Safety in Rhinoplasty
Avoidance and Management of Complications

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KEYWORDS

• Rhinoplasty • Nasal surgery • Septoplasty • Complications • Outcomes

KEY POINTS

- Frequent postoperative checks can allow for early detection of rhinoplasty complications. This early detection allows for early intervention and may ultimately save the patients' rhinoplasty result.
- Patient dissatisfaction can be minimized with appropriate preoperative counseling, which includes comprehensive informed consent and setting expectations during the preoperative appointment.
- Postoperative skin compromise may be treated with topical nitroglycerin, hyperbaric oxygen treatment, a variety of medications, and leech therapy; patients should be monitored closely until resolution is achieved.

PANEL DISCUSSION

Infections? How to diagnose and treat them?
What is your most common complication?
What patients and what procedures are at greater risk? Is the length of surgery a risk factor?
Do you use additional treatments like hyperbaric chamber, nasal soaks, or other treatments?
What does your consent form include regarding complications?
How have your techniques in this area changed over the last 2 years?

INTRODUCTION

The nose is central to identity, and nasal appearance is critical in determining body image and personality development.[1,2] Studies have shown that both nasal cosmesis and function play a role in social interactions, self-confidence, quality of life, and daily function.[1,3,4] As such, rhinoplasty has become one of the most popular operations in the world.[5]

Despite its popularity, rhinoplasty carries inherent risks, and complications can occur during or after surgery. Patient dissatisfaction can stem from a broad range of underlying issues both

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subjective and objective in nature; complications of rhinoplasty include scar, asymmetries, irregularities, imperfections, nasal airway obstruction, skin ischemia or necrosis, nasal collapse, nasal deformity, and overcorrection or undercorrection of a perceived nasal irregularity. Understanding these potential complications, along with strategies for their avoidance and management, is essential for ensuring patient safety and optimizing surgical outcomes.

Complications may arise before, during, or after surgery, necessitating careful consideration, assessment, counseling, and management by plastic surgeons. This article aims to provide a comprehensive overview of complications in rhinoplasty, along with strategies for prevention and intervention.

Question 1: Infections? How to Diagnose and Treat Them?

Salehi/Frants/Nassif

The risk of infection is inherent in any surgical procedure, including rhinoplasty. The risk of infection is significantly higher in revision rhinoplasty cases since the blood supply is not as good as in primary rhinoplasty, and there may be more cartilaginous grafts present with revision rhinoplasty that increase the chance for infection.[6–14]

To minimize the risk of infection, both primary and revision rhinoplasty patients are given a structured regimen of oral, topical, and intranasal antibiotic treatments. These are summarized in **Tables 1** and **2**.

In primary rhinoplasty, patients are instructed to use hypochlorous acid sprays and mupirocin ointment beginning 5 days before surgery. Beginning on postoperative day 1, patients are instructed to continue the aforementioned regimen, while also maintaining excellent wound care and beginning a 5 day course of oral antibiotics. Mupirocin ointment is applied to bilateral nostrils preoperatively and postoperatively to minimize the chance of methicillin-resistant *Staphylococcus aureus* (MRSA) infection.

In revision rhinoplasty patients are instructed to add ciprofloxacin soaks (**Fig. 1**) beginning 5 days before surgery. Beginning on postoperative day 1, patients are instructed to continue the aforementioned regimen with the addition of a second 5 day course of oral antibiotics.

The senior author has incorporated ciprofloxacin antibiotic soaks as part of routine preoperative and postoperative care for revision rhinoplasty patients. The ciprofloxacin soak protocol consists of crushing two 500 mg ciprofloxacin tablets and mixing the powder with 1000 mL of normal saline. A 5.08 cm x 5.08 cm gauze is saturated with the resulting solution and placed carefully in each nostril using a cotton-tipped applicator (see **Fig. 1**).

Any postoperative worsening erythema, foul odor perception, or obvious purulent drainage from any of the incisions is concerning for infection. The patient should be evaluated immediately and cultured. Mupirocin ointment is continued. If an organism is identified, antibiotic treatment should be started promptly. In cases in which clinical suspicion for infection is high, oral antibiotic therapy may be started prior to culture results, and updated as needed.

Friedman

Infections following rhinoplasty are relatively rare events, with reported estimates ranging from 0% to 4%.[15] Rhinoplasty is considered to be a "clean contaminated" operation—organisms living as part of the normal biome, either inside the nose or as skin flora outside of the nose, are also within the surgical field and are, therefore, the most likely potential sources of infection.[16] Recognizing infections early allows for prompt treatment, thereby avoiding long-term irreversible and potentially devastating sequelae. Anecdotally, we have found patients with a history of smoking, radiation therapy, intranasal drug use, chronic pseudomonal or staphylococcal carrier state, or systemic vasculitis to have a higher rate of infection. Among this patient population, we are on higher alert and will see them back in the office more frequently following surgery. The famous and wise Philadelphian Benjamin Franklin advised, "An ounce of prevention is worth a pound of cure," and being that I practice in Philadelphia, I heed his advice vigorously. Specifically, our high-risk patients may at times be asked to swab their nose with betadine solution, irrigate hydrogen-peroxide, or wash with chlorhexidine preoperatively to help reduce risks of postop infections. Intraoperatively, prior to the first surgical incision, we have also at times "prepped" the nose with hydrogen-peroxide irrigations. Among revision rhinoplasty patients who have had prior postnasal surgery infections, or among patients who are chronically colonized with *Staphylococcus* or *Pseudomonas* or other potentially pathologic organisms, preoperative nasal swab culture-directed prophylactic antibiotics[17,18] may be considered. *S aureus* is responsible for most infections after rhinoplasty; however, methicillin-resistant forms and even gram-positive coliforms should be suspected in at-risk patients.[17]

Infections following rhinoplasty may present as cellulitis, vestibulitis, incisional wound breakdown, cartilage graft necrosis, prolonged crusting,

Table 1
Medication protocol for primary rhinoplasty

Begin 5 Days before Surgery	
Hypochlorous acid spray	Spray in nose and mouth 2× daily for 5 d. Start 5 d before surgery
Mupirocin ointment/antibiotic	Apply inside of nostrils 2× daily for 5 d. Start 5 d before surgery
The Night before Surgery	
Famotidine 20 mg	Take one tablet the night before surgery to reduce throat irritation postoperatively
Take the Morning of Surgery	
Aprepitant	1 tablet with a small sip of water upon arrival at the surgery center
Gabapentin	Given in preoperative holding area, weight based per anesthesiologist
Begin the Evening of Surgery—These Are Optional	
Pain control	Alternating acetaminophen and ibuprofen, age-appropriate, maximum dose, every 4 h If needed for severe pain: tramadol: 1 tab every 6 h as needed for pain (take with food)
Benzodiazepine	Half to 1 tab every 6 h as needed for anxiety
Ondansetron	1 tab every 12 h as needed for nausea
Promethazine	Half to 1 tab every 8 h as needed for nausea
Probiotics (Optional)	Follow package instructions as directed
Colace	Take twice a day for 7 d
Begin the Day after Surgery	
Hydrogen peroxide and distilled water	Clean all incisions with three-fourths distilled water and one-fourth hydrogen peroxide twice a day (to clear any crusting/scabbing)
Arnica tablets/gel	Take 1 tablet twice a day for 7 d. Gel as needed for bruising
Sinus irrigation	Do sinus irrigations at least twice a day for 7 d. Can continue as needed after 1 wk
Mupirocin ointment	Apply to incisions and inside nostrils twice a day for 7 d
Cefadroxil	Take 1 capsule twice a day for 5 d
Medrol dose pack	Follow package instructions as directed
Antihistamine	Take as needed for congestion (Please avoid decongestants, general antihistamine recommended instead)
Begin at 1 wk Postop	
Nasal saline spray	As needed for nasal dryness for 2–3 mo
Aquaphor ointment	Apply to all incisions twice daily, begin after sutures are removed
Begin at 2 wk Postop or When Incision Lines Heals	
Silicone-based scar gel	Start 2 wk after surgery. Use for 2–3 mo; use on incision lines

septal abscess, suture abscess, septal perforation, external nasal abscess, and more advanced regional infections including intracranial infections transmitted through vascular channels from the nose to the intracranial cavity. Although rare, central nervous system extension of nasal infection may present a life-threatening complication.[19] Most minor infectious complications encountered are either self-limited or they may be successfully managed with simple measures. Postoperative nasal hygiene is advocated among all patients to prevent infections—saline irrigations, topical

Table 2
Antibiotic protocol for revision rhinoplasty

Begin 5 Days before Surgery	
Hypochlorous acid spray	Spray in nose and mouth 2× daily for 5 d. Start 5 d before surgery
Cipro soaks	(2-Cipro 500 mg tablets dissolved in 1000 mL sodium chloride solution) Twice a day for 5 d prior to surgery. See Cipro soaks attachment for instructions
Mupirocin ointment	Apply inside of nostrils 2× daily for 5 d. Start 5 d before surgery
The Night before Surgery	
Famotidine 20 mg	Take one PEPCID tablet the night before surgery to reduce throat irritation postoperatively
Take the Morning of Surgery	
Aprepitant	1 tablet with a small sip of water upon arrival at the surgery center
Gabapentin	Given in preoperative holding area, weight based per anesthesiologist
Begin the Evening of Surgery—These Are Optional	
Pain control	Alternating acetaminophen and ibuprofen, age-appropriate, maximum dose, every 4 h As needed for severe pain: tramadol: 1 tab every 6 h as needed for pain (take with food)—(we strongly discourage narcotic use)
Benzodiazepine	Half to 1 tab every 6 h as needed for anxiety
Ondansetron	1 tab every 12 h as needed for nausea
Promethazine	Half to 1 tab every 8 h as needed for nausea
Probiotics (optional)	Follow package instructions as directed
Colace	Take twice a day for 7 d
Begin the Day after Surgery	
Hydrogen peroxide and distilled water	Clean all incisions with three-fourths distilled water and one-fourth hydrogen peroxide twice a day (to clear any crusting/scabbing)
Cipro soaks/antibiotic soak	(2-Cipro 500 mg tablets dissolved in 1000 mL sodium chloride solution) Twice a day for 10 d after surgery
Arnica tablets/gel	Take 1 tablet twice a day for 7 d. Gel as needed for bruising
Nasal sinus irrigation	Do sinus irrigations at least twice a day for 7 d. Can continue after 7 d as needed
Mupirocin ointment/antibiotic	Apply to incisions and inside nostrils twice a day for 7 d
Ciprofloxacin	1 tablet twice a day for 5 d
Cefadroxil	Take 1 capsule twice a day for 5 d
Medrol dose pack	Follow package instructions as directed
Antihistamine	Take as needed for congestion (Please avoid decongestants, general antihistamine recommended instead)
Begin at 1 Wk Postop	
Nasal saline spray	As needed for nasal dryness for 2–3 mo
Aquaphor ointment	Apply to all incisions twice daily, begin after sutures are removed
Begin at 2 Wk Postop or When Incision Lines Heals	
Silicone-based scar gel	Start 2 wk after surgery. Use for 2–3 mo; use on incision lines

Fig. 1. Ciprofloxacin soaks.

antibiotic ointment, and cleaning the incisions and surgical areas. The most important advice for diagnosing and treating infectious complications following surgery is to be aware of, and open to, their possible occurrence. The slightest sign of infection such as the most minimal amount of erythema or tenderness in a particular area may indicate a looming infection which, if managed early, may resolve without any consequence. Conversely, if the surgeon is not aware of, concerned about, or worse—is dismissive of—early signs and symptoms of infection, significant long-term problems may ensue.

Cellulitis may be identified as redness, warmth, pain, and tenderness in a particular region of the nose. This may involve the skin externally, which is easily visible to the patient and clinician and, therefore, relatively easy to identify and treat promptly. Cellulitis involving the internal nasal skin, or vestibulitis inside of the nostril, may be more difficult to see and, therefore, to identify promptly. We should remain vigilant and search for signs of infection if patients are complaining of associated symptoms. Once identified, cellulitis and vestibulitis may be easily treated—if it involves an intact area of skin and not an incision-line, these infections may be managed with oral antibiotics. Ideally, culture-directed antibiotics would be employed, but most often when infections are identified early and treated early, there is improvement or resolution before the culture and sensitivities return from the laboratory. Generally, for otherwise healthy and nonimmunocompromised patients, we use empiric antibiotic therapy with amoxicillin–clavulanic acid or a first-generation cephalosporin such as cephalexin (or clindamycin, if β-lactam allergy). If the area infected involves a suture line or sutured area as in the septum, treatment begins with the removal of any irritating or inciting contributors such as suture material that may serve as a nidus of infection or crusts that may be providing cover for underlying bacterial growth. For these open wounds or suture-line or suture-related infections, topical soap and water or topical hydrogen peroxide scrubs to the affected region are very helpful. Additionally, topical antibiotic ointment such as mupirocin or povidone-iodine may be used. More advanced infections such as nasal or septal abscesses may require incision and drainage along with topical therapies and likely systemic antibiotics and potentially hospitalization.

Sykes

Postoperative rhinoplasty infections are uncommon. The vast vascular supply and lymphatic drainage of the nose likely account for the low infection incidence, despite operating in a field that is exposed to nasal and sinus flora and is considered clean contaminated.

The exception to this rare infection rate occurs when a foreign body, such as an alloplast implant, is used during the nasal reconstruction. Alloplasts, such as high-density polyethylene (Medpor–Porous polyethylene, Stryker, Kalamazoo, MI) or gore-Tex (expanded-polytetrafluoroethylene) can be colonized with bacteria during their implantation. This will often result in chronic inflammation or even infection. Infection in rhinoplasty with the use of alloplasts can occur at any time after surgery. Although infections can occur in the early postoperative period, chronic inflammation or infection can happen many years after the surgery and this chronic inflammatory condition is common.

Diagnosis of postrhinoplasty infections requires a careful examination and a high clinical suspicion. A common source of inflammation or infection is from intraoperative suture placement. Mini suture abscesses from transcolumellar sutures are common. These can be treated with suture removal and wound care (topical antibiotic ointment). If the suture abscess is from nasal tip sutures, access to these is more difficult, and removal of the offending suture(s) requires anesthesia of the area and an incision (endonasal or open approach) to expose the area and remove the contaminating suture.

Question 2: What Is Your Most Common Complication?

Salehi/Frants/Nassif

The most common complication in both primary and revision rhinoplasty is unsatisfactory esthetic

outcome. This complication is difficult to measure or objectify, as it is defined by patients' perceptions of what their ideal outcome should be from a functional and cosmetic standpoint. As such, quantifying the success and goals of rhinoplasty surgery is quite difficult. Successful outcomes are contingent on both the surgeon's execution (optimizing both cosmetics and function) and the patient's *perception* of these outcomes. In many cases, the patient may be bothered by an outcome the surgeon finds acceptable (or even optimal).

As such, the best way to minimize complications is astute clinical examination skills and decision-making and exhaustive preoperative and postoperative counseling of realistic expectations and healing timeline. For instance, we routinely tell patients that they will require a full 3 years to heal after rhinoplasty, especially revision cases. Prior to the 3 year healing window, we often do not entertain further revision surgeries unless there is an obvious functional deficit or cosmetic deformity.

Clinicians should always monitor for body dysmorphia and/or unrealistic expectations, as these patients often are unhappy with their outcomes, regardless of surgeon's skill. Notably, there has been a rise of addictive social media use in recent years; this rise has negatively impacted the mental wellness and body image distortion in certain patients.[20] Further, social media use has coincided with a notable rise in misinformation surrounding plastic surgery.[20] Now more than ever, plastic surgeons have a duty to assess and counsel patients thoroughly; in the end, the surgeon that carefully selects patients will minimize unsatisfactory esthetic outcomes.

Friedman

Overall rhinoplasty complications are best divided into 2 categories: early complications and longer term complications. In addition, it is worth highlighting that I can comment from personal experience on the most common early and longer term complications I see among my own patients, but it is more difficult to comment on the very long-term complications I may not be aware of among my surgical patients who may have sought revision surgery elsewhere. I can, however, also comment on the most common reasons patients might seek my opinion for revision rhinoplasty after surgery performed elsewhere.

1. My early complications: The most common complication I see in the early weeks after surgeries that I perform relate to suture-related irritation and low-grade infection. In my earlier years of practice, I noticed problems with irritation from polyester poly (p-dioxanone) (PDS) suture material placed under the septal flaps. Patients experience slight tenderness in the region of the suture and knot, they may develop microabscesses that become visible under the septal mucosa, and often there may be extrusion of the suture material—before the suture material ever dissolved—at 3 or 6 months or longer after surgery. As a result, I moved away from using any slow-dissolving or permanent suture materials submucosally in the septum and only used that suture material when there is a more robust and highly vascular soft tissue coverage available to help bury the suture material more deeply and to help dissolve the material more quickly and without overlying superficial signs of irritation or infection (I continue to use PDS and permanent suture for lower lateral and upper lateral cartilage fixation as this is buried under the thickness of the well-vascularized and cushioned nasal skin). I now use mostly absorbable chromic suture and plain gut suture, placed in an extramucosal location, for nearly all septal work including fixation of cartilage grafts as needed. These sutures generally dissolve quickly, may easily be removed if they are causing irritation and infection and crusting, and are sufficient to provide the necessary strength and support for securing tissues in position until permanent scar tissue associated with proper wound healing fixes them more permanently.
2. My longer term complications: The most common complication I find in the longer term is persistent edema. Common belief led many surgeons to covey to their patients that the permanent result of their surgery would be visible at 12 months postoperatively. Over time, it has become clear that I do not see the expected surgical result at 12 months, and I find that the patients are swollen for much longer than that. As a result, I counsel my patients that they will continue to see resolution of swelling and settling of tissues for a period of 18 to 24 months before the "final result" takes shape. And even after that, I know there will continue to be changes to the skin envelope that will alter the appearance of the nose. A highly satisfactory rhinoplasty outcome is certainly visible in the early postoperative period, within 6 weeks of surgery, both from the patient's perspective and from my perspective, but I know that the nasal appearance will only continue to improve over time as the swelling resolves more fully. Despite this

knowledge and communication of such to the patient preoperatively and again postoperatively, delays in visualizing the ultimate surgery outcome are a source of anxiety and, at times, frustration for the patient and for our team.

There are a number of factors that have been shown to predispose patients to increased and prolonged edema including skin thickness,[21,22] external rhinoplasty approaches,[23,24] osteotomies,[25] and extent of nasal tip dissection.[26] Patient compliance with postoperative rhinoplasty care instructions may also determine the degree of edema, including maintaining the nasal splint and tape, icing the eyes and nose, elevating the head of bed, mobilizing early after surgery, minimizing sun exposure, and others.

In our quest for optimal results and rapid recovery, surgeons have sought ways of improving edema following rhinoplasty. Osteotomy technique has been studied, and periosteal preservation[27] and piezoelectric osteotomy[28–30] have been shown to be helpful in reducing postoperative edema. A 2021 meta-analysis failed to show the external approach to lateral osteotomy beneficial for postoperative swelling and bruising.[25] In conjunction with the anesthesia team, we often employ intraoperative systemic steroids to reduce postoperative nausea and vomiting, but this practice has also been shown effective in reducing the degree of edema seen on postoperative day 1 compared to placebo.[31,32] A single perioperative systemic steroid dose has proven useful, with additional benefit obtained from an additional short postoperative course of steroids.[31] In a meta-analysis of 18 randomized controlled trials, no significant difference was found between the type of steroid used among dexamethasone, methylprednisolone, or betamethasone.[32]

While nasal taping and external splinting after rhinoplasty are the standard practice, there is little evidence to support the practice. At times, surgeons may use tissue glue to seal the "dead-space" between the skin-soft-tissue-envelope and the underlying bony-cartilage skeleton in hopes of reducing edema. Additional recommendations to help control edema include the use of *Arnica montana* and bromide as supplements to help with swelling and bruising. A recent randomized controlled trial using 3 dimensional-printed rhinoplasty splints found superior results for long-term edema reduction of the nose at 6 months and 1 year compared to control (taping; $P \leq .05$), as well as consistent reductions in the tip and dorsum, specifically (1 year, $P \leq .1$, .01, respectively).[33] A commonly accepted practice for the reduction of edema in the early postoperative months following rhinoplasty, which we also incorporate into our practice as needed, includes the injection of triamcinolone into the subcutaneous tissue, especially in the supratip region. Care should be taken in avoiding too superficial an injection or too much injected steroid as skin atrophy and scar may complicate the injection.

3. Complications requiring revision surgery: The most common reasons patients present to me for corrective revision rhinoplasty following primary surgery that was performed elsewhere include nasal obstruction, crooked nose deformities, and dorsal irregularities. The details of my approach to these problems are beyond the scope of this publication, but are mentioned for completeness.

Sykes

The 2 most common infectious complications after rhinoplasty include reaction/infection related to intraoperative suture placement and endonasal infection from postobstructive sinus cavity contaminants. In that the normal draining sinus ostia are often obstructed from postoperative edema or inspissated blood and mucous, it is prudent to use perioperative oral antibiotics as prophylaxis to prevent these infections. Intranasal sinus infections from postobstructive (intranasal packing/stents or intranasal edema) are usually limited by perioperative oral antibiotics and do not typically require intravenous antibiotics or surgical drainage. In most cases, perioperative sinus infections are well treated with a combination of oral antibiotics, nasal saline irrigation, and intranasal decongestant sprays.

Question 3: What Patients and What Procedures Are at Greater Risk? Is the Length of Surgery a Risk Factor?

Salehi/Frants/Nassif

The patients most at risk for complications are revision rhinoplasty patients (with a greater risk with each subsequent surgery), thick-skinned patients, thin-skinned patients, patients suffering from body dysmorphia, patients with unrealistic expectations, prior filler injections to the nose, foreign body injection/implant in the nose, and patients with underlying medical comorbidity.

For instance, patients with underlying autoimmune disease, such as granulomatosis with polyangiitis (GP), are at greater risk for complications. Patients with GP have up to a 20% complication rate,[34] 50% disease recurrence rate,[34,35] and 25% graft resorption rate.[36] Patients with GP are at greater risk for postoperative graft necrosis and infection.[34] In GP nasal reconstructions,

autologous tissue is preferred, with either costal cartilage or calvarial bone grafts.[34] Some advocate for calvarial bone grafts over costal cartilage given GP's tendency to destroy cartilage; though this has not been our experience.[34,37]

Excluding complications of general anesthesia (which we rarely experience), we have not found that the length of surgery has an impact on the surgical risks or outcomes. Often times, more challenging cases may take longer, but that does not necessarily negatively impact the outcomes. In fact, we advocate that in challenging cases the surgeon proceeds with caution and attention to detail to maximize postoperative outcomes.

Friedman

Complications following rhinoplasty are reported with variable incident rates in different studies. In general, surgery performed for patients with poor blood supply as may occur in smokers, patients who have undergone radiation therapy, and patients with vascular insufficiency or vasculitis is of higher risk and prone to complications. Revision surgery, due to scar tissue, altered circulation, need for more aggressive maneuvers, need for cartilage grafts taken from secondary sites, requirements for more comprehensive reconstruction with a greater number and larger incisions and wider areas of soft tissue disruption and dissection are also higher risk situations that require greater care and awareness. A review of the American College of Surgeons' National Surgical Quality Improvement Program database[38] found that the incidence of all complications was 5.4%. Some of the commonly cited surgical complications, and those specifically listed on the American Society of Plastic Surgery's "Consent for Rhinoplasty," were systematically reviewed by Sharif-Askary and colleagues[15] and I will comment on various factors that may contribute to higher risks for some of the listed complications.

Nasal septal perforation Nasal septal perforation is said to occur in under 3% of patients undergoing rhinoplasty. Certain factors may contribute to septal perforation following nasal surgery including surgeon unfamiliar with septoplasty techniques, patients with particularly thin mucosa, patients with nasal crusts and ulcerations who undergo surgery when crusts and ulcers are present, severe septal deviations, revision nasal surgery where septal cartilage and bone has been previously resected, and others. If there is a postoperative infection, or suture irritation or infection, this may trigger septal perforation. In a study specifically looking at patients undergoing repair of septal perforation, we found that among 81 repair procedures, the rate of infection was 3.7% and those patients with infection following surgery were predisposed to a failure of perforation repair.[39] I find that approximating torn septal mucosal flaps if present, excellent postoperative nasal hygiene, and the application of silicone splints during the healing process help prevent the occurrence of septal perforation.

Infection Infection is reported to occur in less than 4% of rhinoplasty patients. Strategies for prevention, identification, and management of infections have been discussed earlier in this publication and the reader is referred to the earlier sections for review or surgical and patient factors associated with this complication. In general, the American Academy of Otolaryngology-Head and Neck Surgery (AAOHNS) Clinical Practice Guidelines do not recommend prophylactic antibiotics for a period greater than 24 hours.[40] There remains variability in surgeon practice.[3,41,42] Among patients undergoing revision rhinoplasty, the use of antibiotic "soaks" or "irrigations" have been shown to be beneficial.[43] An additional study revealed that women undergoing revision rhinoplasty with rib cartilage had a higher rate of postoperative infection.[44]

Bleeding In most patients, rhinoplasty is achieved without complications of postoperative bleeding that requires packing after surgery, and with the extremely rare occurrence of septal hematoma. Conversely, ecchymosis following rhinoplasty is common. Light-skinned and light-eyed patients with thinner skin seem to be more prone to severe ecchymosis, and I generally quote to patients a 33% occurrence of ecchymosis based on anecdotal experience. Patients are instructed to use ice packs on their eyes for 72 hours after surgery, 20 minutes on and 20 minutes off. Among patients who bruise easily by history, I recommend *A montana*, bromide,[45] early and aggressive mobilization, elevated head of bed, and at times oral systemic steroid taper.

Nasal airway obstruction Historically, nasal airway obstruction has been one of the most common long-term complications following rhinoplasty.[46] This is especially true following a purely reductive cosmetic rhinoplasty.[47] During standard "Joseph" dorsal reduction cosmetic rhinoplasty, failure to address septal deviation and/or reconstruct a weak nasal valve results in an increased risk of postoperative nasal airway obstruction. In rhinoplasty education today, facial plastic surgeons continue to appropriately emphasize the confluence of form and function in the nasal organ and recognize the extreme importance and value

in addressing both aspects of the nose among our patients.[48] A variety of surgical techniques have been developed and employed to manage functional aspects of the nose[49] and may often be used in conjunction with rhinoplasty techniques to improve patient quality of life.[50] Given the significant impact nasal obstruction has on a patient's sleep quality and life quality, when performing cosmetic rhinoplasty, surgeons should also aim to improve nasal breathing function.

Sykes

Patients that have preoperative colonization with large amounts of bacteria that are not part of typical respiratory flora are at greater risk of developing postoperative intranasal infections. The most common of these bacterium is MRSA. If the patient is a known carrier of MRSA, preoperative treatment with oral antibiotics known to kill MRSA and topical antibiotic ointment mupirocin for at least 7 days is advised.

Several patient types and conditions increase the incidence of perioperative rhinoplasty infections. These include patients undergoing revision rhinoplasty, especially in those cases in which the skin-soft tissue envelope has been compromised and the vascularity to the skin is compromised or is in question. Additionally, chronic nicotine use and or diabetes mellitus changes the skin vascularity. In patients with these conditions, the infection rate may be increased.

In patients with potentially compromised vascularity to the skin-soft tissue envelope, perioperative treatments with hyperbaric oxygen is indicated.

Question 4: Do You Use Additional Treatments Like Hyperbaric Chamber, Nasal Soaks, or Other Treatments?

Salehi/Frants/Nassif

In addition to the protocols discussed in **Tables 1** and **2**, we do advocate for hyperbaric chamber therapy in patients. Ideally, all patients would undergo hyperbaric oxygen therapy immediately before and for 3 to 5 days after surgery. In revision rhinoplasty patients, especially in the case of multiple revisions, we may require patients to undergo hyperbaric oxygen therapy as a condition for surgery. In cases where postoperative venous congestion is noted, we again send patients for hyperbaric oxygen therapy. Depending on the severity of postoperative concern, our typical protocol is at least five 1 hour treatment sessions at 2.0 atmosphere absolute (ATA) or ten 1 hour treatment sessions at 2.0 ATA.

In addition to daily hyperbaric oxygen treatments, our protocol for venous nasal skin congestion postoperatively includes a multifaceted treatment protocol, with close follow-up until symptoms resolve. We utilize a combination of topical nitroglycerin 2% ointment and *Hirudo medicinalis* therapy (with antibiotic prophylaxis) in the immediate postoperative period, oral aspirin 81 mg daily, and, in severe cases, oral pentoxifylline. Other considerations include avoiding postoperative dressings/splints/tape to avoid pressure and improve postoperative wound monitoring. In patients with underlying autoimmune disease history, providers may consider rheumatologic testing to assess disease reactivation. As with any complication, consistent communication and regular follow-up are critical.

Friedman

I routinely insist that patients stop smoking prior to proceeding with nasal surgery. For routine postrhinoplasty care, I instruct patients to avoid strenuous activities and heavy weight lifting for 10 days, to use ointment in the nose at least 4 times daily, to use saline nasal spray 6 sprays each nostril 6 times a day, to apply saline irrigations to the nose 2 to 3 times daily, and to try to wash any suture lines with soap and water 1 to 2 times daily. Among healthy patients undergoing primary rhinoplasty, the listed instructions form the extent of our basic routine. I generally see patients in follow-up within the first 10 days after surgery, then again a week or two later depending on how things are looking, then again at 1 month after surgery and then at 3 months, 6 months, and 12 months after surgery, and I am always looking vigilantly for any signs of healing problems or developing complications. Among patients undergoing major revision rhinoplasty with rib grafts, recent former smokers, after head and neck radiation therapy, former drug users, patients with vascular issues, and patients with history of chronic bacterial colonization or high risk of this as with patients who are health care workers, I am more vigilant and add more cautionary instructions and follow up. I will routinely have these patients use topical povidone-iodine ointment, chlorhexidine, and/or hydrogen peroxide preoperatively and at times postoperatively if they are at high risk of infection. At the very first sign of suture irritation or infection or cellulitis, I will remove the affected suture and perform a thorough cleaning in the office. The patient will be instructed to more frequently perform soap and water cleansing of the affected area at home, and in addition to the mupirocin antibiotic ointment, I may start the patient on an antibiotic irrigation (ie, gentamicin or other) as well as a possible topical steroid. If there appears to be exposed cartilage or threat of exposed cartilage, I will often place the patient

on oral antibiotics and possibly oral steroid if there is significant inflammation in the region. A culture is taken, and the patient may be started on very strong broad-spectrum antibiotics if the threat of wound breakdown or cartilage loss is significant, for example, levofloxacin and clindamycin. Patients are instructed to be aware of, and seek medical attention immediately, if they develop gastrointestinal issues or loose stools because of any of these treatments. Very rarely have I instituted hyperbaric oxygen therapy for a routine primary or revision rhinoplasty, but in a patient with the risk factors mentioned, this would be considered as clinically indicated.

A recent study of over 3000 patients published by Toriumi and colleagues[43] showed reduced infections when antibiotic soaks or irrigations were used in rhinoplasty as compared with control patients ($P = .0053$). The effect reported was most evident among revision rhinoplasty patients. Chien and colleagues[39] reported on 81 septal perforation repairs among whom the rate of infection was 3.7%, but they noted a significantly lower chance of success of perforation repair among patients who developed infections as compared with the patients who did not develop infection.

Sykes

If the patient has a history of chronic nasal drainage (especially if the drainage is purulent), preoperative nasal cultures are indicated. Treatment should be individualized and directed by culture results.

In patients with potentially compromised vascularity to the skin-soft tissue envelope, perioperative treatments with hyperbaric oxygen are indicated. Also, if the patient develops a postoperative infection, which includes possible vascular compromise or skin ischemia, postoperative hyperbaric oxygen chamber treatments may be indicated. Use of a hyperbaric chamber of at least 4 ATA is advisable. Daily treatments for 7 to 10 days (3 preoperative and 7 postoperative) are indicated.

Question 5: What Does Your Consent Form Include Regarding Complications?

Salehi/Frants/Nassif

Our consent includes all the standard risks of surgery including bleeding, infection, damage to surrounding structures, need for future surgery, cosmetic dissatisfaction, and death. Notably, several topics are discussed (as applicable) at the time of consultation and again at the preoperative visit (**Table 3**). A thorough discussion of these factors is essential in managing expectations with patients.

Friedman

Consent form includes bleeding, infection, nasal obstruction, vision loss, cosmetic dissatisfaction, septal perforation, need for revision surgery, cerebrospinal fluid leak, pain, loss of smell, and risks associated with anesthesia including death.

Sykes

All preoperative informed choice consents should include generalized information regarding the risk of postoperative infection. If prior nasal infection is known, discussion and documentation of an increased risk of perioperative infection should be performed.

A specific discussion relating to the risk of skin compromise, scarring, and the possibility that the infection will affect the final esthetic or functional outcome. This discussion is most important for revision rhinoplasty cases and for the patients with preoperative conditions that may negatively affect healing (smoking, diabetes mellitus, collagen vascular disorders, and so forth).

Question 6: How Have Your Techniques in This Area Changed over the Last 2 Years?

Salehi/Frants/Nassif

We continue to use the diced cartilage glue graft (DCGG) and refine the various grafts that may be created from it.[51–56] DCGG is an excellent tool, as it allows for precise shaping of cartilage grafts and nasal refinement, while providing a layer of camouflage to mask sharp edges. We have found that by mincing the cartilage finely (finer than minced garlic) and applying a thin layer of fibrin glue, we minimize the amount of resorption and unpredictability.

The most significant change to our practice in the past 2 years has been the greater emphasis on dorsal preservation rhinoplasty approaches.[57,58] The dorsal preservation approach allows for optimal dorsal hump reduction while preserving a patient's natural dorsal anatomy.[57] Patient selection and training in dorsal preservation is key to performing these surgeries.

Recently, we have moved toward more endonasal rhinoplasty approaches. The impetus for this change was primarily to minimize postoperative swelling. One of the most frequent complaints of patients after rhinoplasty are postoperative swelling, and it has been our experience that with the endonasal approach patients are less swollen and have a shorter course of postoperative edema. As with any surgery, patient selection is critical in pursuing closed approach rhinoplasty.

Friedman

Throughout my career, I have performed both endonasal and external rhinoplasty, and at different

Table 3
Specific complications discussed at every preoperative visit

Complication	Discussed Material
Expectations	Our goal is improvement, but not perfection. We made this clear to the patient
Morphed images	We showed the patient computer morphs that are not guaranteed surgical results but to help guide surgical discussion. We reminded the patient that the morphs are realistic, but the results are not exact and are not a guarantee. We made clear that even with the morphs, we cannot promise an exact result or promise to over deliver. We showed her the disclaimer on the morphing program that "Simulation—actual results will differ"
Fibrin glue use	We also need to use fibrin glue for the patient. Fibrin glue is made of pooled blood products that has been used safely in surgery for decades. We combine the glue with very finely diced cartilage to create soft moldable grafts to refine the nose, similar to spackling
Asymmetries	We showed pre-existing asymmetries of the face. We want the patient to be aware of the inherent asymmetries of the facial skeleton that will not be changed by this surgery but may affect how the nose looks as it sits on the face. We specifically discussed that we are unable to change the location of the nostril attachment to the face
Rib	Taking cartilage from the rib involves a small incision in the breast crease or pectoral groove that hides well. The cartilage is harvested from the right side, unless there is a medical and/or surgical contraindication. We discussed the risk of pneumothorax. A pneumothorax would require a postoperative chest tube, further procedures, and possibly hospital admission
Cartilage grafts	We discussed that with placement of cartilage there are always several risks, namely rejection of cartilage, warping of cartilage, chondritis, infection of cartilage, and graft rejection
General risks	We discussed the risks of rhinoplasty including asymmetric healing, scarring, bleeding, septal hematoma, septal perforation, saddle nose, infection, damage to surrounding structures, need for future surgeries, need for revision, unsatisfactory results, cosmetic changes, and unsatisfactory cosmetic results
Counseling	In our counseling, we reviewed that the goal with surgery is an improvement and not perfection. We answered the patient's questions regarding healing, including that the patient may have some ecchymosis and mild pain in the immediate postoperative period. All preoperative questions were answered, and a thorough discussion took place about the postoperative course, realistic expectations, and that much time is taken for the nose and face to heal following surgery, which may take up to 3 y. The patient realized the impossibility of creating perfection and realized asymmetries were inevitable because of natural nasal contour irregularities and because the nose is 3-dimensional. The national average need for a revision due to healing, scarring, or other factors is about

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Table 3
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Complication	Discussed Material
	22%. We discussed that *no* nose heals perfectly, and there is nothing we can do to control this. We told the patient that we will only do what is safe and natural. The patient understands
Revision policy	Patient understands revision policy. If a revision is necessary and/or desired, there will be additional fees and charges to be paid by the patient. The patient has read and understands this
Thick skin	The patient does have thick skin, so this may be a limiting factor for her in terms of how small we can get the nose
Nasal tip	We discussed that patient's tip will drop after surgery. We discussed that since we expect a slight drop after surgery, we will overrotate the nasal tip during surgery to account for this. We made clear that this is an unpredictable process, and the tip may remain overrotated, or in some cases drop lower. Our goal will be to optimize rotation, so that once the patient is healed, the tip will be where the patient desires
Pinched nose	We specifically discussed with the patient that we will not attempt any maneuvers that may jeopardize patient's airway and/or breathing. We also discussed that the "pinched" or "defined" look is not normal anatomy. We specifically emphasized to the patient that we will not do any maneuvers that will pinch his tip. We made this clear to the patient multiple times. We emphasized to the patient the impossibility of creating perfection and that asymmetries are inevitable because of natural nasal contour irregularities and because the nose is 3-dimensional. We made clear multiple times that we will not make the tip more "pinched." In fact, we discussed that we will likely widen the tip to improve the airway
Dorsal profile	Esthetically, patient desires a very refined, pointed nose with a steep slope—"ski slope." We discussed that we need to balance a natural look with a safe surgery that will not worsen her breathing. We discussed that aggressive hump reduction has the potential for an increased nasal obstruction and cosmetic deformities (eg, inverted-V deformity). We will do our best to balance a natural esthetic with optimal function. Patient understands this
Alar base modification	We specifically discussed the risk of scarring and hyperpigmentation with this maneuver. We discussed the risk of asymmetries
PDS plate	We discussed the risks of PDS plate including scarring, extrusion, need for removal, implant rejection, and nasal obstruction
Auricular cartilage	We discussed that there is a small possibility we may need to use ear cartilage to achieve the desired surgical goals. This may incur additional surgical time and cost. This involves a postauricular incision. We will use cartilage from the bowl of the ear. Healing will involve a cotton bolster ball in the ear. Taking cartilage from here may result in the ear becoming less prominent, which is why we use the more prominent ear for grafting.

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Table 3
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Complication	Discussed Material
Latera implant	Risks, benefits, and indications discussed. Risks include abscess, implant protrusion, facial pain/discomfort, and failure to absorb. Treatment of these complications include antibiotics, steroid injections, and even removal of implant
Rhinoplasty video	Patient did review Dr Nassif's video on rhinoplasty complications, expected postoperative healing/course, and need for 3 y for full healing

times, the balance has shifted between which technique predominates. I have always been enamored with the simplicity and minimal invasiveness of endonasal rhinoplasty, as I think there are fewer risks of various healing complications—and I subscribe to Bobby Simons' thinking that it should be termed "endonasal rhinoplasty" rather than "closed rhinoplasty," since the word "closed" connotes a lack of visibility, and the reality is that with endonasal rhinoplasty, the surgeon is afforded excellent visualization of the important structures. On the other hand, I have also always been enamored with the precision, beauty, and outstanding results that so many external rhinoplasty teachers and leaders promoted and demonstrated. I have tried to emulate surgery from the masters of both endonasal and external rhinoplasty schools and have found that in the right patient, and with the right technical maneuvers, both surgical approaches allow for outstanding results. Over the past 2+ years, I have continued to favor endonasal approaches to rhinoplasty, and I incorporate the many lessons of external structural rhinoplasty to the endonasal approach.[59] The "Cottle rhinoplasty technique," which in the most recent 5 years has been categorized as a "preservation rhinoplasty" technique, is originally an endonasal operation that combines the most important aspects of functional rhinological surgery with modifications to nasal shape. I continue to perform this operation through the endonasal approach primarily, and I predict that over the next 5 to 10 years, there will be a significant shift toward more frequent use of endonasal rhinoplasty and likely also more Cottle and other preservation techniques. It seems to me that the minimally invasive nature of the operation, and the application of fundamental rhinological and structural grafting principles, allows for reduced complications and faster healing.

Sykes

As surgeons gain more experience, their clinical recognition of and suspicion for possible complications increase. If conditions exist preoperatively that increase the risk of perioperative infection postrhinoplasty, a protocol should exist to minimize the incidence of infection and/or skin compromise. This may consist of the following interventions:

- Perioperative oral antibiotics
- Perioperative topical antibiotics (ointment)
- Perioperative hyperbaric oxygen treatments
- Intraoperative antibiotic irrigations

SUMMARY

The following descriptions summarize common rhinoplasty complications.

Asymmetries and Irregularities

It is critical to perform careful preoperative nasal analysis to note and discuss existing baseline asymmetries and irregularities. Patients are often hypercritical in analyzing their noses postoperatively, so they may notice and be bothered by a pre-existing asymmetry that they had not previously noted. The surgeon should have a very detailed discussion with their patient about which of these imperfections can and will be modified intraoperatively and which cannot be altered. Examples include hemifacial microsomia and differences in alar base height, midface projection, and eyebrow position and height. Additionally, there may be inherent differences in the underlying bony and cartilaginous framework. For example, nasal bones may be oblique or vertical, there may be asymmetric prominence or configuration of cartilages. The baseline imperfections are often more extreme with revision rhinoplasty. We always counsel our patients that asymmetries, contour irregularities, and imperfections will persist postoperatively.

To minimize the appearance of any contour irregularities, we take care intraoperatively to smooth out apparent irregularities of the underlying bony and cartilaginous framework. Unless a patient has extremely thick nasal skin, most irregularities that are visible in the framework will also be visible percutaneously once the nasal skin envelope swelling subsides. We routinely use DCGGs to

create smooth contours and to decrease the chance of visible irregularities.

Overcorrection and Undercorrection

The preoperative consultation is key in defining the esthetic goals of surgery. The authors routinely create simulations of patient photos while their patients are present to show the proposed changes are. The authors also create a nasal diagram that specifies surgical maneuvers and highlights exact location of planned cartilaginous grafts that is reviewed with each patient preoperatively. These steps provide patients with an opportunity to evaluate proposed changes and to work together with the surgeon so that the final goals and vision of reconstruction are aligned. A PowerPoint slideshow is created for each patient, which includes preoperative photos of the nose from all views and the computer-morphed images; the slideshow is displayed on a screen intraoperatively. On the operative bed, photos are then taken prior to incision and at the conclusion of the case (before extubating). The on-the-table result is carefully analyzed by the surgeon to confirm that the desired result was achieved. If any modification is made, a new set of photos is taken and again critically analyzed prior to the conclusion of the surgery. The authors note that these additional steps have decreased the rate of revision surgery and has led to increased patient satisfaction.

Bleeding

Bleeding is a common complication during rhinoplasty. Excessive bleeding particularly from osteotomy sites or along the maxillary crest can lead to septal hematoma, pollybeak deformity, and excessive ecchymosis of the soft tissues. Preoperative administration of tranexemic acid is safe and may decrease bleeding, edema, and ecchymosis in patients undergoing rhinoplasty.[1] Meticulous hemostasis intraoperatively is important to minimize the chance of hematoma formation. If a small perforation is not created accidentally while elevating the mucoperichodrial flaps during the septoplasty, then it is recommended to create a small opening in one of the flaps to ensure there is a path of egress for any blood that may be accumulated between the flaps. Also, temporary application of manual pressure over the osteotomy sites may prevent significant ecchymosis and edema at the osteotomy sites.

Infection

See "Question 1: Infections? How to Diagnose and Treat Them?" section.

Poor Wound Healing and Skin Compromise or Necrosis

Poor wound healing may result due to preexisting conditions, technical error, and/or complications that arise during surgery. Control of comorbidities preoperatively can significantly decrease the likelihood of skin compromise after rhinoplasty. Patients with a history of nicotine use should be counseled on the additional risk this carries for wound breakdown and skin necrosis. Smokers are instructed to avoid all nicotine-containing products (including gum and patches) at least 6 weeks prior to surgery and continue to abstain perioperatively and postoperatively. The authors routinely perform urine nicotine testing preoperatively to confirm patient adherence to protocol. Diabetic patients should optimize their blood glucose prior to proceeding with rhinoplasty, as elevated blood glucose levels can increase the chance of poor wound healing and infection.

Care must be taken to carefully reapproximate tissue during closure to minimize the chance of widened scar or dehiscence. Dehiscence along suture lines may increase the chance of postoperative infection. Patients with a history of multiple prior nasal surgeries or previous dermal filler injections to the nose should be counseled regarding potential for postoperative complications. Preoperative hyperbaric oxygen therapy should be considered in smokers and those with a history of prior skin compromise.

The risk of skin compromise or, in extreme cases, skin necrosis is significantly higher in revision rhinoplasty surgery. This is due to decreased blood supply to the nasal tip, potential prior defatting of the skin envelope, possible prior infections, and scar tissue.

Nasal Airway Obstruction

Every patient should be evaluated for nasal airway obstruction preoperatively. If present, it is important to assess and understand the contributing factors including external nasal valve collapse, internal nasal valve collapse, and nasal septal deviation. As part of the preoperative discussion with patients, we often highlight the general principle that aggressive reduction rhinoplasty (in an effort to create a smaller nose) may destabilize major and minor tip support structures. Aggressive reduction rhinoplasty often leads to nasal airway obstruction in the postoperative period, sometimes progressing years after the surgery. As such, we maintain structural rhinoplasty principles.

CLINICS CARE POINTS

- Aside from meticulous surgical technique and planning, the best way to prevent complications is to counsel patients on pre-operative and post-operative expectations.
- When compliations arise, frequent follow up is recommended.

DISCLOSURE

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