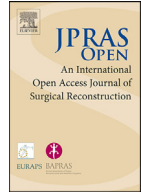




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## Case Report

# The use of Integra™ as a novel technique in deep burn foot management☆

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### ABSTRACT

Deep burns in patients with co-morbidities carry a significant challenge for surgeons. The use of synthetic skin substitutes has played an increasingly important role in tissue reconstruction. Integra™ is an artificial dermal substitute that allows temporary coverage after burn excision. The main advantages of this bi-layered template are its immediate availability, optimal scarring and decreased requirement for donor tissue. However, the downsides are the requirement for complex wound care, risk of infection and two stage procedure that can be both costly and prolong the stay in hospital. Here, we present the case of a patient with deep burns to the plantar aspect of both feet. Given the patient's medical history of diabetes, hypertension and peripheral neuropathy, we elected to use Integra™ in combination with negative pressure wound therapy. Three weeks after the application of the Integra™ matrix, the surface layer was replaced with autograft. At discharge, the patient was fully ambulatory and six months post-operatively this status was maintained without significant graft breakdown. To the best of our knowledge, the use of Integra™ and split thickness skin graft in the management of full thickness burns to the plantar aspect of the feet has not been reported previously. Overall, our experience

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with Integra™ in this setting was found to be satisfactory and can be considered as a promising treatment option in acute burn resurfacing.

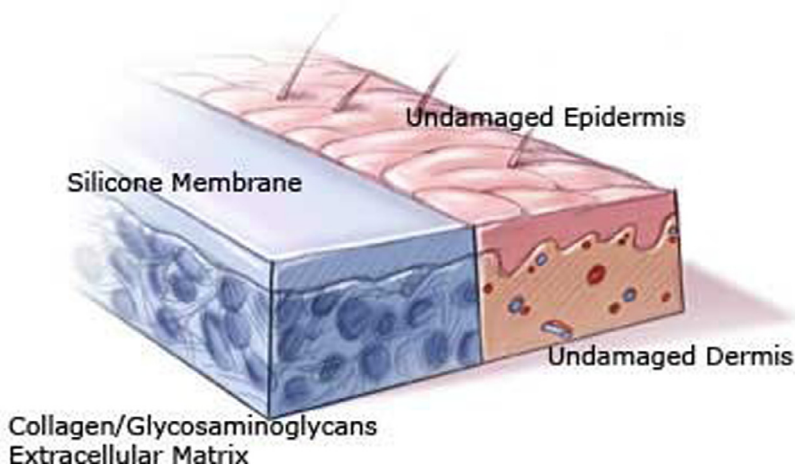
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## Introduction

Achieving satisfactory wound healing of deep burns to the lower extremity can often be complicated by patients' demographics and comorbidities and thus carries a difficult challenge to surgeons.<sup>1</sup> The plantar surface of the foot poses additional problems due to its thick glabrous skin and role in weight bearing.<sup>2</sup> Although the plantar surface of the foot will often re-epithelialize despite what may be initially diagnosed as a full thickness burn, these wounds are usually treated conservatively until it is clinically apparent that spontaneous re-epithelialization will not occur.<sup>3</sup> Treatment options for the plantar surface of the foot include split thickness skin grafting, free tissue transfer and amputation.<sup>4,5</sup> Although split thickness skin grafting is a simple and relatively minimally invasive treatment option, wound breakdown commonly occurs due to the fragility of the skin on a weight bearing surface.<sup>6</sup> The severity of the patient's overall condition may also prove to be incompatible with microsurgical free tissue transfer due to hemodynamic instability, and amputation may be the only viable option.<sup>6</sup> In light of this, the use of novel synthetic skin substitutes in burn reconstruction has been increasingly used due to the limited availability of donor and cadaveric skin.<sup>6</sup> Over a period of time, the Integra™ degrades and is replaced by native collagen without the formation of additional scar tissue.<sup>7</sup>

Integra™ is a synthetic scaffold that acts as a bi-layered skin regeneration template (Figure 1).<sup>7</sup> The top layer simulates the epidermis and consists of poly dimethyl siloxane that limits bacterial invasion and moisture absorption. The bottom layer consists of bovine type I collagen and shark chondroitin-6-sulfate that promotes cell migration and induces regeneration of the dermis.<sup>7</sup> Multiple studies have demonstrated efficacy with Integra™ use in full thickness burns; however, its use



**Figure 1.** Diagram illustrating the application of Integra™ to a full thickness skin defect. The collagen layer acts as a dermal regeneration template, promoting the formation of the new dermis. (Image taken from <http://www.burnresearchcenter.org>)

on the plantar surface of the foot has not been described.<sup>8</sup> We report our experience using Integra™ and split thickness skin grafting in the management of full thickness burns to the plantar aspect of the feet.

### Case report

The patient was a 52-year-old male with a past medical history of poorly controlled type 2 diabetes mellitus, hypertension, peripheral neuropathy and left second toe amputation, who presented with full-thickness burns to the plantar aspect of both feet after walking on hot asphalt (Figure 2). He was admitted to the burn unit and initially managed conservatively with silver sulfadiazine twice daily.

On hospital day 5, the patient became febrile. He was started on intravenous antibiotics and taken to the operating room for excision of bilateral foot burns (Figure 3). Subsequently, he was managed with complex wound care and continued silver sulfadiazine.

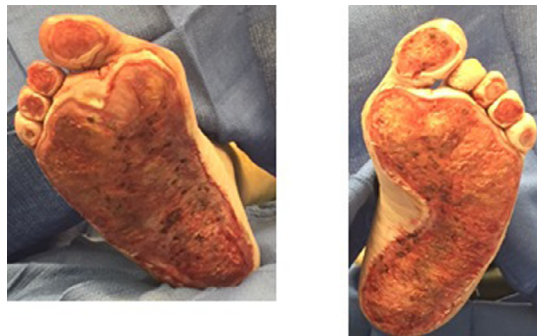
The patient finished a 10-day course of antibiotics. He returned to the operating room on hospital day 24 for re-excision of bilateral foot wounds and placement of negative pressure wound therapy (NPWT). The wound vacuums remained in place for 4 days, at which point they were taken down and healthy granulation tissue was noted. The patient then returned to the operating room on hospital day 31 for Integra™ placement (Figure 4).

After three weeks, on hospital day 47, the patient underwent autografting with split thickness skin graft to the plantar aspect of his both feet (Figures 5 and 6).

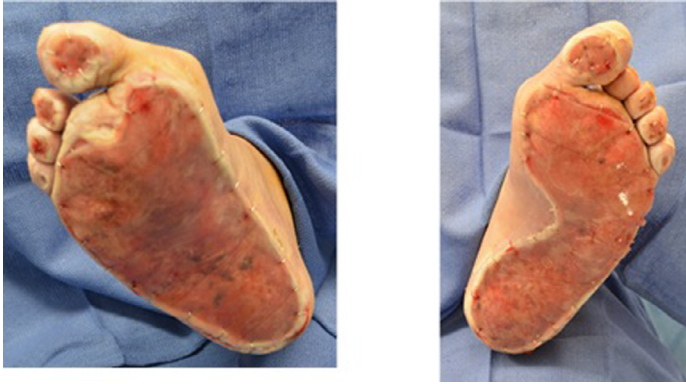
A wound vacuum was placed intraoperatively and taken down on post-operative day 4. Physical exam at that time demonstrated good take (>90%) of the graft. The patient's activity was gradually advanced following removal of the wound vacuums to dangling of his feet and tilt table at six weeks post operation, which he tolerated well. The patient then began weight bearing at eight weeks post operation; initially feet touching the ground and then standing. Unfortunately, we could not fix the microvascular problem in this patient due to the underlying diabetes (blood sugars ranged from 170 to 338mg/Dl) and peripheral vascular disease, and so the patient continued to develop diabetic foot ulcers. Breakdown also occurred in other areas upon increasing ambulation. His sugars were



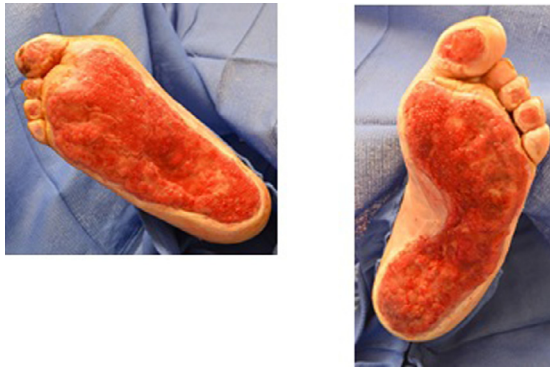
**Figure 2.** Initial burn evaluation demonstrating burns of full-thickness to the plantar aspect of the feet bilaterally.



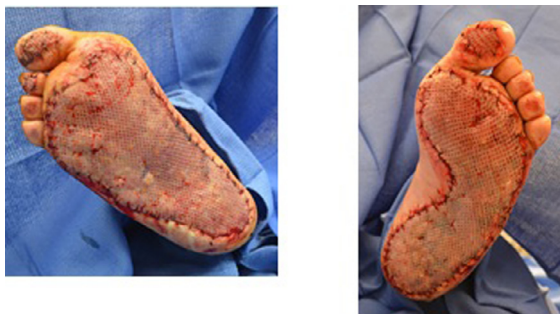
**Figure 3.** Excision of plantar aspect of feet bilaterally. Skin was excised to bleeding subcutaneous tissue.



**Figure 4.** Intraoperative photograph depicting application of Integra™ to plantar aspect of feet bilaterally.



**Figure 5.** Intraoperative photograph depicting wound bed after removal of Integra™.



**Figure 6.** Intraoperative photograph depicting plantar aspect of both foot after application of split thickness skin graft.

subsequently better controlled on Insulin Aspart 18 units three times daily with meals and when necessary, plus Lantus coverage 40 units' daily. Over the next 6 months, physiotherapy oversaw his care from a few steps to full ambulation without further significant graft breakdown or loss.

At the time of discharge (day 82), he was fully ambulatory. [Figure 7](#) demonstrates the appearance of the grafts at approximately 1 month and 6 months post-operatively. Unfortunately, the patient was non-compliant with the rolling walker and did not follow up with podiatry for special shoes. Given



**Figure 7.** Photographs to the left demonstrate appearance of feet at 1 month, and photographs to the right demonstrate appearance of feet at 6 months post-operatively.

the patients' extensive pre-existing chronic disease and failure to comply with post-operative care, the plan to achieve final closure has not yet been attempted.

## Discussion

Early excision is a gold standard in the management of deep burns, and subsequent soft tissue coverage is also essential in preventing the physiological consequences and bacterial invasion.<sup>9,10</sup> In this case, the use of Integra<sup>TM</sup> allowed for good coverage of the burns to the plantar aspect of the feet. The main advantage with Integra<sup>TM</sup> are the optimal scarring and lessened requirement for native donor tissue.<sup>11,12</sup> However, a major drawback is a failure rate up to 25%, with infection being the most common complication.<sup>6,13</sup> Furthermore, a second surgical procedure is required to replace the Integra<sup>TM</sup> with thin autografts, thus lengthening the cost and stay in hospital.<sup>6</sup> Vascularization of the bio-dermal matrix occurs between 2 to 4 weeks, following which the silicone layer can be removed and replaced with a thin layer of split thickness graft.<sup>14</sup> In line with these previous findings, we removed the Integra<sup>TM</sup> at 3 weeks after application and used donor tissue to cover the plantar aspect of the feet.

Negative-pressure wound therapy was also used in this instance. This involves the controlled application of sub-atmospheric pressure to the local wound environment. The wound vacuums help to promote neovascularization through the Integra<sup>TM</sup> matrix, increase stability of the wound bed and promote the development of granulation tissue.<sup>15</sup> The negative-pressure wound therapy also helps remove exudate and reduce bacterial invasion, thereby increasing the feasibility of Integra<sup>TM</sup> use, gives its predisposition to infection.<sup>16</sup> The vacuum therapy however, requires prolonged treatment and can leave the wound bed open to the formation of fragile granulation tissue.<sup>1</sup> Previous studies have recommended the combined use of Integra<sup>TM</sup> and negative pressure wound therapy given a success rate of 90% in comparison to the use of the matrix alone (75%).<sup>6,17</sup> The results of our case report highlight that although the foot was not fully healed, the patient had a successful functional outcome.

Literature has shown that the pathophysiology of impaired wound healing in diabetes contributes to poorer outcomes in these patients.<sup>18</sup> Although the Integra<sup>TM</sup> take was very good initially, the patients' co-morbidities, meant that the overall skin graft outcome was decreased and subject to ulceration, perhaps requiring revision further down the line. In these patients, close monitoring and evaluation of the skin is necessary to ensure good blood flow and prevent wound breakdown. Re-grafting in this group is consistent with other studies.<sup>19</sup> However, the functional successful outcome justifies the use of Integra<sup>TM</sup> in combination with split thickness skin grafting as an acute treatment option in this case.

## Conclusion

To the best of our knowledge, the use of Integra<sup>TM</sup> followed by split thickness skin grafting has not been reported as a successful treatment for full thickness burns to the plantar aspect of the foot.

This treatment may offer an alternative to patients who are not candidates for free tissue transfer and may also be a limb saving method for those patients who would otherwise face potential amputation.

### Conflicts of interest statement

None declared.

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