Case-Based Outcomes Using Boron-Based Bioactive Glass Fiber Matrix Skin Substitutes for Complex Wounds Following Surgical Repair

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INTRODUCTION

Chronic and post-surgical wounds, particularly in patients with comorbidities or a history of surgical complications, have the potential to stall, making healing difficult.[1] Bioengineered skin substitutes have emerged as promising adjuncts in wound care.[2,3] This case series describes the clinical course of three patients with complex lower extremity wounds treated using applications of a Boron-Based Bioactive Glass Fiber Matrix (BBGFM) alongside standard wound care modalities.

METHODS

Three patients with lower extremity wounds were followed over varying treatment timelines.

Case-1: A 50-year-old male diabetic (A1c 10.1) with Charcot foot status post fusion at the tarsal metatarsal joint presented with suspected infection of hardware (Figure 1a and 1b). Findings were positive for osteomyelitis in the talus, navicular, and cuneiform, and negative at the metatarsal base. Hardware removal was completed, and a vessel loop closure procedure was performed alongside the use of negative pressure wound therapy (NPWT) (Figure 1c).

Case-2: A 32-year-old male with no significant past medical history presented 2.5 weeks post operatively from a minimally invasive Zadek Osteotomy (Figure 2a and 2b). Initial treatment at Week 0 consisted of bedside and then operating room debridement with the placement of antibiotic loaded calcium sulfate beads with removal of hardware which was replaced with 1 distal screw (Figure 2c). Closure was completed with the application of the BBGFM alongside NPWT.

Case-3: A 55-year-old male diabetic (A1c 11.8) presented with cellulitis and pruritic over the 3rd and 4th toes. The patient was extremely worried about potentially losing the toes (Figure 3 a). Laboratory testing revealed a white blood cell count of 7.9 and c-reactive protein levels of 120.9, suggestive of underlying infection. The procedure was staged and consisted of a third toe amputation with incision and drainage. A digital pulp flap (DPC) was performed alongside a toe fill flap to fill the defect (Figure 3b). A 50% flap dehiscence was noted and expected as the attempt was to save the 4th toe from amputation.

RESULTS

Case-1: Progressed from 324cm^3 at week 0 to complete closure following six applications of BBGFM at week 6 (Figure 1d), 8, 12, 16 (Figure 1e), 20, and 24 (Figure 1f). Complete closure is depicted in Figure 1g.

Case-2: Following the use of NPWT alongside the application of BBGFM, the incision site wound healed over 6 weeks (Figure 2d).

Case-3: The lateral toe 4th wound healed after 3.5 weeks. Two applications of the BBFGM had taken place up until post operative day 11 (Figure 3c). At five weeks post op, dehiscence and deep tunneling was noted at the incision site (Figure 3d). Complete closure was evident at seven weeks post op with sparing of the 4th digit (Figure 3e).

DISCUSSION

Sequential applications of the BBGFM skin substitute played a pivotal role in accelerating healing in all three of the difficult to treat and contaminated surgical wounds. In all three cases, the BBFGM was associated with robust granulation, epithelialization, and volume reduction. These findings support the integration of bioengineered grafts as part of a multimodal wound care strategy for patients with complex surgical wounds, particularly when combined with antimicrobial control, salvage procedures, skin flap use, and adjunct wound care methods.

Case 1

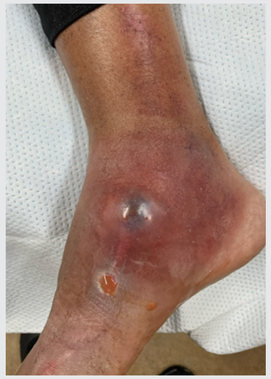

Figure 1a – Initial presentation of incision site following Charcot corrective procedure.

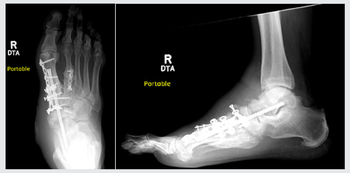

Figure 1b – Radiographic images at initial presentation positive of osteomyelitis in the talus, navicular, and cuneiform.

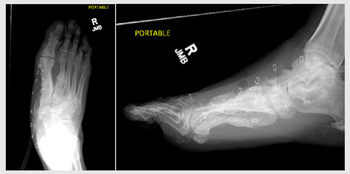

Figure 1c - A vessel loop closure procedure was performed alongside the use of negative pressure wound therapy (NPWT).

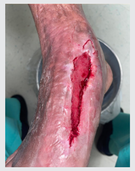

Figure 1d – Incision site following removal of NPWT and vessel loop tension closure.

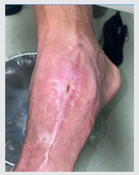

Figure 1f – Incision site at week 24 following six applications of BBGFM

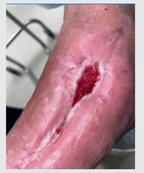

Figure 1e – Incision site at week 16 following four applications of BBGFM.

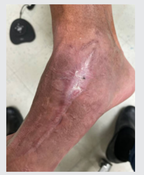

Figure 1g – Incision site at week 26 with complete closure.

Case 2

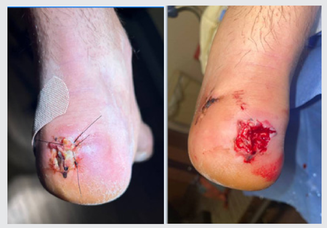

Figure 2a – 2.5 week post operative following minifmally invastive Zadek Osteotomy (left) and post debridement (right).

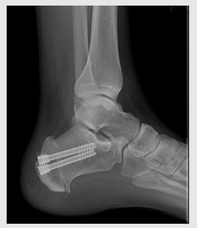

Figure 2b – Radiographs 2.5 weeks post operatively.

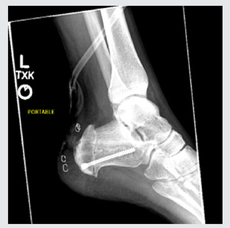

Figure 2c – Radiographs after placement of antibiotic loaded calcium sulfate beads with removal of hardware which was replaced with 1 distal screw.

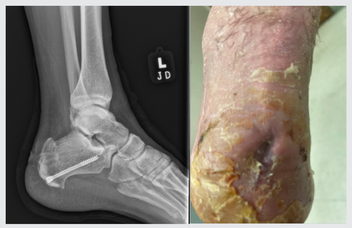

Figure 2d – Radiograph image at week 6 (left) and full wound closure (right).

Case 3

Figure 3a – Initial presentation.

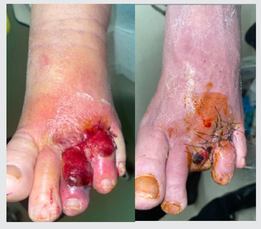

Figure 3b – Pre-operative (left) and post operative DPC and toe fillet flap (right).

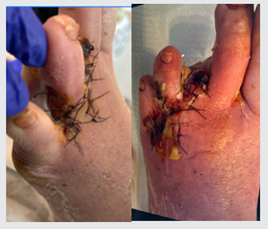

Figure 3c – 11 weeks post op displaying lateral fourth toe wound.

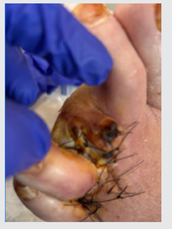

Figure 3d – Five weeks post op with displayed dehiscence and deep tunneling.

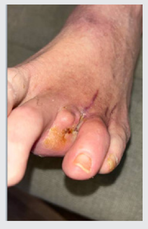

Figure 3e – Seven weeks post op displaying complete wound closure.

References:
1) Schweinberger MH, Roukis TS. Wound complications. Clin Podiatr Med Surg. 2009 Jan;26(1):1-10
2) Kondej K, Zawrzykraj M, Czerwiec K, Deptuła M, Tymińska A, Pikuła M. Bioengineering Skin Substitutes for Wound Management-Perspectives and Challenges. Int J Mol Sci. 2024 Mar 26;25(7):3702.
3) Primous NR, Elvin PT, Carter KV, Andrade HL, La Fontaine J, Shibuya N, Biguetti CC. Bioengineered Skin for Diabetic Foot Ulcers: A Scoping Review. J Clin Med. 2024 Feb 21;13(5):1221.

Acknowledgements: *Mirragen Advanced Wound Matrix, ETS Wound Care, LLC. This poster was prepared in collaboration with ETS Wound Care, LLC. All protocols and clinical assesments were conducted and reported independently by Sutter Health without any financial compensation from the manufacturer. For application instructions and risks of this device, please refer to the Mirragen Instructions for Use.