Wound Management Using Artificial Dermis and Negative-pressure Wound Therapy

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Introduction

Artificial dermis is an "artificial graft" that binds to the connective tissue of a wound bed to form a dermis-like tissue. By adapting to and closely adhering to the vascularized wound bed, capillaries are newly formed in the atelocollagen, creating a three-dimensional dermis-like tissue. This is advantageous since a structure similar to the skin can be generated by applying skin graft onto that tissue. However, tissues such as subcutaneous fat are not regenerated.

On the other hand, the first treatment considered for an open wound is a simple skin graft. However, since the mechanism of grafting is similar to adhesion, there are a number of problems.

Problems arising from skin graft to various types of wounds

- **Tendon-exposed wounds**
  - Tendon adhesion → Dysfunction
  - Poor graft take → Direct grafting to tendon is difficult

- **Nerve-exposed wounds**
  - Nerve adhesion → Pain/Irritability/CRPS

- **Vessel-exposed wounds**
  - Vascular adhesion → Fragility/Ulcer formation

- **Muscle-exposed wounds**
  - Basically treatable by skin graft. However, at the site of the muscle–tendon transition, "muscle fixation" may occur due to skin graft, with restriction of movement.

Scope of applications of artificial dermis

- **Muscle-exposed wounds**
  - These wounds are a good indication for the use of an artificial dermis. After a dermis-like tissue forms on the muscle, skin graft can be performed, and the muscle fixation can be mitigated. Muscles do not have to slide like tendons do, and it is only necessary that their contraction not be impeded.

- **Nerve-exposed wounds**
  - If perineural tissue is present, dermis-like tissue will form. However, since subcutaneous tissue does not exist after skin grafting to the dermis-like tissue, additional treatment such as nerve detachment will become difficult.

- **Tendon-exposed wounds**
  - The circulation will be poor if the paratenon which is the vascular network around the tendon does not survive. As a result, dermis-like tissue will not form even if artificial dermis is applied.
Case 1: PELNAC with PICO

Skin defect with median nerve/flexor tendon exposure following excision of the left forearm tumor

The method used for wound closure is generally determined by the location. Considering the site characteristics of this patient, flap surgery was performed at the tumor excision on the distal forearm (Fig. 1). Artificial dermis and full-thickness skin graft was planned for the donor site on the proximal forearm.

Treatment strategy

Proximal forearm:
- Only muscle was exposed even when the skin flap was harvested
  - artificial dermis + full-thickness skin graft indicated

Distal forearm:
- Exposure of nerves/tendon
  - skin flap was selected due to adhesion and required additional treatment

Technique for donor site: Artificial dermis + NPWT

Take of skin flap was successful one week post-op. However, the donor site was covered with artificial dermis (hereinafter, PELNAC Fenestrated type) as a two-stage graft was necessary due to problems with texture and adhesion (Fig. 2-a). Range-of-motion exercises were performed, but due to exudate from the donor site, dressing change was necessary and PICO*Single Use Negative Pressure Wound Therapy System (hereinafter, PICO) was used to manage exudate (Fig. 2-b, c). A good graft bed was formed in approximately 10 days, and the silicone film was removed (Fig. 2-d). Full-thickness skin graft was performed, and the skin graft was completely taken within one week (Fig. 2-e).

Summary

By using PELNAC at the donor site, a dermis-like tissue formed, and the flexibility of the skin was maintained even after grafting. PELNAC itself is soft, making it suitable for use on and around joints. Managing exudate from the wound using PICO was possible during the time until skin graft. In this case, the advantages using PICO of were as follows: 1. Protection of wound and comfort at home 2. No impediment of elbow movement and allowed aggressive range-of-motion training.
Case 2: PELNAC used as supplement for wound closure

PELNAC, Shoelace method and NPWT were performed together to manage the donor site for incomplete right-hand laceration.

In this case, anterolateral thigh-flap surgery was performed after initial treatment, debridement and internal fixation (Fig. 1). The condition after one month was good (Fig. 2).

The donor site was managed applying PELNAC using the Shoelace method (Fig. 3-b) and RENASYS Negative Pressure Wound Therapy (Fig. 3-c). The wound gradually plicated (Fig. 3-d) and full-thickness skin graft was applied on a Dog Ear created by pulling the skin (Fig. 3-e).

Summary

By combining PELNAC with the Shoelace method and NPWT for open wounds, contraction can be maintained and the possibility of wound closure is high. The key point is to maintain mobility of the wound margin and accelerate wound closure before scarring occurs.
Silicone film

Split-thickness skin graft

Collagen sponge

Healing process

PELNAC is applied to full-thickness skin defects.

Fibroblasts and capillaries invade and infiltrate into the spaces in collagen sponge.

Collagen sponge is gradually replaced by newly synthesized collagen into dermis-like tissue.

After 2-3 weeks, the silicone film is peeled off, leading to wound closure with split-thickness skin graft.

Variation

Fenestrated type

Fortified type

Standard type

Healing process

Silicone film

Collagen sponge

Silicone film

Collagen sponge

Silicone film

Collagen sponge

Product image

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