

Complex Wound Management Utilizing an Artificial Dermal Matrix

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Abstract: The benefits of the Integra Dermal Regeneration Template in the management of extensive burn injuries have been well documented. Integra can reduce donor- and graft-site scarring and has been reported to be capable of vascularizing over small areas of exposed bone and tendon. Given these potential advantages, we have used Integra for a variety of other reconstruction applications. We performed a retrospective review of patients with complex wounds treated with Integra at our burn center. Integra was used in the management of a variety of wounds, including necrotizing fasciitis, extremity degloving injury, meningococemia, Marjolin ulcer, postburn lip reconstruction, and fourth-degree burns with exposed bone or tendon. Engraftment rates of Integra and autograft were $98\% \pm 4\%$ and $97\% \pm 4\%$, respectively. All areas of graft loss healed without need for regrafting. The benefits of Integra in the management of acute burn wounds can be extended to other traumatic and complex wounds.

Key Word: dermal matrix wound coverage

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The benefits of Integra Dermal Regeneration Template (Integra Life Sciences, Plainsboro, NJ) in the management of extensive burn injuries have been well documented.^{1–7} Integra is a bilaminar skin construct with a dermal component composed of bovine collagen and chondroitin-6-sulfate, and a temporary Silastic outer layer that is removed prior to autografting. Integra has been reported to reduce both donor and graft site morbidity and scarring and to vascularize over small areas of exposed bone and tendon.^{1–7} These characteristics

make Integra a potentially useful tool in the management of other acquired soft tissue defects.

The goal of wound coverage is to replace lost tissue with similar tissue to optimize functional and esthetic outcomes. Skin grafts are commonly used to cover soft tissue defects. However, it is not always possible to replace the full thickness of skin or underlying soft tissue. Therefore, split-thickness grafts are commonly used for wound coverage. Whereas split-thickness skin grafts are practical, the lack of full thickness of dermis can compromise both function and appearance. Therefore, a synthetic skin substitute that could augment the native dermis in split-thickness skin grafts could improve durability and function without increasing donor-site morbidity. In addition, a soft tissue substitute that could vascularize over small areas of exposed tendon or bone would similarly provide a powerful tool to the reconstructive surgeon.

Given the successful experiences with Integra in the management of acute burns and the potential benefits of Integra in other types of wounds, we began using Integra in the management of other complex soft tissue injuries. The purpose of this case series is to review our experience using Integra for complex soft tissue reconstruction.

METHODS

Patients

We performed a retrospective review of all patients treated with Integra for complex wounds from 2001 to 2004, with approval of our institutional review board. Patient charts were reviewed, with attention to wound etiology, size, and location; percent Integra and skin graft take; complications, including wound infection and hypertrophic scarring; and, when possible, functional outcome.

Surgical Techniques

In all cases, Integra was prepared in accordance with the manufacturer's guidelines and applied to previously debrided viable wound beds. In the cases of skull coverage, the outer cortex was burred to debride the bone and to increase the rate of Integra vascularization. In all cases, Integra was meshed 1:1, based on our previous experiences with unmeshed Integra.⁷ Integra was affixed to the wound using staples or sutures, based on attending surgeon choice. Integra was dressed with Spandage netting (Sterling Medical Products, Prophetstown, IL) and gauze dressings soaked in 5% Sulfamylon solution.

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Integra was inspected every third postoperative day or as needed to assess vascularization status and to monitor for development of hematomas or infection. Once the Integra was determined to have adequately vascularized (based on physical examination), the outer Silastic was removed and a thin (0.006 to 0.008 inch) skin graft was placed.

RESULTS

Ten patients were identified for the study. Integra was used in the management of a variety of acquired soft tissue deformities, including traumatic extremity degloving, meningococemia/purpura fulminans, necrotizing fasciitis, Marjolin ulcer, exposed calvarium, exposed Achilles tendon, and postburn lip reconstruction (Figs. 1–4).

The patient and wound characteristics are summarized in Table 1. Average patient age was 32 ± 13 (13–50) years; 5 patients were female and 5 male.

The average wound size covered with Integra was 1428 ± 1792 cm². Integra was used to cover small areas of exposed tendon or bone in 4 patients (Fig. 1). The average time from Integra application to subsequent autografting was 19 ± 6

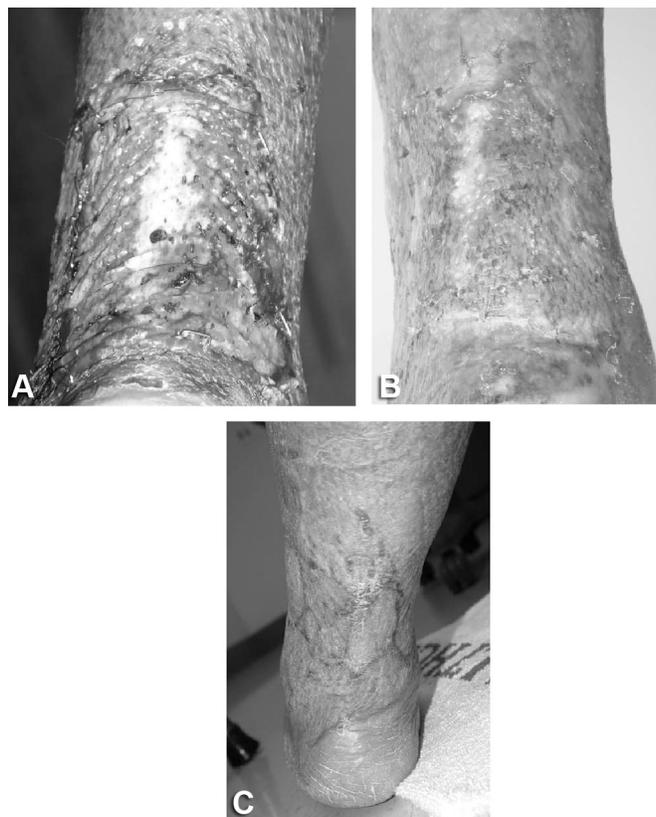


FIGURE 1. A, Fifty-year-old female with 10% circumferential full-thickness flame burn to her right lower leg. Following burn excision and initial skin grafting, a small area of Achilles tendon was exposed. B, Integra was placed on this open area (surface area of 80 cm²). C, The Integra gradually vascularized and was subsequently covered with a split-thickness skin graft.

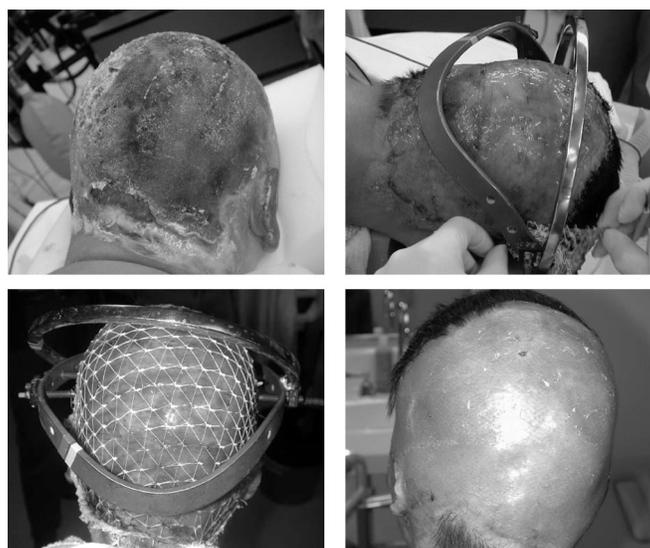


FIGURE 2. Thirty-five-year-old male, who was involved in a motor vehicle accident, with full-thickness burns to his scalp. Following debridement, there was a small area of exposed calvarium. The outer cortex was burred to bleeding tissue, and Integra was then placed over the entire scalp. Once adequately vascularized, the scalp was skin grafted.

days. The overall engraftment rate of Integra was 98% ± 4% and autograft was 97% ± 4%. Two patients developed wound infections following skin graft coverage of the Integra. Both



FIGURE 3. A, Thirteen-year-old female who sustained an approximately 90% total body surface area burn at the age of 3. She developed a chronic, nonhealing ulcer of her right thigh, just proximal to the popliteal fossa. B & C, Biopsy confirmed squamous-cell carcinoma moderately to well differentiated. Given the need to recrop from previously harvested donor sites, the decision was made to close this wound with Integra.



FIGURE 4. A & B, Twenty-four-year-old woman with a traumatic degloving of her right lower extremity. Given the extent and fascial depth of this wound, Integra was used to improve the appearance of the grafted wound and minimize the risk of knee contracture.

patients were treated with topical and systemic antibiotics and healed without the need for regrafting.

No patients developed hypertrophic scarring in the donor or recipient graft sites, and, following a period of postoperative physical therapy, all patients with extremity wounds gained full range of motion.

DISCUSSION

Integra has become a useful adjunct in the management of extensive burn injuries.¹⁻⁷ Integra's ability to augment the native dermis in split-thickness skin grafts and to vascularize over small areas of exposed tendon and bone make Integra an attractive tool in the management of complex wounds. We now consider Integra use in the management of extensive soft tissue defects—as we do in the management of extensive

burn injuries—to minimize donor-site morbidity and optimize the appearance and function of grafted sites.

Integra's ability to vascularize over small areas of exposed bone and tendon is particularly useful in wounds that otherwise would require the use of free tissue transfer. This is of particular relevance in patients with severe systemic illness secondary to extensive thermal injury, meningococemia, or necrotizing infection, who may not be suitable candidates for lengthy microsurgical procedures. In this series, Integra was used to cover small areas of exposed Achilles tendon and a small area of exposed calvarium. Both areas healed following skin grafting and remained closed. One patient who had his skull covered with Integra and subsequently skin grafted extruded small pieces of bone through the skin graft for several months; but this is minimal compared with our experience with bone extrusion in wounds that are grafted without Integra.

Our case series expands the existing case reports of Integra use for nonacute burn injuries.⁸⁻¹² Frame et al⁸ have described the use of Integra in burn reconstruction where there is a need to provide increased thickness of dermis to minimize recurrent contracture. Integra has also been used in the reconstruction of scalp defects following skin cancer excision and radiation, as well as for the coverage of small areas of exposed tendon on the extremities.¹⁰⁻¹²

Our institutional protocol for Integra has evolved to optimize Integra take and minimize infection.^{7,13} Since Integra is initially nonvascularized, it is prone to colonization and subsequent infection. Therefore, it is critical to ensure that the wound bed on which the Integra is to be placed has been adequately debrided. By meshing the Integra, small fluid collections can easily egress from the wound bed and antimicrobial dressings can be used to minimize colonization of the Integra. Sulfamylon solution is applied to the dressings covering Integra to minimize colonization. If a patient develops an allergy to Sulfamylon, then silver nitrate solution (0.5%) is used instead. Following Silastic removal and prior to autograft placement, the Integra is scrubbed with genitourinary irrigation to reduce any bacterial colonization. We have previously demonstrated that this can significantly reduce bacterial bioburden.¹³ In addition, due to the concern for potential infection, we obtain a quantitative culture, and if these cultures demonstrate greater than 10^5 colonies of bacteria, systemic antibiotics are administered.¹³ The most common

TABLE 1. Patient Demographic and Wound Data

Patient No.	Age (yr)	Sex	Location	Cause of Wound	Area of Integra (cm ²)
1	15	Male	Both legs and arms	Meningococemia/purpura fulminans	4500
2	13	Female	Right thigh	Squamous cell carcinoma	200
3	40	Female	Right lateral chest and abdominal wall	Necrotizing fasciitis	1600
4	46	Male	Scalp	Trauma	300
5	33	Male	Left Achilles tendon	Thermal injury	100
6	22	Male	Upper lip	Thermal injury	6
7	24	Female	Both legs	Trauma (crushing/degloving injury)	4500
8	41	Male	Left leg	Necrotizing fasciitis	2400
9	35	Female	Scalp	Thermal injury	600
10	50	Female	Right Achilles tendon	Thermal injury	80

organism identified in these cultures are staphylococcus species.

The required period of vascularization remains the principal drawback to Integra use. Following placement on a vascularized bed of soft tissue, 2 to 3 weeks is required for the Integra to adequately vascularize so that it can support a skin graft. Placement over exposed bone or tendon will require a longer period of vascularization as vessels grow into the Integra from the wound periphery. This not only delays the time to final wound coverage but also requires more than 1 operative procedure. While in acute burn injuries the patient may be in the hospital during this time period anyway due to the severity of their injury or the patient may need a window of time to heal donor sites prior to recropping, in other soft tissue reconstruction procedures, there may not be the same need for prolonged hospitalization. Therefore, one must weigh the benefits of Integra for dermal augmentation against the delay in definitive wound closure and the need for multiple operations. One option would be to discharge patients from the hospital that perform their wound care at home and then readmit them to the hospital for autografting procedure. This would potentially provide the benefits of using Integra while not prolonging hospital stay.

There have been no analyses performed addressing the potential cost-effectiveness or ineffectiveness of Integra use. The costs associated with Integra use reflect both the product cost and the potential increased length in hospital stay. As discussed above, the time required for Integra vascularization may increase hospital length of stay. However, Ryan et al¹⁴ recently reported decreased hospital length of stay for severely burned patients treated with Integra. Clearly, many of the patients in this series could have undergone skin grafting without Integra, thereby potentially shortening hospital length of stay. However, we believe that the long-term functional outcomes, as well as the long-term stability of the grafted wound, would be compromised. These negative long-term outcomes would be difficult to quantify and may be best assessed in a prospective study. Similarly, it is unclear whether Integra use reduces patient pain levels or impacts nursing care needs.

While there are other products available that are purported to provide augmentation of native dermis, the authors have minimal experience with these products. In addition, the available products typically require either immediate skin grafting (ie, there is no temporary outer layer) or are incapa-

ble of vascularizing over small areas of exposed bone or tendon.

Based on our experience, the potential benefits of Integra in the management of acute burn wounds can be extended to other types of traumatic and complex wounds. Successful Integra use requires a clean, viable wound bed, an adequate period for Integra vascularization, and the use of antimicrobial dressings.

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