

An Alternative Dermal Template for Reconstruction of Complex Upper Extremity Wounds

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Summary: The management of upper extremity soft-tissue defects with full-thickness skin loss and denuded tendon and/or bone traditionally requires vascularized tissue reconstruction. Herein, we present patient outcomes utilizing Novosorb Bio-degradable Temporizing Matrix (PolyNovo, Wilmington, Del.), a novel bilaminar dermal regenerative template, followed by skin grafting, for reconstruction of complex upper extremity injuries with exposed tendon and/or bone. We retrospectively reviewed all patients treated at our Level I trauma center with upper extremity trauma and exposed tendon and/or bone who had application of Novosorb Bio-degradable Temporizing Matrix over a 1-year period. At the time of surgery, all nonviable tissue was debrided, and the product was applied according to the manufacturer's instructions. If required, split thickness skin grafting was performed once neodermis appeared perfused, or after the sealing layer delaminated spontaneously. Six patients (four men, two women) with an average age of 49.8 (35–60) years were included in the study. Average defect size measured 97 cm² (10–440). Average time to complete healing was 45 days (27–57). Three patients reepithelialized spontaneously and did not require grafting; average defect size in these patients was 26 cm² (10–42). There were no infections and no loss of the dermal matrix or skin graft, when performed. All patients healed without complication after grafting and did not require further surgical treatment. Therefore, we contend that Novosorb BTM is a dermal regenerative template that shows potential as an alternative option to flap reconstruction in select patients after upper extremity trauma and soft-tissue defects with exposed tendon and/or bone. Further studies will be required to refine indications and evaluate outcomes. (*Plast Reconstr Surg Glob Open* 2021;9:e3674; doi: 10.1097/GOX.0000000000003674; Published online 12 July 2021.)

INTRODUCTION

Reconstruction of upper extremity soft-tissue defects with full-thickness skin loss and exposed tendon without peritenon and/or bone without periosteum has traditionally required vascularized local, regional, or free tissue transfer.^{1,2} However, associated injuries and patient comorbidities may preclude these traditional, complex reconstructive techniques. As an alternative treatment option for these patients, the use of dermal regeneration templates has gained popularity since its first description by Burke et al in 1981.³ The first and most popular commercial dermal regeneration template, Integra (Integra

LifeSciences, Plainsboro, N.J.), has been used for a variety of clinical indications.⁴ However, the use of Integra has been associated with an infection rate as high as 16.9%.⁵ Yet, there remains a paucity of studies exploring applications of dermal substitutes in upper extremity trauma.⁶ Recently, a relatively novel product called Novosorb Bio-degradable Temporizing Matrix (BTM; PolyNovo, Wilmington, Del.) was reported to help achieve wound healing in a heterogeneous population of patients, wound locations, and etiologies.⁷ Herein, we present our experience in the first cohort dedicated to upper extremity reconstruction of complex wounds, and this is the first study to report spontaneous healing using BTM.

METHODS

A retrospective, IRB-approved chart review was performed for all patients treated with Novosorb BTM for

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Table 1. Demographic and Wound Characteristics

Age (y)	Gender	Location	Mechanism	Wound size (cm ²)	Exposed tendon	Exposed bone	Time to STSG (d)	Time to healing (d)
58	Man	Dorsal hand	Avulsion	28	Yes	No	NA	57
60	Woman	Volar forearm	Iatrogenic	10	Yes	No	NA	51
39	Man	Fingers	Avulsion	42	Yes	Yes	NA	27
35	Man	Dorsal hand, fingers	Crush	40	Yes	Yes	55	NA
57	Man	Palm	Crush	110	Yes	No	28	NA
33	Woman	Whole hand, forearm	Burn	440	Yes	No	63	NA

complex (exposed bone or tendon) upper extremity soft-tissue defects at a Level 1 trauma center, over a 1-year period between January 2018 and January 2019. Extracted data included age, mechanism of injury, wound size, time to healing, time to skin grafting, and complications.

At the time of surgery, all nonviable tissue was debrided, and the product was applied according to the manufacturer's instructions. Negative pressure wound therapy was used at the discretion of the surgeon at the time of initial application to prevent shear, promote integration, and decrease the amount exudate. Initially in our practice, BTM was covered with a silver impregnated dressing; however, we have since discontinued this practice. The initial dressing was maintained for 7 days and then a nonstick interface (eg, Adaptic) was placed over the silicone with bacitracin and changed every other day. After 1–2 weeks, the BTM becomes incorporated and typically requires no dressing changes and/or is ready for grafting. If necessary, split thickness skin grafting can be performed once the neodermis appears perfused, or after the sealing layer delaminates spontaneously.

RESULTS

Six consecutive patients (four men, two women) with an average age of 49.8 (range 33–60) were treated with Novosorb BTM for complex (exposed bone and/or tendon) upper extremity soft-tissue defects. All patients were over 18 years of age and had at least 6 months follow-up. Wound locations included dorsal hand, fingers, forearm, and palm (Table 1). Median wound size was 42 cm² (range 28–440). Three patients reepithelialized spontaneously and did not require grafting. In the other three patients, average time to revascularization of the neodermis was 30.3 days (range 23–42), and skin grafting was performed an average of 48.6 days (range 28–63) after injury. There were no infections and no instances of loss of the dermal matrix or skin graft when required. All patients healed without complication, and none required further surgical treatment.

CASE STUDIES

Case 1

A 39-year-old right-hand-dominant man presented with open proximal interphalangeal (PIP) joint dislocations, exposed bone and tendon, and skin loss involving the index, middle, ring and small fingers after a high-speed roll-over motor vehicle accident (Fig. 1). He underwent immediate debridement, percutaneous K-wire

stabilization, and application of Novosorb BTM to his index, middle, ring, and small fingers with a total surface area measuring 42 cm². By postapplication day 33, early reepithelialization can be seen on the index and middle fingers and he went on to heal without skin grafting (Figs. 2, 3).

Case 2

A 57-year-old right-hand-dominant man sustained a crush injury to his left hand, with a degloving-type injury of his palm and open fractures of his middle and ring proximal phalanges (See figure, Supplemental Digital Content 1, which displays a 57-year-old right-hand-dominant man with a degloving injury of the left palm with exposed tendon and fractures of the middle and ring proximal phalanges. (A) Wound appearance at initial presentation. (B) After serial debridement on application of Novosorb BTM on postinjury day 7. (C) Revascularized regeneration matrix immediately before split-thickness skin grafting on postapplication day 28. (D) Result on postapplication day 307 demonstrating good skin graft take and stable wound coverage. <http://links.lww.com/PRSGO/B696>.) He was taken to the operating room on the day of injury for wash-out and stabilization of the fractures. The palmar skin remnants were loosely approximated but did not survive and were debrided on postinjury day 7, during which Novosorb BTM was applied to the wound, with a total surface area measuring 110 cm². On postapplication day 23, the dermal regeneration template was well-perfused and ready for split-thickness sheet grafting, which was performed on day



Fig. 1. Case 1. Multiple open proximal interphalangeal joint fracture-dislocations with exposed bone and tendon devoid of paratenon and periosteum.



Fig. 2. Postapplication day 33. Spontaneous reepithelialization of the index and middle fingers is seen after the sealing layer was removed. Sealing layer was still adherent to the ring finger.

28. The wound healed without complications and no further surgery was required. (See Video [online], which displays Case 2. Clinical examination demonstrating pliability of the soft tissues after BTM and STSG reconstruction.)

DISCUSSION

Traumatic hand and upper extremity injuries often present difficult challenges due to the presence of exposed bone and tendon. These wounds have traditionally required complex reconstructive strategies such as local, regional, or free tissue transfer. However, these techniques may be undesirable in patients with significant comorbidities, or in the absence of appropriate equipment and staffing. In this small case series of early outcomes for the use of Novosorb BTM, we have demonstrated this novel dermal regeneration template to be a promising alternative reconstructive option for such patients.

To our knowledge, this is the first investigation of Novosorb BTM in complex upper extremity wounds. Several studies have examined the use of Integra in similar situations with comparable results.^{8,9} While one study demonstrated a shorter time to grafting using Integra compared with BTM (11.3 versus 30.3 days), the average wound size in this study was also significantly smaller than our 196 cm² in the skin grafting group.

Our study has several limitations, including its size, retrospective design, and variability between wounds. Therefore,



Fig. 3. Postapplication day 82. Stable soft-tissue coverage can be seen. No skin grafting or additional surgery was required.

extrapolation of our results is difficult, and future studies will need to assess functional outcomes after Novosorb BTM reconstruction, such as joint range of motion, pain, and complications. However, based on these early outcomes, Novosorb BTM may be an appropriate option in patients with complex upper extremity wounds who are unable or unwilling to undergo flap reconstruction and may offer advantages over currently available products. (See table, Supplemental Digital Content 2, which displays a comparison between Novosorb BTM and Integra. <http://links.lww.com/PRSGO/B697>.)

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