

Treatment of chest burn contracture causing respiratory compromise with island release and grafting using cross-link collagen and Integra™ bilayer dressing

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ABSTRACT

Post-burn skin contractures of the anterior and lateral abdomen and chest may result in respiratory compromise due to limitation of rib excursion. This case report describes a young man with respiratory compromise limiting his daily activity and function, as a result of a 90% burn sustained 6 years previously. Release of his chest and upper abdomen was achieved using “island” scar releases and a cross-linked bovine tendon collagen and glycosaminoglycan and a semi-permeable polysiloxane bilayer matrix dressing (Integra™) followed by subsequent split thickness skin graft. An immediate increase in maximal inspiratory volume was obtained intra-operatively and in the immediate post-operative period, and this improvement was sustained after healing of all wounds with subjective relief of the patient’s symptoms.

Key words: Integra, Contracture Release, Island Scar Release

INTRODUCTION

The development of scar contractures, especially of the torso and joints, cause various functional defects for burn victims.¹ While recent studies have shown various respiratory complications as a result of burns circumferential torso scars are specifically recognized as having a detrimental effect on breathing.^{2,3} Furthermore, Demling et al. found that pulmonary dysfunction often arises from skin grafts on the chest and abdomen, demonstrating the noncompliance of tissue from typical graft procedures and burn wounds.⁴ However, little research has been done on

scar removal to increase respiratory function. Current literature shows chest wall reconstruction to increase respiration, and one pediatric case established thoracic scar resections as having a positive impact on ventilation.^{5,6} We present a case that demonstrates the physical restriction of breathing from chest contractures and describe a relatively simple, two-stage procedure that is easily replicable and produced good functional and cosmetic results.

CASE PRESENTATION

A 17-year-old male patient with 90% total body surface area burns at age 11 presents with shortness of breath upon minimal exertion which restricted his ability to participate in age-appropriate activities of

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daily living. He also had significant restriction of right arm movement due to contractures. On examination, concentric contracture of the scars across his chest and upper abdomen were noted, with restriction most pronounced anteriorly and laterally, which are the areas of greatest movement during normal respiration.

He had an exaggerated and paradoxical excursion of his lower abdomen during respiration as a compensatory mechanism. His maximal inspiratory volume measured by incentive spirometry was 1700 ml. Contracture along the anterior axilla limited his ability to abduct his arm to 90 degrees (Figure 1).



Figure 1A: Right flank markings in preparation of scar release. Y-V-plasty markings can be seen on right axillary contracture



Figure 1B: Anterior scar release markings



Figure 2: Left flank scar after release



Figure 3: Anterior and right flank wound beds after application of Integra bilayer

A staged procedure was planned, where the circumferential torso scar was first released by developing three “islands” of scar, with release down to fascia along all edges (Figure 2). This allowed immediate improvement in the expansion of the chest and abdomen, with a 150 ml increase in tidal volume under anesthesia. Following this resection, Integra™ Meshed Bilayer Wound Matrix (Integra LifeSciences Corp, Plainsboro, NJ) was used to fill the wound bed. The Integra™ sheets were measured, meshed, and fitted to the wound via staples (Figure 3).



Figure 4: Anterior and left flank wound beds after application of graft

On the first post-operative day the patient's maximum inspiratory volume was 2200 ml on incentive spirometry which improved to 2500 ml at discharge. Three weeks after the first operation, the Integra™ appeared well vascularized. During the second surgery, the silicone layer of the double mesh was peeled away from the wound bed and a thin sheet graft was then placed on the abdominal regions, atop the remaining layer of Integra™ (Figure 4). The patient has subsequently recovered well and had relief of his original symptoms.

DISCUSSION

Burn contractures of the chest, especially in areas of maximal rib excursion, may present a large hindrance to respiration. Contractures can lead to multiple problems, including decreased range of motion of joints, increased difficulty breathing, and further complications of wound care and treatment.⁷ Studies have shown severe functional limitations and disfigurement from scars and have demonstrated the need to promptly and adequately treat burn wounds to prevent contractures from forming.⁸⁻⁹ Chest contractures have also arisen iatrogenically from breast augmentation and reconstruction.¹⁰⁻¹¹ Regardless of the etiology, chest contractures (and contractures in general) cause multiple complications, and their treatment and prevention is important.

The current literature reports numerous techniques and procedures to address burn wounds and contractures. Following the resection of scar tissue, skin flaps are heavily used in surgery. The merits of local flaps,¹²⁻¹³ split-thickness dermal grafts,¹⁴ and “super-thin” flaps¹⁵ have been discussed extensively for the treatment of burn wounds, but each technique has certain drawbacks. Local turn-over flaps allow for exceptional coverage over larger wound areas and cause less contracture than traditional methods, but healthy tissue in severe burns is often not available.¹⁶ Split-thickness grafts and super-thin flaps offer the advantage of harvesting less tissue for full thickness burns, allowing for quick healing of the donor site, and re-harvesting within 6 to 8 weeks. However, both conventional split-thickness grafts and super-thin flaps are associated with significant contracture development resulting from a relative lack of dermis.¹⁷ Finally, cultured epithelial autografts and allografts have been used broadly in reconstruction and burn wounds as a method of gaining larger graft sizes but take a great deal of time to grow, are costly, and have relatively lower engraftment rates.¹⁸⁻²²

In the first stage of the case presented, resection of the large contractures and scar area was

done using an island scar release technique. Linear scar contractures are usually treated with V-Y plasty or various types of local flaps,²³⁻²⁵ but these procedures are not effective for wide or multiple contractures.²⁶ Furthermore, patients with large amounts of burn scars lack suitable donor sites for autografts. In these instances, a circumferential incision technique is effective at releasing the multiple contracture lines, such as those located on the torso, and minimizes the amount of grafted tissue needed for the wound bed.²⁷ Using this particular technique in the three locations on the patient's chest offered a long term solution for the removal of tension lines across the torso and a rapid increase and maintenance of inspiratory volume.

After resecting the contracted tissue via island scar release, the second stage included covering of the wound beds with Integra™ Bilayer Matrix Wound Dressing (a porous matrix of cross-linked bovine tendon collagen and glycosaminoglycan and a semi-permeable polysiloxane (silicone layer)). Harrison et al. have made the case that *in vitro* engineered tissue should be explored for wound healing and graft placement after burns. Using synthetic films, such as Integra™, has the benefit over traditional procedures of autologous flaps and grafts in which scar contractures sometimes gradually reappear.²⁸ The use of Integra™ has been well documented in cases of challenging locations and in burn wounds with excessive scarring and contractures.²⁹⁻³⁰ As mentioned previously, the standard practice of expanded, meshed split-thickness skin autografts achieve wound closure over larger areas, but its disadvantages include fragile wound beds, suboptimal appearance, reduced pliability, and scarring. In patients with large burns, the necessity of multiple flaps and grafts requires repeated harvesting from a donor site; subsequent harvesting makes thinner and lesser quality local flaps.^{18,30} Synthetic dressings such as Integra™ are readily available; this overcomes the burden of finding suitable donor sites, and, perhaps of more importance, the application of Integra™ to cleaned wound beds allows for fewer contractures to develop during the postoperative period than traditional flaps.³¹ The primary drawback of Integra™, especially in developing

countries, is the cost of each unit. The average cost of an 8"x10" sheet is \$2000; however, Ryan et al. have shown a correlation between treatment with Integra™ and a decrease in duration of hospital stay, possibly making the usage of Integra™ a cost effective solution.³²

CONCLUSIONS

In summary, the use of Integra™ for burn scar contracture is a valid option in scar release and a novel method to increase the respiratory volume in burn patients. The patient had an increase in the abduction degree of his right arm and a marked increase in his respiratory function, helping alleviate his shortness of breath. Integra™ Bilayer Matrix Wound Dressing allows for a good functional result from the resection of scar tissue and contractures.

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