The Principles and Practice of Endonasal Rhinoplasty

Special Topics for Clinics in Plastic Surgery Journal

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KEYWORDS

• Endonasal rhinoplasty • Closed rhinoplasty • Airway obstruction • Nasal tip graft • Spreader graft • Dorsal hump reduction • Radix graft • Supratip deformity

KEY POINTS

- Endonasal rhinoplasty, or closed rhinoplasty, aims to minimize surgical dissection, structural disequilibrium, and scar burden, thus limiting unpredictable secondary deformity.
- Endonasal rhinoplasty, or closed rhinoplasty, aims to preserve intrinsic ligamentous support throughout the nasal skeleton, thus obviating the need for techniques that reconstruct them and make the nose unnaturally rigid.
- The entire surgical plan can be constructed preoperatively and all key intraoperative decisions can be made from the nasal surface with the skin sleeve intact.
- Four anatomic variants lead to all 3 patterns of secondary deformity: nasal disproportion or imbalance, supratip deformity, and airway compromise.
- Most primary nasal deformities can be corrected with only 4 techniques: radix/dorsal grafts, tip grafts, spreader grafts, and alar wall grafts.

INTRODUCTION

Equilibrium and Balance

Regardless of preference for open or closed technique, rhinoplasty surgeons endeavor to achieve ethnically appropriate nasal balance and proportions and an open airway. Toward these goals, the surgeon's analysis and planning should lead to predictable and reproducible results with minimal risk of secondary deformity and reoperation. This mandates that the surgeon respect the dynamic equilibrium of forces within the nose and that s/he identifies and avoids pitfalls. Equilibrium is a crucial concept: preoperative nasal shape represents not a static structure but rather a dynamic sum of balanced, opposing forces within and between the nasal soft tissues and their underlying support. At the start of a rhinoplasty, the nose is equilibrated, that is, the sum of all forces equals

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Clin Plastic Surg 49 (2022) 33–47
https://doi.org/10.1016/j.cps.2021.07.004

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zero. Surgical dissection and skeletal reduction disrupt this equilibrium which, like the ripple effect of a stone thrown into a pond, induces soft tissue and skeletal changes until the nose re-establishes a net zero balance of forces. Greater dissection, particularly with wide dissection and degloving, induces greater instability, like a large boulder thrown into a pond produces large "waves" which, in the nasal sense, disrupt equilibrium in a less controllable fashion with higher risk of secondary deformity. Soft tissue scar contracture adds further unpredictability overtime despite a good result early on. Therefore, the surgeon must control the postoperative equilibrium by limiting dissection (ie, scar), by permitting soft tissue contraction only where it is most predictable (eg, over the bony and cartilaginous dorsa) and by minimizing contraction where it is less predictable (eg, the lower nasal third). In doing so, the surgeon immediately gains greater control over the postoperative result and its long-term stability. In no other esthetic surgery than in rhinoplasty is the concept "less is more" more applicable.

Visibility

Much controversy in rhinoplasty theory is centered on visibility. Residents and novice surgeons resonate with the concept that one must "see," in the traditional sense of binocular vision, the skeletal structures on which s/he is operating. Open surgery is based on the premise that "if the nasal skeleton is right, then the nose will be right," which presumes that nasal skin is an inanimate tablecloth, devoid of intrinsic contractility, passively taking on the underlying skeletal contour. If the skin acted this way (which it does not), then one might expect the risk of deformity to be more or less equivalent regardless of open or closed technique. However, the incidence of secondary deformity requiring corrective surgery after open rhinoplasty is 3 to 5 times higher as compared with closed.[1] This disparity is explained by the fact that elasticity of the skin sleeve, in concert with soft tissue scar contractility, exerts tensioning forces on the nasal skeleton and accounts for up to 50% of the final result.[2] Eliminating this variable by open dissection significantly reduces a surgeon's ability to assess nasal shape intraoperatively often leading to deformities such as low dorsum, blunt/rounded and inadequately projected tip, elevated supratip, and retracted columella and/or alar rims, despite a seemingly good result "on table." While wide undermining of soft tissues in facelifting may be well tolerated because of the rigidity of the facial skeleton, the high rate of secondary revision after open rhinoplasty tells us that wide degloving is not tolerated in the nose because of its lack of rigidity. To counteract this, open techniques that make the lower nasal cartilages more rigid have been reported.[3] On balance, the susceptibility of the nose to disequilibrating forces and scar contracture mandates leaving the skin sleeve intact as much as possible. Furthermore, by doing so, the surgeon has "true visibility" of nasal shape, just as the patient will see it, in its most equilibrated state. Paradoxically, total degloving of the nasal skeleton reduces the surgeon's visibility of the true nasal contour despite "better" visibility of underlying structures. Limited endonasal exposure is both adequate and by design: the surgeon dissects structures only to the degree that is essential, and no more, to create the desired contours at the skin surface. As nasal contour is the product of both skeletal shape and its investing soft tissues, only with the skin sleeve intact over the nasal skeleton and the functional nasal layers undisrupted can the surgeon "read" its effects and adjust for them.

ANALYSIS

Rhinoplasty as a "Right Brain" Operation

Endonasal rhinoplasty is not the same as open rhinoplasty performed through a keyhole. The mindset is different and it is a "right-brain" endeavor, that is, one in which the surgeon must translate many complex esthetic concepts into a unified vision for the end result. How to arrive at the "right" unified vision is the exercise requiring diligent study and practice particularly in identifying preoperative deficiencies (such as low radix and inadequate tip projection), which is more difficult than identifying excesses (such as dorsal hump, wide nasal base, etc.). Right brain function can be cultivated by analytical exercises and by studying silhouettes of patient profiles (**Fig. 1**).[2] This allows us to see relative excesses and deficiencies more readily.

Ethnic Variation and Patient Preference

Rhinoplasty is a challenging operation not only due to the dynamic nature of surgical changes but also because esthetic ideals are highly personal and must be ethnically appropriate. Respecting patient preference and ethnic variations is crucial (**Fig. 3**), and to apply blindly a preconceived esthetic ideal to every nose would invariably lead to unhappy patients. Just as a rigid nose is unnatural, a rigid algorithm cannot be applied to such decision-making, as these decisions are highly variable and patient-dependent.

Fig. 1. Woman with low radix, dorsal hump (*C,E*), upper/middle vault asymmetry (*A*), and inadequate tip projection (*C*) treated with endonasal rhinoplasty with dorsal/radix grafts, spreader grafts, tip grafts. Note the correction of the dorsal aesthetic lines (*B,D*) and upward rotation of the tip with dorsal resection and tip grafting (*D,F*). Silhouette analysis of the lateral preoperative (*G*) and postoperative (*H*) views demonstrate the corrections. Intraoperative views are shown in **Fig. 2.** Postoperative images demonstrate 8-month results by author (ANR).

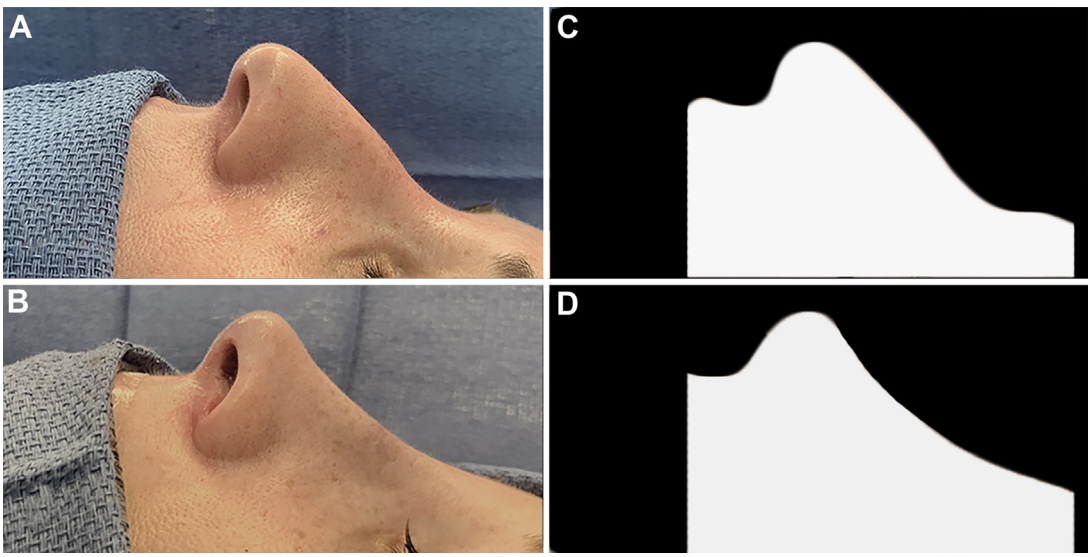

Fig. 2. "On-table" preoperative (*A*) and postoperative (*B*) nasal contours should be esthetically balanced, and contours and grafts should look and feel perfect. With the skin sleeve intact, esthetic assessment is more accurate than when a degloved skin envelope has been redraped over the nasal skeleton. Comparison of silhouettes (*C*, *D*) is instructive for training "right brain" analysis.[2] Eight-month postoperative views are shown in Fig. 2. Results by ANR.

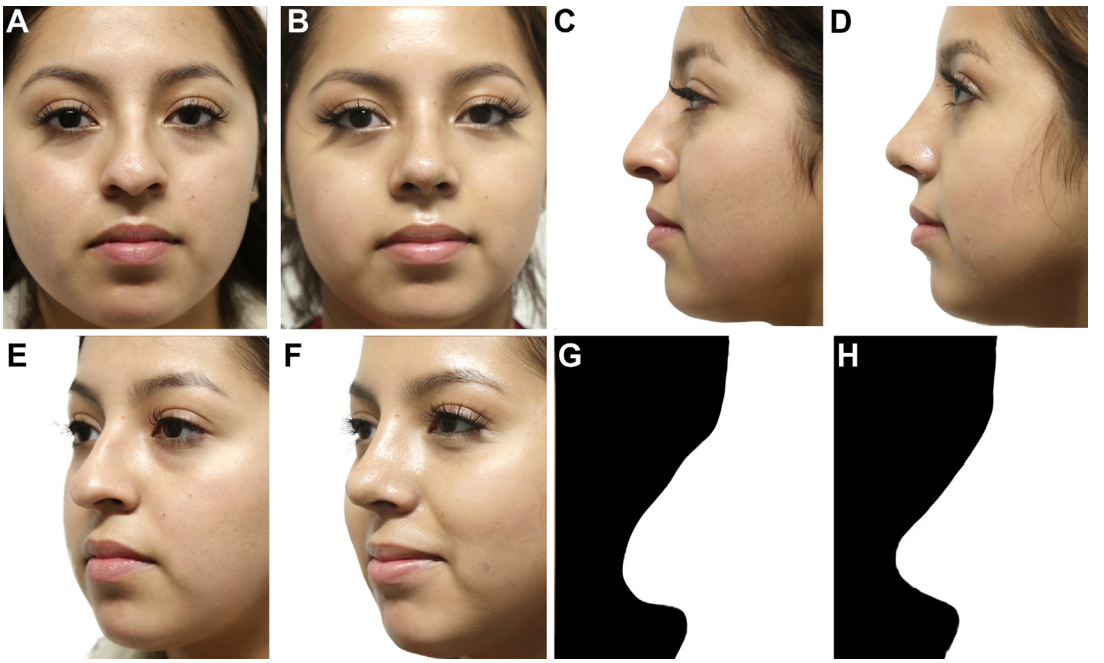

Fig. 3. Ethnic (Latina) woman with low radix, dorsal hump (*C,E*), wide/boxy tip (*A*), inadequate tip projection, alar cartilage malposition and alar rim retraction (*C,E*). Following endonasal rhinoplasty, dorsal reduction, dorsal/radix grafts, spreader grafts, and tip grafts (*B,D,F*). Nasofacial relationships are ethnically appropriate and proportionate. Silhouette analysis of the lateral preoperative (*E*) and postoperative (*F*) views demonstrate the corrections. Postoperative images demonstrate 9-month results by author (ANR).

Nasal Proportion

Nasal and nasofacial proportions entail optical illusions. For example, profile balance is highly influenced by the height (and depth) of the radix; middle vault width should balance with the upper and lower nasal thirds; alar base width should balance with other nasal and facial proportions. The neoclassical canon that the width of the alar base should equal the intercanthal width[4] does not apply to all ethnicities. Although many "ideal" angles and nasal interrelationships have been well described and their discussion is beyond the scope of this article, suffice to say that the surgeon must be able to assess when the nose "just looks right." It is the overall nasofacial proportion with ethnically appropriate balance for each patient that matters.

ANATOMY

The senior author (MBC) has previously published on a 2-layer concept of nasal anatomy. The outer layer, composed of the skin sleeve, alar cartilages, and their associated mucosal lining, dynamically slides over the inner layer composed of the bony and upper cartilaginous vaults, the nasal septum, and their associated linings. This critical anatomic relationship is disrupted as soon as the surgeon degloves the alar cartilages through a transcolumellar incision.[2]

Upper Cartilaginous Vaults

The upper cartilaginous vault is composed of the upper lateral cartilages and their intimate apposition with the dorsal septal edge. The functional importance of this anatomic area is that it comprises the internal nasal valves whose patency depends on the height and width of the middle vault roof. Resection of the middle vault roof during hump reduction destabilizes the upper lateral cartilages whose outer walls tilt medially, thus creating a characteristic "inverted V″ deformity and internal nasal valve obstruction. Middle vault collapse virtually always occurs when the cartilaginous roof has been resected more than 2 mm, whether or not osteotomy has been performed. Although obvious esthetic and functional deformity is more obvious with thin skin, a thick soft tissue envelope may mask the esthetic deformity, and a patient's complaint of breathing obstruction postoperatively maybe its only manifestation. To avoid middle vault collapse and internal valvular incompetence, the surgeon can stabilize the middle vault with spreader grafts and/or a dorsal graft, each providing the same degree of functional

mean nasal airflow improvement as documented by a level II outcome study.[5]

Middle and Lower Cartilaginous Vaults

The upper lateral cartilages articulate with the cephalic margins of the lateral crura in the scroll region. This articulation is a "watershed" area between the internal and external nasal valves, and radical surgery in this area can have problematic esthetic and functional consequences. Radical alar cartilage resection can compromise middle vault support and may leave an external deformity typified by deepening and lengthening of the alar creases. External valvular competence can be compromised particularly in patients whose lateral crura are cephalically rotated[6] (see section 4.3). However, airway support provided by an intact cartilaginous roof is more critical to airway function than support provided by the lower lateral cartilages.

Tip and Supratip

Tip shape and projection are dictated by the middle and lateral crura. True tip projection has nothing to do with the distance from alar base to tip. Tip projection is defined relative to the septal angle and is deemed "adequate" when the tip lobule extends past the anterior septal angle.[6] Dr Jack Sheen realized that true tip projection comes from within the tip, that is, intrinsic, rather than from extrinsic forces.[7] While tip suturing techniques can work in certain circumstances such as with orthotopic lateral crura, in the presence of anatomic variants suturing can create peridomal concavity, alar rim retraction, distortion of the soft triangle, or displacement of the lateral crura into the airway causing airway obstruction. Furthermore, surgical degloving of the tip complex reduces its stability, thus forcing the surgeon to rely on more complex structural methods to reestablish equilibrium and projection. However, even with restabilization, long-term stability is unpredictable. Conversely, the power of endonasal tip grafting lies in its simplicity and in the preservation of structural dome support (by avoiding excessive dissection) on which the grafts are placed. Equilibrium is minimally disturbed, thus stability is maximally preserved.

Septum and Turbinates

The septum should be assessed for deviation, buckling, fracture, and calcification due to prior trauma. Turbinates, if obstructing, may need out fracturing or conservative reduction.

FOUR ANATOMIC VARIANTS

Minimizing invasiveness is the sine qua non of the endonasal approach. In a retrospective analysis of 50 consecutive primary and 150 secondary rhinoplasty patients, 4 anatomic characteristics, specifically (1) low radix, (2) narrow middle vault, (3) alar cartilage malposition, and (4) inadequate tip projection, were identified by the senior author (MBC) as the most important anatomic findings for which surgical correction is crucial.[6] At least one of these 4 anatomic traits was present in each of the 150 secondary patients in one series, and 78% of the secondary patients and 58% of the primary patients had 3 or all 4 traits.[5] The most common grouping in both primary and secondary patients is the triad of low radix, narrow middle vault, and inadequate tip projection (40% and 28%, respectively).

Low Radix/Low Dorsum

First described by Sheen,[7] the diagnosis of a low radix is made when the visual "starting point of the profile," that is, the inflection point at which the contour changes from concave to convex, is caudal to the level of the upper lash margin with the patient's eyes in primary gaze (note that this applies to most Caucasians, but radix height needs to be balanced against nasal base size; for example, it would be lower in many Asians.) A low radix was present in 32% of primary patients and 93% of secondary patients in one series[5] and it creates an imbalance in nasal proportions where the upper nose appears too small for its nasal base. A low radix can create the appearance of a pseudohump (**Fig. 4**). If solely the dorsum is lowered, the nasal base appears disproportionately too large. In this scenario, the surgeon has 2 treatment options: either tip reduction or dorsal/radix augmentation to balance the nasal base. Tip reduction would yield suboptimal results because the skin sleeve has limited contractility. Dorsal/radix augmentation is more predictable and therefore preferable. Elevating a low radix requires less aggressive dorsal reduction which favors stability of the middle vault, tip equilibrium of internal stresses, and optimal nasal balance (**Fig. 5**). Conversely, failure to recognize the low radix or low dorsum invariably leads to deformities from imbalance, disproportion, and disequilibrium.

Narrow Middle Vault

If the middle vault width is 75% or less than that of the upper or lower nasal thirds, then a narrow middle vault is diagnosed.[5] Originally described by

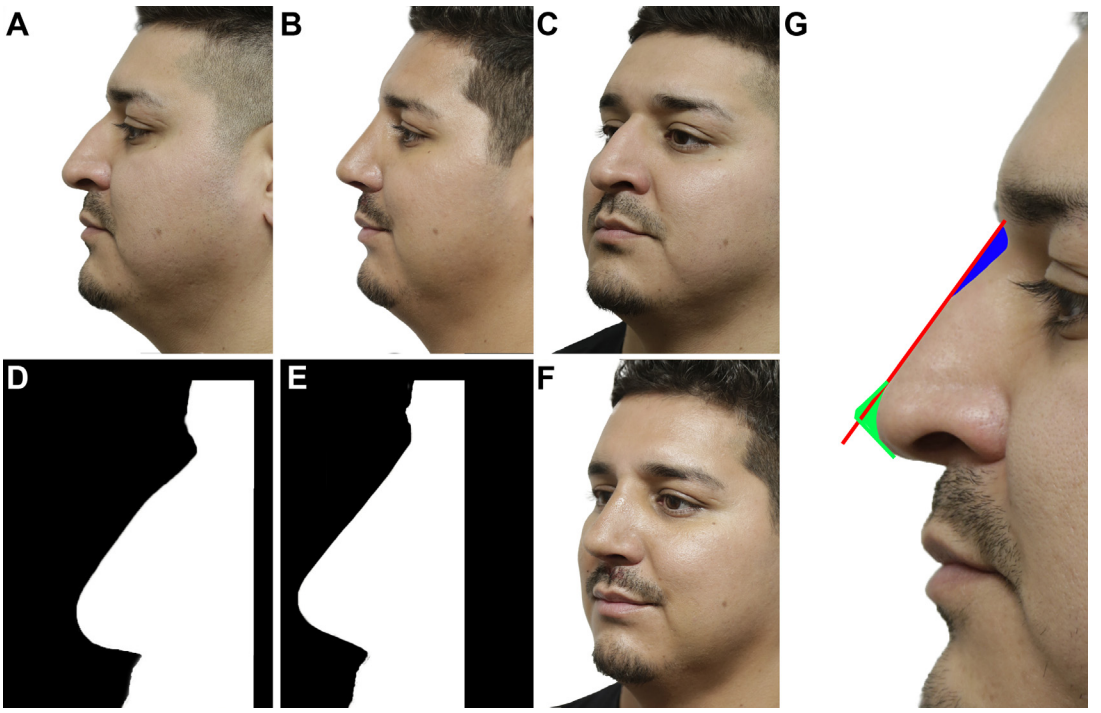

Fig. 4. Man with low radix disproportion which creates the appearance of a dorsal "pseudohump." Frontal bossing and a deep nasofrontal angle exacerbate the depth of the radix. Preoperatively (*A*, *C*), the patient also has inadequate tip projection and alar retraction. Following endonasal rhinoplasty, septoplasty, with layered septal cartilage grafts placed in the radix, conservative rasping of pseudohump (without significant reduction), dorsal and spreader grafts, tip grafts, nasal bone osteotomy and infracture (*B*, *F*). In (*G*), extension of a straight line (*red*) from supra tip to the radix demarcates the region of the radix to be grafted (*blue* filled area), and tip projection that is required (*green* filled area). Note that downward gaze lowers the lash line, which may confuse the diagnosis of low radix. Silhouette analysis of the lateral preoperative (*D*) and postoperative (*E*) lateral views demonstrates the corrections. Postoperative images demonstrate 12-month results by author (ANR).

Sheen in conjunction with short nasal bones,[6] a narrow middle vault places the patient at increased risk for internal valvular obstruction, which can exist preoperatively or may be produced by dorsal resection in the absence of spreader grafts. Surgical resection of the bilateral roofs of the upper lateral cartilages and their articulation with the anterior septal edge (as in dorsal hump reduction) leads to instability of the lateral cut edges of the upper laterals which then tilt inward, pinching the internal nasal valves, and producing a characteristic inverted "V deformity." Airflow obstruction is severe: rhinomanometric studies indicate that valvular obstruction is 4 times more common than pure septal obstruction in primary rhinoplasty patients and 12 times more common in secondary patients; reconstruction of incompetent, internal valves by dorsal or spreader graft doubles nasal airflow.[8] While "spreader flaps" have been described, that is, redundant upper lateral cartilage edges downturned into the internal valve interval and suture fixated to the septal edge, no airway measurements have yet been performed that demonstrate their functional efficacy or superiority to spreader grafts.[9]

Alar Cartilage Malposition

Alar cartilage (or lateral crural) malposition refers to cephalically rotated lateral crura whose long axes run toward the medial canthi instead of toward the lateral canthi[6] (the orthotopic configuration) (**Fig. 6**). The esthetic appearance of a tip lobule with this anatomy is a round or boxy shape and characteristic "parentheses" deformity on frontal view. Functionally, malpositioned lateral crura provide suboptimal alar support and so is a leading cause of external valvular incompetence.[5,6] First recognized by Sheen,[7] alar cartilage malposition is common and present in up to 50% of primary patients and 80% of secondary patients and has important esthetic and functional consequences if not identified and surgically corrected. Worsening of the deformity follows a predictable "ripple effect" especially when an intracartilaginous incision is made at its

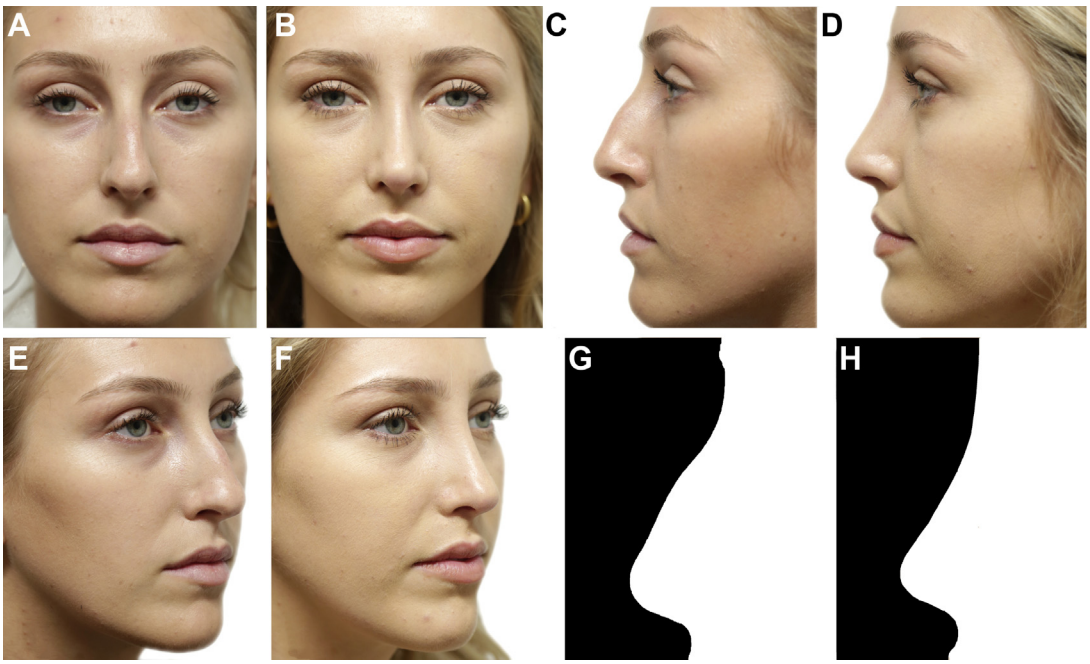

Fig. 5. Woman with subtle low radix disproportion, moderate dorsal hump, mild alar cartilage malposition, and inadequate tip projection (*A*, *C*, *E*) treated with endonasal hump reduction, radix/dorsal grafts, spreader grafts, alar wall grafts, and tip grafts, nasal bone osteotomy and infracture (*B*, *D*, *F*). Silhouette analysis of the lateral preoperative (*G*) and postoperative (*H*) views demonstrates the corrections. Postoperative images demonstrate 12-month results by author (ANR).

usual location but ends up transecting the lateral crura along its short axis, rather than reducing its cephalic margin along its long axis, possibly unbeknownst to the surgeon if s/he has not identified this deformity preoperatively. Treatment of lateral crura malposition requires either (1) resection and relocation, or (2) autogenous cartilage grafting to support the external valves.

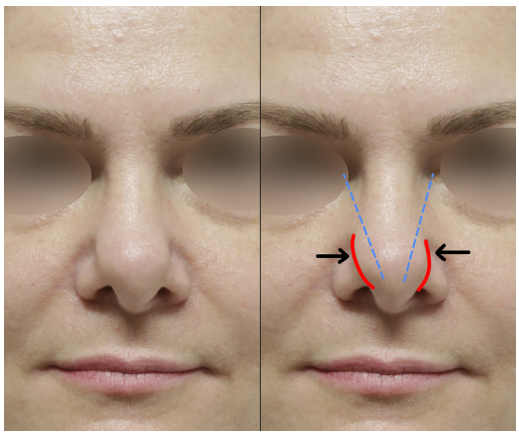

Fig. 6. Alar cartilage malposition results in "parentheses" deformity (*red lines*) and external nasal valve insufficiency/collapse (*black arrows*) due to cephalically rotated lateral crura along an axis from tip to medial canthi (*blue dotted lines*). The traditional intercartilaginous incision can result in inadvertent transection of lateral crura. External nasal valves require reinforcement with alar wall grafts.

Inadequate Tip Projection

Inadequate tip projection is present in 31% of the primary patients and 80% of the secondary patients[5] and is crucial to achieve a straight profile line. An inadequately projecting tip may exist equally with a low dorsum (**Fig. 7**) or high dorsum (**Fig. 8**), and regardless of dorsal height, a straight profile line is not possible without adequate tip projection.

Tips with inadequate "intrinsic" cartilage strength cannot project beyond the septal angle and will appear to "fall off" of the angle with a rounded or deformed supratip. And, when investing soft tissues are stripped from the middle crura, intrinsic support decreases further. Open dissection strips the middle crura of intrinsic ligamentous and cartilaginous support structures, and thus destabilizes the tip. The surgeon must therefore rely on extrinsic methods to reconstruct these structures.[3,10,11] However, these have not been shown to produce a long-term stable outcome. Alar cartilages, and their investing soft tissues, carry a

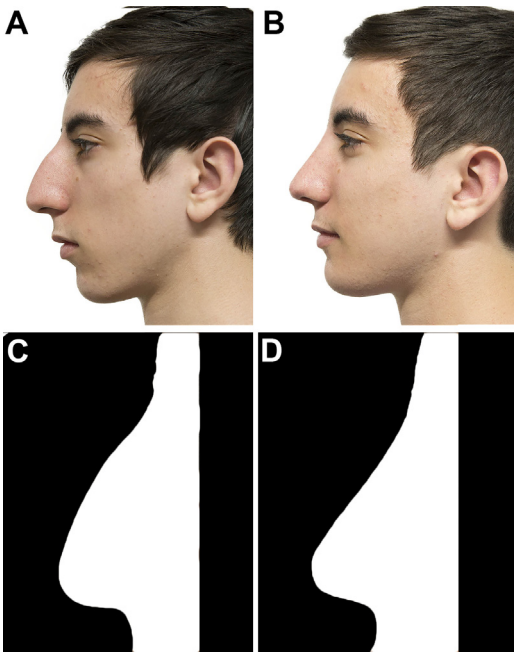

Fig. 7. Man with high dorsum, poor tip projection, and nasofacial disproportion (*A*) treated with endonasal approach, dorsal reduction, dorsal, radix and tip grafts, and chin augmentation with silicone implant (*B*). Note that dorsal reduction without tip grafting would have resulted in supratip deformity and suboptimal nasal disproportion. Silhouette analysis of the lateral preoperative (*C*) and postoperative (*D*) views demonstrates the corrections. Postoperative images demonstrate 12-month results by author (ANR).

larger responsibility for caudal nasal support than may be obvious. This becomes evident with futile attempts to reduce the dorsum/septal angle to compensate for inadequate tip projection and, predictably, the tip lobule falls with it, potentially worsening the deformity unless the middle crura are lengthened and their ligamentous attachments to themselves and to surrounding structures are preserved.

Summary

Tissue excesses are much more readily noticed than tissue deficiencies and so identification of these anatomic variants preoperatively can be difficult unless one's attention is directed specifically to look for them. These 4 anatomic deficits do not always require treatment. For example, the low radix must always be assessed relative to nasal base size: if the base is small, dorsal resection may improve optimal balance. However, the deficits do provide cautionary signs and failure to recognize them can lead to 3 patterns of secondary deformity: (1) nasal disproportion or imbalance, (2) supratip deformity (or soft tissue collapse pattern), and (3) airway compromise (or skeletal collapse pattern). Radix and dorsal grafts correct the imbalance pattern. Tip grafts correct inadequate projection and supratip deformity, which comprise the soft tissue collapse pattern. Spreader and alar wall grafts support the internal and external valves, respectively, the components of the skeletal collapse pattern. Nearly every rhinoplasty follows 1 of only 2 strategies: (1) radix, spreader, and tip grafts, or (2) dorsal and tip grafts, adding alar wall grafts for external valvular insufficiency. Because radix and dorsal grafts are the same graft in different lengths, the surgeon needs only master 4 graft types to solve almost all rhinoplasty problems. Although not easy, these 2 strategies make the operation comprehensible and manageable even for occasional nasal surgeons.

SURGICAL PLANNING AND EXECUTION

Every surgical step should be planned for a specific reason. Incisions and dissection strategies should follow from each step and the rationale for its use is irrefutable. Recognizing the 4 anatomic variants, all visible on the surface, allows the surgeon to make a diagnosis and set a surgical plan. Therefore, the entire surgical strategy can be set preoperatively and the need for dorsal, radix, alar wall, or tip grafts should be planned. The only decisions made intraoperatively are not qualitative but only quantitative, depending on graft availability and quality.

Sequence of Steps

Analysis

- Identify the 4 critical anatomic variants/traps (low radix/low dorsum, inadequate tip projection, narrow middle vault, and alar cartilage malposition)
- Evaluate not only the septum and turbinates but also the preoperative competence of the internal and external nasal valves, as well as the potential intraoperative valvular incompetence created by dorsal or alar cartilage reduction

Surgery

- Step 1: Resect deformities; create spreader graft tunnels
- Step 2: Septoplasty; turbinate modification as indicated
- Step 3: Grafts as indicated: dorsum, radix, spreader, tip, alar walls as indicated
- Step 4: Osteotomy and infracture as indicated

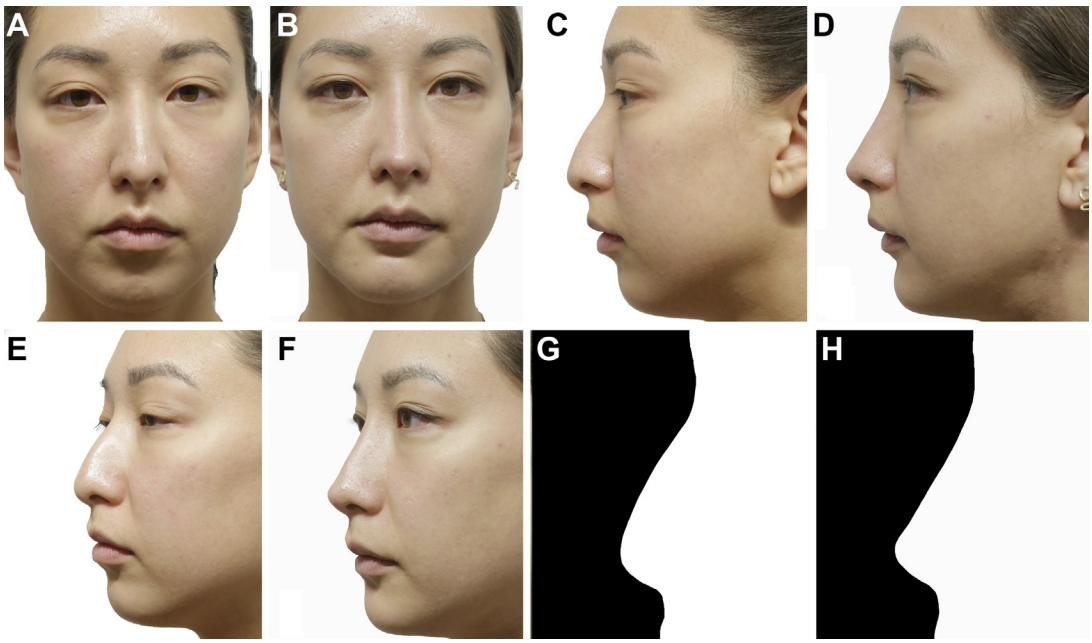

Fig. 8. Woman with low radix, dorsal pseudohump, poor tip projection, and disproportion of nose and mentum (*A*, *C*, *E*). Following endonasal approach with layered radix and tip grafts, conservative dorsal rasping, cephalic trim of alar cartilages, as well as sliding genioplasty (*B*, *D*, *F*). Note that dorsal reduction without tip grafting would have resulted in worsened nasal and nasofacial disproportion and supratip deformity. Silhouette analysis of the lateral preoperative (*G*) and postoperative (*H*) views demonstrate the corrections. Postoperative images demonstrate 10-month results by author (ANR).

Incisions

An exhaustive description of incisions is beyond the scope of this article; a summary is provided in **Table 1**.

Step 1: Resect Deformities and Create Spreader Graft Tunnels

The workhorse incision is intercartilaginous through which blunt scissor dissection gives the surgeon access to the dorsum, radix, septal angle, upper lateral cartilages, and cephalic margin of the lower lateral cartilages (**Fig. 9**). Care should be taken not to skeletonize widely the bony dorsum as this can predispose to lateral displacement of a planned dorsal graft. A Foman rasp is used to roughen the surface of the radix for better graft adherence or to deepen a high radix. Dorsal reduction is performed with rasping of the bony vault. To deepen a high radix, 4 to 6 mm straight osteotomes may be used and then rasping to smooth cut edges. Sharp resection of the cartilaginous dorsum is done with a #11 blade (the tip broken off to prevent skin injury). Once the dorsal line is set, bilateral spreader graft tunnels are created in the submucoperichondrial plane along the cut anterior septal edge using a Cottle elevator. Cephalic margins of the lateral crura are trimmed retrograde (as needed). If alar cartilage malposition was diagnosed preoperatively, the cephalically malpositioned portions of the lateral crura are resected and replaced within the alar walls at the external nasal valves. Nasal shortening via membranous and/or caudal septal resection, as well as medial footplate modification, can be made through a transfixion incision.

Step 2: Septoplasty

The Killian incision gives access for septoplasty and should be done only after dorsal and/or caudal septal resection is satisfactory. Septoplasty should be planned with a minimum 12- to 15-mm-wide contiguous L-strut with undissected mucoperichondrium attached. Bilateral mucoperichondrial flaps are elevated over the resection specimen taking particular care not to dissect lining and potentially enter the spreader graft tunnels. Accidental stripping of soft tissue between tunnels and septal flaps can cause spreader graft displacement making suture fixation necessary (and difficult). Septal cartilage is harvested in 2 strips with angled Knight septal scissors, taken across the articulation with the perpendicular plate of the ethmoid to provide the longest possible graft. Ideally, the septal fragment is harvested

Table 1
Intranasal incisions used in endonasal rhinoplasty provide direct access to target structures and are limited by design to reduce dissection and morbidity

Incision	Relative Importance/ Usefulness	Anatomical Guides	Purpose	Anatomical Structures Accessed by	Cautions
Intercartilaginous incision	****	1. Starts at the lateral aspect of the caudal ULC 2. Extends within the interval between the caudal ULC and the cephalic margin of the ULC 3. Ends at the septal angle	1. Dorsal reduction and augmentation 2. Reduction of the cephalic margin of the lateral crura of lower lateral cartilages 3. Reduction of the caudal margin of the upper lateral cartilage 4. Radix augmentation 5. Spreader graft placement	Nasal dorsum cephalic margin of the lateral crura of the LLC caudal edges of the ULC septal angle	1. Excessively cephalic incision placement can result in inadvertent intracartilaginous incision which, in the presence of alar cartilage malposition can transect the lateral crura thus worsening external valvular support (see "Four Anatomic Variants, Section 4.3")
Infracartilaginous incision	***	1. Starts approximately 2 mm cephalad from the alar margin and at the soft triangle inflection 2. Extends parallel to the alar margin 3. Ends 4–20 mm lateral (length depending on whether only tip grafting is needed or dome delivery/ECR technique is done, respectively)	1. Tip augmentation and/or modification 2. Alar rim grafts 3. External nasal valve grafts 4. Dome delivery and/or ECR technique[15,]*	1. Nasal domes 2. Alar rim 3. External nasal valve	1. *Dome delivery can cause disruption of intrinsic tip support structures and may impair efforts to augment the tip
Transfixion incision	**	1. Starts at septal angle 2. Extends parallel to the caudal septal margin 3. Ends at level of posterior septal angle	1. Reduction of membranous or caudal septum 2. ECR technique[15,]* 3. Tongue-in-groove medial crural advancement technique**	1. Membranous and cartilaginous septum 2. Septal angle 3. Columella/Medial crura of lower lateral cartilages	

Killian incision	***	1. Starts approximately 12–15 mm cephalad from, and posterior to, the caudal septal margin 2. Extends parallel to the caudal septal margin, through unilateral mucoperichondrium and septal cartilage 3. Ends at maxilla	1. Septoplasty 2. Harvest of perpendicular plate of the ethmoid	1. Access to mid-portion of cartilaginous septum, Ethmoid bone, Vomer	1. A septal cartilaginous "L-strut" must be contiguously intact and be at least 12 mm wide. 2. The mucoperichondrium overlying the L-strut must be preserved, both for stability and spreader graft tunnels
Nasal floor incision	**	1. 5 mm stab incision over pyriform aperture	1. Lateral "low to high" nasal bone osteotomy 2. Maxillary augmentation	1. Pyriform aperture/ nasal bone 2. Anterior maxilla	1. In nasal bone osteotomy, use curved guarded osteotomes 2. In maxillary augmentation, take care not to over dissect the pocket for maxillary graft

Abbreviations: ECR, endonasal complete release[15]; LLC, lower lateral cartilages; ULC, upper lateral cartilages.

* = rarely useful
** = sometimes useful
*** = very useful
**** = essential

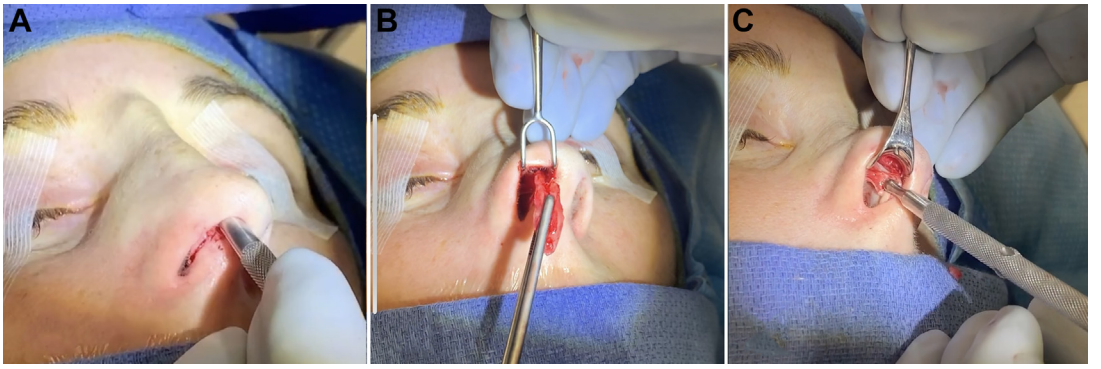

Fig. 9. Limited skeletonization of the dorsum and radix through unilateral endonasal intercartilaginous incision (*A*, tip of Freer elevator at radix), cartilaginous dorsal hump resection specimen (*B*), and bilateral spreader graft tunnels (*C*, Freer elevator inserted at septal angle and extends to mid-vault). Images by author (ANR).

with the ethmoid bone attached. Grasping the specimen at the ethmoid/cartilage articulation with a Killian septal forceps allows harvest in one long piece yielding approximately 25 to 30 mm. The posterior septal cartilage strip is done by gentle separation from the Vomerine groove using a narrow straight osteotome or periosteal elevator. Mucoperichondrial flaps are closed with mattress 4-0 Chromic. However, before complete closure, the surgeon should take inventory of the quality and quantity of graft material and determine the amount that is needed for grafting; possible excess cartilage may be banked within the septal flaps as a "back up" in case secondary rhinoplasty becomes necessary. Communicating, bilateral mucosal tears can lead to septal perforations postoperatively. However, initial practice on "straight forward" primary septorhinoplasty facilitates dexterity. Indeed, learning and becoming facile with the finesse of endonasal septoplasty reaps tremendous rewards in avoiding the vagaries of open septoplasty: disruption of critical intrinsic support structures in the middle vault and its articulations with the alar cartilages increases the chance of secondary deformity. In contrast, approaching the septum via a separate incision endonasally preserves intrinsic stability thus reducing risk.

Partial inferior turbinectomy, defined as a trim of the anterior edge sufficient to obtain 3 mm clearance to the septum or nasal floor, is valuable adjunctive airway treatment if indicated. Rhinomanometric data by the senior author (MBC) suggest that aggressive turbinate treatment is unnecessary in most patients if septal and valvular causes have been adequately relieved.[8] Turbinate outfracture may suffice in patients whose voluminous turbinates contain significant cystic bone and in whom adequate airway size can be achieved by crushing with the septal forceps and without resection. When resection is necessary, biopsy forceps allow smaller, more incremental changes than angled scissors. The raw surfaces left will contract and epithelize, further reducing the size of the remaining turbinate. Conservatism is best as over-resection is not correctible.

Step 3: Grafts

Graft material yielded from septoplasty should be inventoried, assessed for quality, and then prioritized according to need: the best pieces are reserved for radix or dorsal grafts; other grafts can be fashioned from the remaining pieces. The surgeon should endeavor for "hand in glove" fit of all grafts to avoid the need for suture fixation. Following graft placement, contours should look and feel perfect.

Spreader grafts

With dorsal reduction or preoperatively diagnosed narrow middle vault, spreader grafts are essential. Acting as spacers, spreader grafts prevent the collapse of the upper lateral cartilages onto the septum and consequent internal valve obstruction. Spreader grafts may be symmetric, whereas with septal deviation or middle vault asymmetry, one graft may need greater width and/or curvature to counterbalance the anatomic deviation. Spreader grafts are inserted into tight tunnels along the undissected dorsal septal strut. When properly performed, grafts are secured in the pockets usually with a single transfixing suture at the caudal end adjacent to the septal angle to close the tunnels.

Radix/dorsal grafts

Soft tissue swelling noted intraoperatively can mask a low radix identified preoperatively. Therefore, the surgeon is generally well served to stay with his/her preoperative plan for dorsal and radix

augmentation. A dorsal graft, with adequate length, edges beveled and its substance lightly crushed, as with a Sheen-Constantian morselizer (Marina Medical), should be fashioned to extend from radix to, and past, the bony-cartilaginous junction of the middle vault. The graft should not be palpable after placement and should taper seamlessly to the distal dorsum. Edges that are too thick can create supratip deformity. For greater proximal dorsal elevation, grafts may be layered and fixated to one another with an absorbable suture.

Tip grafts

Customarily the final grafts to be placed, tip grafts increase tip lobule projection, effectively increasing middle crural length. Careful scissor dissection through a single infracartilaginous incision directly over the domes gives access and must be done conservatively as over dissection can cause grafts to shift. The pliability (ie, solid, bruised, or crushed) and number of grafts selected are dictated by how much projection is needed, and by the thickness of the skin. Thicker skin requires more solid grafts to apply greater tension; a "buttress" graft, composed of solid cartilage or ethmoid can be placed to support overlying bruised or crushed cartilage grafts. Conversely, thin skin requires soft grafts. Multiple grafts placed sequentially through a very short, unilateral infracartilaginous incision evenly distribute tension under the skin and avoid issues with irregularities.

There are multiple advantages to using tip grafts via an endonasal approach placed into a precise pocket over the domes. As they do not require exposure of the tip via delivery techniques, the patient's intrinsic tip support remains undisturbed. The effect is seen immediately on the table and is persistent postoperatively if the tip skin is adequately supported against postoperative change (**Fig. 10**). Also, in addition to providing instant intrinsic tip projection to achieve a straight dorsum, they improve definition by tensioning the skin. Even in cases where the tip is relatively broad and/or bifid, tip grafts are frequently sufficient to create a tip that looks narrower. Finally, if problems arise after healing, revision becomes a much simpler endeavor than if the lower lateral cartilages had been extensively modified primarily.

Alar wall grafts

Alar grafts are crucial to address alar cartilage malposition (variant or risk factor #3) for which lateral alar concavity and external valve incompetence are esthetically and functionally common preoperative findings. Alar grafts can easily be placed through a small incision made perpendicular to the rim. The lining is dissected to create a pocket that spans the area of collapse. With respect to graft material, septal cartilage or remnant lateral crural cartilage resected from its cephalic malposition is most often used. In the absence of these sources, conchal bowl ear cartilage is ideal due to the convex contour which nicely conforms to this area, and lightly bruised rib cartilage works very well.

Osteotomy and Infracture

Osteotomy achieves 2 goals: reducing bony vault width (**Fig. 11**) and closing the open nasal roof. Because the bony vault may remain unopened after conservative dorsal resections, it is the former of these 2 objectives that is probably more important. Nasal bone osteotomy destabilizes the nasal framework, causing nasal lengthening. Therefore, before performing any osteotomy, the surgeon should be sure that one is necessary. If the lower nasal third is already appropriately wider than the bony vault, narrowing the upper nose further may be counterproductive by making the nasal base appear larger. If there is a high septal deviation, bilateral osteotomies may create a newly asymmetric nose because one nasal bone will move medially farther than the other. In the elderly patient (in whom comminution of the nasal bones may occur), the patient who wears heavy eyeglasses, or the patient with nasal bones extending less than one-third the distance to the septal angle (in whom middle vault width depends partially on bony vault width), the surgeon may wish to omit osteotomy.

DISCUSSION

> *The grand aim of all science is to cover the greatest possible number of empirical facts by logical deductions from the smallest possible number of hypotheses or axioms.*
>
> *—Albert Einstein, quoted in Nash 1963, p. 173*

The beauty of endonasal surgery is its simplicity. Resident and novice surgeons are often overwhelmed by the many varied open techniques required for mastery. Taking a "beginners mind," one must ask why such a difference in simplicity versus complexity? The answer is rooted in the disequilibrium concept: open and closed proponents share the common view that a surgically-induced scar burden and its associated contracture have deleterious effects on nasal stability. Although the former counteracts this by adding structural rigidity and stiffness to

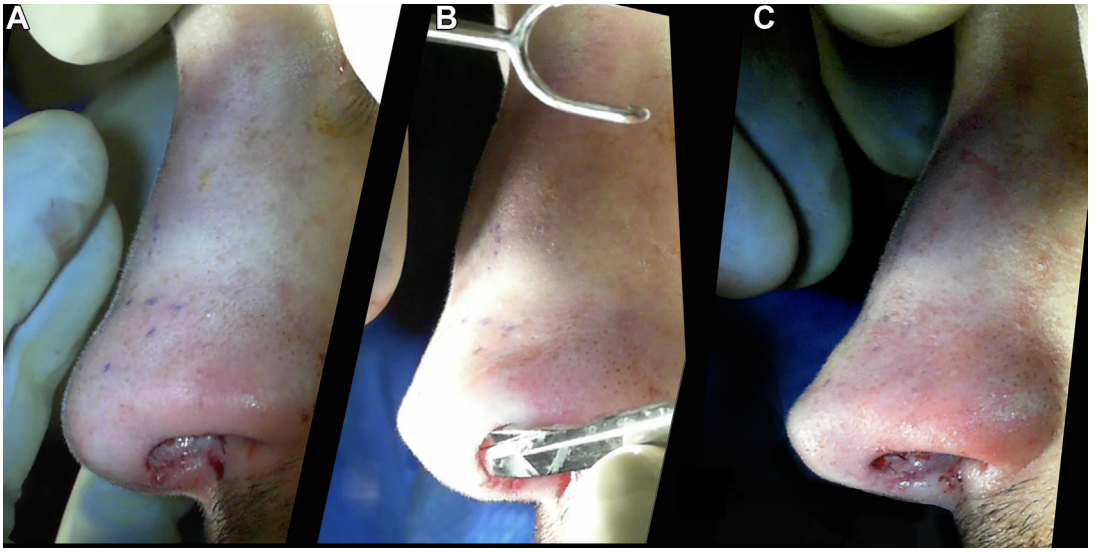

Fig. 10. With the skin sleeve undissected, the surgeon is able to accurately assess tip shape before tip grafting (*A*). Limited dissection with a sharp iris scissor over nasal domes through a unilateral infracartilaginous incision mimics the desired tip shape (*B*). The final contour after endonasal placement of cartilage grafts should show excellent tip projection which predictably will remain because intrinsic tip support has been preserved (*C*). Images by author (ANR).

the nose,[12] it is at the expense of unnatural stiffness, prolonged tip edema, bulk, greater need for grafting material, greater complexity of techniques in the form of columellar struts, septal extension grafts, lateral crural strut grafts,[3,10–12] a higher risk of secondary deformity, and a visible scar. The proliferation in the peer-reviewed literature of open structural rhinoplasty techniques speaks to the vagaries and complexity of open rhinoplasty. Thus begging the question: alternatively, and more simply, is it better to reduce surgical dissection thus reducing scar burden and the risk of associated deformities? Furthermore, applying Occam's razor as a guide (ie, the principle that, of 2 explanations that account for all the facts, the simpler one is more likely to be correct),

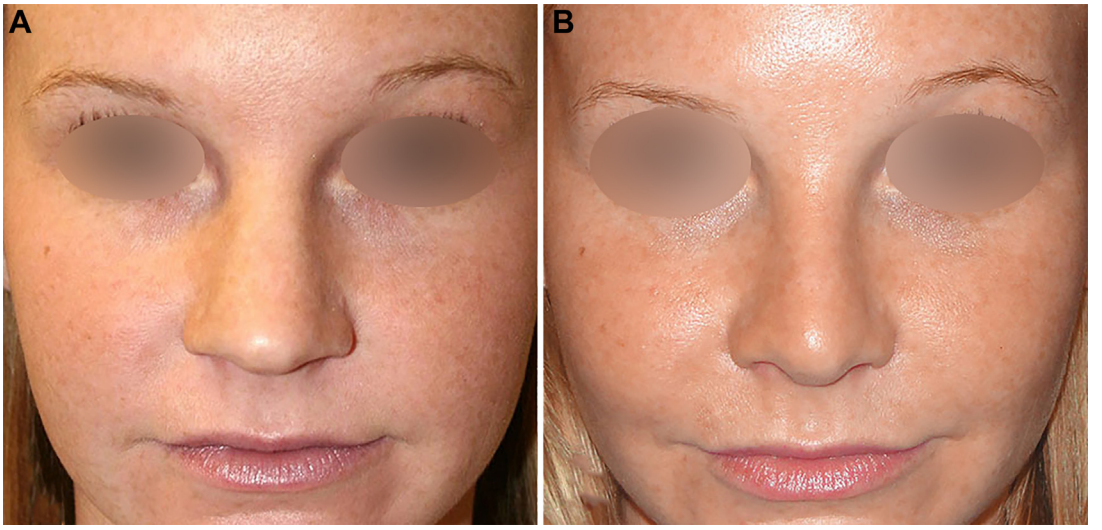

Fig. 11. Woman with widened upper bony vault (*A*) treated with endonasal nasal bone osteotomy and in fracture (and buccal fat pad resection) (*B*). Note, supratip has also been modified with cephalic trim, and the alar base modified with rim excisions. Postoperative image demonstrates 24-month postoperative results by author (ANR).

this leads us to the latter conclusion, that reducing scar burden, the sine qua non of the endonasal approach, is best. Therefore, it is the view of the authors that endonasal rhinoplasty achieves the ideal trifecta of simplicity, minimal scar burden, and "true" visibility.

Learning rhinoplasty can be a confusing endeavor for the novice rhinoplasty surgeon.[13] However, Sheen's principles of "observation, realization, and change,"[14] which allow us to question what we do, why we do it, and how we can improve our understanding and therefore our techniques, cannot be overemphasized.

CLINICS CARE POINTS

- Limiting surgical dissection only to that which is absolutely necessary, rather than complete degloving of the nasal skeleton, is essential to limit the risk of secondary deformity.
- Leaving the skin sleeve intact over the nasal skeleton allows the surgeon to recognize and react to surface skin-level changes; conversely, stripping the skin sleeve from the skeleton removes this important feedback.
- Endonasal rhinoplasty simplifies an otherwise complex operation as only 4 techniques are needed to address most primary rhinoplasties: radix grafts, dorsal grafts, spreader grafts, and tip grafts (alar wall grafts are occasionally needed).
- Reconstruction of both internal and external valvular incompetence triples or quadruples airflow in most patients without concomitant septoplasty or turbinectomy.
- The entire surgical plan can be constructed preoperatively and all key planning and intraoperative decisions can be made from the nasal surface.

DISCLOSURE

Dr M.B. Constantian receives royalties from Taylor and Francis and from Thieme for his textbooks, and from Marina Medical Company for designing surgical instruments. He also receives royalties from Quality Medical Publishing for his instructional surgical videos. All amounts are nominal.

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