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Reconstructive

Use of Dermal Substitute Matrices for Coverage of Exposed Limb Vascular Repairs: A Literature Review

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Background: Prompt coverage of vascular repairs in the extremities is needed to protect from desiccation and trauma. In the absence of local soft tissues to provide early coverage pending demarcation of the tissues and the zone of injury, there is no clear data in the literature on the ideal coverage method. This article is the first to review the use of dermal substitutes for temporary coverage of extremity vascular repairs pending definitive coverage.

Methods: We conducted a review of the literature to identify previous articles indexed in PubMed and Ovid using these search terms: [(skin) OR (artificial skin) OR (Integra) OR (dermal substitute) OR (dermal substitute matrix) OR (dermal regeneration) OR (dermal regeneration matrix) OR (dermal regeneration template)] AND [(bypass) OR (graft) OR (vascular surgery) OR (revascularization) OR (salvage) OR (limb salvage) OR (vascular repair) OR (artery repair) OR (arterial repair)] AND [(limb) OR (extremity) OR (leg) OR (arm) OR (vascular injury) OR (amputation)].

Results: Of the 32 articles retrieved for initial review, five case reports with six patients of dermal substitute use for direct coverage of extremity repairs were identified. In all cases, the dermal substitute was able to provide stable coverage pending definitive coverage or was allowed to heal secondarily.

Conclusions: Dermal substitute matrices are a potential means of temporary coverage of exposed extremity vascular repairs when there is a paucity of local soft tissues pending more definitive coverage. *(Plast Reconstr Surg Glob Open 2024; 12:e5855; doi: 10.1097/GOX.0000000000005855; Published online 4 June 2024.)*

INTRODUCTION

The use of dermal substitute matrices for the management of wounds was first described by Burke et al.[1] Although initially used for extensive large surface area burns, their clinical applications have now expanded to include the treatment of many injuries of the integument as a bridge to skin grafting, and it has thus become a major step along the reconstructive ladder. These partial and full-thickness injuries include but are not limited to burns,[2] tumors,[3] pressure injuries,[4] degloving injuries,[5] diabetic and venous ulcers,[6] traumatic wounds,[7] and postinfectious wounds after receiving the needed debridement and courses of antibiotherapy.[8]

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Among the most widely used and commercially available dermal regeneration templates is Integra (Integra LifeScience Corporation, Plainsboro, N. J.), which is a bilayer matrix composed of porous bovine type I collagen cross-linked with glycosaminoglycans from shark chondroitin sulfate with an overlying semipermeable silicone layer.[9,10] Another commonly used dermal substitute is AlloDerm (LifeCell Corporation, Branchburg, N. J.), an acellular dermal matrix composed of collagen, elastin, and laminins that are derived from cadaveric human skin.[11]

Although effective and yielding good functional and aesthetic outcomes in their various clinical applications[7] and having been described for coverage of exposed bone, tendon, and joints in the extremities,[12] there is a paucity of data describing the use of dermal substitute matrices in the coverage of exposed vascular repairs. This is an especially important consideration in limb salvage where vascular repair can be needed, and there are often insufficient soft tissues for coverage.[13] This article is therefore the first that aims to synthesize the current literature on dermal substitute matrix-based coverage of vascular repairs in the extremities.

Disclosure statements are at the end of this article, following the correspondence information.

METHODS

A comprehensive literature search was performed on Ovid and PubMed to identify articles for review. The search items used were: [(skin) OR (artificial skin) OR (Integra) OR (dermal substitute) OR (dermal substitute matrix) OR (dermal regeneration) OR (dermal regeneration matrix) OR (dermal regeneration template)] AND [(bypass) OR (graft) OR (vascular surgery) OR (revascularization) OR (salvage) OR (limb salvage) OR (vascular repair) OR (artery repair) OR (arterial repair)] AND [(limb) OR (extremity) OR (leg) OR (arm) OR (vascular injury) OR (amputation)]. Timeframe of the search was not restricted. A total of 32 articles were recovered using this search for initial review. Peer-reviewed publications, case reports, and case series in which dermal substitute matrix was used for coverage of extremity vascular repairs were included.

Takeaways

Question: In cases of extremity vascular repairs where local soft tissues are not available for coverage, what are alternative modes of coverage that can be used in the acute setting?

Findings: Dermal substitute matrices were successfully used as temporary coverage for vascular repairs pending more definitive coverage. This was based on review of all cases where dermal substitutes were used for this purpose, and all reported cases provided safe coverage in the temporary period.

Meaning: Dermal substitutes can provide temporary coverage of vascular repairs in the extremities pending more definitive coverage.

RESULTS

A total of five case reports were retrieved from the literature, in which dermal substitute matrix was used for coverage of vascular repairs in the extremities. There was a total of six patients in these reports (n = 6). Table 1 summarizes these studies. The dermal substitute used was Integra in three cases and AlloDerm in three cases. Four of these cases involved the upper extremities, whereas two cases involved the lower extremities. Dermal substitute matrix was used as a temporary coverage method in five of the six cases. The final reconstruction involved flap-based coverage in three cases, split-thickness skin grafting in one case, and serial excision of the dermal substitute with delayed primary closure in one case. Duration of temporary coverage ranged from 1 to 4 weeks. In the case in which AlloDerm was used definitively, vascular coverage was stable until a duration of 1 year, when the patient required mid-tibial amputation due to thrombosis of the graft and progression of the patient's peripheral artery disease. Moreover, the two patients requiring temporary coverage of the lower extremities had severe peripheral arterial disease, but there were no issues with take of the dermal substitute and no complications related to durability of the vascular repair.

Table 1. Summary of Case Reports Where Dermal Substitute Was Used for Coverage of Vascular Repairs in Extremities

No.	Summary of Case	Exposed Vascular Repair	Size of Defect	Dermal Substitute Used	Duration of Coverage	Definitive Coverage and Outcome
1[14]	32-y-old woman with right mangled hand postcrush injury	Dorsal vein graft from right foot to superficial palmar arch	$8 \times 10\,cm^2$	Integra	3 wk	Lateral arm flap, complete healing
2[15]	37-y-old man with left antebrachial fossa degloving injury post-MVA	Reversed greater saphenous vein graft to brachial artery injury	$6 \times 10\,cm^2$	AlloDerm	1 wk	Lateral arm flap, complete healing
3[15]	32-y-old woman with left antebrachial fossa degloving injury post rollover MVA	Reversed greater saphenous vein graft to radial artery injury	$12 \times 20\,cm^2$	AlloDerm	8 d	2-stage thoracoabdominal flap, complete healing
4[16]	73-y-old woman with peripheral artery disease requiring right femorotibial bypass complicated by overlying skin necrosis in the distal third of the leg	Femorotibial bypass	X	Integra	4 wk	Split-thickness skin graft, complete healing
5[17]	53-y-old man with peripheral artery disease requiring synthetic PTFE graft from external iliac to distal posterior tibial artery, complicated by skin necrosis on medial leg	PTFE graft from external iliac to distal posterior tibial artery	X	Integra + NPWT for 3 wk	1 y	Secondary healing, amputation at 1 y
6[18]	58-y-old man with left upper extremity zebra bite and degloving injury	Nonreversed greater saphenous vein graft to brachial artery injury	$8 \times 15\,cm^2$ (dermal substitute only applied to small portion that could not be covered with fasciocutaneous flap)	AlloDerm	3 wk	Serial excision of Integra and delayed primary closure

MVA, motor vehicle accident; PTFE, Polytetrafluoroethylene.

DISCUSSION

Prompt coverage of vascular repairs is essential to protect from desiccation and trauma and to minimize the risk of infection. Although coverage with local muscle flaps and vascularized tissues can afford such protection to exposed vascular repairs, there may be a paucity of such nearby soft tissues in extensive extremity defects.[19,20] Moreover, definitive closure can be undesirable in such cases pending demarcation of tissues in the zone of injury or patient stabilization.

The data in the literature are unclear on the ideal temporary coverage method of exposed vascular repairs in the extremities. Calligaro et al[20] found a graft failure rate of 25% with the use of local wound care and secondary healing in the management of infected lower extremity bypass grafts, and this rate was higher than local muscle flap coverage. Although Dosluoglu et al[21] described the direct application of negative pressure wound therapy (NPWT) dressing on exposed vascular grafts without intervening muscle coverage with success, this was not the case with Ali et al,[15] where vacuum-assisted closure dressing caused compression of the bypass and loss of distal pulses in the lower extremity. Moreover, direct application over blood vessels and anastomotic sites is cited as a contraindication of NPWT due to risk of bleeding.[22] However, as reported in the results, NPWT was used by Abou Issa et al[17] over the dermal substitute matrix with success.

Our review of the literature reveals cases where dermal substitutes such as Integra and AlloDerm were successfully used as a novel method of temporary coverage of exposed vascular repairs in the extremities without compromising bypass function and structure pending definitive coverage. These dermal substitutes provide the time needed for establishing the vascularity of the extremity after vascular repair, demarcation of the zone of injury, and patient stabilization.[23] They are readily available, come with no added donor site morbidity, and obviate the need for dressing changes over a directly exposed vascular repair.[24] Although dressing changes may still be required with the use of single-layer dermal substitutes such as AlloDerm, the vascular repair is protected by the dermal substitute by resisting the tear forces that would otherwise be harmful with dressing changes directly over the vascular repair.[25] Limitations on their use are high cost, which may be a hindrance to their use in low-income countries, and the need for further studies and larger case series to potentially consolidate their role within this scope. Moreover, it is crucial to emphasize that the absence of country-specific regulations on the use of human- and animal-derived dermal substitutes can impede their accessibility in particular regions across the globe. Furthermore, beyond legislative concerns, sociocultural factors specific to each region can also serve as impediments to their widespread adoption.[26] We would also like to highlight the potential for publication bias; although all case reports published in the literature showed success of the technique reviewed, this is not to say that failures do not exist but may simply have not been published.

CONCLUSION

Dermal substitute matrices can be a potential means of temporary coverage of exposed extremity vascular repairs when there is a paucity of local soft tissues pending more definitive coverage.

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DISCLOSURE

The authors have no financial interest to declare in relation to the content of this article.

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