Simultaneous Septal Perforation Repair with Septorhinoplasty: A 31-Year Experience

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A nasal septal perforation (NSP) is a hole in three distinct layers composed of right and left mucoperichondrial flaps and the intervening cartilage¹ (► Fig. 1). Posterior NSPs are usually asymptomatic. Small NSPs may cause nasal whistling. Anterior and large perforations can create turbulent airflow that disrupts localized heat and moisture exchange, may decrease olfaction, usually desiccate nasal mucosa, and often cause a sensation of obstruction in the absence of physical obstruction.¹⁻³ Over time, the dried mucosa around the perforation periphery becomes scarred and dysfunctional, provoking crust formation and epistaxis, and may progress to chondritis and incremental mucosal necrosis.⁴⁻⁵

Abstract

Septal perforation repair and septorhinoplasty (SRP) each present unique surgical challenges. However, in many instances, these procedures may be performed together successfully. In this study, the authors aim to determine the safety and effectiveness of combining primary or revision SRP and septal perforation repair via an open approach. A retrospective review was carried out of all consecutive patients who had SRP and septal perforation repair via an open approach between 1986 and 2017 in the senior author’s practice. Perforation closure in surgery and at the patient’s last follow-up, resolution of presenting symptoms, cosmetic results, and complications were analyzed. Records for 141 patients who had simultaneous septal perforation repair and SRP via an open approach, with a mean follow-up of 3.24 years, were reviewed. The mean anterior–posterior perforation dimension was 1.41 ± 0.89 cm, and the mean vertical perforation dimension was 1.16 ± 0.59 cm. The most common etiologies for septal perforation were previous SRP (35.4%) and septoplasty (24.1%). An overall 93.6%, perforation closure, 91.1% symptom relief, and 91.2% patient satisfaction with cosmetic results were achieved. Septal perforations under 1.5 cm in height were closed in 96.7% of patients as opposed to 71.4% of patients with perforations 1.5 cm or taller. Minor revision rhinoplasties were performed in 7.0% of patients. Postoperative infections were rare and noted in only two (1.4%) patients. In the largest study of its kind to date, the authors have shown that in experienced hands septal perforation repair may be performed simultaneously with primary or revision SRP via an open approach without compromising the perforation repair outcome. The vertical dimension of a septal perforation and presence of mucosa above and below a perforation are important considerations for the difficulty of a perforation closure, as septal mucosa is recruited from these locations in our technique of four-quadrant intranasal bipedicled mucosal advancement flap closure.

Keywords

► nasal septum
► rhinoplasty
► septoplasty
► nasal reconstruction
► advancement flap

A nasal septal perforation (NSP) is a hole in three distinct layers composed of right and left mucoperichondrial flaps and the intervening cartilage¹ (► Fig. 1). Posterior NSPs are usually asymptomatic. Small NSPs may cause nasal whistling. Anterior and large perforations can create turbulent airflow that disrupts localized heat and moisture exchange, may decrease olfaction, usually desiccate nasal mucosa, and often cause a sensation of obstruction in the absence of physical obstruction.¹⁻³ Over time, the dried mucosa around the perforation periphery becomes scarred and dysfunctional, provoking crust formation and epistaxis, and may progress to chondritis and incremental mucosal necrosis.⁴⁻⁵
Surgical repair of an NSP can be tedious and complicated, and requires operating within the narrow confines of the nasal cavity without inadvertently enlarging the perforation. Consequently, NSP repair is a challenging procedure that many surgeons avoid because available methods are technically demanding and require considerable training. Numerous NSP repair techniques have been described, but the techniques that have the best physiologic outcomes, success rates, and long-term patient acceptance incorporate intranasal mucosal advancement flaps with an interposition connective tissue graft.

An open rhinoplasty approach provides the necessary exposure for an NSP repair. Although septorhinoplasty (SRP) can be a challenging operation due to the considerable variance in the configuration, size, strength, and thickness of the nasal skin, cartilages, and bones between individuals, SRP can be performed simultaneously with NSP repair via an open approach. While the NSP closure should remain a surgeon’s priority, SRP modifications may be attempted secondarily, without compromising the NSP repair.

In this study, we review the senior author’s (R.W.H.K.) experience in performing simultaneous NSP repair and SRP via an open approach in 180 consecutive cases over a 31-year period.

Methods

A retrospective review was conducted on all consecutive patients who had NSP repair with primary or revision SRP via an open approach in the senior author’s (R.W.H.K.) private practice between 1986 and 2017.

Surgical Technique

Bilateral marginal incisions joined to an “inverted-V” transcolumnellar incision and elevation of the nasal skin envelope over the nasal framework provides the initial exposure. Dissection through the soft tissue between the medial crura allows access to the caudal septum, where mucoperichondrial flaps are elevated bilaterally. The dissection continues along the dorsal septum to enable submucosal sharp detachment of the upper lateral cartilages (ULCs) from the dorsal septum while maintaining the septal flap attachments on the underside of the ULCs (Fig. 2). The mucosa around a perforation tends to be adherent, especially if septal cartilage had been previously resected. Therefore, it is crucial to elevate and separate the mucosal flaps circumferentially around an NSP before entering the perforation, to avoid enlarging it. Inferiorly, the NSP is approached via retrograde dissection from the nasal floor toward the maxillary crest. Where the vomer meets the maxillary crest, branches of the sphenopalatine arteries emanate from the septal flaps can be seen entering the incisive foramina on both sides of the crest to supply the anterior palate in the oral cavity (Fig. 3). These vessels are consistently identified during nasal floor mucosa elevation and need to be cauterized to mobilize the mucosal advancements flaps fully. Mucoperichondrial elevation continues posteriorly until normal residual septum is encountered, which may be far posterior. Residual septal or maxillary crest obstructions can be addressed at this time.

Because there is no elastic tissue within the septal mucosa, adequate septal flap mobilization is imperative for a tension-free closure. Four-quadrant intranasal bipedicled mucosal advancement flaps are recruited from the nasal floor and ULCs to close an NSP. The nasal floor mucosa is elevated laterally to below insertion of the inferior turbinate. A lengthwise incision of the mucosa along the lateral nasal wall, together with anterior and posterior back cuts, releases the flap for medial advancement. Care is taken to avoid injury to the nasolacrimal duct or inadvertent entry into the maxillary sinus (Fig. 4). Superiorly, mucosa is teased away from the underside of the dorsal ULCs and nasal bones. No incisions are placed in the superiorly based mucosal advancement flaps to maximize blood supply (Fig. 5).
The right and left septal flaps are repaired individually using simple interrupted 5–0 plain suture in a posterior to anterior manner (►Fig. 6). For larger perforations or when the mucosa is friable, 4–0 chromic suture is used. Suture pack foil is placed between the septal flaps temporarily to prevent the suture needle from catching the contralateral flap during the repair.

A connective tissue graft is placed between the repaired septal flaps and sutured to the anterior septum. We prefer human acellular dermal grafts (AlloDerm, Life-Cell Corp.), which have similar success as autologous connective tissue grafts and are easier to manipulate and suture without the added operative time or morbidity of harvesting autologous grafts. A connective tissue interposition graft is necessary for consistent successful perforation closure for several reasons. First, it forms a barrier between the corresponding mucosal flap closures during the healing period, decreasing the risk of reperforation. Second, it serves as a structural framework for cellular and vascular ingrowth that can nourish the septal flaps. Third, the tissue graft provides a matrix for epithelial migration when mucosal edges are not fully apposed or when contraction pulls the edges apart during the healing period (►Fig. 7).1,6,13,14

Advancement and closure of the mucosal flaps can exert tension on the ULCs and medial crura, which may rotate the nasal tip. If the patient has a ptotic tip, this sequela may improve the aesthetic outcome. However, if the patient already has an over-rotated nose, it may be necessary to counteract these changes with cartilage grafts, such as extended spreader grafts sewn to the medial crura. (►Fig. 8) Dissociation of the lower lateral cartilages (LLCs) and ULCs by excising the scroll may decrease the amount of distortion that the pull on the ULCs transmits to the LLCs. Scroll excision is often combined with a cephalic trim of the lateral crura, which narrows the supratip lobule, but can also lead to tip rotation. Pulling the caudal septal mucosa anteroinferiorly and securing it with an absorbable transmucosal mattress suture through the medial crura anterior to the caudal septum may reduce rotation and...
columellar retraction. If significant rotation persists despite the maneuvers discussed earlier, lateral crural repositioning may be necessary.

Because of the vertical tension of the perforation closure, downward traction on the ULC can cause an unnatural "pinched" appearance at the dorsum after surgery. A temporary suture securing the ULCs to the dorsal septum at an appropriate height prevents excessive downward pull on the ULCs as the septal flaps are sewn together. A continuous quilting 4–0 Chromic suture, placed above and below the NSP repair, reapproximates the septal flaps, secures the interposition graft in place, and reinforces the NSP closure. This stitch is brought no further than the most caudal extent of the septum to permit further nasal tip modifications.

SRP can now be performed, without compromising the integrity of the NSP repair. Dorsal hump reduction and osteotomies are accomplished before reattaching the ULCs to the dorsal septum. A large dorsal hump reduction can be beneficial for the NSP repair because by reducing the central bony and cartilaginous dorsum and preserving the height of the ULCs, the ULCs can be reattached to a now lowered dorsum, which decreases the tension on the NSP closure. Patients who have had previous nasal surgery may have deficient caudal septums, which become evident as empty space is encountered when dissecting between the medial crura. This finding is often accompanied by weak tip support, which is further destabilized by the dissection through the fibrous attachments of the medial crura and caudal septum necessary to expose and repair the NSP. Patients with an NSP

![Fig. 5 Illustration demonstrating the recruitment of mucosa from the underside of the upper lateral cartilage.](Image)

![Fig. 6 (a) Endoscopic image in the left nasal cavity showing the placement of a temporary intermediary foil placed between the septal flaps to prevent the needle from inadvertently capturing the contralateral septal flap during flap suture closure.](Image)
will often not have sufficient residual septal cartilage for grafting and require non-nasal sources of cartilage, such as costal cartilage. Spreader grafts are imperative to prevent internal valve collapse. A columellar strut is often necessary to augment tip support. If the caudal septum is deficient or absent, a caudal septal replacement graft can be used instead. Depending on the particular cosmetic and functional needs of the patient, additional grafting can be performed at this time (►Fig. 9).

Bilateral thin, transparent, and pliable Silastic (Dow Corning) sheets are secured to the anterior septum to protect the NSP repair from inadvertent injury from suctioning and from drying out during the healing period. The Silastic allows for direct visualization of the repair site postoperatively (►Fig. 10). Strips of gelatin are packed along the exposed areas of the nasal floor and lateral nasal wall under the inferior turbinates to minimize bleeding and provide moisture that expedites healing. A light nonadhesive internal dressing covered with antibiotic cream is placed in both nostrils and removed the following day. A routine external nasal splint is used. The splint and transcolumellar sutures are removed on postoperative day 5 to 7.

Surgical antibiotic prophylaxis begins one day before surgery and continues for seven more days. Frequent saline drops and ointment applications keep the nasal passages...
moist until the perforation heals. Patients are regularly seen for monitoring of the NSP closure and suctioning. The Silastic sheets are removed two weeks after surgery, but are well tolerated and can be left in longer if necessary.

Results

A total of 180 patients had concomitant NSP repair and SRP via an open approach between 1986 and 2017; of this group, records for 141 were located. The average age was 39.5 years (14–70 years). The mean and median length of follow-up was 3.24 and 1.08 years, respectively. Approximately two-thirds of the patients were female (Table 1).

The most common NSP etiologies were previous SRP (35.4%) and previous septoplasty (24.1%). Patients with NSPs secondary to SRP had on average 1.94/1.23 previous SRPs (range 1–7). Other etiologies included midface trauma (11.8%), cocaine (9.0%), digital trauma (4.2%), topical decongestant overuse (4.2%), infection (2.8%), transsphenoidal hypophysectomy (1.4%), orthognathic surgery (1.4%), cautery (1.4%), and autoimmune disease (0.7%). The etiology was unclear in 3.7% of patients. While only one patient with NSP due to previous SRP presented to us after an unsuccessful NSP repair, five patients with NSPs from previous septoplasties presented to us after unsuccessful repair attempts elsewhere.

A majority of patients presented with nasal obstruction (74.0%). Approximately half the patients reported crusting (52.0%) and epistaxis (49.2%). Those with smaller perforations experienced nasal whistling (25.0%). Twenty-eight (19.8%) patients had dorsal saddling of varying degrees.

The mean anterior–posterior (AP) perforation dimension was 1.41 ± 0.89 cm (0.15–3.5 cm) and the mean vertical

Fig. 9 Intraoperative photographs demonstrating reconstructive rhinoplasty grafting using (a) an interdigitating dorsal augmentation graft with a caudal septal replacement graft, (b) an auricular composite graft, and (c) a tip graft. (©Russell W.H. Kridel, MD. Used with permission.)

Fig. 10 Bilateral thin, transparent, and pliable Silastic (Dow Corning) sheets are sutured to the anterior septum using nonabsorbable sutures to protect the nasal septal perforation repair from inadvertent injury from suctioning and from drying out during the healing period and permits direct visualization of the repair site postoperatively. The Silastic sheets are removed 2 weeks after surgery, but are well tolerated and may be left in longer to promote healing if necessary. (©Russell W.H. Kridel, MD. Used with permission.)
perforation dimension was 1.16 ± 0.59 cm (0.13–3 cm). The mean perforation surface area was 1.95 ± 1.67 cm². Most (95.6%) patients had a single perforation, six patients (4.3%) had two perforations, and one patient (0.7%) had four small perforations. Additional physical findings included septal deviation (58.5%), internal nasal valve collapse (57.1%), weak tip support (55.2%), external nasal deviation (37.6%), dorsal hump (26.7%), dorsal saddling (19.8%), dorsal irregularities (16.8%), intranasal synechiae or adhesions (19.6%), broad nasal tip (10.7%), alar notching (9.1%), columellar retraction (4.2%), retrusive caudal septum (3.5%), and Polly beak deformity (2.8%). Patients with NSPs following previous SRPs had statistically significant fewer dorsal humps (p = 0.003) and more alar notching (p = 0.029), loss of tip support (p = 0.041), dorsal irregularities (p < 0.0001), intranasal synechiae (p = 0.0002), and caudal septum insufficiency (p = 0.0008) than patients with NSPs due to other etiologies, which contributed to the difficulty of their revision SRPs (∼Table 2).

With the utilization of four-quadrant intranasal bipedicled mucosal advancement flaps with an interposition connective tissue graft, 119 (84.4%) NSPs were fully closed at the time of surgery. Of this group, 4 (3.3%) patients reperforated at a later date. Although 22 (15.6%) NSPs could not be fully closed during surgery, 14 (64%) NSP repairs continued to heal over the interposition grafts and became fully closed by the patients’ final visit. After a single repair attempt, 129 (91.5%) perforations were completely closed at the patients’ last clinical visit.

Reperforations were detected in 12 (8.5%) patients at a mean 6.25 years after surgery (range 3 months to 15 years). In all cases, the perforations were made smaller. In six patients, the NSP surface areas decreased by an average of 92.1% from before surgery, and the patients’ symptoms either resolved or improved substantially enough such that further surgery was unnecessary. Four patients underwent a second perforation repair, of which three were successful, yielding an overall closure rate of 93.6%. Two patients that reperforated had NSPs due to previous septoplasty. Each of the patients also had two prior failed perforation repair attempts before presenting to us, resulting in extensive scarring and unfavorable, devascularized surgical beds. No further repair attempts were made following their third unsuccessful NSP repair with us. One patient developed a methicillin-resistant Staphylococcus aureus (MRSA) infection that required long-term intravenous antibiotics, and her NSP recurred despite a second repair attempt (∼Table 3).

Long-term successful closure was achieved in 97% of NSPs under 1.5 cm and 83.0% of NSPs 1.5 cm or greater in the AP dimension, and 96.7% of NSPs under 1.5 cm and 71.4% of NSPs 1.5 cm or greater in the vertical dimension. Statistically significant differences in septal perforation dimensions were noted for both AP and vertical dimensions when comparing the patients with successful closure to those who reperforated (∼Table 4).

All patients had domal suturing to refine and strengthen the nasal tip, improve symmetry, and prevent tip bossae. Cephalic trims (70.1%) were performed to refine the nasal tip and dissociate the ULCs from the LLCs by excising the scroll region but were often unnecessary in patients who already had cephalic trims from previous surgery. More than half (58.6%) of the patients had a clinically significant septal deviation that warranted correction. Columellar struts (52.4%), caudal septal replacement grafts (13.5%), and total septal replacement grafts (0.7%) were employed to provide

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**Table 1** Patient demographics

<table>
<thead>
<tr>
<th>Patient Demographics</th>
<th>n (%)</th>
<th>n (%)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total patients</td>
<td>141</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age, y</td>
<td>Mean 39.5 ± 11.9</td>
<td>Range 14–70</td>
<td></td>
</tr>
<tr>
<td>Gender, n (%)</td>
<td>Male 46 (32.6%)</td>
<td>Female 95 (67.4%)</td>
<td></td>
</tr>
<tr>
<td>Ethnicity, n (%)</td>
<td>Caucasian 114 (80.8%)</td>
<td>Hispanic 16 (11.3%)</td>
<td></td>
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<tr>
<td></td>
<td>Middle Eastern 8 (5.7%)</td>
<td>Asian-American 2 (1.4%)</td>
<td></td>
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<tr>
<td></td>
<td>African-American 1 (0.7%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Length of follow-up</td>
<td>Mean 3.24 ± 4.38 years</td>
<td>Median 1.08 years</td>
<td>Range 1 week–27 years</td>
</tr>
</tbody>
</table>

**Table 2** Comparison of presenting physical findings between patients with nasal septal perforations due to previous septorhinoplasty and all other etiologies

<table>
<thead>
<tr>
<th>Physical findings</th>
<th>Previous Septorhinoplasty (n)</th>
<th>All other etiologies (n)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deviated nasal septum</td>
<td>33 (66%)</td>
<td>48 (53%)</td>
<td>0.137</td>
</tr>
<tr>
<td>Internal valve collapse</td>
<td>29 (58%)</td>
<td>50 (55%)</td>
<td>0.732</td>
</tr>
<tr>
<td>Weak tip support</td>
<td>33 (66%)</td>
<td>44 (48%)</td>
<td>0.041</td>
</tr>
<tr>
<td>Nasal asymmetry</td>
<td>22 (44%)</td>
<td>31 (34%)</td>
<td>0.242</td>
</tr>
<tr>
<td>Dorsal hump</td>
<td>6 (12%)</td>
<td>32 (35%)</td>
<td>0.003</td>
</tr>
<tr>
<td>Dorsal saddling</td>
<td>6 (12%)</td>
<td>22 (24%)</td>
<td>0.088</td>
</tr>
<tr>
<td>Dorsal irregularities</td>
<td>17 (34%)</td>
<td>6 (7%)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Intranasal synechiae</td>
<td>18 (36%)</td>
<td>9 (10%)</td>
<td>0.0002</td>
</tr>
<tr>
<td>Bulbous nasal tip</td>
<td>7 (14%)</td>
<td>9 (10%)</td>
<td>0.478</td>
</tr>
<tr>
<td>Alar notching</td>
<td>8 (16%)</td>
<td>5 (5%)</td>
<td>0.029</td>
</tr>
<tr>
<td>Columellar retraction</td>
<td>2 (4%)</td>
<td>4 (4%)</td>
<td>1.000</td>
</tr>
<tr>
<td>Pollybeak deformity</td>
<td>3 (6%)</td>
<td>1 (1%)</td>
<td>0.085</td>
</tr>
<tr>
<td>Absent or retractive caudal septum</td>
<td>6 (12%)</td>
<td>0 (0%)</td>
<td>0.0008</td>
</tr>
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</table>

Note: p < 0.05 considered statistically significant.
additional tip support or to supplement a retractive caudal septum. Spreader and extended spreader grafts (48.4%) were used to augment the internal nasal valve, add symmetry to the midvault, and lengthen the overshortened nose. Common rhinoplasty modifications included dorsal reduction (33.0%), osteotomies (20.3%), dorsal onlay (57.6%), and dorsal augmentation grafts (20%). Other procedures included the tongue-in-groove technique, rim grafts, alar batten grafts, lateral crural strut grafts, lateral and medial crural overlays, composite auricular grafts, plumping grafts, tip grafts, radix grafts, and alar base reductions.

An overall symptom relief of 91.1% was observed. Nasal obstruction improved significantly in 92.6% of patients. Epistaxis and crusting resolved in 98.5% of patients. One patient developed an intranasal MRSA infection that required long-term antibiotics, and one had a septal abscess that did not result in reperforation. Five patients (3.5%), all of whom were stage IV according to the revision rhinoplasty grading system as described by the senior author (R.W.H.K.),15 presented with such severe nasal deformities before their surgery with us that the need for additional surgery was anticipated. The revision rhinoplasty grading system prognosticates the difficulty of a revision rhinoplasty depending on the presenting nasal deformities, the number and source of cartilaginous grafts required for nasal reconstruction, and the number of previous surgeries. Together, these considerations provide a stage I through IV designation, with a stage I patient requiring only minor rhinoplasty modifications and a stage IV patient needing major, and possibly staged, reconstruction. For example, two of these five patients had previous nasal silicone filler injection that resulted in significant nasal deformities that could not be remedied by surgery alone. We believe the fact that these five patients required additional major rhinoplasty for cosmetic and functional deficits was reflective of their challenging reconstructive needs rather than shortcomings of combining SRP with NSP repair. It is also important to note that the NSP remained successfully closed in all five patients. Minor revision rhinoplasty was performed for 7.0% of patients to address dorsal irregularities or trim cartilage grafts. Overall, 91.2% of patients were satisfied with their nasal appearance after their simultaneous NSP repair with SRP, based on in-office questioning at their last follow-up visit (►Figs. 11–14).

**Discussion**

In the largest study of its kind, we have shown that NSP repair and both primary and revision SRP can be combined safely and effectively via an open approach in 141 patients over
31 years without compromising NSP closure. We observed an overall 93.6% closure rate, 91.1% symptom relief, and 91.2% cosmetic result satisfaction (► Table 5). No major revision rhinoplasty attributable to compromised SRP by combining SRP with NSP repair was noted, and only 7.0% of patients required minor revision rhinoplasty. We have also shown that the height of an NSP, as opposed to its length, is a more significant determinant of NSP repair success when using intranasal bipedicled mucosal advancement flaps for NSP closure.

We find it concerning that 62.4% of our patients had NSPs attributable to iatrogenic causes. Repair of septal flap tears at the time of the original surgery can prevent iatrogenic NSPs when it is easier to repair than at a later date. When corresponding bilateral septal flap perforations are encountered, the chance of developing a postoperative NSP may be further minimized with the placement of an interposed connective tissue graft, in addition to closure of the tear.

Adequate exposure and room to work are paramount for septal perforation repair. Fairbanks\textsuperscript{11,16} described an endonasal approach to correct small perforation and occasionally used an alar crease rhinotomy to improve exposure for larger perforations, which may leave the patient with a visible scar. While effective, this method is technically challenging, inadequately addresses more posterior perforations, and is limited by the nostril aperture, especially in patients who have had a previous alar base reduction. Pedroza reported a 21% conversion rate from an endonasal to an open approach when repairing NSPs.\textsuperscript{6} Ribeiro and da Silva\textsuperscript{7} reported an impressive 99.6% overall perforation closure rate using bilateral pedicled mucosa advancement flaps with an interposition graft via an endonasal approach. However, Ribeiro and da Silva admit that the perforation closure might be challenging for those without the appropriate fine instruments and unfortunately do not disclose the perforation dimensions of their NSP repair cohort, which may provide more information regarding the difficulty of their NSP repairs.

Endoscopic NSP repair has been described in small studies with success ranging from 75–100\%\textsuperscript{17} While feasible, the endoscopic technique can be time consuming for an already challenging surgery, and the endoscope may be unwieldy for work on the anterior septum. Although we employ diagnostic

Fig. 11 A 28-year-old man with a nasal septal perforation secondary to midface trauma who had previously had a 2.8-cm septal perforation repair elsewhere. The perforation recurred 3 years later and enlarged further. The patient presented to us for a second opinion after his original surgeon recommended a radial forearm free flap for closure of his reperforation. On presentation he reported significant nasal obstruction and crusting. In addition to a septal perforation that measured 3.5 cm (anterior-posterior) by 2 cm (vertical), he had a markedly deviated nose and ptotic nasal tip, septal deviation, internal valve collapse, and bilateral inferior turbinate hypertrophy. He underwent septorhinoplasty with irradiated costal cartilage and revision nasal septal perforation repair using bipedicled mucosal advancement flaps repaired over an interposed AlloDerm graft. The septal flaps were each repaired individually. The left septal perforation was closed entirely, but on the right there was a small area of exposed AlloDerm where the perforation could not be closed fully. For the patient’s septorhinoplasty, dorsal reduction, septrhoplasty, lateral crural overlay, osteotomies, and domal suturing were performed. The patient recovered well and the septal flaps healed over the interposition graft within one month for a successful complete perforation closure. (A,C,E) Before surgery. (B,D,F) One month after surgery. (©Russell W.H. Kridel, MD. Used with permission.)
nasal endoscopy routinely as part of our NSP repairs, we prefer the binocular exposure and working space provided with an open approach and ability to use both hands to operate rather than having one hand occupied by an endoscope.

The open rhinoplasty approach provides excellent exposure and a field without distortion that endonasal retraction creates, permitting maneuvers that would otherwise be difficult or impossible to perform endonasally. By avoiding a hemi or full transfixion incision, the open approach preserves the anterior columellar lymphovascular supply to the septal mucoperichondrial flaps and may improve flap viability. In the previously operated nose where the caudal septum may have been resected and the tissue planes obliterated, the open approach provides direct access to the dorsal septum, which is usually unaltered, facilitating elevation of the already friable mucosal flaps without further enlarging the perforation. Furthermore, sufficient exposure is required to adequately dissect free the delicate mucosa from the underside of the ULCs, which may be technically challenging to perform endonasally. The one major drawback to an open approach is the separation of the medial crura from the caudal septum, a major tip support mechanism. It is, therefore, compulsory that the surgeon re-establish tip support after the perforation repair. The small transcolumnellar incision is not an issue when closed meticulously, does not compromise perfusion to the mucosal advancement flaps, and provides excellent exposure and access to all structures and the perforation.

The goals of NSP surgery should include the restoration of normal nasal function by restoring laminar airflow, warming and humidification of inspired air, mucus production, and mucociliary transport. Bilateral tension-free mucosal closure with physiological nasal mucosa is the key to successful NSP closure and symptom improvement.\(^1,5,6,14\) We have shown that when the perforation is fully closed at the time of surgery, 96.7% of the NSP repairs remained successfully closed, regardless of the original NSP dimensions. Split-thickness skin grafts,\(^18\) tunneled sublabial mucosal flaps,\(^19\) pedicled facial artery musculomucosal flaps,\(^20\) pericranial flaps,\(^21\) and radial forearm free flaps\(^22\) have been described in detail for NSP closure. The one commonality among these

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**Fig. 12** A 38-year-old woman who developed a septal perforation following intranasal trauma sustained while attempting to trim her nasal hair, exacerbated by a history of habitual Oxymetazoline nasal spray use. She presented to us after a total of eight previous unsuccessful septal perforation repair attempts that have included a J-flap advancement and placement of AlloDerm or temporalis fascia without mucosal advancement flaps on multiple separate occasions with splinting of the septum. She reported nasal whistling, crusting, epistaxis, and nasal obstruction. On examination, she had a 1 cm (anterior–posterior) by 0.6 cm (vertical) septal perforation, under-rotated nasal tip, internal valve collapse, and overly resected inferior turbinates. Although the septal perforation was small, the patient’s significantly scarred and attenuated septal mucosa made for a very challenging dissection. She underwent a septorhinoplasty with irradiated costal cartilage and revision nasal septal perforation repair using bipedicled intranasal mucosal advancement flaps repaired over an interposed AlloDerm graft. The perforation was fully closed bilaterally with minimal tension. For her septorhinoplasty, cephalic trim, dorsal hump reduction, spreader graft placement, and domal suturing were performed. (a, c) Before surgery, (b, d) 20 months after surgery. Endoscopic images of the septum from the right (e) before surgery and (f) 20 months after surgery. (©Russell W.H. Kridel, MD. Used with permission.)
A 55-year-old man with a history of multiple nasal fractures who developed nasal collapse and septal perforation following a septorhinoplasty and inferior turbinate reduction performed elsewhere, where his recovery course was complicated by columellar cellulitis. He reported whistling on inspiration, nasal crusting, and bilateral significant nasal obstruction on presentation. The patient underwent revision rhinoplasty with lysis of intranasal synechiae and nasal septal perforation repair using bipedicled intranasal mucosal advancement flaps closed primarily over an interposed AlloDerm graft. The perforation was fully closed bilaterally with minimal tension. His nasal reconstruction required the usage of caudal septal replacement, dorsal augmentation, tip and rim grafts carved from irradiated costal cartilage and an auricular composite graft. (a, c, e) Before surgery (b, d, f) At 26 months after surgery, when the patient had also recently undergone full face CO2 laser skin resurfacing. Preoperative endoscopic image demonstrating (g) a septal perforation with significant scar tissue deposition as seen on the right and (i) synechiae formation between the septum, middle turbinate, and lateral nasal wall on the left. Endoscopic imaging showing successful correction of (h) the septal perforation as seen from the right and (j) the middle turbinate synechiae at 26 months after surgery. (©Russell W.H. Kridel, MD. Used with permission.)
procedures is the closure of an NSP with nonphysiological tissue. Techniques that do not restore ciliated pseudostratified columnar epithelium to the perforation repair site will leave patients with a dry nose that continues to crust and bleed.  

Although the pedicled inferior turbinate flap provides nasal mucosal coverage, its utility is restricted by its limited reach and size, need for a second stage to divide its pedicle, and unilateral coverage. Kim and Rhee found in a systematic review of NSP closure that bilateral mucosal coverage showed statistically significant higher rates of closure success than unilateral coverage alone (84.5 versus 73.4%, \( p = 0.017 \)).

Important prognostic factors for surgical success when evaluating an NSP are (1) the size of the perforation and (2) the amount of remaining mucosa above and below the perforation available for recruitment, with an emphasis on the proportion over the absolute value of these factors. For instance, a 1-cm perforation in a child may be more difficult to repair than a 2-cm perforation in an adult with a much larger nose and septum. Theoretically, a perforation can encompass almost the entire length of the septum and still be closed relatively easily as long as the vertical dimension is manageable. In this study, when stratified by vertical perforation dimension, 96.7% of NSP were successfully closed for perforations with a height of 1.5 cm or less, as opposed to 71.4% of NSPs that were than 1.5 cm or taller. The importance of the vertical dimension of NSP is not widely distinguished in other publications and can be a significant prognosticator for NSP repair success. Because perforations are often not circular, we also propose measuring perforations in both AP and vertical dimensions to provide more meaningful data. The nationally reported revision rates for primary rhinoplasty ranges from 5 to 15%, and is even higher for revision rhinoplasty. However, no article specifically discusses the revision rates for revision rhinoplasty; so, it is not possible to ascertain whether a minor or major revision was needed.

Fig. 14 A 38-year-old man who suffered from worsening nasal obstruction following septoplasty and bilateral inferior turbinate reduction elsewhere. On presentation, he was noted to have a large 1.7 cm (anterior–posterior) by 0.6 cm (vertical) septal perforation with crusting, persistent septal deviation, internal valve collapse, nasal vestibular stenosis, and a large dorsal hump. The patient underwent septorhinoplasty and nasal septal perforation repair using bipedical intranasal mucosal advancement flaps closed over an interposed AlloDerm graft. Both septal flap perforations were closed completely at the time of surgery. For his septorhinoplasty, the patient had a revision septoplasty, cephalic trims, a dorsal reduction, osteotomies, and nasal valve grafts. (a, c) Before surgery. (b, d) 27 years after surgery. (e) Endoscopic photograph of the large septal perforation as taken from the left nasal cavity, before surgery. The contralateral middle turbinate can be seen through the perforation. (f) Endoscopic photograph of the septal perforation repair site from the right at 27 years after surgery demonstrating a successful perforation repair and healthy-appearing mucosa.
in most instances.\textsuperscript{15} Reasons for revision rhinoplasty range from the small deformities that can be corrected in the office to major cosmetic and functional deficits that require multiple procedures to address. A surgeon’s true revision rate may also be confounded by the fact that patients usually return to their original surgeon for minor revisions, but will often seek a new surgeon for major revisions.\textsuperscript{32} Additional major rhinoplasty after simultaneous NSP repair and SRP was performed for five (3.5\%) of our patients, as expected according to their preoperative revision rhinoplasty staging system stage IV designations, and not due to compromised SRP as a result of combining the two procedures. Only 7.0\% of our patients required minor revisions, ranging from dorsal irregularities rasping to cartilage graft trimming.

Irreversible intranasal mucosal damage from the NSP etiology and protracted turbulent airflow likely explain the persistent symptoms experienced by 8.9\% of patients despite successful NSP repair. Interestingly, one would expect that superior and inferior mucosal advancement flaps might narrow the internal nasal valve and cause more nasal obstruction following with surgery. However, in our series, we found that with the routine use of spreader grafts, nasal obstruction improved or resolved in 92.6\% of patients.

Although rare, infection following NSP repair, particularly in patients who have compromised intranasal vascularity from previous surgery, can be devastating. Preoperative nasal saline irrigation and emollients, culture-directed antibiotics, topical mupirocin ointment or povidone-iodine solution on swabs, intraoperative sterile technique, and perioperative antibiotics are essential in minimizing unwanted infections.

A limitation of this study is the retrospective and subjective nature of the assessment of patient breathing, satisfaction with the cosmetic outcomes, and resolution of presenting symptoms. Unfortunately, validated patient questionnaires were not available and commonly employed during the 1980s and 1990s, which this review dates back to. The application of validated questionnaires would provide more objective data for future studies. Despite this, we believe valuable insight can be gleaned from our 31-year experience of the largest series of its kind to-date examining outcomes for patients undergoing simultaneous NSP repair and SRP via an open approach.

**Conclusion**

In this study, we have shown that NSP repair using four-quadrant intranasal bipedicled mucosal advancement flaps

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<td>Kridel (Present Study)</td>
<td>141</td>
<td>Bipedicled superior and inferior mucosal adv flaps with interposed graft</td>
<td>AP dimension: 1.41 ± 0.89 cm (0.15–3.5 cm) Vertical dimension: 1.16 ± 0.59 cm (0.13–3 cm)</td>
<td>3.24 ± 4.38 y</td>
<td>93.6% overall closure 96.7% closure rate for perforations &lt;1.5 cm in the vertical dimension 96.6% closure rate when both septal flaps were fully closed at the time of surgery, regardless of perforation dimension 91.1% overall symptom relief 91.2% patient satisfaction with the cosmetic result 92.6% improvement or resolution of nasal obstruction</td>
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<tr>
<td>Foda 2006\textsuperscript{33}</td>
<td>80</td>
<td>Bipedicled superior and inferior mucosal adv flaps with interposed graft</td>
<td>1–5 cm</td>
<td>Not Specified</td>
<td>90% closure in perforations &lt;3.5 cm 70% closure in perforations &gt;3.5 cm 95% patient satisfaction with the cosmetic result</td>
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<td>Hong 2016\textsuperscript{34}</td>
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<td>4.24 y</td>
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<td>&gt;1 y</td>
<td>99.6% overall closure 99.2% symptom relief 98.8% patient satisfaction with the cosmetic result</td>
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Abbreviations: Adv, advancement; AP, anterior-posterior; LOF, length of follow-up.
Simultaneous Septal Perforation Repair

Kridel, Delaney

with an interposition graft and primary or revision SRP and can be combined safely and effectively via an open approach without compromising NSP repair results. When stratified by vertical perforation dimension, 96.7% of perforations under 1.5 cm were successfully closed as opposed to 71.4% of perforations with vertical heights of 1.5 cm or greater. The vertical dimension of an NSP and presence of mucosa above and below the perforation are important considerations when determining the difficulty of an NSP repair, as septal mucosa is recruited from above and below the perforation.

References