

A Case Report of the First Nonburn-related Military Trauma Victim Treated with Spray Skin Regenerative Therapy in Combination with a Dermal Regenerate Template

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Summary: Massive soft tissue and skin loss secondary to war-related traumas are among the most frequently encountered challenges in the care of wounded warriors. This case report outlines the first military nonburn-related trauma patient treated by a combination of regenerative modalities. Our case employs spray skin technology to an established dermal regenerate matrix. Our patient, a 29-year-old active duty male, suffered a combat blast trauma in 2010 while deployed. The patient's treatment course was complicated by a severe necrotizing fasciitis infection requiring over 100 surgical procedures for disease control and reconstruction. In secondary delayed reconstruction procedures, this triple-limb amputee underwent successful staged ventral hernia repair via a component separation technique with biologic mesh underlay although this resulted in a skin deficit of more than 600 cm². A dermal regenerate template was applied to the abdominal wound to aid in establishing a "neodermis." Three weeks after dermal regenerate application, spray skin was applied to the defect in conjunction with a 6:1 meshed split thickness skin graft. The dermal regenerate template allowed for optimization of the wound bed for skin grafting. The use of spray skin allowed for a 6:1 mesh ratio, thus minimizing the donor-site size and morbidity. Together, this approach resulted in complete healing of a large full-thickness wound. The patient is now able to perform activities of daily living, walk without a cane, and engage in various physical activities. Overall, our case highlights the potential that combining regenerative therapies can achieve in treating severe war-related and civilian traumatic injuries. (*Plast Reconstr Surg Glob Open* 2016;4:e1174; doi: 10.1097/GOX.0000000000001174; Published online 27 December 2016.)

Complex soft tissue and skin loss secondary to war-related traumas are among the most frequently encountered challenges in the care of wounded

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warriors.¹ Regenerative modalities offer novel options for complicated reconstructions.²⁻⁴ Herein, our case report outlines the first military nonburn-related trauma patient treated by a combination of a dermal regenerate template (DRT) followed by application of spray skin and 6:1 meshed skin grafts to address a more than 600-cm² abdominal skin and soft tissue deficit. Together, this approach resulted in complete healing of his otherwise debilitating full-thickness wound.

CASE STUDY

While deployed in Afghanistan during Operation Enduring Freedom, a 29-year-old active duty male presented to the North Atlantic Treaty Organization Role 3 Multinational Medical Unit after sustaining a combat blast trauma.

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He was the only survivor of the explosion. He was transferred to the University of Maryland Shock Trauma Center in Baltimore, Md., where his intensive care course was complicated by severe necrotizing fasciitis, eventually requiring more than 100 surgical interventions, including bilateral lower and left upper extremity amputations (Fig. 1).

Additionally, the necrotizing infection compromised his entire abdominal wall (>400 cm²), which was treated with serial debridement and reconstructed in a staged fashion with application of a DRT (Integra Lifesciences Corp., Plainsboro, N.J.) followed by autologous split-thickness skin grafting. However, despite obtaining soft tissue coverage, his initial reconstruction resulted in a large ventral hernia with complete loss of domain (Fig. 2). Given his triple amputation status, rehabilitation largely depended on restoring core function.

SURGICAL COURSE

In October 2013, during a secondary procedure, the patient underwent a ventral hernia repair with component separation and biologic mesh to achieve definitive abdominal wall closure. However, this required excision of previously placed skin grafts and poorly vascularized surrounding skin/soft tissue, resulting in a skin deficit of approximately 600 cm². Without viable options for immediate skin coverage, DRT was placed on his abdominal wound for initial coverage.

After seeking and obtaining approval from the Walter Reed National Military Medical Center Institutional Review Board and Food and Drug Administration, a one-time application of an autologous skin cell harvesting and spray skin processing device (Recell; Avita Medical Americas LLC,



Fig. 1. Patient at presentation to Walter Reed National Military Medical Center.

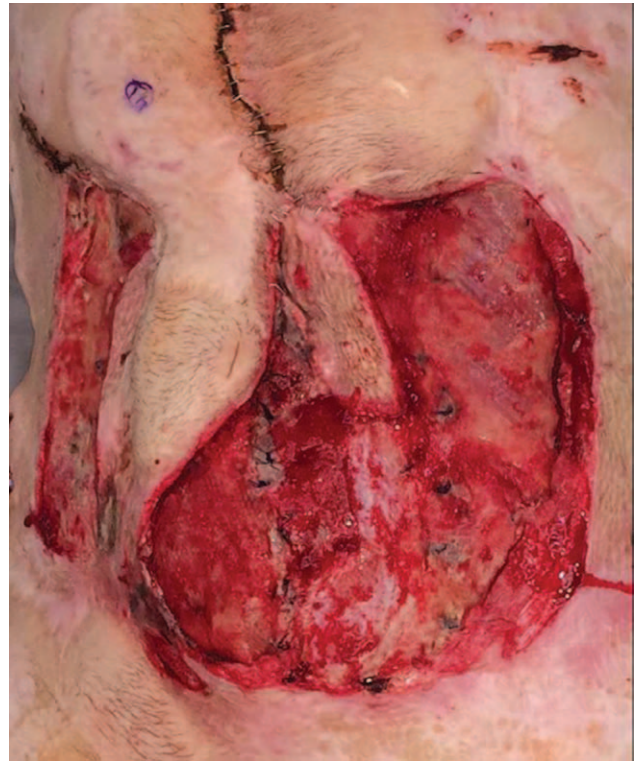


Fig. 2. Initial ventral hernia defect, greater than 400 cm².

Wimbledon, London, UK) was approved. In November 2013, a thin 6:1 meshed split-thickness skin graft in combination with spray skin was applied to the abdominal wound; spray skin was also applied to the skin graft donor sites (total 750-cm² effective treatment area from the 10-cm² spray skin donor site). The spray skin technique was estimated to cover approximately 80-cm² of skin defect per 1 cm² of donor skin processed. Using the spray skin technology enabled our team to successfully treat a 600-cm² abdominal wound defect using a 140-cm² split thickness skin graft (STSG) donor site. After surgery, the patient was monitored for infection and/or complications, remaining as an inpatient for 21 days after the spray skin therapy and skin grafting.

Routine follow-up continued after discharge with his first follow-up appointment being at 4 weeks post spray skin therapy. His early findings exhibited a well-healing abdominal wound with stable skin regenerates at both the donor sites and recipient sites. There were 2 small areas of ulceration along the right margin of the abdominal wound, which healed by secondary intention. By 2 months post spray skin, his previous abdominal wound and donor sites were completely healed. All of his previous abdominal wounds and skin regenerates were completely stable and intact, without evidence of infection or other complications, and the skin regenerate had begun thickening. The patient continued regular follow-up and progressed without complications, eventually achieving donor-/recipient-site color match at 12 months post spray skin application (Fig. 3).

The patient is now able to perform activities of daily living, walk without a cane, and engage in various physical



Fig. 3. Patient 12 months after spray skin application and STSG.

activities, including swimming and push-ups (Fig. 4). In 2015, he completed the Boston Marathon in 3 hours and 18 minutes.

DISCUSSION

Massive soft tissue and skin losses secondary to war-related traumas are great challenges faced by reconstructive surgeons in treating our wounded warriors.^{1,2,4} Skin and soft tissue losses are especially challenging in patients with multiple extremity and/or amputee injuries.



Fig. 4. Patient after abdominal wall reconstruction and extensive rehabilitation.

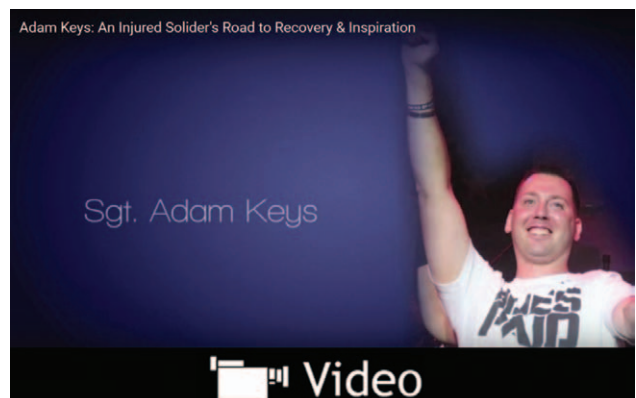
These patients not only lack the availability of donor tissue but are also at risk of increased compromise in the maintenance/salvage of a functional extremity or residual limb.

The conventional approach to patients with severe soft tissue losses involves the reconstructive ladder/elevator and includes various closure techniques, healing by secondary intent, skin grafting, local flaps, pedicles flaps, and free tissue transfers. However, in patients with a paucity of donor tissue, such as war victims, many of these procedures may result in decreased functional outcomes, significant donor-site morbidities, and nondurable surface areas prone to breakdown or erosive wear with prosthetic use. The recent introduction of regenerative medicine therapies such as the application of extracellular matrices for addressing full-thickness wounds has gained a significant role in treating combat casualties.² These matrices convert wounds from full-thickness injuries to partial-thickness wounds via establishment of a “neodermis,” which can accept autologous skin grafts. Spray skin is a second regenerative modality that allows for processing of a small sample of skin into a single-cell suspension containing keratinocytes, melanocytes, Langerhan cells, and fibroblasts; this has shown early promise in burn patients.^{3,5}

In our case study, we report the novel use of a combination of regenerative therapies to address a severe full-thickness, nonburn-related traumatic wound with long-term positive outcomes. In the first stage, DRT was used for initial coverage. In a second stage, spray skin technology was employed at the time of autologous skin grafting. The DRT allowed for optimization of the wound bed for skin grafting. The use of spray skin allowed for a 6:1 mesh ratio, thus minimizing the donor-site size and morbidity. Together, this approach resulted in complete healing of a large (>600 cm²) full-thickness wound. Further studies are necessary to better understand the mechanisms by which the initial placement of DRT optimizes the wound bed for application of spray skin/skin grafting and the role that spray skin plays in aiding skin graft take and wound healing.

PATIENT OF COURAGE VIDEO

The patient described in this case was nominated by the senior author as a 2015 Patient of Courage. The patient was



Video 1. A video detailing the patient’s journey can be found here: <https://youtu.be/HeMD6zfJBu0>.

honored with a special video presentation at the Opening Ceremonies for the American Society of Plastic Surgeons: The Meeting 2015 in Boston, Mass. The video detailing the patient's journey can be found here: <https://youtu.be/HeMD6zJJBu0>. The American Society of Plastic Surgeons Patients of Courage program is sponsored by the Integra Foundation; the production of the videos was supported by this funding. For any permission requests, please contact the American Society of Plastic Surgeons.

SUMMARY

In summary, we used a combination of a DRT followed by application of spray skin and 6:1 meshed skin grafts to address a more than 600-cm² abdominal skin and soft tissue deficit in a military nonburn-related trauma triple amputee patient. The DRT allowed for optimization of the wound bed for skin grafting. Additionally, the use of spray skin allowed for a wide meshing of skin grafts, thereby minimizing the donor-site size and morbidity in a patient with very limited donor skin. Together, this approach resulted in complete healing of a complex full-thickness wound. The patient is now able to perform activities of daily living, walk without a cane, and engage in various physical activities. Overall, our case highlights the potential that combining regenerative therapies can achieve in treating severe war-related and civilian traumatic injuries.

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PATIENT CONSENT

The patient provided written consent for the use of his image.

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