

Dermal Substitute Integra for the Treatment of Mammalian Bite Injuries of Nose: a New Reconstructive Ladder

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Background: Bite injuries affecting the nose are uncommon occurrences characterized by their intricate nature and potential for severe complications. These injuries, inflicted by animals such as dogs and cats, and occasionally by humans, often result in traumatic nasal defects, with the lower third of the nose being the most affected area. Current reconstructive options for nasal defects include full-thickness skin grafts, local or regional flaps, and composite grafts. The traditional reconstructive ladder serves as a valuable guide for surgeons, outlining a continuum of treatment options from simpler to more complex interventions. Advancements in reconstructive technologies, such as the introduction of dermal substitutes, have reshaped the decision-making process, ushering in a new era of facial reconstruction.

Methods: In this context, dermal substitutes have emerged as promising adjuncts in nasal reconstruction, drawing from their success in burn surgery. Notably, the bilayered dermal substitute Integra has demonstrated efficacy in promoting wound healing and facilitating tissue regeneration. By harnessing the regenerative potential of Integra, plastic surgeons can address specific nasal defects arising from bite injuries with greater precision and improved outcomes.

Results: This study aims to present a case series of patients with bite injuries to the nose, showcasing the successful application of Integra dermal substitute in conjunction with secondary full-thickness skin grafting.

Conclusions: Through a retrospective analysis of patient demographics, injury characteristics, surgical interventions, and postoperative outcomes, we seek to underscore the utility of this combined approach in achieving optimal functional and aesthetic results. We aim to contribute to the evolving paradigm of nasal reconstruction. (*Plast Reconstr Surg Glob Open* 2024; 12:e6319; doi: [10.1097/GOX.00000000000006319](https://doi.org/10.1097/GOX.00000000000006319); Published online 20 November 2024.)

INTRODUCTION

The most common mammalian bite injuries are inflicted by dogs, cats, and humans.¹ Bite injuries to the nose are uncommon traumatic nasal defects mainly involving the lower third of the nose.^{2,3}

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The current reconstructive options for traumatic nose defects are full-thickness skin grafts, local or regional flaps, and composite grafts.^{4,5}

An adequate reconstructive plan is strictly connected with the missing anatomical components: the soft-tissue coverage and the osteocartilaginous framework.^{6,7} The reconstructive choice is based on the site and the extension of soft-tissue defects complicated or not by exposure and/or loss of osteocartilaginous structures.⁸ The reconstructive ladder represents a guideline that assists the surgeon in finding the best solution for the closure of a specific defect, starting from the easiest to the most complex option.^{6,9}

According to the traditional reconstructive ladder, closure with a full-thickness skin graft is a procedure more straightforward than local flaps.

Coverage with skin graft often results in subsidence deformities and poor graft survival over the exposed cartilage.¹⁰

Disclosure statements are at the end of this article, following the correspondence information.

Table 1. Patient Demographics, including Age and Sex

| Patient | Age, y | Sex |
|---------|--------|-----|
| 1 | 21 | M |
| 2 | 47 | F |
| 3 | 25 | M |
| 4 | 36 | M |
| 5 | 33 | F |
| 6 | 19 | M |
| 7 | 23 | F |
| 8 | 34 | M |
| 9 | 38 | M |
| 10 | 42 | M |
| 11 | 20 | F |
| 12 | 40 | M |
| 13 | 30 | F |
| 14 | 45 | M |
| 15 | 27 | M |
| Average | 32 | |

Blue coloring highlights patients with treatment failure.

We aim to contribute to the evolving paradigm of nasal reconstruction. The use of dermal matrices in the reconstructive ladder, an approach published since 2015, provides a valuable addition to the options available for complex reconstructions.¹¹

Moreover, most flap reconstructions of nasal defects result in secondary donor site scars: because of the unlikely additional incisions, this procedure is often refused by young patients.^{1,3} We reviewed our experience over the years in patients with bite injuries of the nose treated with Integra dermal substitute followed by a full-thickness skin graft.

PATIENTS AND METHODS

A retrospective review was conducted on patients who presented with mammalian bite injuries to the nose and subsequently underwent treatment with Integra dermal template at our institution between February 2013 and October 2019 (Table 1).

Takeaways

Question: Is Integra an effective choice in the treatment of mammalian bites to the nose?

Findings: The study retrospectively reviewed 15 patients with nasal injuries from mammalian bites, treated with the Integra dermal template followed by full-thickness skin grafting.

Meaning: This article demonstrates that using Integra dermal substitute followed by full-thickness skin grafting is a successful approach for reconstructing nasal defects resulting from mammalian bites, leading to improved functional and aesthetic outcomes.

The inclusion criteria for this study encompassed individuals who had nasal injuries specifically resulting from mammalian bites and underwent treatment involving the application of Integra dermal template. Defects of the distal third of the nose, including the tip and nasal ala, with lesion sizes ranging from 0.6 to 2.0 cm² were included in the criteria.

A total of 15 eligible patients were identified for inclusion in the study. Comprehensive data pertaining to patient demographics, details of the injury, specifics of surgical interventions, and postoperative follow-up were retrieved from electronic medical records maintained within the hospital's database. Surgical treatment modalities used, including the techniques utilized for Integra dermal template application and subsequent full-thickness skin grafting, were recorded in detail. We administered targeted antibiotic prophylaxis to all patients based on the specific flora associated with dog and human bites, typically using broad-spectrum antibiotics such as amoxicillin-clavulanate. Additionally, any supplementary procedures undertaken to address complications or refine outcomes were documented for comprehensive analysis.

The follow-up phase of the study involved periodic assessments conducted postoperatively to evaluate the

Table 2. Details of Nasal Defects and Cartilage Involvement Based on Etiology and Size

| Patient | Size (cm ²) | Etiology | Nasal Defect | | |
|---------|-------------------------|----------|----------------|--------------|--------------|
| | | | Alar Cartilage | Crus | Cartilage |
| 1 | 1.5 | Dog | Right | Lateral | Exposure |
| 2 | 1.7 | Human | Right | Medial (dom) | Exposure |
| 3 | 2.0 | Dog | Left | Medial (dom) | Partial loss |
| 4 | 1.9 | Dog | Left | Lateral | Exposure |
| 5 | 2.0 | Human | Left | Lateral | Total loss |
| 6 | 1.9 | Human | Right and left | Medial (dom) | Partial loss |
| 7 | 1.6 | Human | Right and left | Medial (dom) | Exposure |
| 8 | 1.8 | Dog | Right | Medial (dom) | Exposure |
| 9 | 2.0 | Dog | Left | Lateral | Partial loss |
| 10 | 2.0 | Human | Right and left | Lateral | Exposure |
| 11 | 1.4 | Dog | Right and left | Medial | Exposure |
| 12 | 1.5 | Human | Right and left | Lateral | Exposure |
| 13 | 1 | Human | Right | Medial (dom) | Total loss |
| 14 | 2.0 | Human | Left | Medial (dom) | Exposure |
| 15 | 1.9 | Dog | Left | Lateral | Partial loss |

Blue represents patients with treatment failure.



Fig. 1. Patient 3 progress. A, Patient with partial loss of medial crura, with the inset of Integra. B, Patient at 1-month follow-up, from the left lateral profile. C, Patient at 1-month follow-up, from the right profile. D, Patient at 1-month follow-up, from frontal profile.

progress of wound healing, graft integration, and overall patient recovery. Parameters such as aesthetic outcomes and functional restoration were evaluated to gauge the success of the reconstructive approach.

RESULTS

A total of 15 patients were included in the study, 10 men and 5 women, with an average age of 32 years (19–47 y) (Table 1). Bite injuries inflicted by dogs and humans resulted in nasal defects averaging 1.8 cm² (ranging from 0.6 to 1.5 cm²). These injuries varied in the extent of involvement, affecting the skin, subcutaneous tissues, nasal tip, columella, and nostrils, often leading to cartilaginous exposure and disruption (refer to Table 2 for detailed findings). Upon admission to the emergency department, standard wound management protocols were initiated, including thorough washout, debridement, and administration of appropriate antibiotic coverage.

Reconstruction of nasal defects was performed in 2 sequential steps. Initially, the Integra dermal template was meticulously inset into the defect under local anesthesia (Fig. 1A). Subsequently, postauricular full-thickness skin grafts were applied over the dermal substitute after a 3-week interval. All donor sites were closed primarily following the grafting procedures.

All patients were followed up for a minimum duration of 1 year postoperatively, with the exception of 1 patient (patient 8) who developed an Integra infection at a 7-day follow-up, and no signs of infection were observed in the remaining cases. The infected patient underwent prompt removal of the dermal matrix, followed by infection treatment and subsequent coverage with a local transposition flap.

Among the 14 patients without infection, the use of Integra dermal substitute significantly improved graft capability and reduced tissue size defects. Three weeks

Table 3. Patient-reported Satisfaction Scores on a Scale from 1 to 10, with 10 Being Extremely Satisfied

| Patient | Score |
|---------|-------|
| 1 | 8 |
| 2 | 8 |
| 3 | 9 |
| 4 | 7 |
| 5 | 4 |
| 6 | 8 |
| 7 | 7 |
| 8 | 3 |
| 9 | 4 |
| 10 | 8 |
| 11 | 7 |
| 12 | 8 |
| 13 | 7 |
| 14 | 8 |
| 15 | 4 |
| Average | 8.0 |

Blue coloring highlights patients with treatment failure.

post Integra application, full-thickness skin grafts from the retroauricular area were successfully performed in all cases, with complete graft intake observed in all patients at the 1-month follow-up (Fig. 1). No instances of regrafting were required. The majority of patients (80%, 12) achieved satisfactory aesthetic outcomes at 3 months postoperatively.

Patient satisfaction was measured on a scale of 1–10, with 1 being extremely dissatisfied and 10 being extremely satisfied. The results indicated overall satisfaction, with an average score of 8.0 in patient satisfaction score (Table 3); the average score of surgeon satisfaction was 8.5 (Table 4).

Patients were categorized based on the type and extent of cartilage involvement in nasal injuries. The classification criteria included the following:

- Medial cartilage involvement:
 - Medial cartilage exposure (5 patients: 2, 7, 8, 11, 14).
 - Partial loss of medial crus cartilage (2 patients: 3, 6).
 - Total loss of medial crus cartilage (1 patient: 13).
- Lateral cartilage involvement:
 - Lateral cartilage exposure (4 patients: 1, 4, 10, 12).
 - Partial loss of lateral crus cartilage (2 patients: 9, 15).
 - Total loss of lateral crus cartilage (1 patient: 5).

In cases of medial cartilage exposure, Integra with skin grafting was successful for all patients except 1 (patient 8), who developed an infection after 7 days. Similarly, for lateral cartilage exposure, this treatment approach was successful in all cases (Fig. 2).

For patients with partial loss of medial crus cartilage, Integra with skin grafting yielded successful outcomes (Fig. 3). However, in cases of partial loss of lateral crus cartilage (patients 9 and 15), initial treatment with Integra and skin grafting resulted in external valve collapse, necessitating reoperation with cartilage grafting and flap reconstruction (Fig. 4).

Total loss of lateral crus cartilage also required reoperation (patient 5). Integra with skin grafting was

Table 4. Surgeon-reported Satisfaction Scores Based on Outcomes, on a Scale from 1 to 10, with 10 Being Highly Satisfied

| Patient | Score |
|---------|-------|
| 1 | 9 |
| 2 | 10 |
| 3 | 9 |
| 4 | 9 |
| 5 | 4 |
| 6 | 9 |
| 7 | 9 |
| 8 | 3 |
| 9 | 4 |
| 10 | 9 |
| 11 | 9 |
| 12 | 9 |
| 13 | 9 |
| 14 | 9 |
| 15 | 4 |
| Average | 8.5 |

Blue coloring highlights patients with treatment failure.

initially attempted but resulted in external valve collapse. Subsequent surgical intervention involved cartilage grafting, with cartilage harvested from the concha in 1 case.

These findings underscore the efficacy of the combined approach utilizing Integra dermal template and full-thickness skin grafts in nasal defect reconstruction while also highlighting the importance of individualized management strategies for patients with complex nasal injuries.

DISCUSSION

Mammalian bite injuries to the nose represent complex traumatic defects, with dogs and cats being the primary culprits. Human bite injuries, although less common, can be categorized into 2 types: clenched fist injuries, occurring during altercations when the hand strikes the teeth with sufficient force to break the skin, and occlusive bite injuries, where the teeth close over tissue, potentially leading to avulsion^{5,12}

Predominantly affecting the lower third of the nose, these injuries pose significant challenges for reconstruction due to the intricate 3-dimensional nature of nasal anatomy. The nose comprises an osteocartilaginous framework enveloped by skin externally and mucosa internally, necessitating consideration of both soft-tissue coverage and skeletal support in reconstruction.¹³

The nasal prominence's primary support derives from the midline, including the dorsal cantilever of nasal bones and the osseous septum cranially, and the abutment of medial crura and cartilaginous septum caudally. The side-walls, consisting mainly of the lateral crura of the alar cartilages and upper lateral cartilages, serve as secondary supporting subunits.¹⁴ In our experience, reconstruction using the dermal regeneration template Integra has shown promise in repairing nasal bite injuries. Integra mitigates subsidence deformities commonly observed after conventional skin grafting and minimizes secondary



Fig. 2. Patient 11 progress. A, Patient with exposed cartilage. B, Patient at 1-month follow-up, from frontal profile. C, Patient at 1-month follow-up, from the right lateral profile. D, Patient at 1-month follow-up, from the left lateral profile.

scarring associated with local flaps. Additionally, in cases of exposed cartilage, where skin grafting is contraindicated due to the lack of a vascular wound bed, Integra provides a viable alternative.

Several studies have explored the use of dermal substitutes in nasal defect reconstruction, demonstrating varied aesthetic and functional outcomes. The integration of dermal matrices into the reconstructive ladder since 2015 has opened new avenues for addressing complex defects.¹¹ However, it is important to note that although Integra is effective for soft-tissue coverage and some cases of cartilage exposure, its success in cases with significant cartilage loss, particularly involving the lateral crus, may require additional structural support through cartilage grafting.

Although some studies report favorable results with Integra, others highlight limitations such as significant

wound shrinkage or fistula formation with alternative substitutes such as MatriDerm. Blanco et al¹⁵ presented 3 cases of Integra coverage of large nasal defects with exposed cartilage following skin cancer resection: all patients showed an excellent healing process with satisfactory final aesthetic results.

In their study, Koenen et al¹⁶ evaluated the efficiency of Integra dermal regeneration template single layer combined with split-thickness skin graft in 1-stage closure of deep facial surgical wounds in older patients. Despite positive patient grading and satisfaction with the procedure, all their wounds showed significant shrinkage.¹⁶ According to Riml et al,¹⁷ the use of MatriDerm as a dermal substitute results in excellent reconstruction of the nasal tip; nevertheless, they do not consider it successful because of fistula formation. Tiengo et al¹⁸ presented a case of nose tip avulsion caused by a dog bite



Fig. 3. Patient 6 progress. A, Patient with partial loss of medial crura. B, Patient at 1-month follow-up, from frontal profile.

treated with the combined use of mucoperichondrial septal flap, cartilage graft, dermal substitute Integra graft followed by full-thickness skin graft with an optimal result in terms of stable symmetry, skin texture, and functional airway.¹⁸

The decision-making process in nasal reconstruction has evolved with the introduction of new technologies, leading to the development of a revised reconstructive ladder. Incorporating advancements such as reconstructive matrices, negative-pressure wound therapies, and tissue expansion, this updated framework enables surgeons to navigate complex cases more effectively.

Our findings support the use of Integra followed by skin grafting as a viable option for nasal defects involving soft tissue and cartilage exposure, aligning with the principles of the new reconstructive ladder. However, our experience suggests better outcomes when the injury primarily involves the sidewall structures of the nose, necessitating traditional techniques such as composite grafts or local flaps.

In our case series, which included distal third nasal injuries ranging from 0.6 to 2 cm² in both the median and lateral portions of the nose with cartilage exposure, and in cases of total or partial loss of cartilage limited to the median portion, the use of Integra followed by skin grafting was found to be effective, yielding excellent aesthetic and functional outcomes. However, in cases of total cartilage loss, additional surgical intervention with cartilage grafting may be necessary to prevent external valve collapse and achieve satisfactory functional and aesthetic outcomes. The involvement of the lateral crura represents a gray area, and careful consideration is needed when deciding on the treatment approach. Further studies with larger sample sizes are warranted to validate these findings

and refine treatment algorithms for nasal reconstruction after trauma.

CONCLUSIONS

Our study underscores the importance of tailoring surgical approaches to the specific nasal cartilage defect. We found that our technique offers favorable outcomes in cases involving skin and soft tissue with exposure of the medial and lateral crura or loss of the lateral crus of the alar cartilage. However, when faced with the loss of the major framework unit, such as the lateral crura, a secondary surgery utilizing a composite graft or local flap may be warranted to establish a new support structure beneath the nasal tip.

The success of our approach hinges on the precise location and architectural significance of the missing subunits. By leveraging the combined use of dermal regeneration template and full-thickness skin graft, we can effectively address traumatic nasal defects in alignment with the principles of the new reconstructive ladder. This tailored approach holds promise in achieving both functional and aesthetic restoration for patients with diverse nasal injuries.

In our study, the use of Integra followed by skin grafting for injuries involving the lower third of the nose represents a viable alternative to complex reconstructions using flaps and cartilage grafts, especially in young patients who may not accept scars in donor areas of the face.

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Fig. 4. Patient 5 progress. A, Patient with total loss of lateral cartilage. B, Patient 5 days after inset of Integra. C, Patient at 1-month follow-up, from frontal profile. D, Patient at 1-month follow-up, from the left lateral profile.

DISCLOSURE

The authors have no financial interest to declare in relation to the content of this article.

PATIENT CONSENT

Patients provided written consent for the use of their images.

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