

CASE REPORT **BURNS**

Does it stack up? Stacked biodegradable temporising matrix for contracture release of the foot: a case report

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Introduction

Burn contractures of the foot can significantly impact mobility.¹ Surgical release is often necessary to restore range of motion, but managing soft tissue deficits remains a challenge after forefoot contracture release.^{2,3} Traditional soft tissue solutions using skin grafts and local flaps may be unsuitable due to unfavourable wound beds and limited donor sites.^{4,5}

In recent years, dermal substitutes, particularly NovoSorb (PolyNovo Biomaterials Pty Ltd) biodegradable temporising matrix (BTM), have emerged as promising alternatives.^{6,7} This case report highlights the use of stacked BTM in forefoot contracture release with tendon lengthening and exposed extensor tendons.

Case

A 15-year-old patient presented with dorsal contracture of all toes secondary to a burn scar on the dorsum of his foot. The plantar surfaces of toes 2 through to 5 were not contacting the ground at rest, affecting the patient's ability to push off effectively during walking (**Figure 1**).

The patient proceeded to a forefoot contracture release. During the surgery, all extensor tendons were step lengthened except for the extensor hallucis longus (EHL), which underwent tenolysis. The new position of the toes was temporarily fixed with Kirschner wires (K-wires) across the metatarsophalangeal joints. Following release, the soft tissue defect was covered with a single layer of BTM and dressed with a negative pressure dressing. The first layer of BTM appeared sufficiently integrated at six weeks (**Figure 2a**). Following delamination, however, it became apparent that there were still exposed tendons on view (**Figure 2b**). A second layer of BTM was placed over the first layer of integrated BTM following delamination and light Versajet (Smith and Nephew, Multipoint Technologies Pty Ltd) debridement. The K-wires were removed during this same procedure. The area was again dressed with a negative

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Fig 1. Preoperative image of dorsal scar contracture with toes raised above the ground



Fig 2a



Fig 2b

Fig 2. (a) Showing the dorsal scar contracture release and integrating first layer of BTM; (b) after delamination of first layer of BTM showing exposed tendons

pressure dressing. The integration of the second BTM layer occurred more rapidly than the first, as the underlying bed had become more vascularised compared to the initially scarred bed.

The additional layer of BTM covered the areas of exposed tendon, allowing delamination and split thickness skin graft coverage four weeks later (**Figure 3**). Postoperatively, the patient had an uneventful recovery (**Figure 3**). Following surgery, the patient wore a full-time, toe-down splint for eight weeks, transitioning to night-time splinting for an additional three months. Gradual weight bearing commenced after eight weeks. Once the skin graft matured, active scar management was initiated using silicone sheets and pressure garments on the foot. Over a follow-up period of three months, significant improvement in the patient's gait was noted, especially during the push-off and stance phases.

Discussion

Burn contracture releases of the foot represent a significant and multifaceted surgical challenge, primarily due to the unique combination of functional demands that the foot must meet and the constraints imposed by the available local soft tissue. The foot plays a vital role in weight bearing, mobility and balance, making any loss of function or deformity particularly debilitating. In the context of burn injuries, these deformities often result from the formation of tight, scar tissue that limits the normal range of motion and mobility of the foot, impairing essential functions like walking and standing.

The process of releasing these contractures typically involves several surgical interventions, including not only the excision of the thickened scar tissue but also more complex procedures such as tendon lengthening and tendon transfers. These procedures aim to restore normal movement and reduce deformities caused by the scarring.

Moreover, the situation is further complicated by the fact that extensive burns often result in significant soft tissue loss, creating large, non-graftable defects. In such cases, reconstructive surgery may require the use of free flaps, local or regional tissue rearrangement to cover areas of tendon lengthening, or reconstruction.

The priority following the release of burn contractures of the foot is to address the resulting soft tissue defect with a material that is both pliable and robust enough to allow smooth gliding of the underlying extensor tendons. The primary challenge in reconstructing the foot following contracture release is selecting a method of soft tissue coverage that covers the defect, facilitates tendon gliding and minimises the risk of future deformity.

Several options for soft tissue coverage are available, each with distinct advantages and limitations. These options include split thickness skin grafts, full thickness skin grafts, local or locoregional flaps, free tissue transfer and, more recently, dermal substitutes.

Split thickness skin grafts are commonly used due to their ease of harvest and relatively straightforward application, but they come with



Fig 3. Four weeks post-surgery with healed skin graft

notable drawbacks. One major limitation is the risk of secondary contracture, which can lead to the relapse of the original deformity. Additionally, split thickness grafts often lack the necessary durability and resilience required in the foot, an area that endures constant pressure from footwear and daily activities. Moreover, these grafts do not provide an ideal gliding surface for the underlying tendons, which is essential for maintaining proper tendon function.

Full thickness skin grafts, on the other hand, offer a more durable and robust solution, with a reduced risk of secondary contracture compared to split thickness grafts. Once fully healed, full thickness grafts are more resistant to long-term stretching and contraction, making them a preferred choice for covering areas subjected to repetitive motion and pressure. In cases where the soft tissue bed is of poor quality, such as when exposed tendons or other non-graftable elements are present, full thickness skin grafts are at a higher risk of partial or complete failure. Furthermore, full thickness grafts do not inherently provide the necessary gliding surface for extensor tendons, which can limit their functional effectiveness.⁸

Local or locoregional flap coverage can provide robust, vascularised soft tissue but unfortunately there is a scarcity of local or locoregional flap options for the forefoot. Free vascularised tissue transfer can be used, but it is more technically demanding and time consuming. Furthermore, due to the thin adipose layer of the dorsal foot, these reconstructions are often bulky and require multiple secondary thinning procedures to improve the foot's contour and allow wearing of unmodified footwear.

Dermal substitutes offer a robust, simple alternative, by providing a 'neodermis' prior to split thickness skin grafting. The creation of a neodermis increases the durability of the reconstruction and creates a gliding plane for the extensor tendons.^{9,10} It also allows for a reconstruction with improved contour and minimal donor site morbidity when compared to free vascularised tissue transfer.^{7,9,10} NovoSorb BTM is a thick synthetic dermal matrix composed of a biodegradable polyurethane scaffold for vascular

ingrowth covered by a non-biodegradable sealing membrane that is removed at the time of split thickness grafting.¹¹ When applied to a soft tissue defect, a single layer of BTM creates a vascularised bed with an average thickness of approximately 2 mm.^{9,12} In cases with more complex soft tissue deficits, a single layer of BTM may not provide sufficient coverage of exposed tendons or might leave contour irregularities. To address this, stacking a second layer of BTM following integration and delamination of the initial layer can significantly enhance the robustness of the vascularised bed and improve functional and aesthetic outcomes.

The disadvantages of stacking BTM include the duration of dressing changes, the need for additional procedures and the time until complete healing occurs. This inconvenience is offset by the functional and aesthetic outcomes. As we become more familiar with this technique, the duration between stacking is likely to reduce and the future likely holds pre-stacked BTM layers that can integrate.

Conclusion

Stacked BTM is a feasible alternative to flap cover following the release of complex burn contractures with exposed tendons. It provides robust, well-contoured, soft coverage and, where necessary, a gliding plane for underlying tendons.

Patient consent

Patients/guardians have given informed consent to the publication of images and/or data.

Conflict of interest

Dr Monique Bertinetti received an honorarium for a lecture for PolyNovo on 18 June 2024. PolyNovo had no involvement in patient selection or preparation of this how to guide or its submission for publication. The other authors have no conflict of interest to disclose.

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