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Reconstructive

Effect of Negative Pressure Wound Therapy in Electrical Burns

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Summary: Electrical burns are capable of damaging cells through both thermal and nonthermal mechanisms. The complexity of these wounds, the deterioration in time, and the conversion during the first days make managing them a challenge. Negative pressure wound therapy (NPWT) is a technology that can be used as a tool to improve outcomes in patients with burns in the acute and reconstructive phases of the treatment. We describe 2 cases in which we apply this technology in electrical injuries. We present 2 cases of patients with electrical burns who underwent NPWT with instillation (NPWTi) with saline solution in the acute phase, to block the conversion of the burn and to improve the granulation tissue and in the reconstructive phase, as a tool to improve the grafts take. Both patients showed early formation of granulation tissue adequate for surgical reconstruction, and neither of them presented loss of skin grafts. In the acute phase, NPWT with instillation when applied in these patients showed fast formation of granulation tissue adequate for early reconstruction, whereas NPWT in the reconstructive phase when applied to bolster grafts showed improvements in grafts take. NPWT is a useful tool to support the surgical management of the electrical injuries during the acute phase to prepare the wound for early reconstruction and after the skin grafts reconstruction to improve the grafts take. *(Plast Reconstr Surg Glob Open 2021;9:e3383; doi: 10.1097/GOX.0000000000003383; Published online 17 February 2021.)*

INTRODUCTION

Burns are a major public health problem. The complexity of these wounds makes managing them a challenge, depending on multidisciplinary and specialized work to achieve therapeutic goals. According to the International Society for Burn Injury, early surgical management in a burned patient is considered essential[1] because early wound excision and grafting have reduced mortality, decreased loss of exudative protein, lower risk of burn infection, and decreased muscle catabolism.[2] Therefore, early debridement and reconstruction of the burned tissue should ideally be achieved within the first 24–72 hours, taking into account all the techniques of the revised version of the reconstructive ladder.[3] One of the challenges with the burned patients is to block the conversion of the burn in the intermediate zone or stasis zone (Jackson). In this zone, between the coagulation and the hyperemia zone, specific alterations of the microvasculature with variable degrees of inflammation and hypoperfusion occur. This tissue may endure progressive cellular damage and death if the burn is not adequately treated.[4–6]

Research has been key to better understanding the process of burn conversion. Schmauss et al analyzed 29 studies in 2012 to 2013 investigating experimental burn conversion treatments and found that NPWT is a promising approach.[6,7]

Negative pressure reduces edema, increases blood flow, cleanses the wound, decreases bacterial load, and accelerates protein formation and granulation tissue.[8] Application of NPWT to the wound bed causes microscopic deformation in the cytoskeleton of the cell, which, in addition to changes in blood flow in the wound periphery, induces the formation of granulation tissue. The application of micromechanical forces may be a useful method to stimulate wound healing through promotion of cell division, angiogenesis, and local elaboration of growth factors.[9] Another described mechanism is the reduction of the size and complexity of the wound by generating granulation tissue and by external contraction or macro-deformation.

NPWTi is a technology in which fluid instillation consists of a closed wound dressing affixed to an NPWT pump with the advantage to apply intermittent negative pressure. When pressure is stopped, the device can instill a fluid of choice (often an isotonic solution or an antiseptic

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in wounds with increased risk of infection) into the wound for the duration of the "off-cycle." When negative pressure is activated, the fluid is removed into the waste canister along with the wound fluid.[10]

In our cases presentation, we use the NPWT twice in the treatment. In the initial phase, we use NPWTi to prepare the wound and to accelerate granulation tissue formation for an early reconstruction. After the reconstruction, we use NPWT to improve the graft take (Figs. 1–5).

CASE PRESENTATION

Case 1

A 33-year-old man was admitted to the burn unit with deep second- and third-degree burns of 18% TBSA affecting the left shoulder, arm, forearm, elbow, and right leg. After 2 surgical procedures of debridement and tangential excision without adequate granulation tissue formation, we performed a third surgery, in which we initiated NPWTi with Veraflo Cleanse Choice with a volume of 50 ml of saline solution for 2 hours with suction pressure of −125 mm Hg for 3 hours. After 5 days with the instillation therapy, the granulation tissue became suitable for reconstruction. In the fourth procedure, autografts were performed on the left shoulder and right leg bolstered with negative pressure wound VAC therapy with Whitefoam under a Granufoam dressing at −100 mm Hg continuous pressure. Four days later, the grafts showed an integration of 100%. There were no areas of graft loss, seromas, or signs of infection. In this patient, we evidenced adequate granulation tissue formation for graft reconstruction after 5 days with NPTWi.

Case 2

A 43-year-old man was admitted to the burn unit with a third-degree electrical burn compromising the right upper limb and both feet, with a 15% TBSA. He was taken to emergency surgery for debridement and tangential excision. He required a trans-tibial amputation of the right leg because of devitalized muscle with bone and tendon exposure. The left foot in his medial area had a deep burn with bone exposure; thus, we applied VAC therapy with Veraflo Cleanse Choice, at volume of 30 ml of saline solution for 20 minutes and −125 mm Hg for 4 hours. After 4 days with the NPWTi, adequate granulation tissue was achieved for reconstruction. The grafts in the left foot and the right upper limb

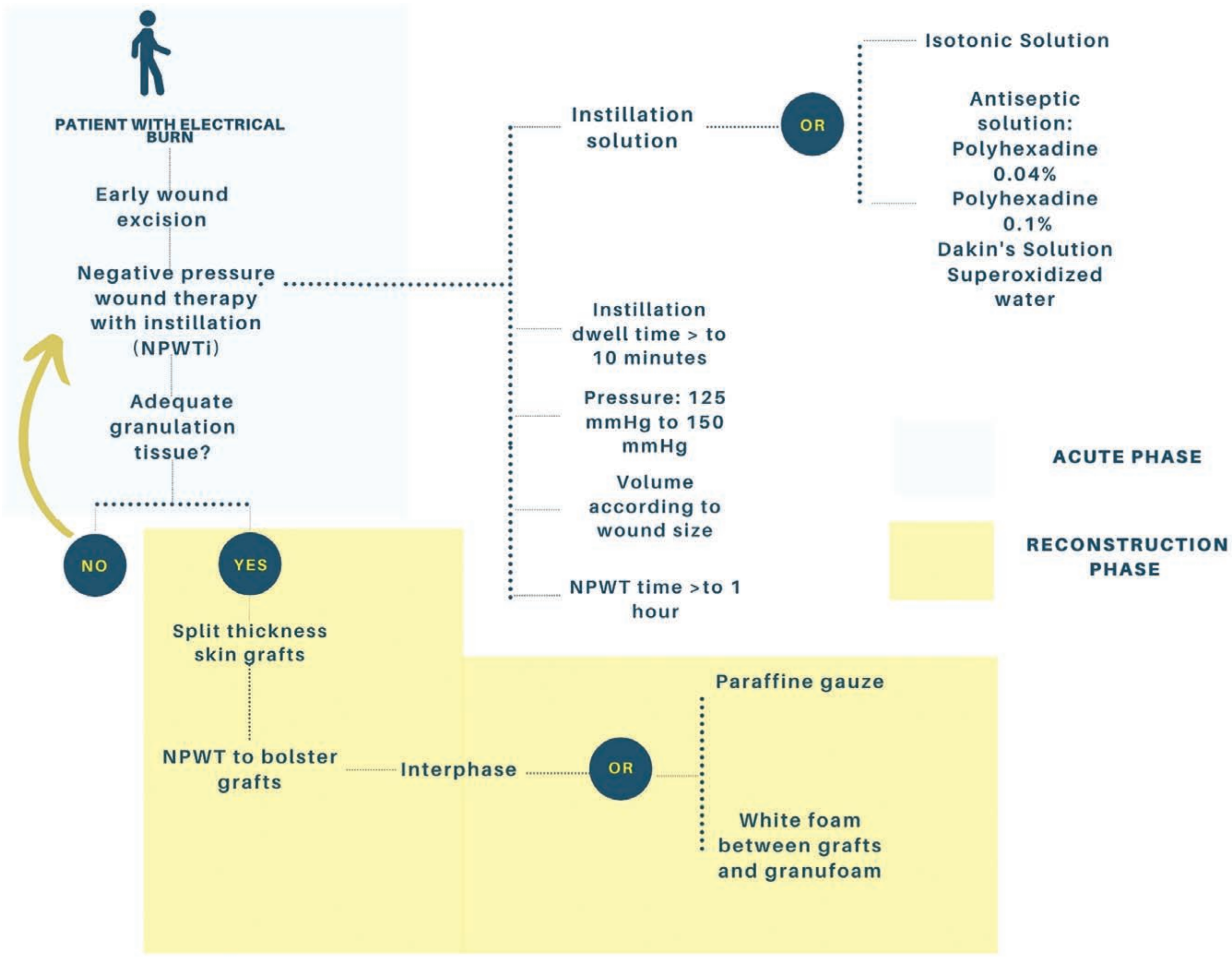

Fig. 1. Algorithm of application of NPWT and NPWTi in the acute and reconstructive phases of a patient with an electrical burn.

Fig. 2. Adequate granulation tissue after 5 days with NPWTi on the left shoulder.

Fig. 3. Follow-up of the patient after reconstruction with split-thickness skin grafts.

Fig. 4. Granulation tissue (after 4 days of NPWTi) over exposed bone in the left foot of a patient who suffered a third-degree burn.

Fig. 5. Adequate Integration of the split-thickness skin grafts that were bolstered with NPWT.

were bolstered with VAC therapy with GRANUFOAM dressing at continuous pressure of −100 mm Hg. After 4 days, the first dressing change was performed, evidencing adequate take of the grafts with an integration greater than 85% in the left foot and 100% in the right upper limb. During hospitalization, the patient did not present infection or loss of the grafts; he began physical therapy and the rehabilitation process early.

DISCUSSION

NPWT has been well studied and described as a tool to improve reconstructive outcomes in complex wounds; however, its use in patients with burns is still not well standardized. Furthermore, the positive effect of NPWTi in patients with electrical burns in terms of blocking the conversion of the burn has not been deeply studied. An important explanation could be the cost of the therapy, which limits its use especially in low- and middle-income countries. It would be interesting to develop studies of cost-effectiveness with this therapy in the specific group of burned patients.

Birke-Sorensen et al, in the review of evidence-based recommendations for NPWT 2010, described the use of NPWT in combination with a fluid-instillation protocol as a possible therapy to contribute to infection control.[10] In our 2 cases, neither of the patients had infection.

The last conference held in 2019 by an international multidisciplinary panel of experts recommended that NPWTi could be used as an adjunct therapy in full-thickness burns.[11] As shown in this study, the patients presented electrical complex third-degree burns managed with NPWTi in the acute phase and with NPWT in the reconstructive phase, with adequate and quick formation of the granulation tissue and a graft take of >85%.

On the other hand, it is observed that NPWT applied to the grafts improves the graft take by bolstering and decreasing the friction in the grafted area.[12] According to the panel of experts, the NPWT should be used to bolster grafts as a Recommendation A, which was applied in this case presentation with a graft take of >85%.

CONCLUSIONS

NPWT has been used in various stages of burn management, focusing mostly on its role in bolstering skin grafts. Its efficacy as a primary treatment in the setting of acute burns, however, remains controversial.

In our experience, when using the NPWT with instillation in patients with electrical burns, the adequate granulation tissue was achieved 4–6 days after the application of the therapy, which allowed a prompt reconstruction.

We consider that, in burned patients, it can present a key point to accelerate the healing process and stop conversion of the burn. Recognizing the limitations of this study, we acknowledge that large-scale prospective studies are needed to prove its use on electrical burned patients.

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