Advantages of Zinc Oxide Compression Wrap to Enhance Post-Surgical Wound Healing

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Abstract
We introduce a practical and inexpensive approach to wound healing that uses an Unna boot in a lower-limb, ulcerated wound that would otherwise require a skin graft. The Unna boot is a zinc-oxide-based compression wrap commonly used to enhance the healing of venous stasis ulcers and burn wounds. We present a case of a patient who presented with a large, calcified hematoma that was treated with surgical removal and debridement, followed by prophylactic systemic and topical antibiotic treatment and then an outpatient Unna boot application weekly. The lesion epithelialized completely without the use of skin grafts or surgical reconstructions.

Introduction
Skin grafting has commonly been employed in wound treatment when the area of skin loss is too big for primary closure techniques. Skin grafting, although widely accepted, is a painful surgical process that requires healing of both the donor site and the donor recipient site. Treatment of lesions associated with venous stasis ulcers and burn sites have employed Unna boots to increase blood flow to the area.

There are numerous compression wraps available to treat venous ulcers, such as compression hosiery and inelastic, elastic, short stretch, single-layer, and multilayer bandages. A systematic review by Cullum et al. found that high-compression bandaging is at least twice as effective as no-compression or low-compression treatment in complete venous-ulcer healing. Multilayer compression bandaging seems to be superior to single-layer bandaging, and elastic multilayer bandaging is superior to inelastic multilayer bandaging. The treatment choice depends on the patient’s preference, lifestyle (such as occupation), social needs and functional status, as well as the wound itself.

The Unna boot, a zinc-oxide compression wrap, also known as a zinc-paste bandage, is the most traditional method. The non-elastic bandage provides a semisolid mold that acts as an effective compression device, applying high pressure when the muscles are contracted, such as while walking, and light pressure at rest. It is usually made of cotton, with zinc-oxide paste applied uniformly to the entire bandage. It may contain calamine, as well, which is a combination of zinc oxide and iron(III) oxide or glycerin, providing relief for itchingness by attracting water and sealing it in. Normal daily activities can be resumed providing the bandage is kept dry.

Case Presentation
A 75-year-old Haitian man with a medical history of hypertension presented with a painful, foul-smelling lesion of the left lower extremity that had been growing for more than a year. The patient recalled an inciting trauma to the area, in the form of a stone hitting his leg when a car was passing by him on a gravel road, approximately seven months prior to seeking assistance at a local hospital for the growing lesion. A review of the patient’s hospital records showed that over time, the lesion grew larger and became tender and foul smelling. Our patient did not experience any fevers or chills. Upon hospitalization, physical exam showed an ulcerated, purulent ulcer, 6 cm in diameter, overlying a firm subcutaneous mass. The periphery of the wound was friable and erythematous (Figure 1). Palpable groin lymphadenopathy was noted, indicating presence of reactive lymph nodes or neoplastic involvement.

Further hospital workup revealed a complete blood count with peripheral leukocytosis and neutrophilia. All cultures were negative. An X-ray showed a soft-tissue mass with mostly peripheral calcification in the medial aspect of the left lower extremity adjacent to the distal tibial diaphysis, measuring approximately 5.7 cm x 4.1 cm, with an intact cortex. MRI without contrast showed a circumscribed, encapsulated mass in the soft tissue and subcutaneous tissue. The muscle ligaments were not displaced by the mass.

The calcified hematoma was excised and debrided. Biopsy of the excised specimen revealed traits of an organized hematoma with calcifications. A split-thickness skin graft was recommended following excision, but it was not performed due to the patient’s preference.

One week post-excision, the patient was seen in the dermatology outpatient clinic, at which point the size of the wound was 8 cm x 6 cm on the left distal pre-tibia, involving subcutaneous fat (Figure 2a, week 0). The wound was cleaned with hydrogen peroxide, and an Unna boot zinc-oxide wrap was applied with moderate pressure. A dry gauze wrap layer was placed over the Unna boot to absorb the anticipated wound drainage. The gauze was secured in place by bandage pins and self-adhesive tape. The patient was seen weekly for Unna boot dressing changes and wound checks.

Figures 2a-e show the progression of wound healing from week 0 to week 12, with the initial treatment a week after surgery. The approximate time to complete the re-epithelialization process was 12 weeks. At each visit, the wound appeared well-moisturized, without any signs of infection, indicating the dressing allowed for a clean and occlusive environment.

The patient tolerated his weekly wound-check visits well and was able to perform activities of daily life. The patient did not note any discomfort besides complaining that it felt hot when wearing the boot. There was minimal pain or tenderness associated with the Unna boot. The patient reported high satisfaction with his results and was able to return to work a week after the initial treatment.

Discussion
Skin grafts are used to permanently replace damaged or missing skin or to provide a temporary wound covering when primary closure is not possible. They are also used to prevent fluid loss, help with temperature regulation, and prevent bacterial infection.

There are multiple factors involved in skin-graft healing, such as graft size, location, steroid use, and patient age, immune status and BMI, among other considerations. On average, healing can take several months or longer. Three stages of healing play a role in graft survival: plasmatic imbibition, in which the initial passive absorption of nutrients occurs; insolation, in which the ends of blood vessels between the

Figure 1. Tumor pre-excision.
donor and wound bed meet; and angiogenesis, in which the blood vessels grow into the graft and the graft becomes vascularized.

Insufficient vascularity of the recipient site, hematoma, seroma, infection, excessive tension, mechanical shearing forces and other elements can lead to graft failure. Patient comorbidities such as diabetes, smoking, and nutrient deficiency are detrimental and can also lead to graft failure. In addition to skin-graft rejection, there is the possibility of infection. In general, lower-limb skin grafts are thought to have higher failure rates than skin grafts in other body sites. According to one study, up to one-third of lower-limb skin grafts fail at six weeks. The failure rate is most likely due to multiple factors, including hemodynamic forces in circulation, whereby venous circulation in the legs is improved in the decubitus position, but arterial flow is reduced.

The wide variety of skin grafts available today, such as allografts, xerographs, cultured skin grafts, and dermal substitutes, as well as newly introduced stem-cell grafts, allows for a more individually tailored treatment.

Skin grafts, depending on size and location, can be extremely effective. A study done on split-thickness skin grafts with negative-pressure wound therapy showed the mean percentage of graft survival after removal of vacuum-assisted closure can reach 94%, with complete graft survival in 63% of cases. However, the six-month cost of this treatment protocol and standard twice-weekly compression therapy is estimated at roughly $27,000 to $28,000.

We recommended our patient get a split-thickness skin graft containing a variable dermal thickness, which has successfully treated large chronic wounds, including those on the leg and sole of the foot; however, he chose not to undergo the procedure.

In 1996, Sanford et al. looked at using an Unna boot to facilitate the healing of a skin graft. Split-thickness skin grafting was used on burns limited to the distal elbow. Application of the skin graft in addition to the Unna boot revealed a 95% or greater take on all skin grafts at follow-up, with no infectious complications. This study seems to demonstrate the efficacy of Unna-boot support and calcium-alginate dressings of donor sites in limited skin-graft procedures.

Studies have found the Unna boot by itself to be an alternative treatment for leg ulcers. In 1997, Fletcher et al. presented a systematic review indicating the Unna boot as superior to moist, non-compressive dressings. An Unna boot not only serves a compressive purpose that allows for a reduction in healing time, but also has been shown to have occlusive properties that, by keeping the surface moist, allows for improved healing. Rate of re-epithelialization has been shown to increase by 40% when using occlusion for partial-thickness wounds. The moist environment allows for keratinocyte migration and growth factor (GF) proliferation. Transforming growth factor-beta (TGF-B), produced by platelets and macrophages, seems to be the most important growth factor in wound healing, as it facilitates monocyte chemotaxis, fibroblast migration and proliferation, angiogenesis, and fibronectin synthesis. Other growth factors include platelet-derived growth factor (PDGF), vascular endothelial growth factor (VEGF), epidermal growth factor (EGF), and fibroblast growth factor (FGF), all of which play a role in proliferation of granulation tissue, which increases angiogenesis, vascular permeability, fibroblast mitogenesis, and collagenation. Occlusion also has been shown to reduce the inflammation phase. Furthermore, the therapeutic effects of zinc oxide include promotion of wound healing, decreasing wound debris, and increasing epithelialization. Zinc preferentially accumulates in mitotically active keratinocytes and up-regulates intracellular mitogenic signaling. Topical zinc has also been shown to possess antimicrobial properties, inhibiting the growth of Gram-positive cocci.

Conclusion

The Unna-boot approach to wound healing utilizes the four principles of osteopathic medicine: 1) The body is a unit; the person is a unit of body, mind, and spirit; 2) the body is capable of self-regulation, self-healing, and health maintenance; 3) structure and function are reciprocally interrelated; and 4) rational treatment is based upon an understanding of the basic principles of body unity, self-regulation, and the interrelationship of structure and function.

The use of an Unna boot in our patient significantly improved the healing process and simplified his wound-care needs. It is a practical, cost-effective method of wound treatment in which the necessary lifestyle adjustments are minor, and there is no postoperative down time. Our patient’s satisfaction rate was high, and with less manipulation of the wound, the chance of infection was greatly decreased.
References


