doi: 10.1097/GOX.0000000000001883; Published online 3 August 2018.)*

INTRODUCTION

The care of chronic wounds often presents a difficult challenge for health care practitioners due to their resistance to many of the current modalities and approaches to treatment. Presently, chronic wounds negatively affect patients' quality of life in addition to incurring a huge financial burden on the U.S. health care system of over $25 billion per year.[1]

Frequently, bacterial biofilms are a major offender in the delayed healing of chronic wounds through production of bacterial proteases and disruption of host immune cellular function.[2–4] As a result, wounds persist in a state of chronic inflammation without progressing to stable healing. Pressurized irrigation offers a solution through its ability to mechanically debride and reduce bacterial colonization.[5,6] It offers an inexpensive and easy to administer method of treating chronic wounds that can be accomplished in any wound treatment environment. Additionally, it offers further opportunities for cost savings through the use of tap water as an irrigation solution, as tap water has not been associated with increased risks for infection when compared with sterile saline.[7]

Despite its efficacy and potential for cost savings, the field of wound care has frequently overlooked hydromechanical therapy for more expensive, often less effective modalities. In this article, we present a single clinical case treated with hydromechanical therapy using tap water. We intend to demonstrate that this traditional and inexpensive modality can promote significantly improved healing in nonhealing chronic wounds that have failed other more conventional and costly approaches.

CASE EXAMPLE

A 67-year-old ambulatory patient from the author's practice with severe peripheral neuropathy and type I diabetes on insulin pump, with relatively good glycemic control, presented with a large chronic plantar foot wound (6.5×10 cm) with significant plantar tendon and metatarsal head exposure that had failed 3 months of negative pressure therapy (Fig. 1). The patient self-administered twice daily 5-minute hydromechanical debridements using a home hand-held showerhead with tap water and wet-to-moist dressing changes. Degree of pressure administered was adjusted by the patient based on what flow of water was tolerable, minimizing pain and potential tissue damage while strong enough to dislodge devitalized tissue and adherent bacteria. No antibiotic was required. Within 2 months, the wound had significantly improved

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Fig. 1. This is a 67-year-old type I diabetic patient with a large chronic plantar foot wound with significant plantar tendon and metatarsal head exposure (A). Hydromechanical treatment with daily home tap water irrigation was performed. By 2 months, there was healthy granulation tissue formation (B), and the wound was subsequently grafted with a full-thickness skin graft (C) with eventual full healing (D).

with healthy granulation tissue formation and was subsequently grafted with a full-thickness skin graft (2.5×7 cm). At 15-month follow-up, the wound had achieved stable healing with no recurrence.

DISCUSSION

We have presented here a representative case of a nonhealing chronic wound that achieved stable healing through the use of hydromechanical therapy, despite previous failed attempts with negative pressure wound therapy. Hydromechanical therapy has been utilized in operating rooms and emergency departments for years but offers an important asset to the field of chronic wound care through its ability to mechanically debride and cleanse wound surfaces.[8–10] Additionally, this inexpensive and easily administrable modality exerts repetitive mechanical forces through continuous impact that is thought to promote tissue regeneration and achieve wound healing.[11]

Currently, mechanical pressurized irrigation is primarily utilized in hospital settings for its ability to disrupt bacterial adherence and devitalized tissues,[12,13] but its ease of application and minimal ancillary resources required to administer the therapy offer a convenient and affordable option for patients in the outpatient setting. Furthermore, while sterile saline irrigation is the most commonly used irrigation solution, other various cleansing solutions, such as tap water, have been suggested with studies reporting no significant difference in clinical infection rates in their treatments of acute wounds[7,14,15] or chronic wounds.[16] This offers an enormous opportunity to reduce costs associated with the care of chronic wounds.

Biofilms are a relatively new concept in the field of chronic wound treatment and consist of complex microbial communities embedded in a protective extracellular polymeric substance secreted by each biofilm bacteria.[17] Current research suggests that while mechanical debridement is the best way to remove biofilm, any residual pathogen

can reconstitute the biofilm within days.[18,19] Unfortunately, while other popular chronic wound care modalities may promote tissue regeneration and decrease bacterial counts, including negative pressure wound therapy, they do not involve a frequent daily mechanical debridement force. Hydromechanical debridement, however, provides a potential mechanism for dislodging both devitalized tissue and its associated biofilm without incurring substantial damage to the surrounding healthy tissue when administered daily. The precise pressure utilized may vary from application to application, but the general consensus appears to suggest a pressure greater than 10 psi, which is just strong enough to remove unwanted materials on the wound surface, and less than 50 psi, above which there might exist concerns of tissue damage, patient intolerance, and bacterial injection into tissue. In addition, there is evidence that, similar to other mechanical forces such as suction and vibration, the percussive forces delivered by irrigation fluid upon a wound surface induce heightened granulation tissue formation and hasten wound closure.[20]

Finally, in addition to its efficacy, hydromechanical therapy offers a tremendous opportunity to reduce costs associated with the treatment of chronic wounds. Due to the wide availability of water or saline and minimal training required to deliver this simple modality, hydromechanical debridement can be carried out in both home and facility settings. As the care of chronic wounds continues to contribute a large financial burden to the rapidly increasing costs of health care, this traditional approach of hydromechanical debridement should be revisited.

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REFERENCES

1. Sen CK, Gordillo GM, Roy S, et al. Human skin wounds: a major and snowballing threat to public health and the economy. *Wound Repair Regen.* 2009;17:763–771.
2. Attinger CE, Janis JE, Steinberg J, et al, Clinical approach to wounds: debridement and wound bed preparation including the use of dressings and wound-healing adjuvants. *Plast Reconstr Surg.* 2006;117:72S–109S.
3. James GA, Swogger E, Wolcott R, et al. Biofilms in chronic wounds. *Wound Repair Regen.* 2008;16:37–44.
4. Schierle CF, De la Garza M, Mustoe TA, et al. Staphylococcal biofilms impair wound healing by delaying reepitheliazation in a murine cutaneous wound model. *Wound Repair Regen.* 2009;17:354–359.
5. Stotts NA. Wound infection: diagnosis and management. In: Morison MJ, Ovington LG, Wilkie K, eds. *Chronic Wound Care. A Problem-based Learning Approach.* Philadelphia, Pa.: Elsevier; 2004: 101–116.
6. Whiteside MCR, Moorhead RJ. Traumatic wounds: principles of management. In: Miller M, Glover D, eds. *Wound Management Theory and Practice.* London, United Kingdom: Emap Healthcare Limited; 1999.
7. Bansal BC, Wiebe RA, Perkins SD, et al. Tap water for irrigation of lacerations. *Am J Emerg Med.* 2002;20:469–472.
8. Edlich RF, Rodeheaver GT, Morgan RF, et al. Principles of emergency wound management. *Ann Emerg Med.* 1988;17:1284–1302.
9. Halvorson EG. Wound irrigation in the emergency room: a simple, effective method. *Plast Reconstr Surg.* 2007;119:2345–2346.
10. Nourse AM, Myers W. Dental water irrigating device used for cleaning decubitus ulcers. *Phys Ther.* 1978;58:1219.
11. Nandhagopal V, Chittoria RK, Mohapatra DP, et al. Role of jet force technology in wound management. *Plast Aesthet Res.* 2015;2:277–281.
12. Luedtke-Hoffmann KA, Schafer DS. Pulsed lavage in wound cleansing. *Phys Ther.* 2000;80:292–300.
13. Madden J, Edlich RF, Schauerhamer R. Application of principles of fluid dynamics to surgical wound irrigation. *Curr Topics Surg Res.* 1971;3:85–93.
14. Angerås MH, Brandberg A, Falk A, et al. Comparison between sterile saline and tap water for the cleaning of acute traumatic soft tissue wounds. *Eur J Surg.* 1992;158:347–350.
15. Moscati RM, Mayrose J, Reardon RF, et al. A multicenter comparison of tap water versus sterile saline for wound irrigation. *Acad Emerg Med.* 2007;14:404–409.
16. Griffiths RD, Fernandez RS, Ussia CA. Is tap water a safe alternative to normal saline for wound irrigation in the community setting? *J Wound Care.* 2001;10:407–411.
17. Leid JG, Bacterial biofilms resist key host defenses. *Microbe.* 2009;4:66–70.
18. Stewart PS. Biophysics of biofilm infection. *Pathog Dis.* 2014;70:212–218.
19. Rhoads DD, Wolcott RD, Percival SL. Biofilms in wounds: management strategies. *J Wound Care.* 2008;17:502–508.
20. Irion GL, Stone S, Fischer T, et al. Accelerated closure of biopsy-type wounds by mechanical stimulation. *Adv Skin Wound Care.* 2006;19:97–102.