Staged Reconstruction of Soft Tissue Defects of the Foot and Ankle with Exposed Bone and Tendon Using a Bilaminar Matrix and Split Thickness Skin Grafting

Cara Beach, DPM[1], Brian Kuklok, DPM[2], Andrew Shinabarger, DPM, MS, FACFAS[3]

[1] Third Year Resident, Legacy Health, Portland, OR

[2]First Year Resident, Legacy Health, Portland, OR

[3]Assistant Residency Director, Legacy Health, Portland, OR

Statement of Purpose

The purpose of this study is to retrospectively review the outcomes of a single surgeons experience with bilaminar dermal allograft skin with subsequent split thickness skin grafting for the closure of complex wounds of the foot and ankle with exposed bone, joint and or tendon from an infectious or traumatic etiology.

Level of Evidence

Level IV, Therapeutic Case Series

Literature Review

The anatomic complexity of the foot and ankle routinely presents challenges for surgeons in obtaining adequate soft tissue coverage for the closure of complicated wounds. Bilaminar dermal matrix allografts mimic both dermal and epidermal function and have been proven to provide a scaffold to assist in wound healing. Graft success has been shown to be dependent on the absence of infection and adequate vascular supply to the wound bed.[1] The application of this graft is usually accompanied with negative pressure wound therapy (NPWT) and subsequent split thickness skin grafting (STSG) at an accepted value of roughly three weeks. The longevity and success of the STSG has been shown to be improved with the use of NPWT prior to its application in obtaining wound closure.[2] In addition, it has been shown that the use of the allograft matrix with NPWT and STSG increases the TCPO2 level of the affected area, assisting in wound healing when compared to just NPWT and STSG.[3] The role of this allograft in the closure of wounds with exposed deep soft tissue and bone is promising in upper extremity and burn reconstructive literature, warranting further investigation into its applications in the foot and ankle.[1]

Methodology

A retrospective review was performed of patients undergoing staged foot and ankle reconstruction with a bilayer dermal matrix allograft and split thickness skin grafting for exposed bone, joints and tendon over a period of 5 years at a single institution by a single surgeon. We evaluated all patients wound size, the presence or absence of Diabetes, PAD, Osteomyelitis, ESRD, the location of the wound, time from allograft application to STSG, time from STSG to 100% epithelialization, and for any complications. We also looked at the level of amputation that would have been needed at time of debridement in order to achieve a tension free closure.

Figure 1: Image Progression of Limb Salvage

Procedure

All wounds underwent serial debridement until each wound was judged to be clean, and free of infection or nonviable tissue. At that time, a bilayer dermal matrix allograft was then placed over the wound and secured with staple fixation and negative pressure wound therapy. Negative pressure wound therapy was continued with changes every 48-72 hours until a granular wound bed was achieved. Once this was present a split thickness skin graft was harvested from the ipsilateral extremity and secured to the wound. All patients were then followed until there wounds were 100% epithelialized.

Results

Over a five year period, 27 patients and 30 total wounds underwent surgical treatment resulting in exposed tendon and/or bone. 87% of these wounds had exposed bone while 13% had only exposed tendon. All the wounds with bone present had osteomyelitis that underwent surgical debridement prior to graft application. After an average of 47 days following surgical debridement and application of the bilaminar matrix allograft, all wounds underwent application of STSG. The average amount of time to complete wound healing after STSG application was 46 days. 100% of these patients went on to heal. One of these patients required repeat STSG grafting after failure of 1st STSG. Overall, complete wound healing occurred in an average of 91 days. All patients achieved successful limb salvage without the need for more proximal amputation for wound closure.

Figure 2: Patient and Wound Characteristics

Characteristic	N (%)
Total Patients	27
Total Wounds	30
Mean Wound Size	30 cm^2
Mean Age	55 years
Female:Male	8:22
Diabetes Mellitus	25 (93%)
End Stage Renal Disease	5 (19%)
Peripheral Vascular Disease	11 (41%)
Wounds with the Presence of Osteomyelitis	26 (83%)

Figure 3: Wound Healing Results

Outcome Measure	Result
Time to STSG Application	Avg. 47 days Range: 17-134 days
Time to Complete Wound Healing after STSG	Avg. 46 days Range 12-140 days
Total Time to Heal from Application of Allograft	Avg. 91 days Range: 41- 274
Wounds with Complete Epithelialization	30/30 (100%)

Figure 4: Prevention of Proximal Amputation

Outcome Measure	Results
# of Wounds Requiring BKA for Primary Closure at time of initial debridement	19/30 (64%)
# of Wounds Requiring TMA for Primary Closure at time of initial debridement	8/30 (27%)
# of Wounds Progressing to Proximal Amputation	0/30 (0%)
# of Wounds with Amputation prior to graft application	15/30 (50%)

Analysis & Discussion

Current literature has shown up to an 86% percent wound healing rate using a bilaminar dermal allograft following similar protocols to this study.[4] We achieved 100% limb salvage without progression to a more proximal amputation following the treatment algorithm of extensive debridement, bilaminar allograft, NPWT and STSG application.

Typically, once the outer silicone layer is removed from the allograft at the three week mark, the STSG is applied at the same time, or within a few days of removal.[2] In our study, the outer layer was removed at three weeks, but the STSG was not applied until an average time of 47 days from the initial application of the allograft. This was done to ensure the wound bed was healthy, granular and capable of accepting the STSG. Our study is one of the first to document this extended period of time until STSG application and shows an extremely high limb salvage and wound closure rate. This could be due to the fact that the TCPO2 continues to rise within the wound bed after use of this type of allograft matrix for 24 months after application, with its greatest increase seen between 4 weeks and 3 months.[3]

The patients and wounds treated in this study were extremely high risk for major amputations, with 83% of wounds found to have previous bone infection and 63% of wounds needing a BKA for definitive closure at the time of initial debridement. These type of wounds are associated with a higher mortality and morbidity and longer time periods needed for healing.[5] Our results showed complete wound healing in an average of 91 days, which exceeds current literature.[5] These results are very encouraging and demonstrate that the use of this allograft dermal substitute with STSG needs to be considered for preservation of maximum foot length and functionally when faced with complex wounds of the foot and ankle.

References

1. Reynolds, Michael, David A. Kelly, Nicholas J. Walker, Clayton Crantford, and Anthony J. Defranzo. "Use of Integra in the management of complex hand wounds from cancer resection and nonburn trauma." *HAND* 13, no. 1 (2018): 74-79.
2. Ramanujam CL, Zgonis T. Stepwise surgical approach to diabetic partial foot amputations with autogenous split thickness skin grafting. *Diabet Foot Ankle.* 2016;7:27751 Iorio, Matthew L., Jesse Goldstein., Melissa Adams, John Steinberg, and Christopher At tinger. "Functional limb salvage in the diabetic patient: the use of a collagen bilayer matrix and risk factors for amputation." *Plastic and reconstructive surgery* 127, no. 1 (2011): 260-267.
3. Papa G, Spazzapan L, Pangos M, Delpin A, Arnez ZM. Compared to coverage by STSG grafts only reconstruction by the dermal substitute Integra plus STSG increases TcPO2 values in diabetic feet at 3 and 6 months after reconstruction*. G Chir.* 2014;35(5-6):141-145.
4. Clerici, Giacomo, Maurizio Caminiti, Vincenzo Curci, Antonella Quarantiello, and Ezio Faglia. "The use of a dermal substitute to persevere maximal foot length in diabetic foot wounds with tendon and bone exposure following urgent surgical debridement for acute infection." *International wound Journal* 7, no. 3 (2010): 176-183.
5. Iorio, Matthew L., Jesse Goldstein., Melissa Adams, John Steinberg, and Christopher At tinger. "Functional limb salvage in the diabetic patient: the use of a collagen bilayer matrix and risk factors for amputation." *Plastic and reconstructive surgery* 127, no. 1 (2011): 260-267.

Financial Disclosures

No financial disclosures to report for any of the authors of this poster.