A Synthetic Biodegradable Temporising Matrix in Degloving Lower Extremity Trauma Reconstruction: A Case Report

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Summary: Presented is the case of an obese, 72-year-old diabetic man with a dorsal foot degloving injury. Whilst the tendons of extensor hallucis longus, extensor digitorum longus to all digits, and extensor digitorum brevis to hallux and second toe were intact after surgical debridement, none had any covering paratenon. The joint between the medial cuneiform and first metatarsal was open. Reconstructive options were limited by his age and co-morbidities. A novel, completely synthetic dermal matrix (NovoSorb BTM) was applied, after which the patient was discharged home to attend for dressings and review of integration progress as an outpatient. He was allowed to mobilise without limitation. Because of the poor quality of the wound bed (and patient), the material integrated slowly over 9 weeks. Delamination of the matrix, and definitive closure by application of sheet split skin autograft, produced a robust, soft, mobile and excellent aesthetic result, over which he could wear footwear immediately. Clinically, the paratenon-denuded tendons glided under the neo-dermis without tethering to the overlying integrated matrix, allowing a full range of digital movement. This was confirmed on ultrasound examination, which also demonstrated no inflammation or oedema. Already proven in extensive burns, necrotising fasciitis and complex surgical wounds, BTM represents a useful addition to the reconstructive surgeon’s toolbox. (Plast Reconstr Surg Glob Open 2019;7:e2110; doi: 10.1097/GOX.0000000000002110; Published online 2 April 2019.)

CASE

An obese, 72-year-old man degloved the soft tissues of the dorsum of his right foot, when it was crushed and sheared between a car door and a metal cupboard in his garage when the car rolled with handbrake failure. He had hypertension and diabetes. Initial surgery involved extensive soft-tissue debridement of the dorsum of the foot, exposing deep structures, including bone. Dorsalis pedis and posterior tibial pulses were palpable. The avulsed soft tissues were not suitable for replantation as a graft. A novel, completely synthetic dermal matrix (NovoSorb BTM) was applied, after which the patient was discharged home to attend for dressings and review of integration progress as an outpatient. He was allowed to mobilise without limitation. Because of the poor quality of the wound bed (and patient), the material integrated slowly over 9 weeks. Delamination of the matrix, and definitive closure by application of sheet split skin autograft, produced a robust, soft, mobile and excellent aesthetic result, over which he could wear footwear immediately. Clinically, the paratenon-denuded tendons glided under the neo-dermis without tethering to the overlying integrated matrix, allowing a full range of digital movement. This was confirmed on ultrasound examination, which also demonstrated no inflammation or oedema. Already proven in extensive burns, necrotising fasciitis and complex surgical wounds, BTM represents a useful addition to the reconstructive surgeon’s toolbox. (Plast Reconstr Surg Glob Open 2019;7:e2110; doi: 10.1097/GOX.0000000000002110; Published online 2 April 2019.)

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joints, with the potential for open joints requiring amputation later. Despite his age, obesity, and comorbidities, reconstruction by free tissue transfer was discussed with the patient, who was keen to avoid prolonged surgery. BTM was offered as a simple potential solution, to which he was agreeable, and a surgical plan was formulated.

His wound was further debrided under regional anesthesia and BTM applied (Fig. 1) on what we consider to be “Day 0.” Four days later, the BTM was showing the early signs of integration (Fig. 2). He was discharged home on day 7 post-BTM application and attended for outpatient dressing changes twice a week to monitor integration.

On day 63, he returned to theater for delamination of BTM (Fig. 3) and definitive coverage with fenestrated sheet split thickness autograft. A small area of breakdown adjacent to the extensors hallucis longus (EHL) tendon required further skin grafting before full healing.

Sixteen months postsurgery, he has a mature, pliable stable scar (Fig. 4) and full range of motion of his toe extensors (first recorded at 9 months) [see Video 1, Supplemental Digital Content 1, which displays wound appearance, digital and ankle movement at 9 months (267 days) post-BTM application, and 204 days post graft application, http://links.lww.com/PRSGO/A978].

**Fig. 1.** Day 0, following debridement of nonviable tissue exposing superior and inferior extensor retinacula, digital extensor expansions (I and II), one of the terminal branches of the superficial peroneal nerve, the terminal branch of the saphenous nerve and the tendons of EHL and EHB, and EDL to all 4 toes. All of the tendons are denuded of paratenon. The joint between the medial cuneiform and the base of the first metatarsal is also open. EDL indicates extensor digitorum longus; EHB, extensors hallucis brevis.

**Fig. 2.** BTM applied, held with staples on day 4. Pallor over EHL is obvious, but integration has commenced over the rest of the wound.

**Fig. 3.** Delamination and dermabrasion of the underlying neoepidermis on day 63; this was followed by fenestrated sheet split skin graft application.

**Fig. 4.** The result at review on day 486.

**Video Graphic 1.** See video, Supplemental Digital Content 1, which displays wound appearance, digital and ankle movement at 9 months (267 days) post-BTM application, and 204 days post graft application, http://links.lww.com/PRSGO/A978.
Video Graphic 2. See video, Supplemental Digital Content 2, which displays the ultrasound of the unimpeded movement of the EHL tendon deep to the graft over the integrated BTM on day 486, http://links.lww.com/PRSGO/A979.

DISCUSSION

Degloving injuries of the lower limb are challenging, as extensive tissue damage often curtails reconstructive options. Treatment involves adequate debridement, and, if appropriate, the avulsed skin can be defatted and remain attached, or excised and defatted, to be re-applied as an autograft. If avulsed tissue is unsuitable, autologous skin grafting onto a healthy wound bed is preferred. Adjunctive techniques include closed drainage with compression bandaging, bolstering of grafts, and topical negative-pressure therapy dressings applied over the skin reconstruction of choice. However, degloving injuries involving deeper tissues are associated with increased risk of infection and graft loss, particularly in the elderly.

Developments with acellular dermal matrix (Integra, produced by Integra LifeSciences, Plainsboro, New Jersey, USA)) and split skin grafting offer a staged reconstructive option, improving vascularity, contour, and quality of the wound bed before definitive closure. In 7 pediatric patients with lower extremity wounds and exposed tendons, minimal complication and good function were reported according to Foot and Ankle Ability Measures. Tendon glide was, however, not imaged by any modality in these articles, and it was not reported whether the tendons had been traumatically denuded of paratenon before wound reconstruction. Precedence for using a dermal substitute in our case had thus been established.

This case involved avulsion of the dermis and subcutaneous tissue, paratenon-denuded extensor tendons, and exposed bone. The rationale for using BTM was based on our extensive experience of the qualities of BTM in establishing a robust tissue layer for encouraging and incorporating split skin graft take. In particular, the preservation of tendon glide had been noted clinically when BTM was used in radial forearm donor site reconstruction. This case differed because paratenon was lost. The ultrasound scan at 16 months demonstrated EHL and extensor digitorum longus tendons gliding freely under the site of the graft repair without evidence of tethering. The normal tendon fibrillary pattern was preserved with no evidence of peritendinous edema, or hyperemia, to suggest inflammation.

This case is published in isolation to illustrate a particular finding (tendon gliding under the material despite lack of paratenon), and readers should reference our previous work for other examples of outcome. BTM is regulated in the United States under an FDA 510(k) (a regulatory pathway granted by the US Food and Drug Administration prior to a company commercialising its product, where evidence that the medical device intended to be marketed is safe and effective) for use in wounds (excluding deep burns) and can be used now by US surgeons for similar indications. It is fully regulated for use in any wound in Australia and is also available in South Africa, India, Saudi Arabia, and Israel. The authors’ understanding is that the cost of the material will vary according to jurisdiction and that costs have not yet been finalized. In Europe, Conformité Européenne marking has not yet been achieved.

CONCLUSIONS

This case reports the successful use of BTM and split thickness skin grafting for a lower limb degloving injury. Ultrasound examination suggests that BTM applied over denuded tendons does not seem to restrict glide or induce tethering.

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