

Reconstruction of a Near-total Scalp Avulsion with NovoSorb Biodegradable Temporizing Matrix: Pediatric Case Report

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Summary: Traumatic dog bites of the face and head are common among the pediatric population, although injuries resulting in total or subtotal scalp avulsions are rare and life-threatening. Standard treatment in these cases includes attempts at replantation or free tissue transfer; however, these procedures may not always be possible. An alternative treatment option involves the use of dermal substitutes, such as Integra (Integra LifeScience Corporation), with subsequent skin grafting. More recently, an alternative skin substitute called NovoSorb Biodegradable Temporizing Matrix (BTM) (PolyNovo North America LLC) has displayed favorable reconstructive outcomes in recent burn literature. NovoSorb BTM is a novel, fully synthetic bilayer scaffold made of biodegradable polyurethane matrix covered with a sealing membrane. In this report, the authors describe a 3-year-old boy who presented emergently with a severe dog bite avulsion to the subpericranial level of approximately 80% of his scalp, which was not replantable. The surgical plan involved a staged reconstruction using Integra and later skin grafting. Purulent infection ensued and required removal of Integra less than 2 weeks from application. Upon clearing of the infection, the wound was successfully closed with BTM and subsequent skin grafting. With proper wound management and over 6 months of follow-up, the patient experienced excellent healing of the graft with stable calvarial coverage and an acceptable aesthetic outcome. He will undergo tissue expansion of the remaining hair-bearing scalp in the future. (*Plast Reconstr Surg Glob Open* 2022; 10:e4717; doi: [10.1097/GOX.0000000000004717](https://doi.org/10.1097/GOX.0000000000004717); Published online 13 December 2022.)

Dog bite injuries to the head are common among pediatric patients, yet severe cases resulting in total and subtotal scalp avulsions are considerably rare.^{1,2} Microsurgical replantation, the gold standard, or flap reconstruction are often used for treatment; however, both options may not be feasible where vessels are unsuitable for microvascular anastomosis, the avulsed scalp is improperly preserved, and/or warm ischemia time is prolonged.^{1,2} In such instances, a popular closure alternative

is staged reconstruction using a dermal substitute, such as Integra (Integra LifeScience Corporation, Plainsboro, N.J.) followed by skin grafting.^{1,3}

In this report, we present the case of a 3-year-old boy who sustained a subtotal scalp avulsion following a dog attack. The resulting wound was successfully closed using NovoSorb Biodegradable Temporizing Matrix (BTM) (PolyNovo North America LLC, Carlsbad, Calif.) with subsequent split-thickness grafting. BTM is a novel, completely synthetic bilayer scaffold made of biodegradable polyurethane matrix covered with a sealing membrane.^{3,4} Its use has displayed promising performance in recent burn literature, including a case report of total scalp reconstruction in an elderly burn victim.^{3,4} The authors here further emphasize BTM's utility in complex

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wounds by signifying its role in the reconstruction of a traumatic near-total scalp avulsion in a pediatric patient.

CASE PRESENTATION

A 3-year-old boy presented to the emergency department at the Children's Hospital of Philadelphia after a devastating dog bite insult to the face and scalp. Injuries included complex lacerations of the face, fractures of the facial skeleton, and near-total scalp avulsion of approximately 80% of the hair-bearing scalp. The patient was intubated in the emergency room, and after fluid resuscitation and blood transfusion, was taken to the operating room (OR) for initial debridement and closure of facial lacerations. The scalp wound measured 400 cm², with calvarial exposure to the subpericranial level. Replantation of the scalp was considered; however, the condition of the avulsed scalp segment combined with a lack of suitable microvascular anastomoses precluded this treatment option.

Following initial debridement of the wound, Dakin's Solution Quarter Strength (0.125%) wet-to-dry dressings were placed, and patient was taken to the intensive care unit. Three days later, the patient underwent further scalp debridement along with calvarial burring until punctate bleeding was seen from the diploic space (Fig. 1). Integra bilayer wound matrix was subsequently placed with adjuvant wound vac therapy. Unfortunately, regions of non-adherence and purulent infection necessitated removal of the Integra less than two weeks after application. The patient returned to the OR for removal of Integra, debridement of infected tissues, and placement of V.A.C. VERAFLU Therapy with Dakin's Solution quarter strength infused every 2 hours with a soak time of 10 minutes. Repeat Integra placement was not considered due to fear of recurrent infection. Further debridement of bone to the diploic space and direct skin grafting was not considered due to a lack of the diploic space in a 3-year-old and the lengthy time for sufficient granulation



Fig. 1. Post injury day 3 before second debridement, showing the wound with missing pericranium and 80% of the calvarium exposed.

tissue to form.^{1,5} After 5 days of V.A.C. VERAFLU therapy, the patient underwent wound vac removal, repeat calvarial burring and placement of NovoSorb BTM skin substitute stapled over the now 432 cm² wound (Fig. 2). ADAPTIC was placed over the BTM followed by a V.A.C. GRANUFOAM SILVER sponge. Weekly wound vac changes were performed in the OR for four weeks, with two being performed outpatient.

One month following BTM placement, the sealing membrane was removed in the OR. The BTM was fully integrated with healthy granulation tissue covering the entire calvarium (Fig. 3). There was no evidence of recurrent infection. After lightly scrubbing the granulation



Fig. 2. Appearance of the scalp immediately following NovoSorb BTM placement.



Fig. 3. Evidence of healthy granulation tissue after removal of NovoSorb BTM sealing membrane at 4 weeks from initial placement.



Fig. 4. Six-month postoperative outcome.

tissue with a scrub brush and a curette, a split-thickness sheet graft, 12 thousandths of an inch, from the thigh was stapled over the BTM. Wound vac therapy continued for 2 weeks (with a change at 1 week), then transitioned to xeroform dressings. There was complete take of the skin graft, and at 6-month follow-up, he had stable calvarial coverage and an acceptable aesthetic outcome (Fig. 4, Video). He will undergo tissue expansion of the remaining hair-bearing scalp in the future. (See Video [online], which shows the treatment course for reconstructing a near-total scalp defect using Novosorb BTM.)

DISCUSSION

Integra and other skin substitutes have been used recently to reconstruct large scalp avulsions with exposed calvarium deemed unsuitable for scalp replantation and flap reconstruction.¹ Nonetheless, these products can be associated with high cost, antigenicity, and infection.^{6,7} A 2020 systematic review on Integra use revealed approximately 38% of studies reporting complications related to infection and concluded the risk of infection was a drawback of Integra use.⁷ Nonetheless, Integra has become the skin substitute of choice for many surgeons. The purpose of this report is not to discredit Integra but highlight an alternative skin substitute that also performs well for soft-tissue reconstruction. Although we have no way of knowing whether BTM would have become infected had it been placed first, it did perform well in the setting of recent infection. This finding is consistent with existing literature demonstrating effective closure of previously infected necrotizing fasciitis and IV drug-associated wounds with BTM.^{8,9} Additionally, BTM does not use biological materials in its composition, which significantly decreases its production cost.^{3,4} At our institution, BTM is roughly one-fifth

the cost of Integra (\$10.50 per cm² for BTM and \$47.78 per cm² for Integra).

BTM's presence in the literature has grown over the last several years displaying considerable efficacy in closing a variety of complex wounds.^{3,4,8,9} A recent report in India demonstrated BTM use with adjuvant platelet-rich plasma therapy in reconstructing a 45 cm² posttraumatic adult forehead and scalp defect composed of barren skull without periosteal covering.¹⁰ The author in this case found successful wound regeneration within 5 weeks and favorable aesthetic and sensory outcomes after six months of follow-up.¹⁰

CONCLUSIONS

This case report highlights the successful wound closure of a near-total scalp avulsion at the subpericranial level in a child using NovoSorb BTM, a novel, fully synthetic bilayer skin substitute. BTM performed well in the setting of a previously infected wound, which stands to be consistent with the current literature. This adds a cost-effective alternative to the reconstructive toolbox for treating complex wounds with exposed bone. Further studies are needed to compare efficacy of BTM to other available products.

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