

Using Integra for Reconstruction of Facial Defects after Mohs Micrographic Surgery

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Background: We aimed to identify how Integra bilayer wound matrix has expanded facial reconstruction options after Mohs surgery due to its reliability in both single- and dual-stage reconstruction.

Methods: A retrospective review of patients undergoing Mohs surgery and alloplastic facial reconstruction with Integra between 2012 and 2022 was performed. Patients who underwent single-stage reconstruction and dual-stage reconstruction with skin graft with at least 90 days of follow-up were included.

Results: One hundred thirty patients with a median age of 76 years were included. Basal cell carcinoma was the most common malignancy (39%). One hundred forty-two lesions were treated and reconstructed same-day with Integra. Lesions most commonly involved the nose (34%) and forehead (22%). The mean postoperative defect size was 26.9 cm². An estimated 45.5% (n = 60) of defect sites underwent single-stage reconstruction with healing by secondary intention, whereas 54.5% (n = 72) underwent dual-stage reconstruction with skin graft. Integra success rate was 90.2%. Average time to re-epithelialization was 32.2+7.3 days. Average time to repigmentation was 169.5+14.6 days. The complication rate was 12.8% (n = 17), with 12 undergoing debridement, three needing new Integra graft, and seven needing new skin grafts. Average size for successful healing without complication was 26.6 cm². Nineteen sites (13.2%) underwent aesthetic improvement procedures, with the majority occurring after dual-stage reconstruction (n = 13).

Conclusions: Integra is a reliable outpatient reconstructive option for facial Mohs defects that can increase the threshold for autologous tissue harvesting and successfully reconstruct large defects of 26.6 cm² on average with low complication and reoperation rates. (*Plast Reconstr Surg Glob Open* 2023; 11:e5474; doi: 10.1097/GOX.0000000000005474; Published online 18 December 2023.)

INTRODUCTION

High concentrations of ultraviolet (UV) radiation exposure in the facial region contributes to the development of cutaneous malignancies and is why the nose and upper third of the face is sometimes referred to as the “sun terrace.”¹ Mohs micrographic surgery (MMS) is the gold standard surgical technique for excising facial skin cancers with histologically clear margins and maximum tissue preservation.² Tissue preservation is important in the facial region to maximize reconstructive options as well as functional and aesthetic outcomes.^{3,4}

Unfortunately, obtaining clear margins with Mohs surgery can still cause substantial soft tissue defects and lead to significant functional, cosmetic, and psychological sequelae.⁵

Facial reconstruction is guided by the utilization of the reconstructive ladder concept, beginning with primary closure, and then graduating to skin grafts, locoregional flaps (LRFs), distant skin flaps, and free tissue transfer. After primary closure, Integra Bilayer Wound Matrix (Integra, Integra LifeSciences, Plainsboro, N.J.) has more recently proven itself to be worthy of a position on this ladder, due to its ease of application and ability to achieve satisfactory outcomes in both single- and dual-stage reconstruction, even in challenging areas like the nose.⁶⁻⁹ However, too few case studies and series have been made available to truly understand the capabilities or limitations of utilizing Integra for facial reconstruction. Given the paucity of literature available, our aim in this study is to report our 10-year experience using Integra to achieve aesthetic facial reconstruction after Mohs surgery.

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Received for publication June 7, 2023; accepted October 18, 2023.

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DOI: 10.1097/GOX.0000000000005474

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

METHODS

This retrospective study received approval from the institutional review board on human research, and the requirement for informed consent was waived. The surgical logs from eight surgeons (plastic & reconstructive surgery division and the department of dermatology) at our institution were queried. Case logs were reviewed from February 2012 to February 2022 for all cases involving MMS of the face (defined as the forehead, temple, brow, nose, cheeks, pre-auricular area and ears, upper lip, lower lip, and chin), followed by reconstruction with Integra Bilayer Wound Matrix. Patients were excluded if they were younger than 18 years of age, or if their defect involved the scalp.

Patient demographics, medical history, surgical history, and index surgical data were collected from the electronic medical record. The indication for reconstruction with Integra was recorded when available, along with reasoning for why they did not undergo further reconstruction after placement of the Integra graft. Operative notes from the Mohs surgeon were utilized to determine the location, diagnosis, and number of stages and sections required for tumor clearance. Patient outcomes were then also gathered from the electronic medical record, including average time to Integra graft, average time to skin graft, recurrence rate, reoperation rate, and time to both re-epithelialization and re-pigmentation. Technical success of Integra was defined as bridging patients to either secondary skin graft or secondary intention within 4 weeks, without additional coverage procedures. We defined healing in two different aspects to accurately convey wound maturity: the first being time to re-epithelialization, and the second being time to re-pigmentation with normalization to the surrounding tissue. Patient follow-up, satisfaction, and interventions performed to achieve aesthetic improvement were recorded directly from patient encounter notes. Continuous data were summarized as means and ranges/SDs, whereas categorical data were reported as counts and percentages of the total number of operative sites.

RESULTS

One hundred thirty patients (85 men, 45 women) met inclusion criteria with a median age of 75.5 and an interquartile range (IQR) of 15 years. Non-Hispanic White patients made up the majority of the cohort (98.5%), with 41% having a history of tobacco use (Table 1). Twenty-one percent of the population was diabetic, and 11% of patients were immunosuppressed. Twenty-nine patients had a history of prior excision at the site of Mohs surgery, and one patient had a history of radiation. Basal cell carcinoma (BCC) was the most common cutaneous malignancy diagnosed (39%), followed by squamous cell carcinoma (SCC) (27%) and melanoma in situ (13%), malignant melanoma (11%), SCC in situ (8%) and Merkel cell carcinoma (1%) (Table 1). The most common lesion locations involved the nose (35%), forehead (21%), temple (13%), ear (6%), and cheek (4%).

A total of 136 surgical sites were treated and subsequently reconstructed on the same day with Integra

Takeaways

Question: Integra bilayer wound matrix has emerged as a popular reconstructive option for acquired defects after Mohs surgery, but what are its true capabilities and limitations in reconstructing Mohs defects of the face?

Findings: In 136 facial defect sites after Mohs surgery, Integra successfully reconstructed and bridged 90.2% to delayed skin graft or complete secondary intention healing, without additional coverage procedures. The mean facial defect size was 26.6 cm², with an average time to re-epithelialization and re-pigmentation of 32.2±7.3 days and 169.5±14.6 days, respectively. The total complication rate was only 12%, with a low reoperation rate of 9% and 17% for single- and dual-stage reconstruction.

Meaning: Integra bilayer wound matrix is worth primary consideration in facial defects up to 27 cm² when attempting an aesthetic reconstruction of the face after Mohs surgery.

Table 1. Demographic and Clinical Characteristics of the Patients

Covariate	Value (N = 130)
Age (y), median (IQR)	75.5 (15)
Male sex	85 (65)
Race/ethnicity	
White	128 (98)
African American/Black	2 (2)
Non-Latino Ethnicity	128 (98)
Medical comorbidities	
Current/former tobacco use	52 (40)
Diabetes mellitus	27 (21)
Chronic kidney disease	12 (9)
Active immunosuppression	14 (11)
Diagnosis	
Basal cell carcinoma	55 (39)
Squamous cell carcinoma	38 (27)
Melanoma in situ	19 (13)
Malignant melanoma	15 (11)
Squamous cell carcinoma in situ	11 (8)
Merkel cell carcinoma	2 (1)
Other	2 (1)
Lesion location	
Nose	47 (35)
Forehead	28 (21)
Temple	18 (13)
Ear	8 (6)
Cheek	6 (4)
Eyebrow	3 (2)
Pre-auricular	4 (3)
Chin	1 (1)
Lip	1 (1)
Multi-site	20 (15)

Data presented as frequencies and percentages.

(Table 2). The mean preoperative lesion size was 9.6 cm², with a mean postoperative defect size of 26.9 cm². The mean number of slices taken during MMS excision was 2.3±1.3. After Mohs surgery, 42.6% (n = 58) of defect sites underwent same-day Integra reconstruction and

Table 2. Surgical Characteristics and Outcomes

Covariate	Value (N = 130)
Lesions	142
Surgical sites	136
Size (cm ²), mean (SD)	
Preoperative	9.67 (10.75)
Postoperative	26.38 (23.38)
No. MMS stages, median (range)	2 (1-14)
No. MMS sections, mean (range)	9 (1-34)
Time to Integra placement (d), mean (SD)	0.31 (1.43)
Integra take, N (%)	124 (90)
Time from Integra placement to skin grafting (d)	30.54 ± 14.60
Time to re-epithelialization (d)	32.2 ± 7.3
Time to re-pigmentation (d)	169 ± 14.6
Local recurrence at site of Integra, N (%)	0 (0)
Total recurrences, N (%)	0 (0)

were allowed to heal by secondary intention (Figs. 1, 2), whereas 57.4% (n = 78) underwent two-stage reconstruction with delayed skin graft (Fig. 3). Integra successfully reconstructed and bridged 90.2% of the patient population to delayed skin graft or complete secondary intention healing, without additional coverage procedures. Delayed skin grafts were placed an average of 30.54 ± 14.60 days after application of Integra. Average time to re-epithelialization was 32.2 ± 7.3 days. Average time to re-pigmentation was 169.5 ± 14.6 days. During the 434 days of average follow-up, there were no local recurrences at the site of Integra, nor in total.

The total complication rate was 12% (n = 16), including an overall infection rate of 10% (n = 13), and two instances (1%) of minimal necrosis (Table 3). Twenty (13%) underwent additional procedures, including debridement (n = 10), placement of a new Integra graft (n = 2), placement of a new full thickness skin graft (FTSG) (n = 2), placement of a new split-thickness skin graft (n = 1), and

other (n = 12) (Fig. 4). The average size for successful healing without complication was 26.6 cm². The average defect size for complications or failure of skin graft was 27.41 cm². After completed healing, 19 sites (13.2%) underwent procedures for aesthetic improvement (Table 3, Fig. 5). Those who underwent cosmetic improvement therapies had a median age of 68 years with an IQR of 23. Of these 19 sites requiring aesthetic revision, 13 occurred after two-stage reconstruction with a skin graft.

DISCUSSION

Skin cancer incidence in the United States has tripled since the 1970s, making it more prevalent than all other types of cancer combined.¹⁰ As reported in past literature and our study results, BCC is the most common type of skin cancer, most found on the face. When excision is performed via Mohs surgery, recurrence rates of facial BCC are lower than wide local excision or any other treatment techniques.¹¹ Even with tissue-preservation, skin cancer resection on the face can still lead to significant soft tissue deficits and represent a continuous challenge for both the dermatologic and plastic surgeon. Facial reconstruction is guided by utilization of the reconstructive ladder concept, which advocates for a graduated approach from the simplest reconstruction method to more advanced methods.¹² Although each subunit of the face requires unique consideration, a recent meta-analysis of 21 facial reconstruction studies reported linear closure to be the predominantly used technique, followed by skin grafts and LRFs.⁵ However, one-stage FTSGs have been known to undergo varying severities of contracture on the face, whereas the drawback of LRFs is that they often involve an inpatient procedure; staged revisions; and sometimes, patchy or bulky outcomes.^{13,14} Dermal substitutes such as Integra have become another viable technique at this

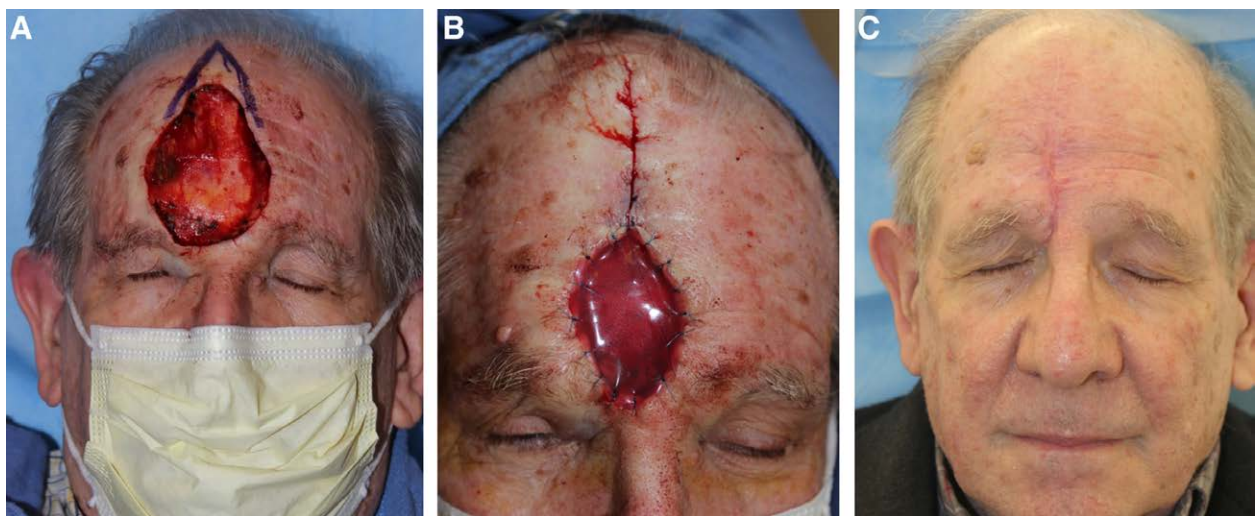


Fig. 1. Single-stage reconstruction of right paramedian forehead defect with healing by secondary intention. A 78-year-old man with melanoma in situ and infiltrative BCC of the forehead after resection with 39.75 cm² right paramedian forehead defect (A), after partial closure and application of Integra over partially reconstructed 28.6 cm² defect (B), and at completed healing 6 months after reconstruction (C).

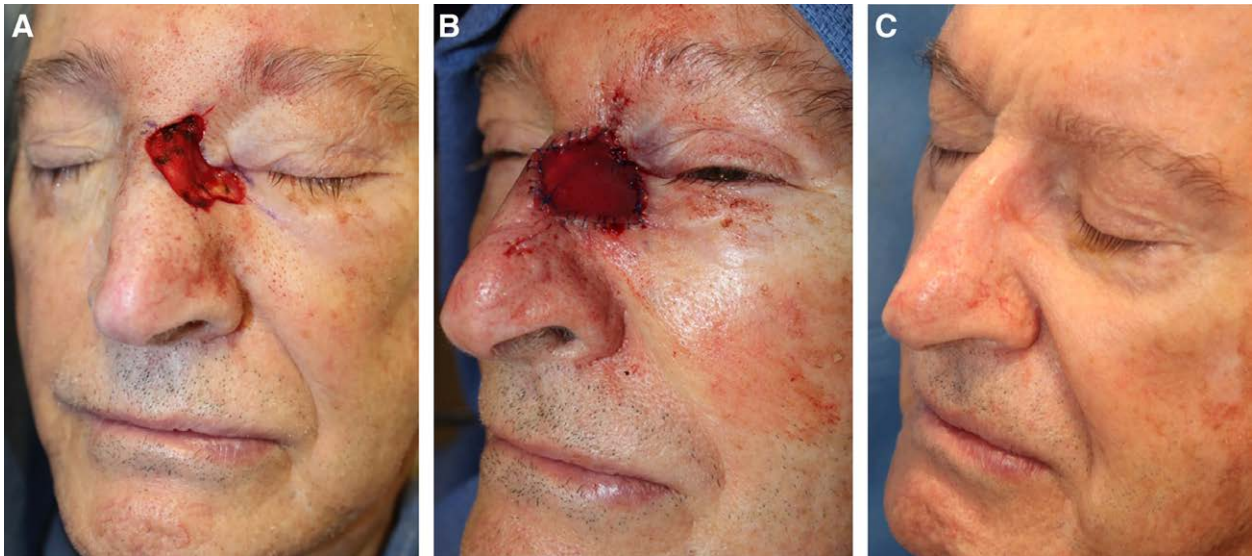


Fig. 2. Single-stage reconstruction of left nasal bridge defect with healing by secondary intention. An 80-year-old man with well-differentiated SCC of the left nasal bridge after resection with a 10.5 cm² defect (A), at the time of Integra application (B), and at completed healing 4 months after reconstruction with Integra (C).

level of the reconstruction ladder not only because of its ability to optimize delayed grafting and heal by secondary intent, but also because of its ability to provide additional volume for deeper defects, and additional structure to reduce wound contraction.^{15–17} Additionally, in the population of people aged 65–75 years, where the prevalence of anticoagulation use is higher, it is beneficial to have an option that can provide an immediate wound bolster and help avoid secondary surgery sites for procedures such as immediate skin grafting. Having a reliable outpatient reconstructive procedure that can achieve acceptable aesthetic and functional outcomes is pivotal as the volume of Mohs surgery increases in our aging society.

In the early 2000s, Integra was a less popular dermal substitute due to its lack of active cells, need for macrophage clearance, and chemical cross-linking, which was believed to contribute to a low-moderate infection rate.^{18,19} However, its continually reported success in a wide variety of complex wounds, ready availability, long shelf-life, lack of rejection, and good long-term aesthetics have led to its popularity skyrocketing in recent years.^{18,20,21} In this study, we analyzed the management and outcomes of a patient population who underwent Mohs tumor excision on the face, followed by reconstruction with Integra to facilitate soft tissue coverage. A total of 136 facial defect sites among 130 patients were repaired with Integra utilizing single- (n = 58) or dual-stage (n = 78) reconstruction, with no instances of local recurrence in either cohort. The time from Mohs surgery to alloplastic reconstruction was 13 hours (0.56 days) on average in our patient population. The most common subunits reconstructed were the nose, forehead, temple, and cheek. Integra successfully reconstructed and lead to the re-epithelialization of 90.2% of the facial defects, with a mean size of 26.9 cm². Prior studies exploring facial reconstruction have referred to a defect size of 30 cm² or greater as the size limit where a

free fasciocutaneous flap should be recommended over an LRF.²² We believe Integra can provide an additional rung on the reconstructive ladder to not only narrow the indication for LRFs, but also bridge the gap between primary closure and more complex procedures that require autologous tissue harvesting. Autologous reconstruction with FTSGs and LRFs in facial subunits such as the nose have been associated with complication rates of around 40%.^{23,24} Our analysis revealed complication rates for single- and dual-stage reconstruction of the face to be only 14% (8/58) and 9% (7/78), respectively, with no reconstructive complications until the mean defect size reached 27.4 cm². In the absence of complex functional needs, increasing the threshold for LRFs with Integra can help reduce the morbidities of raising skin flaps, preserve future reconstruction options, and decrease latency to the reconstructive procedure.

Transdermal defects create aesthetically challenging reconstructions because of the loss in dermis. A loss of dermis has been known to result in severe scarring and contracture, and can be accentuated by wound healing issues, tension, or any type of flap necrosis.^{24–26} Although FTSGs do incorporate a small portion of dermis, increasing wound depth can cause irregular graft take and recurrent contracture, but large wounds over bone or cartilage are prone to failure.^{27,28} It is likely for this reason, in addition to better regionally-matched skin color, that LRFs have been shown to have a statistically significant advantage in observer-rated scar scoring when compared with single-stage FTSGs.²⁶ The dermal regenerative properties of Integra help address this issue by primarily promoting granulation tissue at the base of dermal defect, which thereby aids in the avoidance of wound depth discrepancies and subsequent contracture.⁶ With its additional ability to generate neodermis on both exposed bone and cartilage, while also minimizing bacterial invasion, it is not



Fig. 3. Dual-stage reconstruction of right antihelix defect with Integra and FTSG. A 70-year-old man with infiltrating and superficial BCC of the right antihelix after resection with an 8.25 cm² defect (A), at application of Integra (B), at application of FTSG 3 weeks postoperatively (C), and at completed healing 4 months after reconstruction (D).

surprising that reoperation rates were low for both single and dual-stage reconstructions performed with Integra [9% (5/58) versus 17% (13/78)]. Reliably providing wound coverage with low complication and reoperation rates then allows for more focus to be placed on optimizing aesthetic satisfaction postoperatively.

The face is a difficult area to achieve aesthetic reconstruction to begin with due to the variable topography, surface contours, and symmetry created by the major facial structures and landmarks.²⁶ LRFs may provide donor tissue with comparable skin color and contour, but Integra has also shown its capability of re-pigmenting

Table 3. Surgical Complications and Revisions

Complications	
Before definitive coverage (Integra complications)*	7 (5)
Hematoma	1 (1)
Infection	6 (4)
After definitive coverage (delayed graft or secondary intention complications)	9 (7)
Hematoma	0 (0)
Infection	7 (5)
Dehiscence	0 (0)
Minimal necrosis	2 (1)
Reoperations by site	
One reoperation	15 (11)
Two reoperations	4 (3)
More than two reoperations	1 (1)
Reasons for reoperations	
Recurrence	0 (0)
Debridement	10 (7)
Placement of new STSG	1 (1)
Placement of new FTSG	2 (1)
Placement of new Integra	2 (1)
Other	12 (8)
Aesthetic revisions after completed healing	
Laser therapy	4 (4)
Dermabrasion	1 (1)
Kenalog injection	6 (4)
Scar revision under local anesthesia	8 (5)
Z-plasty	2 (1)
Other	2 (1)

Data presented as frequencies and percentages.
 *One patient experienced two complications.

and re-epithelializing well to surrounding tissue.^{29,30} Aside from patient preference, this could be one of the reasons why patients who received dual-stage reconstruction with skin graft underwent more aesthetic interventions (17% versus 9%) than those who received single-stage Integra

reconstruction alone. For single-stage patients who show early postoperative color discrepancy or contracture, the reconstructive surgeon then has the flexibility to choose a graft site that best suits the wound, knowing that aesthetic intervention is far simpler than the procedures necessary to modify or revise an LRF. Aesthetic results in our study were monitored with a postoperative visit and photographic documentation at 1, 3, and 6 weeks, followed by an additional photographic check-in between postoperative month 4 and 6. This allowed for wound care decisions to be made collaboratively between patient and provider, up until completed healing with both re-epithelialization and re-pigmentation.

This study supports Integra’s place on the reconstruction ladder for facial defects created by MMS. However, we do acknowledge the potential limitations in the application of our study beyond this scope. Soft tissue defects created by wide local excision are capable of producing bigger depth discrepancies and larger dermal violations than those created by MMS. Thus, it is possible for the chances of contour deformity to be greater if Integra is applied in this setting, in addition to an increased latency period to second-stage reconstruction while waiting for the defect to fill in with granulation tissue. Furthermore, we acknowledge that in the facial region, deeper defects which suffer a great loss in cartilage sometimes require more adequate structural support and tissue bulk from a free or local flap, to overcome more severe contracture. In regard to the cost of Integra application in our experience, Integra is more expensive than autologous reconstruction, but there is evidence that displays the skin substitute’s affordability compared with repairs using free flaps or LRFs,³¹ as well as the incurred costs of operating rooms and general anesthesia.^{6,9} Another limit of this study was that patient subjects were predominantly White, although this may be indicative of the disease, with White people being more likely to acquire carcinoma. The median age of patients in our study was also 75 years of

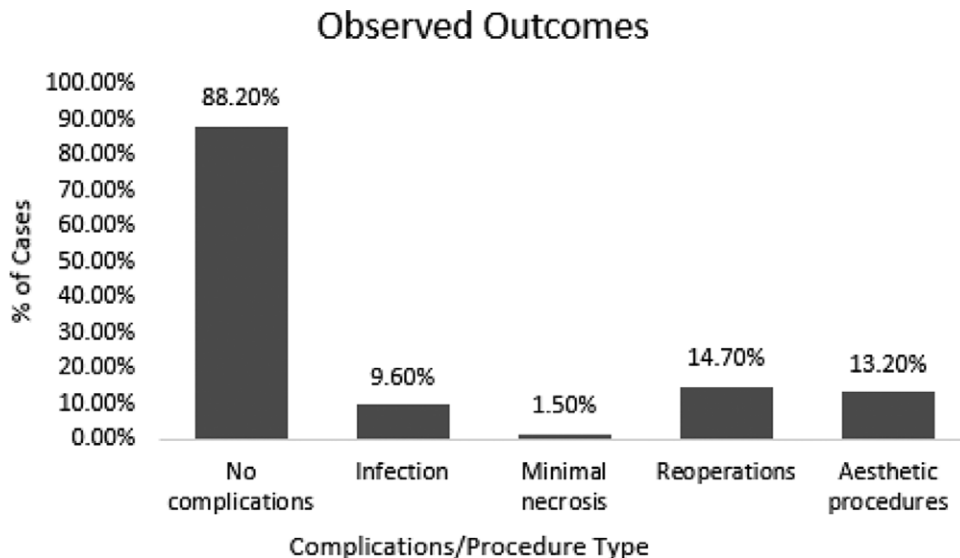


Fig. 4. The observed outcomes in patients with both dual- and single-stage reconstruction.

AESTHETIC REVISION PROCEDURES

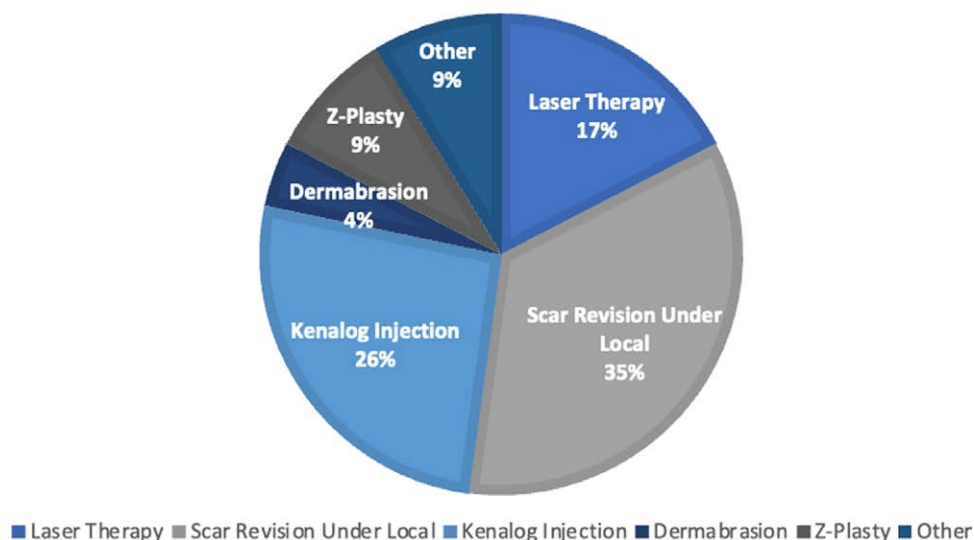


Fig. 5. Aesthetic revision procedures undergone by 19 patients who sought cosmetic improvement.

age and may contribute to skewed results showing more patient preference, versus decisions based on purely aesthetics. Of the 58 patients who underwent single-stage alloplastic reconstruction, it was unknown why 35 (60%) of the sites did not undergo second-stage skin grafting. Eighteen (31%) of the patients who were reconstructed with a single stage actually deferred a second-stage skin graft because they were pleased with how their defect was healing cosmetically. Therefore, it is important for reconstructive surgeons to continually monitor patient results postoperatively, so the need for aesthetic intervention can be identified and a second-stage skin graft offered if able to provide a superior result.

CONCLUSIONS

Integra provides a reliable outpatient alloplastic reconstruction option when managing various facial defects after Mohs surgery. Although Integra may not be able to replace large structural deficits, it can reliably produce granulation tissue and lead to successful reconstruction in large defects of around 27 cm² on average, with low complication and reoperation rates. With the indication for free flap reconstruction somewhere around 30 cm²,^{2,22} Integra significantly increases the threshold for autologous tissue harvesting needs and lessens the potential for donor site morbidity unless significant tissue bulk is required. Furthermore, by providing satisfactory aesthetic results and thus allowing for simpler cosmetic procedures for improvement, Integra has proven itself worthy for primary consideration when attempting an aesthetic reconstruction of the face.

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DISCLOSURES

Dr. Kovach has received consultant payments from Becton Dickinson and Integra Life Sciences. All the other authors have no financial interest to declare in relation to the content of this article.

PATIENT CONSENT

The patients provided written consent for the use their images.

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