Functional Nasal Surgery in a Compromised Soft Tissue Envelope

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Abstract

Functional nasal surgery in the setting of a compromised soft tissue envelope (STE) requires significant planning and preparation. Proper preoperative evaluation is imperative to assess the degree of STE compromise and determine the best surgical approach. Alternative approaches to functional nasal surgery, such as limited access surgical approaches, should be considered to minimize complications while achieving functional improvement. Given the increased risk of ischemia and necrosis in individuals with a history of a compromised STE, a comprehensive postoperative treatment algorithm is necessary to identify and treat signs of early vascular compromise.

Keywords

- nasal soft tissue envelope
- compromised soft tissue envelope
- functional nasal surgery
- vascular compromise
- necrosis

With the majority of rhinoplasty surgeons focused on the management of the osseocartilaginous framework, the nasal soft tissue envelope (STE) is often secondary in functional nasal surgery. This is reasonable as most articles in functional nasal surgery focus on surgical maneuvers and techniques of the underlying structural framework. The STE is often described as a mere covering or a drape over the anatomical framework. This theory is known as the surgical drape philosophy, which most rhinoplasty surgeons have adopted.[1] This universally accepted idea becomes challenged in individuals with a compromised nasal STE.

The nasal STE is composed of skin, subcutaneous fat, and muscle with the overlying superficial musculoaponeurotic system (SMAS). These layers vary in thickness and quality based on age, gender, ethnicity, and prior injury or surgery. Healthy nasal skin is freely mobile from the underlying osseocartilaginous architecture.[2] The extensive network of blood vessels from the internal and external carotid arteries makes the nasal STE resilient to injury. In this article, we describe our systematic approach both inside and outside of the operating room for those with a compromised STE undergoing functional nasal surgery.

Preoperative Assessment of Compromised Soft Tissue Envelope

Assessment of the nasal skin and soft tissue requires a clear understanding of its anatomy. A healthy nasal STE covers the underlying osseocartilaginous framework with the SMAS layer over a mobile glide plane. Evaluation of tissue mobility over the framework is the initial assessment of STE injury. A skin pinch test at multiple locations on the nose to assess thickness and pliability of the tissue provides guidance to its health especially after previous injury. ►**Table 1** provides an overview of our classification system of nasal STE injury based on etiology and clinical findings. This can be utilized as a guide when approaching challenging cases of nasal STE compromise.

The impact of previous surgery of the STE is dependent upon whether the SMAS plane was respected or whether the SMAS layer was resected. Both sub-SMAS plane of dissection and supra-SMAS (subcutaneous) plane of dissection pose mild injury and risk to the STE. Likewise, local and regional flap surgery replacing soft tissue defects with like tissue is also considered a mild form of STE injury. For example, SMAS

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Table 1 Classification of nasal soft tissue (STE) injury based on etiology and clinical findings

Severity	Mild	Moderate	Severe
Etiology	• Previous nasal surgery respecting sub-SMAS dissection.	• Skin graft • Radiation • SMAS resection during nasal surgery	• Secondary healing of a defect, ischemia due to intravascular filler injection, burn or laser injury • Infected nasal implant or congenital sinus tract
Clinical findings	• Well-healed surgical scar • Minimal telangiectasia • Good mobility of STE over bone and cartilage	• Thinning or depression compared to surrounding STE • Significant telangiectasia • Limited mobility of STE over bone/cartilage	• STE immobile and fixed to the underlying osseocartilaginous framework • Contracture of STE causing distortion of the osseocartilaginous framework

(*Continued*)

and skin defects can be replaced with a superior extended nasal myocutaneous island (SENMI) flap maintaining a healthy STE[3] (►**Fig. 1**).

Moderate STE injury would include destruction of tissue planes such as SMAS resection in rhinoplasty. Reconstruction of skin and muscle defects with a skin-only flap would represent the moderate category of injury. Similarly, reconstruction of skin defects with skin grafts creates significant SMAS scarring and contracture with decreased vascularity of tissue.

Prior radiation to the nose results in extensive skin and soft tissue changes from microvascular injury.[4] The nasal STE 1 year after radiation typically appears atrophic, hypopigmented, and telangiectatic. This represents a moderate form of STE injury (►**Fig. 2**).

Severe nasal STE compromise is caused by secondary intention healing following full-thickness tissue injury. Such examples include flap ischemia and necrosis, filler vascular occlusion and tissue necrosis, and burn or laser injury (►**Fig. 3**).

Assessment of low-grade or subclinical infection in a compromised nasal STE is critical. It can result from a congenital sinus tract or an infected nasal implant. Signs of infection are erythema, warmth, and pain. However, subclinical infection signs can present only with occasional bad odor and recurrent crusting representing minimal purulent drainage. After the resolution of these infections, scarring and contracture of STE pose a significant risk to subsequent nasal surgery (►**Fig. 4**).

Preoperative Management of Soft Tissue Envelope

For individuals with a compromised nasal STE, the timing of functional nasal surgery after the original injury requires

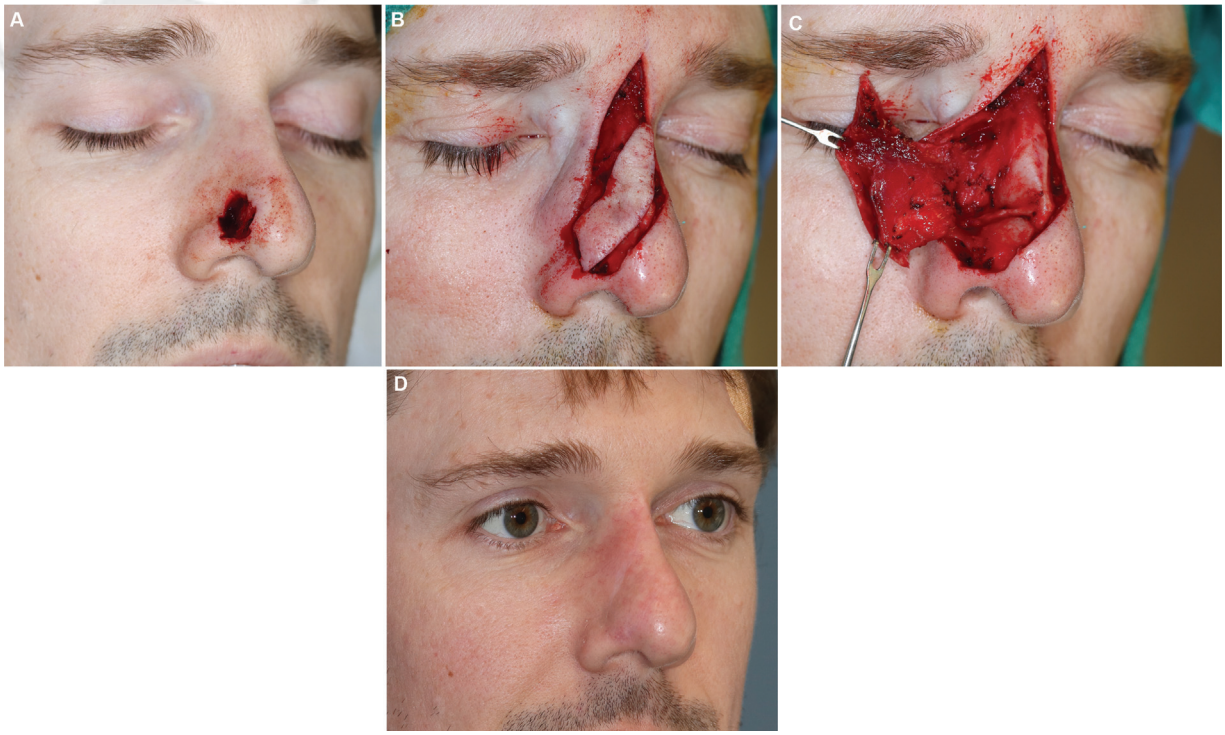

Fig. 1 Construction of the SENMI flap. (**A**) 1.3 × 1.3 cm partial thickness defect on nasal tip and ala. (**B**) Flap mobility. (**C**) Pedicled flap viewed laterally. (**D**) Final aesthetic outcome 7 months postoperatively after two stages. SENMI, superior extended nasal myocutaneous island.

Fig. 2 Postradiation changes of the nasal soft tissue envelope representing moderate STE injury.

Fig. 3 Severe STE injury following ablative laser resurfacing of a previously operated nose (5 months).

Fig. 4 Infected allograft (irradiated rib cartilage) 9 month postoperative with subclinical signs of infection—minimal bloody purulence expressed through a sinus tract

allowing enough time for recovery. The traditional school of thought of waiting 1 year for the maturation of scar tissue is not necessary in most cases depending on the degree of soft tissue compromise. For mild cases, the senior author (S.M.) has found success in performing functional nasal surgery at about 3 months following flap reconstruction. This approach is typically via an external localized approach through a prior external incision or by more limited intranasal approach. For moderate and severe cases of soft tissue compromise or if the classic external rhinoplasty approach is required, delaying surgical management 6 months to 1 year is appropriate.

Preoperative management techniques are useful to prepare the STE for surgery including massage, stretching, triamcinolone and 5-fluorouracil injection, silicone sheeting, and isotretinoin. Massage and stretching helps to physically break down scar tissue and increase the mobility of the skin STE. This is typically introduced 3 to 6 weeks following the initial STE injury and encouraged for up to 3 months. Triamcinolone and 5-fluorouracil injections can be injected as early as 6 weeks and typically require one to three injections spaced monthly for an optimal breakdown of scar tissue. Silicone sheeting is typically introduced at 3 weeks and continued daily up to 2 to 3 months. Silicone sheeting acts as an occlusive dressing, which reduces scar evaporative and thermal loss thus decreasing inflammation. Although not typically used in our practice, some providers describe using oral isotretinoin for acne and selected patients with thick sebaceous skin and followed up closely with monthly laboratory testing including pregnancy tests.[2]

Surgical management of postradiation STE is based on the two factors—acute inflammation and chronic atrophy and scarring. We believe that surgical management after radiation can resume 6 months after completion of radiation when the acute radiation inflammation resolves. Some breast cancer surgeons use the 3-month point after radiation if acute inflammation has resolved in order to expedite reconstruction.[5] The literature on the subject is almost exclusively limited to breast cancer reconstruction.

The only other consideration of postradiation nasal surgery is ruling out residual cancer. This is particularly relevant in the setting of compromised STE due to postradiation ischemia. Ischemic injury and postradiation necrosis of the nose are sources of cancer recurrence until proven otherwise.

Intraoperative Management of Compromised Soft Tissue Envelope

Functional nasal surgery in individuals with a compromised STE requires the least invasive surgical approach that accomplishes the desired functional improvement. We have summarized the approaches in ►**Table 2**.

Avoiding the compromised STE altogether with intranasal access to the airway would be the preferred approach if possible. Traditional septoplasty with a caudal septal incision is the time-proven classic. The surgeon still must be mindful of the potential loading force on the septum with a severely contracted skin STE. Incisions in the septum can unmask this

Table 2 Summary of functional nasal surgical approaches from least invasive to most invasive

Types of nasal surgery
• Intranasal classic approach—septoplasty, caudal approach. • Intranasal localized approach—composite grafts, alar battens, lateral crural strut graft. • External rhinoplasty classic approach—structural grafting. • External localized approach—ala debulking, flap scar incisions, vertical transcolumellar. • Flap surgery to add tissue—internal or external.

force as the surgeon sees the dorsum collapse and the cut edges of the septal cartilage telescope onto themselves.

Alternatively, the intranasal localized approach to the nasal valve with a composite ear graft can be a more predictable procedure. Placement of the graft in the lateral wall of the nasal vestibule is highly reliable as long as basic principles are followed (►**Fig. 5**).[6]

A localized internal approach with batten grafts placed from the piriform aperture to the nasal tip can be placed either under the lateral crura or over it via an incision in the lateral nasal vestibule. Because of the length and the rigidity of the batten graft required in this application, rib cartilage graft is needed.

The classic external rhinoplasty approach offers the surgeon the greatest opportunity for addressing structural and soft tissue problems. But, it poses the greatest risk in the setting of a compromised STE.[7] Flap ischemia reported in those settings can be avoided with meticulous sub-SMAS dissection. In these cases, the tissue planes are obliterated with scars leading the surgeon into the dangerous subcutaneous plane. A combination of blade dissection and microsnip scissor dissection is required to avoid that complication. But once elevated, functional nasal surgery with structural graft rhinoplasty provides the most versatility. The larger reconstructed nasal structure does not just stretch a tight skin envelope but recruits elastic skin from surrounding cheeks and glabella. On the contrary, stretching the elevated columella and infratip skin with grafts must be balanced with the assessment of the skin flap vascularity.

The localized external rhinoplasty approach can provide a limited but targeted correction of the nasal airway and shape. Soft tissue debulking of a flap used previously to reconstruct a soft tissue defect is one common example. The culprit may be the flap pedicle (SENMI) or the flap bulk due to the muscle and subcutaneous layers (forehead flap). Either can weigh down the nasal valve compressing the airway. Areas of the lateral nasal tip or ala can be approached directly through an external incision in a previous scar or via an incision in the nasal alar groove. After the flap is debulked, the dermis can be tacked down to the underlying scar with deep sutures or with transmucosal percutaneous buried sutures. This brings the skin and the nasal valve in close apposition limiting blood collection under the debulked flap.

Incisions in the previously operated nasal ala pose a unique risk of ischemia. The authors have experienced localized ischemic tissue loss, particularly with internal sutures tacking the skin to the deep scar. The random blood supply to the edge of the skin flap, especially across an old scar, can be limited in the nasal ala (►**Fig. 6**).

Another localized external approach is the underutilized vertical columellar incision extending to the infratip. Originally described for cleft lip rhinoplasties, the incision exposes the domes of the alar cartilages and can be used to access the caudal septum as well.[8]

The prerequisite for successful airway correction is the internal nasal lining. Severe contracture must be addressed first, whether with composite cartilage grafts, mucosal grafts, or even flaps to expand the internal lining (►**Fig. 7**).

Fig. 5 Correction of nasal ala retraction. (**A**) Patient with moderate alar retraction following nasal ala and sidewall reconstruction with bilobed flap by another surgeon. (**B**) Large composite graft inserted between marginal incision via perichondral underlay technique. (**C**) Final aesthetic outcome 6 weeks after surgery.

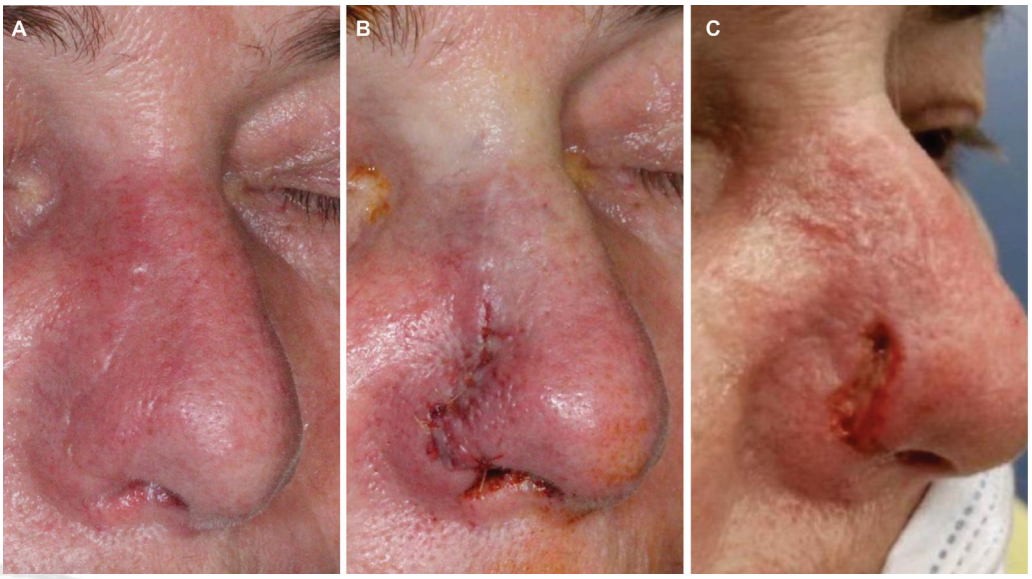

Fig. 6 Localized external approach with limited incision resulting in skin edge ischemia of the nasal ala. (**A**) A 59 year old woman 2 months after an SENMI flap with auricular cartilage grafts. (**B**) Immediate postoperative evidence of ischemia after subcutaneous undermining and flap debulking, (**C**) After scab debridement 1 week postoperative.

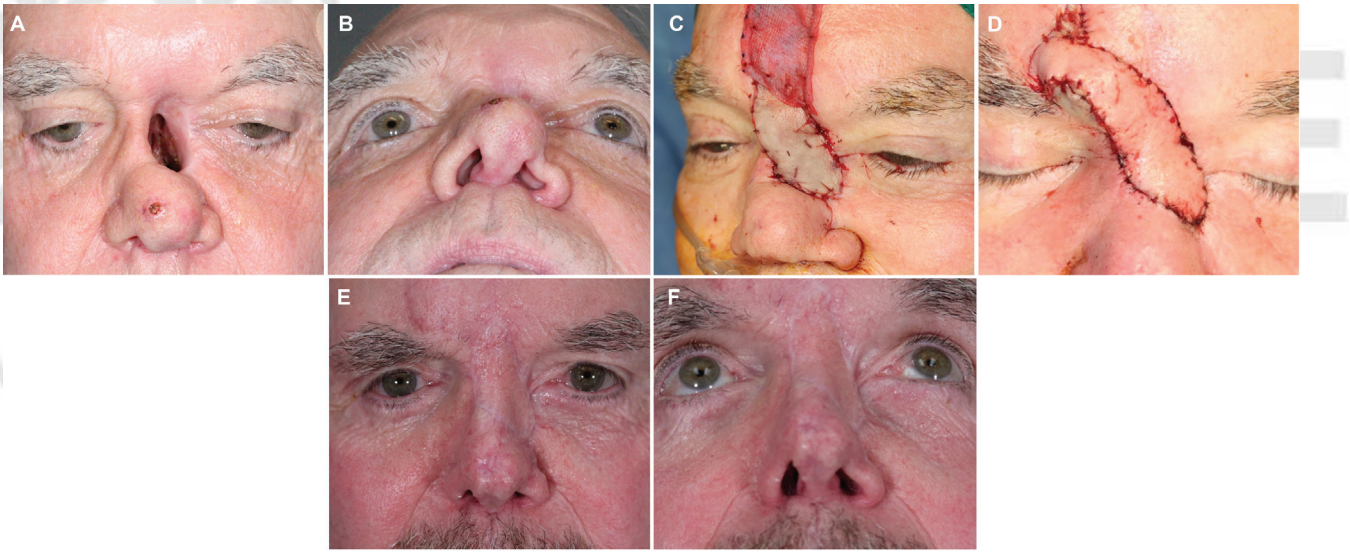

Fig. 7 Internal nasal lining defect with full thickness contracture. (**A**) 71 year old man with full thickness nasal defect 10 months after resection and radiation of deeply invasive SCC. (**B**) Severe nasal valve collapse due to intranasal lining contracture. (**C**) Reconstruction of internal nasal lining with central forehead flap. Forehead skin serves as the new nasal lining, while a skin graft covers the raw portion of the flap. (**D**) Right paramedian forehead flap for replacing of the skin graft and structural reconstruction with rib cartilage grafts 2 months later. (**E, F**) After several stages, 1 year after the initial stage.

Early Postoperative Management of Compromised Soft Tissue Envelope

Functional nasal surgery in the setting of a compromised STE places individuals at an increased risk for postoperative ischemia and necrosis. Treatment of the postoperative compromised STE is time sensitive and requires early identification. For this reason, a comprehensive treatment algorithm is important to minimize unwanted consequences.[9] Treatment interventions are typically reserved for individuals with obvious signs or symptoms of vascular compromise given the risk of medication side effects and the time and emotional burden placed on the patient. Early signs of vascular compromise are well studied and include findings such as delayed capillary refill (>2 s), mottled, pale or violaceous skin color, tense or edematous STE, poor bleeding, or dark blood color with pinprick.[7] These signs of skin compromise can be seen as early as the closing of the columellar incision. Increased tension at the time of skin closure can disrupt the blood flow and result in signs of ischemia. Mechanisms of vascular compromise include increased adrenergic input causing vasoconstriction, venous stasis, decreased arterial blood flow, and decreased tissue oxygenation.[10,11]

Once skin compromise has been recognized, the first line of treatment involves placing a thin layer of low-dose topical nitroglycerin (2%) to the region of concern. This treatment is applied twice per day for a total of 5 days. Nitroglycerin is a vasoactive drug that relaxes smooth muscle in peripheral arteries and veins. A proposed mechanism for skin compromise includes venous dilation and preferential dilatation of spastic vessels within ischemic tissue. Together this helps to increase blood flow to the region of ischemia along with relieving venous congestion.[10] Patients are counseled about the potential side effects including site irritation, erythema, edema, papules, and dermal thickening. Although uncommon, there is a risk of severe headache and systemic hypotension, which should be discussed with each patient. Overall, this medication is well tolerated and is a great first-line treatment for vascular compromise.[9]

Prophylactic antibiotics are prescribed at the earliest sign of vascular compromise. Cefadroxil (1 g daily for 7 days) is a broad-spectrum antibiotic of the cephalosporin type with similar coverage to cephalexin with decreased dosing frequency. This is the drug of choice for the senior author (S.M.) for all postoperative nasal surgery.

For individuals with more extensive signs of vascular compromise or significant systemic risk factors (i.e., nicotine use, diabetes mellitus, and granulomatosis with polyangiitis, also known as Wegner's granulomatosis), hyperbaric oxygen (HBO) is the next line of treatment. Despite limited clinical evidence specifically in rhinoplasty patients, there is extensive literature to support its benefits in the salvage of compromised grafts and flaps. HBO between 2.0 and 2.5 atm increases the likelihood of composite graft survival, improves skin graft outcomes, and enhances flap survival. Proposed mechanisms include increased oxygenation, improved fibroblast function, neovascularization, and amelioration ischemia-perfusion injury.[12]

Some additional treatments not utilized by the senior author (S.M.) that have been described in the early management of a compromised STE are low-dose aspirin and leech therapy. Although there is limited evidence for low-dose aspirin, some authors advocate for 81 mg aspirin to reduce the risk of clot formation in a setting of venous stasis. For these individuals, antacid medication is concurrently prescribed to reduce the risk of peptic bleeding or ulcer formation. Leech therapy has a long history of successful outcomes in the setting of microvascular flaps throughout the body.[13] Leeches improve venous congestion by secreting factors that interfere with the coagulation cascade and platelet aggregation. The main risks of leech therapy are bleeding and infection with *Aeromonas hydrophilia*, which can be prevented with the use of prophylactic antibiotics.[14]

Conclusion

In summary, it is crucial for the functional nasal surgeon to evaluate the severity of soft tissue injury to minimize postoperative complications. A more limited surgical approach in the setting of a compromised STE is important to consider as this can provide adequate functional improvement with reduced risk of unwanted consequences. With an increased risk of additional STE compromise in the postoperative period, it is imperative for the rhinoplasty surgeon to follow a comprehensive treatment algorithm to ensure optimal results.

Author Contribution
B.S.D. and S.M. was responsible for lead conceptualization, resources, writing-original draft, and writing-reviewing and editing.

Conflict of Interest
None declared.

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