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Case Report

Skin graft fixation with negative pressure wound therapy with instillation and dwelling (NPWTi-d) for contaminated complex wounds of the extremities

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ABSTRACT

Objective: Negative Pressure Wound Therapy (NPWT) is increasingly being used as a major method of skin graft dressing and fixation. Negative Pressure Wound Therapy with Instillation and Dwelling (NPWTi-d) further enhances wound care over regular NPWT. However, only a few reports have been made on its use for skin graft fixation due to concerns of graft maceration or detachment. We used NPWTi-d to fix skin grafts for 4 cases of severely contaminated complex posttraumatic wounds.
Methods: The age ranged from 37 to 72 years, and included trauma of the lower leg, forearm dog bite and incomplete amputations of the upper arm and hand respectively. The mean instillation saline volume per wound size was 0.21 ml/cm^2 and the dwelling time reduced to 3 min. The NPWTi-d skin graft fixation was removed after about a week.

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Results: All the grafts healed well and no complications such as infection or contracture were observed. Follow-up time was 1 -8 months.

Conclusions: NPWTi-d may be a useful option for fixing skin grafts particularly in contaminated wounds with a high risk of infection.

Introduction

Skin grafting contaminated wounds caries a risk of wound infection and graft loss during the fixation period which typically ranges from 3 to 10 days.[1] Negative Pressure Wound Therapy (NPWT) has become a major alternative method for graft fixation, however regular NPWT is contraindicated for contaminated and infected wounds.[2-3] To overcome this challenge, we report the use of NPWT with Instillation and Dwelling (NPWTi-d) for skin graft fixation and dressing in contaminated complex wounds.

Materials and method

Four consecutive cases including 3 upper limb and 1 lower limb posttraumatic contaminated wounds with an average size of 147cm^2 (range 50 - 300cm^2) were treated with skin grafts fixed with NPWTi-d (VAC Ulta: KCL Co., Ltd. USA) from August 2020 to December 2020 (Table 1). The grafts were dressed with non-adhesive silicon gauze, hydrophobic foam (VAC GRANUFOAM®□, KCI Co., Ltd.) and sealed with film. The settings used were negative pressure −125 mmHg, dwell time 3 min and cycle frequency 3.5 h. The average amount of saline per wound area was 0.21 ml/cm^2 (range 0.067 - 0.4 ml/cm^2). Fixation with NPWTi-d was kept in place for one week without dressing change. All skin grafts were successful without any complications. Total follow-up time was 1 – 8 months.

Table 1
Patient characteristics and NPWTi-d settings.

Case	1	2	3	4
Age	72	62	37	65
Sex	M	M	M	M
Mechanism of injury	Steel flame fell on the foot	Dog bite	Traffic accident	Steel flame fell on the hand
Site	Right lower leg	Right forearm	Left upper arm	Right hand
Comorbidity	none	RA* (PSL 10 mg/day)	none	none
Follow-up time	6 months	7 months	1 month	8 months
Complications	none	none	none	none
Wound size	270cm^2	30cm^2	35cm^2	20cm^2
Foam size	300cm^2	50cm^2	160cm^2	80cm^2
Suction pressure	−125mmHg	−125mmHg	−125mmHg	−125mmHg
Saline amount	20ml	20ml	10ml	10ml
Dwell time	3min	3min	3min	3min
NPWT time	3.5h	3.5h	3.5h	3.5h
Saline amount/cm^2	0.067ml	0.4ml	0.25ml	0.125ml
Period of use	8days	7days	15days	7days

* RA: Rheumatoid arthritis.

Case reports

Case 1

A 72-year-old man suffered a degloving wound on his right leg after an iron plate fell on it during work. His-tibia was exposed but the tibialis anterior fascia was preserved and no neurovascular damage was observed. Debridement and wound closure were performed. However, skin necrosis gradually developed around the wound edges. Repeat debridement was performed one month later, and the wounds managed with daily dressings. Two months after the injury, a split-thickness skin graft (STSG) from the thigh was used to reconstruct the defect with NPWTi-d graft fixation (Supplementally Fig.1–4). The wound size was 270cm^2 and the foam size used was 300cm.^{2} The set saline amount was 20 ml. The ankle was splinted 90° for one week until the graft had taken. The graft took completely with no complications and full ankle joint movement recovered.

Case 2

A 62-year-old man injured his right forearm and right lower leg following a dog bite. Debridement and wound closure were performed on the same day, but the skin flap on his right forearm wound gradually became necrotic. One month later, full-thickness skin grafts (FTFG) harvested from the inguinal region were performed with NPWTi-d after debridement. The wound size was 30cm,^{2} foam size 50cm^2 and the saline amount set to 20 ml. All the skin grafts healed well with no complications and rehabilitation was started.

Case 3

A 37-year-old man sustained near-complete amputation of his upper right arm (with only a posterior skin bridge and some triceps attaching) following traffic injury with heavy contamination from dirt and debris. Humerus fixation and revascularization of the arm by vascular anastomosis of the brachial arteries and veins with vein grafts were performed. Radial, median, and ulnar nerve repairs were then performed, and the skin defect was covered with artificial dermis. Screw insertion of the humerus was performed on the 10th day post injury and the wounds covered with NPWTi-d after debridement of the necrotic tissues. Two weeks later, FTFG from the inguinal region was performed with NPWTi-d fixation for the three forearm skin defects. The total defect size was 35cm.^{2} The foam size was 160cm^2 and the saline amount was set to 10 ml. The skin grafts healed well. No complications were observed and rehabilitation was commenced.

Case 4

A 65-year-old man suffered an incomplete amputation of his right wrist joint during work. The wound had a large amount of impacted debris and mud that could not be completely removed by washing (Fig 1). Bone fixation of the forearm and each finger was performed followed by revascularization of the hand by anastomosis of radial and ulnar arteries, and veins. Repair of the median nerve and tendons was then performed. Due to the severe wound contamination, postoperative NPWTi-d was applied. Definitive bone fixation was performed 2 weeks later and NPWTi-d reapplied. Screw and FTFG with NPWTi-d dressing were performed a week later, 3 weeks after injury (Fig 2, Supplementary Fig5–7). Skin grafting was performed on the volar and dorsal sides of the wrist joint. The defect size was 20cm,^{2} foam size 80cm^2 and the saline instillation amount 10 ml. The skin grafts survived completely and no complications were observed (Fig 3, Supplementary Fig8).

Discussion

Postoperative fixation is important for successful survival of skin grafts with various methods such as tie-overs with cotton balls and gauze often used.[1] Originally intended for wound healing, the fixation of skin grafts by NPWT was first reported by Schneider et al. in 1998.[4] Xiao Shen later reported

Fig. 1. Heavily contaminated incomplete hand amputation wound in Case4 with dirt and debris, bone, neurovascular and tendon injury at the time of presentation to hospital.

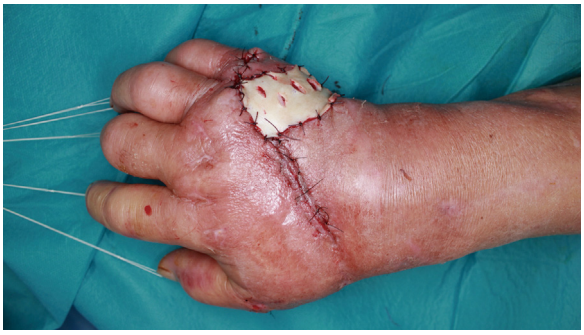

Fig. 2. Full-thickness skin grafting of the remaining skin defects in Case 4 three weeks after hand revascularization, bone fixation, and tendon and nerve repairs following contaminated incomplete hand amputation.

that overall survival rate of FTFG was significantly higher in the NPWT group than conventional tie-over dressing group.[5] They further showed that complications including hematomas and infection rates were lower in patients who received NPWT.[5] Although NPWT has been used to fix skin grafts, there are very few reports of using NPWTi-d[2] to fix skin grafts, this may be due to concerns that the skin graft may soften or detach due to the fluid instillation process. However, our cases demonstrate successful utilization of NPWTi-d for fixing skin grafts without these complications.

At present, there is no clear standard for the amount of instillation solution, but the standard concept is that the foam is sufficiently immersed, and the preferred dwell time by consensus is 10 min.[6] We reduced the set amount of both instillation solution to 0.21 ml/cm^2, and dwell time to 3 min, taking into consideration the risk of skin graft detachment, and to avoid leakages in the vacuum seal due to the high mobility of the hands and feet. However, we maintained the recommended suction pressure of −125 mmHg in all the cases.[6] Increased saline instillation amount or lengthening of the dwelling time increase the likelihood of leakage and loss of the suction pressure. This may in turn reduce skin graft take.

NPWTi-d makes it possible to manage contaminated wounds by injecting saline while performing NPWT with added periodic automatic washing functions. NPWTi-d is more resistant to infection compared to regular NPWT which does not effectively reduce the number of bacteria,[3,7] and is contraindicated for infected wounds. Kim et al. reported that NPWTi-d is more beneficial than NPWT for the adjunctive treatment of acutely and chronically infected wounds.[8] The continuous wound cleansing of NPWTi-d reduces the risk of infection and skin graft loss due to infection and makes it suitable for

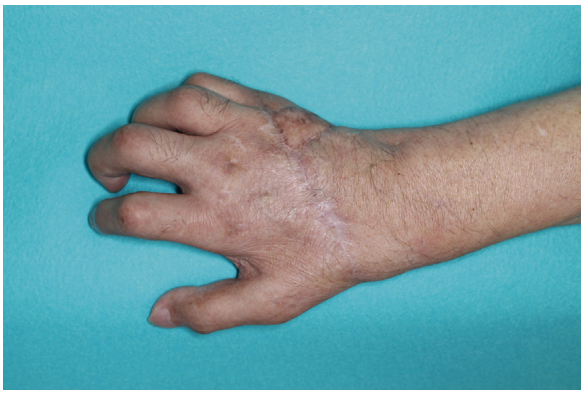

Fig. 3. Successful complete healing of the skin graft with no complications in Case 4 eight months after revascularization and skin grafting.

use in contaminated wounds. Furthermore, in contrast to regular NPWT that originally recommended dressing replacement 2–3 times a week, NPWTi-d may be safe to use for a week allowing the skin graft to fully engraft undisturbed. The main limitation of NPWTi-d is its relative high cost and the need for the patient to move around with a machine. Although further studies with large populations may be required to establish the optimal clinical application and benefits of this method, it is a useful alternative for skin graft fixation and dressing and particularly effective for cases of contaminated wounds.

Conclusions

We report the successful treatment of severely contaminated traumatic wounds with NPWTi-d dressing and fixation of skin grafts without any complications. With adjustment of instillation settings, NPWTi-d may be effective for skin grafting particularly on contaminated wounds.

Declaration of Competing Interest

None.

Consent

Informed consent was provided by each patient to publish the case details and associated images.

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Ethical approval

Not required.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.jpra.2022.09.009.

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