RHINOPLASTY

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30 Topics

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INTRODUCTION
Optimal results in cosmetic rhinoplasty demand much of the surgeon. Detailed knowledge of the complex three-dimensional anatomy of the nose, familiarity with all the described techniques of rhinoplasty, and a well-developed aesthetic sense are essential.

HISTORY
Cosmetic rhinoplasty evolved from and has contributed to reconstructive nasal surgery. From its early origins as an augmentation (reconstructive) operation, rhinoplasty subsequently became a reduction (cosmetic) technique and has progressed full circle to its current dual role for both reconstructive and cosmetic purposes. Rogers and Eisenberg presented comprehensive reviews of the history of rhinoplasty.

Indian techniques for reconstructive rhinoplasty began with Sushruta in 500 BCE, continued and evolved during the invasion of India by Alexander the Great in 327 BCE, and subsequently waned after the Mohammedan conquest in 997 CE. The Indian knowledge of rhinoplasty is recorded in Sanskrit manuscripts, but Western scholars were not aware of it until the British entered India in the 18th century. The legendary clay potters of Satra, India, practiced Sushruta’s methods for recreating noses, and when these ancient techniques were translated into English, rhinoplasty was finally introduced to the European medical community.

Two German surgeons, von Graefe and Dieffenbach, substantially contributed to the advance of rhinoplasty in the early 1800s. In 1887, John O. Roe introduced the intranasal approach to rhinoplasty, and in 1891, Roe described cosmetic reduction of an entire nose with removal of the bony and cartilaginous hump through an intranasal approach.

In 1898, Jacques Joseph of Berlin pioneered modern reduction rhinoplasty with the publication of his first paper. His technique removed a V-shaped segment of the nasal dorsum through an external incision; included in the excision were skin, bone, cartilage, mucosal lining, a full-thickness portion of ala, and a wedge from the lower portion of the septum. Joseph analyzed and classified various nasal deformities and introduced numerous operative procedures for their correction. His monumental two-volume textbook on plastic surgery of the nose was published in 1931, and a few years later, his teachings were brought to the English-speaking world by Safian and Aufricht.

ANATOMY
Dingman and Natvig presented illustrations of the general anatomy, skeletal elements, blood supply, and innervation
of the nose (Fig. 1). The skeletal framework of the nose is highly variable and frequently asymmetrical. Natvig et al.\textsuperscript{9} illustrated several cartilaginous configurations (Fig. 2). Bernstein\textsuperscript{10} and Broadbent and Woolf\textsuperscript{11} reviewed the anatomy of the upper, middle, and lower third of the nose and its clinical application in rhinoplasty.

The nasal bone is widest at the nasofrontal suture (14 mm), is narrowest at the nasofrontal angle (10 mm), and then widens again to a maximum of 12 mm approximately 9 to 12 mm inferior to the nasofrontal angle.\textsuperscript{12} The nasal bone is thickest superiorly at the nasofrontal angle (mean thickness, 6 mm) and thins progressively toward the tip.

\textbf{Figure 1.} General anatomy of the nose. (\textit{Modified from Dingman and Natvig.\textsuperscript{9}})
Daniel and Lessard noted the following:

- The critical, fixed anatomic landmark of the nose is the medial canthal ligament, which in many noses corresponds to the desired level of the transverse fracture line.
- The soft-tissue coverage consists of skin (thickest at the tip and thinnest at the rhinion), subcutaneous tissue (most prominent in the supratip area), and muscles (ranging from 3.5–9.2 mm in thickness).
- The nasofrontal suture is 10.7 mm above the intercanthal line (Fig. 3), and the intervening solid “bony triangle” is virtually impossible to narrow by digital pressure or to deepen by rasping.
- The keystone area of nasal bone overlapping the upper lateral cartilage (ULC) extends farther along the septum (7.6 mm) than laterally (3.8 mm).
- The dorsal hump is predominantly (57%) cartilaginous rather than bony (43%).
- The dorsal border of the cartilaginous septum progresses from a Y, with a supraseptal depression at the keystone area, to a T, and eventually to an I by the septal angle.
- In most cases, the alar domes project far above and caudal to the septal angle, thus discounting direct septal support for the tip.

McKinney et al. confirmed fusion of the ULC and nasal septum in the dorsal midline. Only at the level of the septal angle are these structures separate (Fig. 4) and merely connected to each other by fibrous tissue.

Accessory cartilages are interspersed in the aponeurosis connecting the lateral crus to the piriform aperture. A continuous, supporting ring of cartilaginous and fibrous tissue circumscribes the nasal lobule, with connections between the medial and lateral crura and the floor, as follows:

- The first accessory cartilage underlies the alar crease.
- The second accessory cartilage is attached to the piriform aperture by the deep portion of the alar nasal muscle arising from the undersurface of the maxilla.
- The third accessory cartilage has a definite fibrous attachment to the nasal spine and forms the internal nostril fold on the floor of the nasal vestibule.

The ring consists of the caudal septum resting on the nasal spine of the maxilla, the medial and lateral crura, and a chain of three or four accessory cartilages. Rohrich et al. described the pyriform ligament, which is a broad dense fascial system spanning the pyriform rim from the nasal bone to the anterior nasal spine and inserting onto both the upper and lower lateral cartilage. It includes the previously described lateral sesamoid complex ligament and the ligament between the upper and lower lateral cartilage.
Daniel and Letourneau\textsuperscript{16} found no deterioration of the cartilage with age and doubted that attenuation of the cartilage and fibrous supporting structures is responsible for the drooping nasal tip seen in the elderly. Rather, it seems the drooping tip results from resorption of the maxillary alveolar crest. Holden et al.\textsuperscript{18} analyzed the human nasal cartilage ultrastructure using scanning electron microscopy. The authors reported a significant difference between the cartilage of the nasal septum and the lower lateral cartilage. The nasal septum has more organized, layered, thicker collagen fibers, whereas the lower lateral cartilage has a less organized pattern with smaller collagen fibers.

Rohrich et al.\textsuperscript{19} discussed their approach to the management of the nose in the aging patient. With age, the lower third of the face decreases in height secondary to muscle atrophy of the orbicularis oris, fatty tissue absorption, and maxillary alveolar hypoplasia (from tooth loss and subsequent bony resorption). With advanced age, the nose lengthens and the nasal dorsum becomes more convex as a consequence of downward rotation of the lobule and relative columellar retraction. The tip elongates and droops and the flow of air shifts superiorly, often causing functional airway obstruction. Osteotomies are recommended because of the fragile nature of the bony nasal pyramid.

Daniel\textsuperscript{20} emphasized the importance of the three crura of the lower lateral cartilage—the medial, middle, and lateral crus—and of the three nasal tip angles—the angle of tip rotation, angle of dome definition, and angle of domal divergence (Fig. 5). The anatomy of the ULC correlates strongly with tip aesthetics.

Histologically, the bulbous tip consists of collagenous fibrous tissue and skeletal muscle; the adipose tissue component is far less than expected.\textsuperscript{21} The tissue makeup, blood supply, and lymphatic drainage are directly related to postoperative edema and scar formation and influence the resection that is performed for tip modification.

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**Figure 3.** Critical landmarks and relationships of the nose. \textit{(Modified from Daniel and Lessard.\textsuperscript{13})}

**Figure 4.** Cross-section of the ULC-septal angle at three levels. \textit{(Reprinted with permission from McKinney et al.\textsuperscript{14})}

**Figure 5.** Angles in the nasal lobule relevant to rhinoplasty surgery.
Copcu et al.\textsuperscript{22} described the interdomal fat pad as a separate anatomic component not structurally attached to the subcutaneous tissue. The fat pad consists purely of adipocytes and varies in size from 1.2 × 2.4 mm to 3.6 × 5.2 mm. Ultrasonography shows larger pads occupying the interdomal space. Coskun et al.\textsuperscript{23} corroborated the finding of this distinct interdomal fat pad in a cadaveric and clinical radiological study.

Rohrich et al.\textsuperscript{24} studied the blood supply of the nasal tip before and after transcolumellar incision in a fresh cadaver model. The lateral nasal artery was present in all specimens and was located in the subdermal plexus 2 to 3 mm superior to the alar groove. The columellar branch of the superior labial artery was variable. Even after transcolumellar incision, crossover flow was consistent from the lateral nasal artery arcade to the distal aspect of the transected columellar branches. The authors concluded that external rhinoplasty does not compromise nasal tip blood supply unless extensive tip defatting or extended alar base resection above the alar groove is performed.

Toriumi et al.\textsuperscript{25} assessed the effect of external rhinoplasty on the vascular anatomy of the nose. The study involved pre- and postoperative clinical evaluation, cadaver dissection, lymphoscintigraphy, and histological evaluation. The major arterial, venous, and lymphatic vessels course in or above the musculoaponeurotic layer of the nose. The authors suggested that with the external rhinoplasty approach, dissection in the areolar tissue plane below the musculoaponeurotic layer will minimize tip edema and protect against skin necrosis by preserving the major vascular supply to the nasal tip. Loss of normal flow of tracer occurred with the external approach, which used dissection that disrupted the musculoaponeurotic layer with supratip debulking.

To minimize injury to the external nasal branch of the anterior ethmoidal nerve, Han et al.\textsuperscript{26} performed anatomic dissections in 10 fresh cadavers and concluded that dissection deep to the nasal superficial musculoaponeurotic system is safe. They recommended keeping the dissection to within 6.5 mm of the midline and limiting onlay graft widths at the rhinion to 13 mm.

Pitanguy et al.\textsuperscript{27} described a dermocartilaginous ligament that might influence dorsum-tip relationships, especially in patients with a bulbous tip and in black patients in whom a convexity of the lower third of the nose is still apparent after classic modification of the osseocartilaginous structures. Division and partial resection of the dermocartilaginous ligament releases the lower third of the nose, and the nasal tip moves upward. Hwang et al.\textsuperscript{28} reported a close relationship between the dermocartilaginous ligament and the depressor septi nasi muscle and confirmed that it acts as a nasal tip depressor. In a follow-up article, Pitanguy\textsuperscript{29} validated the presence of this subseptal tip-anchoring structure and detached it subcutaneously through an open browlift approach for the aged, drooping nose. Saban et al.\textsuperscript{30} described the deep and the superficial medial expansion of the nasal superficial musculoaponeurotic system. The dermocartilaginous ligament, previously described by Pitanguy, corresponds to the deep medial expansion. Both the deep and superficial components contribute in lowering the ligaments of the nasal tip, and transection of these structures allows cephalic rotation of the nasal tip.

Figallo\textsuperscript{31} described a dynamic structure in the nasal tip, neither osseous nor cartilaginous, which he thought to be a digastric muscle linking the nose to the upper lip. This complex anatomic structure is joined through a pulley to the anterior nasal spine and is thought to account for the plunging tip. A distinction between this “new” structure and the nasal depressor muscles is unclear. Figallo and Acosta\textsuperscript{32} provided a detailed update on the muscles of the nose.

Ozturan et al.\textsuperscript{33} used electromyography to study the intrinsic nasal musculature as it relates to airway collapse before and after rhinoplasty. The authors cautioned against inadvertent disruption of the procerus, transverse nasalis, and dilator nasalis muscles during rhinoplasty, which would affect nasal movements postoperatively. They emphasized remaining in the appropriate tissue plane beneath the musculature and over the perichondrium to achieve the best functional result.

In a cadaveric study, Ali-Salaam et al.\textsuperscript{34} found the alar lobule to be an area where dermis interdigitates with muscle throughout and down to the alar rim. The alar groove is defined by a differential in fibrofatty bulging anterior and posterior to it. The authors also studied the soft triangle and described the anatomy of the insertion of the dilator naris muscle down to the nostril rim.\textsuperscript{35}
PHYSIOLOGY

Baker and Strauss\textsuperscript{36} reviewed the physiology of the nose and noted that septal deviation and spur formation are anatomic variants prevalent in normal populations. The nasal cycle is a physiological response characterized by alternate shrinkage and engorgement of the nasal turbinates that repeats every 30 minutes to 4 hours. While one side of the nasal airway is experiencing shrinkage of its nasal turbinates and giving off secretions of serous fluid and mucus, the opposite airway is involved in the process of turbinate engorgement. This cycle occurs in 80% of individuals and its exact function is unknown. Total airway resistance remains relatively constant despite continuous changes in the size of the turbinates. Baker and Strauss presented a discussion of the physiological basis of nasal obstruction relative to pathological states of the nasal turbinates. Rhinitis is classified as allergic, vasomotor, atrophic, hyperplastic, medicamentosa, or post-rhinoplastic. The differential diagnosis and treatment of obstructive rhinitis were reviewed by Baker and Strauss.

On the basis of his vast experience treating patients with nasal obstruction, Canady\textsuperscript{37} offered a relatively simple algorithm (Fig. 6) to identify the causes and management of nasal obstruction. He thought the algorithm might allow the surgeon to recognize patients who will not be satisfied, even with a technically good result, and thereby avoid performing surgery on those patients.

Jesson and Malm\textsuperscript{38} followed 67 patients who were considered candidates for septoplasty because of nasal obstruction and deviated nasal septum. The patients did not undergo surgery because their nasal airway systems were discovered to be normal based on rhinometry. At 5 and 10 years of follow-up, 20% and 36% of patients, respectively, showed improvement in relief of nasal symptoms. The authors concluded that the majority were in fact suffering from vasomotor rhinitis, which tends to disappear with time, and recommended careful evaluation to distinguish between anatomic obstruction and physiological obstruction.

Deron et al.\textsuperscript{39} evaluated the influence of septal deviation on eustachian tube function and concluded that surgical correction improved tubal opening pressure in both the deviated side and the non-deviated side. Fomon et al.\textsuperscript{40} and Courtiss et al.\textsuperscript{41} stated that unless the internal or external valves are adversely affected or unless a simultaneous septal operation results in septal perforation, aesthetic rhinoplasty does not affect nasal airflow. Infrafracturing of the nasal bones takes place cephalad to the internal nasal valves and presumably does not impair airflow.

Ford et al.\textsuperscript{42} studied the effects of various osteotomy techniques on the size of the airway in cadavers and concluded that an interrupted transperosteal osteotomy preserving intervening strands of periosteum results in a more stable nose with less compromise of the airway.

Guyuron\textsuperscript{43} studied the effect of osteotomy on the airway of 48 patients (96 nasal bones). The length of the nasal bones and the position of the inferior turbinates were recorded preoperatively and correlated with the type of osteotomy performed and extent of bone movement. Each side was assessed independently. The high-to-low osteotomies produced the least narrowing of the nasal passages. Patients with short nasal bones had less constriction of the airway than patients with either normal or long nasal bones. Airway narrowing was more marked when the inferior turbinates were positioned anteriorly. The author concluded that nasal osteotomy does constrict the nasal airway in most instances and to a degree varying with length of the nasal bones, extent of nasal bone repositioning, position of the inferior turbinates, and type of osteotomy.

Grymer et al.\textsuperscript{44} studied the influence of placement of the lateral osteotomy at levels above and below the insertion of the inferior turbinates in 16 cadavers and found no difference between noses that underwent high lateral osteotomy and those that underwent low lateral osteotomy. Both groups showed a 12% to 16% decrease in mean cross-sectional area at the piriform aperture after lateral osteotomies were performed. This reduction was independent of osteotomy placement but was probably caused by detachment of the bony box from the underlying structures.

Becker et al.\textsuperscript{45} developed a rationale for selecting the correct osteotome for endonasal lateral osteotomy. The mean bony lateral wall thickness was measured by computed tomography in 56 adult patients and was found to be $2.47 \pm 0.47$ mm in men and $2.29 \pm 0.40$ mm in women. The 4-mm osteotome caused intranasal mucosal tears 95% of the time; the 3-mm osteotome created tears in 34% and the 2.5-mm osteotome in 4%.
Malm\textsuperscript{46} introduced the concept of acoustic rhinomanometry, described the technical aspects of the procedure, and listed clinical norms. Grymer\textsuperscript{47} used acoustic rhinomanometry to measure the internal dimensions of the nasal cavity in 37 patients before and after reduction rhinoplasty. A 22\% reduction in minimal cross-sectional area was noted at the nasal valve, and an 11\% reduction in the cross-sectional area was noted at the piriform aperture.

Vomeronasal Organ
M Moran et al.\textsuperscript{48} and Stensaas et al.\textsuperscript{49} independently investigated the vomeronasal organ (Jacobson organ). Interest in this vestigial structure stems from its similarity to the vomeronasal system of other vertebrate species, in which Jacobson organ plays a crucial reproductive role by detecting pheromones. The authors collectively evaluated 600 human study participants and found paired vomeronasal pits in the anterior third of the nasal cavity.
septum in all individuals who had no underlying septal pathological conditions. The pits signified the presence of closed tubes that were 2 to 8 mm long and lined by unique pseudostratified columnar epithelium, unlike any other in the human body. Two potential receptors were identified in the epithelial lining. The function of Jacobson organ in humans is still in question, but it seems to be immune from injury by submucoperichondrial dissection of the septum.

**AESTHETICS AND FACIAL ANALYSIS**

Implicit in a surgeon’s ability to correct nasal deformities is an understanding of aesthetic proportions of the face, not just the nose. Farkas and colleagues and Ricketts reviewed modern standards in facial aesthetics. Bernstein delineated relationships between facial shape and nasal width, discussed nose-chin proportions, and listed differences between male and female noses. According to these authors, the aesthetically pleasing face is not divided into equal thirds or fourths, but rather the lower face is longer than the midface, which in turn is longer than the upper face. Springer et al. reported that gender-related differences in nasal shape appear to be subtle, with nason position being one of the main factors. According to their judging panel, a nasal hump and a supratip break are not desirable.

Greer et al. reviewed the importance of the submental region in improving the perceived appearance of the nose. They advocated neck-rejuvenating procedures for improving results. Byrd and Hobar reported a consistent relationship between vertical dimensions and anteriorly projecting characteristics of the nose, lips, and chin. They proposed a dynamic system of analysis that describes key measurements of the nose relative to other facial features and that maintains an overall proportion among the nose, the chin, and the rest of the face. According to their system, for any individual, the ideal nasal length (RT) is determined by non-nasal facial measurements (Fig. 7). Specifically, RT is equal to 67% of the midfacial height (MFH) and equal to the chin vertical measurement (SMes).

\[ RT = 67\% \text{ MFH and } RT = SMes \]

Nasal tip projection equals 67% of the calculated ideal length. The nose-lip-chin plane (NLCP) is determined by a line drawn through a point halfway down the ideal nasal length and touching the upper lip vermilion. In men, the chin projects to this line, but in women, it is 3 mm posterior to it. Other details of the facial analysis method are as follows:

1. The MFH is measured from glabella to alar base plane. The lower face height (LFH) is measured from alar base plane to mentum. MFH should be equal to or slightly less than 3 mm LFH. If it is not, reaffirm occlusion and look specifically for the presence of long- or short-face syndrome or microgenia.

\[ \text{MFH} < \text{LFH} (\leq 3 \text{ mm}) \]
2. Select the mid- or lower facial subunit as the standard for determining ideal nasal length. When the mandible is normal and MFH and LFH are nearly equal, nasal length should be planned on the basis of chin vertical as measured from stomion to mentum.

\[ RT_i = SM_e \]

In cases of microgenia or maldevelopment of the mandible, the ideal nasal length is determined from the MFH.

\[ RT_i = 67\% \text{MFH} \]

Similarly, when the midface is overdeveloped and is not to be corrected orthognathically, the nose should be proportional to the midface rather than to the smaller mandibular segment.

3. With the ideal nasal length established, adjustments to the existing nasal length and possibly the chin vertical should approximate the ideal nasal length. The treatment plan is ultimately determined by safe and reliable surgical guidelines.

4. Multiply the ideal nasal length by 0.67 to determine the ideal tip projection.

\[ \text{Ideal tip projection} = 67\% \times RT_i \]

If actual tip projection is equal to or greater than calculated value, tip projection is adequate despite its appearance in relation to the dorsum. If actual tip projection is less than the calculated ideal, surgical steps to increase tip support should be considered.

5. Measure the distance between corneal plane and radix plane. The ideal radix projection should be 28% of the ideal nasal length.

\[ \text{Ideal radix projection} = 28\% \times RT_i \]

(9–14 mm)

If less than the calculated value and if a dorsal hump is present, consider a radix graft. If greater than 28% RT_i and if the radix breakpoint is poorly defined, consider radix reduction.

6. Note any difference in nasal length when measured from supratarsal fold R and visual radix breakpoint. If nasal length is normal as measured from R but the nose appears short because of a low breakpoint, it can be corrected with a radix graft to raise the visual break.

7. Mark a point on the dorsum of the nose equivalent to one-half the ideal nasal length as measured from R. Drop a line from this point tangential to the vermilion of the upper lip. The projecting point of the chin should touch the line in men and lie approximately 3 mm back of this plane in women.

\[ \text{Chin projection} = \text{NLCP (men)} \]

\[ \text{Chin projection} = \leq 3 \text{ mm NLCP (women)} \]

The aesthetically pleasing female face has an MFH that is equal to or slightly less than lower facial height (mean MFH, 61 mm). Nasal length equals chin vertical distance and averages 41 mm (Fig. 8).

8. On lateral view, the mean distance between nasal root plane and corneal plane is 11 mm or approximately 28% RT_i. The nose projects from the face at an angle of 30° to 36°, whereas the nasolabial angle varies from an average of 90° in men to 95° to 110° in women. A 2- to 3-mm segment of columella should be seen below the rim of the ala.

McKinney and Sweis\textsuperscript{62} sought to define the elements of the ideally balanced white nose. Ideal dorsal length was 2× rhinion height and tip projection. Ideal radix height was 0.75× tip projection + rhinion height. In his discussion of the McKinney and Sweis article, Daniel\textsuperscript{63} referenced the ideal nasion relative to its surrounding anatomic landmarks: 15 to 20 mm from medial canthus; 9 to 14 mm anterior to corneal plane on profile; 4 to 6 mm behind glabellar line; and at lower border of upper lid, among others.
VISUAL DOCUMENTATION

Photography

Krugman reviewed photoanalysis and emphasized the neoclassical facial proportions and holistic treatment planning. Guyuron indicated the advantage of full-scale, life-sized photography as an adjunct to soft-tissue cephalometric analysis for rhinoplasty and described his facial analysis system, which includes proportions, angles, measurements, and recommended profile template. Preoperatively, the system is used to confirm the treatment plan and to serve as a baseline; postoperatively it can help identify shortcomings in the rhinoplasty technique. Schwartz and Tardy proposed a standardized system of photodocumentation for rhinoplasty and made specific recommendations regarding views, lighting, and equipment.

Galdino et al. listed additional considerations for maintaining detail and consistency in digital photodocumentation of the nose. The authors discussed various printing methods.

Anatomic Drawings

Gunter suggested a pictorial system to graphically record intraoperative maneuvers during rhinoplasty. With this system, a worksheet consisting of four views of the nose and a checklist of possible surgical details and steps are included in every patient’s chart. The type of rhinoplasty; surgical approach; operations on the tip, lateral crura, medial crura, dorsum, and nasal bones; use of grafts or implants; and miscellaneous adjunctive procedures are all recorded. The actual events during rhinoplasty are drawn in on the anatomic illustrations and are marked on the checklist. The value of this standardized graphic record lies in the objective correlation it affords between what was done surgically and the operative outcome.

Computer Imaging

Computer imaging is another graphic tool that can be used for preoperative evaluation and postoperative assessment. Sophisticated hardware and software are available in both PC and Macintosh platforms. The more valuable systems can import undistorted, life-size images and alter them by incremental differences in nasal length, tip projection, angles, width, and shadowing.

For computer representations to be realistic, users must project their true surgical skills. Computer imaging is controversial because it is so powerful: Used as a marketing tool, it can mislead patients into expecting a surgical result that is impossible to achieve. Used properly, computer imaging can offer a precise record of the deformity and its proposed correction, a scaled surgical plan, and an exact surgical record.

Mattison presented a review of facial video image processing, with emphasis on image capture, software modification, development of a surgical plan, and comparison of pre- and postsurgical results. Schoenrock reported his 5-year experience with computer imaging. Bronz recounted the predictability of surgical planning with a computer imaging system in 100 primary rhinoplasty cases.

Vuyk et al. used a patient questionnaire to assess the role of computer imaging in facial plastic surgery. Most patients (>80%) found computer imaging to be helpful in communicating with the surgeon, both for expressing their wishes and expectations and for facilitating the
decision for or against a particular surgical change. The majority of the patients who participated in the study also thought that computer imaging should be a routine part of preoperative evaluation for plastic surgery. The predictive value of computer tracings was approximately 80%.

Adelson et al.,73 in a retrospective study, objectively evaluated the accuracy by which computer-simulated rhinoplasty images reflect the surgical outcomes. No significant difference was observed when comparing computer-simulated images and 6-month postoperative photographs when analyzing nasolabial angle, nasofrontal angle, columellar:infratip lobule ratio, and tip projection. The only measurement found to be significantly different was the columella tip angle. The authors concluded that computer-simulated images help educate and engage the patient in a discussion in which desires and expectations are assessed and controlled.

PATIENT SELECTION
Selection of the appropriate patient for rhinoplasty depends on communication. The surgeon must listen and understand the patient’s wishes and balance them against his or her estimate of what can reasonably be achieved surgically.

Thomson74 listed criteria to be used in the selection and counseling of patients for rhinoplasty and cautioned against certain recognizable types of individuals: those who are super-secretive, are unable to identify their desires, request urgent operation, are overly concerned with minor deformities, have secondary motivations, are excessively demanding, carry a number of photographs describing their preferred nose, or are extremely indecisive and male patients. Tardy et al.75 emphasized the importance of preoperative interviews.

Goin76 discussed the psychology of rhinoplasty patients. Honigman et al.77 reviewed the literature on psychological outcomes after cosmetic surgery and identified consistent predictors of a poor psychosocial outcome.

In a retrospective study of 150 secondary rhinoplasty patients, Constantian78 noted four anatomic variants that are strongly predisposed to unfavorable results: low radix and/or low dorsum, narrow midvault, inadequate tip projection, and alar cartilage malposition. The triad of low radix, narrow midvault, and inadequate tip projection was the most common combination (40%) in patients seeking secondary rhinoplasty. More recently, Constantian79 reviewed 100 consecutive cases of primary rhinoplasty and reported inadequate tip projection in 67%, cephalic malrotation of the lateral crura in 46%, and too prominent s tip in 23%.

Hellings et al.80 reported that long-term satisfaction after revision rhinoplasty was obtained mainly in young adult and middle-aged patients, without major differences between male and female patients. Not surprisingly, an inverse correlation was found between satisfaction and number of previous rhinoplasties.

Male Rhinoplasty
Daniel81 acknowledged the validity of the SIMON profile presented by Gorney82: Single, Immature Male, Overly expectant, and Narcissistic. These patients are psychologically unstable and poor candidates for rhinoplastic surgery but reportedly constitute only approximately 15% of men seeking rhinoplasty. Men’s noses tend to be more variable in aesthetic measurements, with wide ranges in level of nasion, height of nasion, and relation between endocanthus and nasal base. Daniel’s goal in male rhinoplasty is a “strong” profile and no supratip break.

Rohrich et al.83 described male rhinoplasty patients as typically nonspecific regarding their complaints, more demanding, and less attentive during consultations. It is important to avoid excessive dorsal reduction or tip refinement in this patient cohort.

Timing
Septal cartilage and nasal bones have important roles in the outgrowth of the midface. Therefore, rhinoplasty should be postponed until growth affecting this region is completed. van der Heijden et al.84 performed a systematic review to determine the end of the nasofacial growth spurt, which was defined as the age at which nasofacial growth velocity curves have their steepest descending slope. The authors concluded that rhinoseptoplasty can be safely performed in girls after the age of 16 years and in boys after the age of 17 years. Based on their retrospective
clinical study, Shandilya et al. outlined the indications for nasal correction in the pediatric population: acute nasal trauma, septal abscess, malignancies, severe septal deviations causing nasal airway obstruction, benign tumors, and nasal deformities associated with cleft lip.

ANESTHESIA

General anesthesia is recommended when operating on an apprehensive patient, for procedures involving deep septovomerine manipulation, and in some posttraumatic deformities accompanied by intranasal scarring. A prospective study conducted by Demiraran et al. evaluating postoperative analgesia and vasoconstriction concluded that local infiltration of levobupivacaine 0.25% plain was significantly more potent and longer lasting than that achieved by lidocaine 2% with epinephrine in patients undergoing nasal surgery. No significant difference was noted between the study groups regarding the preoperative and postoperative hemoglobin values.

Moscona et al. compared sedation techniques for outpatient rhinoplasty in 859 cases. Patients were assigned to one of two groups: those who received midazolam and those who received midazolam plus ketamine. Sedation scores showed that both groups were adequately sedated. Patients in the midazolam plus ketamine group were less likely to remember the injections and were more satisfied with their surgical experience. Van Noord and Cupp examined different types of systemic sedation-analgesia in nasal surgery. The authors concluded that intravenously administered conscious sedation is associated with a lower risk of airway or ventilation problems when compared with deep sedation and a lower risk of deep vein thrombosis when compared with general endotracheal anesthesia. A high level of patient satisfaction was noted with intravenously administered conscious sedation.

Miller et al. recommended topical administration of 4% to 5% cocaine solution to enhance anesthesia and induce vasoconstriction while avoiding high plasma concentrations of cocaine. Mixing cocaine with epinephrine offers no advantage, and the toxic effects of “cocaine mud” are well documented. Thivasagayam et al. in a prospective study, noted no significant difference in blood loss or surgical field visualization between a group infiltrated with lidocaine 2% with epinephrine 1:80,000 and another group infiltrated with lidocaine 2% plain. A significant increase in systolic blood pressure was observed in the group receiving epinephrine. The authors concluded that the use of epinephrine with cocaine paste does not improve hemostasis or surgical field visualization.

In a prospective, randomized study of 12 consecutive patients, Liao et al. tried to identify factors that influenced the safe use of topical cocaine during rhinoplasty. Group 1 received cotton pledges soaked in 4 mL of 4% cocaine solution for 10 minutes; group 2 received 4 mL of 4% solution for 20 minutes; and group 3 received 4 mL of 10% solution for 20 minutes. Serum cocaine concentrations were measured at intervals of 5, 10, 15, and 20 minutes. Of the total cocaine applied, 35% was absorbed systemically within 15 minutes of application. This absorption rate was four times higher than expected and led the authors to conclude that topical use of 10% cocaine was to be avoided. Metzinger et al. recommended adding 1 part sodium bicarbonate to 5 parts local anesthetic to lessen the pain and irritation of injections during rhinoplasty.

SURGICAL TECHNIQUES

The classic concept of “reduction rhinoplasty” presented by Joseph and updated by Aufricht has evolved substantially during the past 35 years. According to Rees, “...the highly styled retroussé nose of the past has given way to emphasis on a more natural look with higher dorsal profile, less tip elevation, and less sculpturing of the alar cartilages. The ‘operated look’ is to be avoided at all costs.”

In 1977, Rees listed the trends in rhinoplasty as follows:

- less removal of tissue
- more preservation of structures
- a decided tendency toward “under-operation” rather than “over-operation”

To this list, we can now add the following:

- incisions designed to preserve lining and soft tissue
- resection of only the bare redundancy of the ULC
- correction of the nasal tip first, or at least early in the procedure, before modifying the dorsum
• a tendency to avoid transecting the domes or otherwise avoid interrupting the spring of the alar cartilages
• maximum preservation of the caudal border of the septum
• resection of the nasal spine only in well-defined, isolated cases
• less frequent medial osteotomies
• rare outfracturing

The techniques presented by Anderson, Peck, Rees, Sheen and Sheen, and Goodman are representative of current concepts in rhinoplasty. Peck described the preferred basic approach to rhinoplasty and emphasized that the most important aesthetic goal is to create a pleasing tip that will stand out gracefully from the straight nasal bridge.

Sheen’s original methods of nasal augmentation, along with his refinements of surgical techniques for the correction of secondary nasal deformities, further expanded modern rhinoplastic alternatives. In a retrospective titled “Rhinoplasty: Personal Evolution and Milestones,” Sheen reviewed the milestones in this evolution, as follows:

1) vestibular stenosis: diagnosis of a surgical consequence
2) etiology and treatment of supratip deformity: the dynamic relationship of soft-tissue contour to skeleton
3) etiology and treatment of the tip with inadequate projection: tip graft design
4) practical aesthetics of balance: the augmentation-reduction approach to rhinoplasty
5) support of the middle vault: functional and aesthetic effects
6) malposition of the lateral crura: recognition and management
7) significance of the middle crura: clinical and aesthetic considerations

The review by Sheen and the techniques therein should be carefully studied by all rhinoplastic surgeons.

**Intranasal Approach**

The intranasal approach to rhinoplasty includes several routes of access to the nose (Fig. 9), as follows:

- intercartilaginous incisions between the upper and lower lateral cartilages
- transcartilaginous (cartilage-splitting) incisions through the lower lateral cartilages
- infracartilaginous incisions following the caudal border of the lower lateral cartilages
- combinations of the above, with or without a transfixion incision through cartilaginous or membranous septum caudally

Deformities requiring wide exposure, such as tip asymmetries, high dorsal septal deviations, and severe posttraumatic deformities, frequently are approached through cartilage-delivery methods using infracartilaginous or marginal incisions, singly or in conjunction with an intercartilaginous incision. They can also be combined with a transcolumellar incision and converted to an external approach. If the nasal tip morphology is normal, one should avoid dissection of the tip structures as part of the exposure.

![Figure 9. Rhinoplasty intranasal incisions. (Reprinted with permission from Dingman and Natvig.)](image-url)
External (Open) Approach

The open approach to rhinoplasty consists of bilateral marginal or rim incisions along the inferior border of the alar cartilages that are connected in the midline by a transcolumnellar skin incision 5 to 7 mm long (Fig. 10); it does not include the large skin incision presented by Joseph. Aksu et al. compared two different columellar incision designs in a retrospective study. The authors concluded that the inverted-V incision results in a better scar formation and less notching than does a transverse columellar incision. The main difference between the external and internal approaches is that the external approach allows exposure of the tip-lobule complex without disturbing intercrural and alar-septal attachments.

Adams et al. reviewed nasal tip support in open and closed rhinoplasty. The mean loss of tip projection with the open approach was 3.43 mm, versus 1.98 mm for the closed approach. The difference was attributed to greater ligamentous disruption and skin undermining with the open approach. Septal manipulation was associated with decreased tip support regardless of approach.

Rethi used a partial, high-transverse columellar incision that failed to uncover the entire nasal skeleton. Sercer extended the incision used by Rethi to expose the entire osseocartilaginous framework of the nose.

Padovan further expanded the open rhinoplasty concept and incorporated his treatment of the nasal septum. Bravo and Schwarze described a closed-open rhinoplasty technique with extended lip dissection, which comprises an alar base resection incision with complete undermining of the area between the nasal base and the upper lip. The approach allows full access to the entire osseocartilaginous framework while avoiding a transcolumnellar incision. Goodman described his technique of external rhinoplasty and reported his experience with 74 patients. Wright and Kridel endorsed the method presented by Goodman and listed the following advantages to the external rhinoplasty procedure:

- better binocular visualization for teaching and studying deformed anatomy
- control of bleeding by electrocautery
- more accurate diagnosis
- more precise correction of deformities

The external approach offers all the advantages of the cartilage-delivery technique plus simultaneous bilateral visualization of the lower lateral cartilages in their resting state without retraction. This additional exposure can be of benefit when dealing with an asymmetric tip or when correcting tip projection, for which it is desirable to maintain the soft-tissue attachments while simultaneously evaluating the unloaded support to the tip complex.

On the other hand, the external approach implies unnecessary degloving of the tip-lobule complex when tip projection is normal. In this case, the increased exposure gained by the open approach must be balanced against the risk of altering tip support or tip definition while dissecting the dome. Goodman noted the following limitations and potential complications of the open approach:

- separation and secondary healing of the transverse columellar incision
- additional edema of the nasal tip persisting for several months
- increased operative time for incision closure

The indications for the external approach remain arguable, even among current masters of rhinoplasty.
Anderson\textsuperscript{119} expressed some concern regarding the resulting scar and suggested that the external rhinoplasty technique might be most applicable in long-standing, severe, posttraumatic nasal deformities. Friedman and Gruber\textsuperscript{120} adopted the open rhinoplasty technique because of the increased exposure it affords but concluded that it probably is not necessary if the cartilaginous vault or tip does not need much modification.

Constantian\textsuperscript{121} reviewed 100 consecutive patients who underwent secondary rhinoplasty and reported that 36\% had undergone open rhinoplasty at the previous surgery. The patients’ symptoms were related to an over-resected dorsum or tip and internal nasal valve collapse. Excessive columellar length, hard columellar struts, alar and/or nostril distortion, narrow nose, and external valvular obstruction were more common in this group than in patients undergoing primary closed rhinoplasty.

**Surgical Approaches to the Tip**

Most surgical approaches to the nasal tip are variations of the retrograde technique, cartilage-splitting technique, cartilage-delivery technique, or external approach.

**Retrograde Technique**

The retrograde or eversion technique presented by Converse\textsuperscript{122} uses a single intercartilaginous incision for access to the nasal dorsum, the cephalic portion of the alar cartilage, and the inferior scroll of the ULC. It also preserves an intact caudal rim of alar cartilage after resection. The retrograde technique is indicated for deformities requiring minimal cephalad resection of the alar cartilages, minimal dome manipulation or modification, and minimal cephalad rotation of the lobule complex. Relative disadvantages of the retrograde technique are a difficult dissection, less visibility, and limited access to the dome-medial crural areas.

**Cartilage-Splitting Technique**

Anderson\textsuperscript{95} and Webster et al.\textsuperscript{123} used intracartilaginous incisions paralleling the caudal border of the alar cartilages. At the lateral aspect of the lateral crura, variable amounts of cartilage are resected according to individual anatomy and degree of tip rotation desired (Fig. 11).\textsuperscript{123}

The cartilage-splitting approach is best suited to symmetrical tips that require cephalad resection of the alar cartilages, with or without cephalad rotation of the lobule complex, and to tips that require only minimal refinement. If substantial asymmetry is present or the dome needs to be modified, it might be better to use a different approach to gain direct access to the area. Peck\textsuperscript{102,124} noted a preference for the cartilage-splitting incision for routine rhinoplasties.

The advantages of the cartilage-splitting technique are as follows: 1) one incision with minimal trauma to the cartilage and soft tissue, 2) no disruption or dissection of the residual caudal alar segment, and 3) absence of an incision through the “nasal valve” area at the junction of the upper and lower laterals. Disadvantages include the following: 1) limited visibility of the dome and medial crura; 2) possible asymmetry if the incisions are not precisely equal bilaterally; 3) decreased tip projection if the incision at the dome is too far caudal, which alters the pivot point of the lobule (Fig. 12);\textsuperscript{96} and 4) possible collapse of the lateral crura and alar notching if the caudal rim is weakened by over-resection.

**Cartilage-Delivery Techniques**

Techniques that deliver the alar cartilages for direct visualization have been described by Sheen and Sheen,\textsuperscript{100} Becker,\textsuperscript{125} and Bernstein.\textsuperscript{126} Access to the lobule is by combined intercartilaginous and infracartilaginous (alar margin) incisions that offer greater visibility of the alar cartilages. The entire lower lateral cartilage with attached vestibular skin and mucosa is exteriorized as a bipedicled chondrocutaneous flap. It is easier to manipulate the dome areas under direct vision to correct secondary tip deformities, and better postoperative tip symmetry can be achieved because the surgeon can see the amount of cartilage remaining and possibly contour the existing cartilage without resection. The cartilage-delivery technique is most appropriate for difficult nasal tip deformities such as asymmetries and twisted, bulbous, box, bifid, or over-projecting tips.\textsuperscript{127}

Disadvantages of the cartilage-delivery technique include increased trauma from the dissection, a worse scar from two incisions, and the risk of injury to the caudal
strip of the alar cartilage from the marginal incision. One must be careful not to penetrate the soft triangle, because, as noted by Sheen and Sheen, any incision in the soft triangle could cause deformity of the tip.

THE OSSEOCARTILAGINOUS VAULT

Dorsal Reduction

The nasal dorsum can be lowered either before or after the tip is modified. Rees, Anderson, and Peck noted a preference for initial tip modification with subsequent lowering of the dorsum to a level appropriate for the revised tip. Safian and Sheen, on the other hand, noted a preference for initial reduction of the dorsum and then tip modification.

When tip projection is adequate or excessive and a small hump removal is anticipated, dorsal reduction might best be performed before tip modification. A conservative, controlled dorsal reduction using a sharp rasp is a safe way to avoid over-reduction, according to Rees, Sheen and Sheen, and Peck. When tip projection is marginal or inadequate, it seems logical to maneuver the tip first to achieve as much tip projection as possible and then lower the dorsum (instead of first lowering the dorsum, perhaps excessively, in an attempt to achieve a dorsal line below the level of tip projection). Constantin described a notch that tends to appear “at the midpoint of the nasal dorsum when the bridge has been resected beyond the ability of the soft tissues to contract. This notch, commonly seen in secondary rhinoplasty patients, occurs at the cephalic end of the supratip convexity and appears whether or not the tip has been overresected.”

Skoog performed composite resection of the bony and cartilaginous dorsum, tailoring the removed unit and replacing it as a dorsal osseocartilaginous composite graft. The original indications for the operation included severely deviated noses in which extensive dorsal reduction was anticipated; any residual septal deformities could thus be camouflaged by the dorsal autograft.

Regnault and Alfaro further refined the procedure, and Lejour et al. used the Skoog technique routinely when dorsal reduction was indicated. Although hump reinsertion might seem overly aggressive by current

Figure 11. Tip reduction by resection of variable amounts of alar cartilage to produce cephalad rotation of the tip. A, Complete strip excision. B, Rim strip excision. C, Lateral crural flap. D, Complete curved strip excision. (Reprinted with permission from Webster et al.)

Figure 12. Cartilage-splitting incisions have changed the pivot point of tip rotation. Before (A) and after (B) splitting the alar cartilages. (Modified from Anderson.)
standards of practice, the technique should be considered in patients with very short nasal bones for whom lateral osteotomies would be risky and in select cases of septal deviation in which septal modification could lead to total collapse of nasal support. The disadvantage of the Skoog technique for routine rhinoplasty is the potential for displacement and resorption of the dorsal graft.

Often, the dorsal hump deformity consists more of cartilage than of bone. The cartilaginous dorsum, including the septum and ULC, can be reduced by composite resection or by separating the ULC from their junction with the septum dorsally and resecting each separately.

With small dorsal humps (most frequent), composite resection maintains mucosal integrity without formal extra-mucosal tunnel dissection and avoids the risk of narrowing mucosal surfaces at the septum-ULC junction as a result of scar contracture. With large hump deformities, it is necessary to divide the ULC from the septum extra-mucosally and to resect the attached and potentially redundant mucosa to keep it from heaping over the dorsal profile. When ULC have to be separated from the dorsal septum to correct a markedly deviated nose or for better septal exposure, submucosal tunnels or extramucosal dissection from the underside of the septum-ULC junction preserves mucosal integrity.

Rohrich et al. advocated a gradual approach to dorsal reduction to avoid complications such as dorsal irregularities, over-resection, inverted-V deformities, and excessive narrowing of the midvault. The authors listed five critical steps: 1) separation of the ULC from the septum, 2) incremental reduction of the cartilaginous septum, 3) dorsal bony reduction with rasps, 4) verification by palpation, and 5) final modification. Bilateral submucoperichondrial tunnels are created before releasing the ULC from the septum to preserve the cartilages and mucosa of the internal nasal valves.

Sheen and Sheen recommended oblique rasping across the bones to minimize pull on the ULC from below. This prevents accidental avulsion of the cephalic portions of the ULC from their junction with the nasal bones during rasp reduction of the bony dorsum. Guyuron recommended the use of a guarded power burr for deepening the nasofrontal angle. In substantial reductions of the nasofrontal junction, the burr is more effective than a rasp, electric saw, or osteotome.

Mommaerts et al. described a reduction osteotomy in which the osteotome enters the vertical frontonasal suture behind the nasal bones and in front of the nasal spine of the frontal bone. In our view, reduction of the nasofrontal junction presents two problems. One, the soft-tissue response to bony removal is approximately 50%. Two, as the nasofrontal junction deepens, the intercanthal bridge lines visibly widen. Successful bone removal in this area, therefore, can be tempered by a compromise in nasal aesthetics.

Sheen and Sheen recommended spreader grafts for reconstruction of the middle roof in patients who have a narrow nose with visible depression of the lateral walls and abnormal valving on inspiration. Noses predisposed to midvault collapse (e.g., noses with short bones, thin skin, weak cartilages, or combinations of these) are too narrow after resection of the roof and might benefit from spreader grafts.

Byrd et al. described the use of an autospreader flap when performing dorsal reduction. Autospreader flaps consist of the transverse portion of the ULC, which are rotated medially to function as a local spreader flap while reducing the profile of the dorsum and preserving the aesthetic lines (Fig. 13). Gruber et al. reported a similar technique that uses spreader flaps to reconstruct the middle third of the nose in primary rhinoplasty.

Skeletal Manipulation and the Soft Tissues

Guyuron studied the reaction of the soft tissues to skeletal reduction over several zones of the nose (Table 1). The author combined data on soft-tissue response with preoperative records of the soft-tissue outline to formulate a plan for precise nasal reduction.

Two factors influence the response rate: 1) the thickness of the skin and soft tissues overlying the skeleton; and 2) patient age, which modulates the degree of movement of the soft tissues in several zones. Unfortunately, in the clinical situation, the soft-tissue response to skeletal reduction is not linear over the length of the nose (i.e., a direct, regularly progressive soft-tissue response does not hold throughout). As the degree of skeletal reduction increases, the soft-tissue response decreases because of redundancy and “memory” of the
soft-tissue envelope. Some studies\(^\text{140,141}\) indicated that standard maneuvers in tip modification usually decrease tip projection.

Statistical analysis of these changes led Guyuron\(^\text{142,143}\) to the following conclusions:

- Reduction of the nasion renders the appearance of increased intercanthal distance and a longer nose.
- Reduction of the nasal bridge results in a wider nose on frontal view and a tip rotated upward on profile.
- Augmentation of the bridge makes the nose look narrower.
- Resection of the caudal septum, caudal borders of the medial crura, or cephalic portions of the lower lateral cartilage (LLC) produces cephalad rotation of the tip, in decreasing order of effectiveness.
- Resection of the alar base not only narrows the nostrils but also moves the alar rims caudally and reduces tip projection when severe enough.
- Resection of the nasal spine increases upper lip length on profile and decreases tip projection by weakening support for the medial crura.

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**Figure 13.** Internally rotating the upper lateral cartilage maintains the nasal valve (green arrows). *(Reprinted with permission from Byrd et al.\(^\text{137}\))"
Pessa et al.\textsuperscript{144} used three-dimensional computed tomographic scans of patients in two age groups to assess skeletal remodeling of the nasal profile after rhinoplasty. The authors reported continued, differential growth of the craniofacial skeleton, with the piriform aperture area changing the most. This ongoing posterior movement of the maxilla manifested as a retruded nasal profile with age.

**Dorsal Augmentation and the Nasofrontal Angle**

The higher the nasal dorsum is, the smaller the nasal base looks. Constantin\textsuperscript{145} recommended raising the nasal bridge to offset the appearance of an augmented base. This strategy limits the amount of nasal skeletal reduction necessary, decreases the potential for postoperative change and soft-tissue distortion, and increases the surgeon’s control over the results.

Ortiz-Monasterio and Michelena\textsuperscript{146} presented a review of techniques for nasal dorsal augmentation with autogenous cartilage and bone grafts. The authors preferred nasal septum as a graft material, sometimes stacked two and three layers thick. The longitudinal graft pieces are scored lengthwise on their external surface so that they conform to the nasal bridge contour. When the septum is not available in sufficient quantities, the authors recommend use of composite cartilage-bone grafts from the rib molded to the appropriate shape.

Gunter and Rohrich\textsuperscript{147} described U- and A-shaped modifications of septal cartilage grafts for nasal dorsal augmentation to raise the nasofrontal angle. The authors included descriptions of the indications and surgical technique for these tailored septal grafts.

Dorsal surface irregularities can occur after alteration of the osseocartilaginous vault. McKinney et al.\textsuperscript{148} advocated use of a thin septal graft to reconstruct the nasal dorsum after osteotomy. The authors noted, “nasal hump resection converts a smooth, fused nasal ‘cap’ into five separate components. This may unmask a twist in the septum, expose sharp irregular edges, evidence an open roof deformity, and/or develop a pinched middle third as a result of removal of the spreader effect of the hump.” The septal graft proposed by the authors is durable enough to camouflage contour irregularities yet thin enough not to raise the dorsum. If septum is not available, the authors opt for a double layer of temporalis fascia rather than synthetic material.

Endo et al.\textsuperscript{149} reviewed 1200 cases of augmentation rhinoplasty with ear cartilage grafts, including replacement of silicone prostheses in 40%. Complications developed in 4\% of the cases, the most common of which was graft malposition. The infection rate in that series was 0.5%. Crushed cartilage grafts have also been recommended for use after reduction of the dorsum.

\begin{table}[h]
\centering
\caption{Reaction of Soft Tissues to Skeletal Reduction\textsuperscript{139}}
\begin{tabular}{|c|c|}
\hline
\textbf{Bony Reduction} & \textbf{Soft-Tissue Response (%)} \\
\hline
Nasion and nasal spine & 25 \\
Proximal and midnasal bridge & 60 \\
Supratip & 43 \\
Tip-lobule angle and infratip & 40 \\
\hline
\end{tabular}
\end{table}
More recently, Gryskiewicz et al.\textsuperscript{150} proposed the use of Alloderm (LifeCell Corporation, Branchburg, New Jersey) for the correction of dorsal contour irregularities and minimal dorsal augmentation. The authors reported that Alloderm is stable (non-shifting), soft, and natural-looking. A 2+-year follow-up of 20 patients disclosed partial graft absorption in 45%; three patients required reoperation. The authors recommended slight overcorrection in the nasal dorsum, which exhibits the highest rate of resorption. A subsequent article\textsuperscript{151} assessed results in patients who had undergone secondary rhinoplasty and confirmed 20% to 30% graft resorption over the dorsum and 10% to 15% resorption over the tip.

Jackson and Yavuzer\textsuperscript{152} noted excellent outcomes with Alloderm for camouflage of dorsal nasal irregularities. Alloderm blocks adhesions between the osseocartilaginous vault and overlying skin and helps conceal scars. The authors found no substantial absorption or recurrence of deformity in 15 patients who were followed for 6 to 24 months postoperatively.

Erol\textsuperscript{153} described an adjunctive procedure for dorsal camouflage or augmentation in primary and secondary rhinoplasty. The technique, called \textit{Turkish delight}, involves diced cartilage wrapped in Surgicel (Johnson & Johnson Ethicon, Somerville, New Jersey) and shaped as a tube. The roll is inserted in the nasal dorsum and molded to fit the desired contour after closure of incisions. The author reported a 0.7% complication rate in 2365 rhinoplasties, with over-correction and partial resorption in 0.5%.

Elahi et al.\textsuperscript{154} used a modified Erol technique for augmentation rhinoplasty in 67 patients and reported good retention of the graft material for up to 24 months. Subsequent studies by other authors using the technique presented by Erol\textsuperscript{153} have yielded variable results. Daniel and Calvert\textsuperscript{155} examined the use of diced cartilage wrapped in Surgicel (group 1), wrapped in fascia (group 2), and with no wrapping (group 3). Complete resorption of the cartilage occurred in the Surgicel group and good survival of the cartilage grafts occurred in the other two groups. The authors reported that the Turkish delight technique might be useful for minor camouflaging but question its usefulness for marked dorsal augmentation.

Brenner et al.\textsuperscript{156} studied the survival of four kinds of diced cartilage grafts implanted in dorsal skin pockets of rats: cartilage and Surgicel, cartilage and fascia, fascia alone, and Surgicel alone. The lowest cartilage viability occurred in the cartilage wrapped with Surgicel group, probably because of the inflammatory response elicited by Surgicel.

Daniel\textsuperscript{157} reviewed three types of diced cartilage grafts in rhinoplasty: diced cartilage, diced cartilage wrapped in fascia that is sewn closed, and diced cartilage covered with fascia after graft placement. Diced cartilage without fascia is mostly reserved for the peripyriform and radix area and for alongside structural rib grafts. Good results were achieved with all three diced cartilage techniques, and no revision surgery was needed. The most common technical problems were overcorrection, visibility, and junctional step-offs.

### Nasal Osteotomies

Outfracture involves levering the nasal bones laterally through a medial osteotomy to complete the cephalad portion of the fracture of the nasal bones. The current trend in rhinoplasty is away from this maneuver because it can produce a “rocker” deformity.

The indications for nasal bone infracture continue to be debated. Infracture is useful for accomplishing either of two goals: 1) closure of an open roof after hump removal to narrow the apex or roof of the nose, and 2) narrowing the base of the bony cartilaginous pyramid. Depending on the thickness of the septum and the dorsal angle of the septum-ULC- junction, a certain amount of the nasal dorsum can be removed without creating a space between the septum and nasal bones or between the septum and upper laterals (an open roof). Removal of a small dorsal hump deformity does not necessarily produce an open roof, and infracture of the nasal bones only narrows the base of the bony cartilaginous pyramid, not its apex or roof.

Two questions should be asked before undertaking an osteotomy: 1) Is there an open roof rendering a flat appearance to the nasal dorsum? and 2) Is the base of the bony pyramid excessively wide on frontal view such that the aesthetic lines at the base of the pyramid do not parallel the aesthetic lines from superciliary ridge to nasal tip along the dorsum of the pyramid? Routine or unnecessary nasal bone infracture in the absence of a notable open roof or when the nasal bones are not
divergent can produce a pinched appearance to the upper and middle third of the nose.

Osteotomies of the nasal bones are classified as follows:

- low-to-low lateral osteotomy with greenstick fracture of the cephalic portion of the nasal bones at their junction with the frontal bones
- low-to-low osteotomy along the frontal process of the maxilla and extending to connect the cephalic portion of the lateral osteotomy with the nasal dorsum at the radix
- low-to-high osteotomy beginning low at the frontal process of the maxilla caudally and curving upward to pass lateral to the dorsum at the radix
- high lateral osteotomy beginning along the base of the nasal bones at the frontal process of the maxilla caudally and curving toward the dorsum at the radix
- medial osteotomies passing vertically between the septum and the nasal bones and extending cephalad to the nasal process of the frontal bone

Sheen and Sheen listed the advantages of the low-to-high osteotomy as follows: 1) the residual cephalic nasal bone bridge is narrow and can be fractured with minimal digital pressure; 2) bony continuity is maintained when the remaining cephalic segment is greenstick fractured; and 3) outfracture, infracture, and disarticulation of the nasal bones are unnecessary.

In cases in which the bony pyramid has an excessively wide base and bony apex but the dorsal projection is normal, a lateral osteotomy is indicated. Care must be taken to circumscribe the abnormally wide portion of the skeleton with the osteotomy. Laterally, periosteal elevation and soft-tissue undermining should be kept to a minimum to maintain soft-tissue attachments to the lateral portion of the nasal bones. The soft-tissue attachments keep the bones from collapsing into the piriform aperture when mobilized. Arfaj et al. recommended performing lateral osteotomy without periosteal elevation to minimize postoperative periorbital ecchymosis despite the higher chance of disrupting blood vessels and causing bleeding. The intact perioisteaum acts as a barrier, preventing the blood from extravasating to the adjacent periorbital subcutaneous tissue. Infracture alone will not succeed in narrowing the apex, however, so that a medial osteotomy and frequently a medial osteotomy are necessary to displace the osteotomized segment medially.

Rees and Sheen caution that an excessively high osteotomy performed laterally along the nasal bone can produce a visible ridge or stair-step deformity at the base of the bony pyramid. To avoid this problem, the authors proposed technical modifications that leave a narrow residual cephalic segment that is reportedly easier to greenstick fracture without direct or medial osteotomy.

Wright in 1961 and later Daniel and Lessard evaluated the effects of various types of hump removal, osteotomy, and nasal dorsal dissection using cadavers. The authors concluded the following:

- saw cuts produce less comminution than chisel cuts (but this seems to be more of a disadvantage than an advantage)
- rasping is safest and simplest for hump reduction
- closure of an open roof necessitates medial movement of the bony vault that is greater at its caudal end
- the length of the hump, especially its cephalic extent, determines how medial movement will occur
- after excision of a hump that extends above the inter-canthal line, medial fracture or osteotomy might be required
- in smaller humps that end below the inter-canthal line, a transverse fracture is required
- the most satisfactory infracture method is that presented by Becker (lateral osteotomy with greenstick fracture at the cephalad portion of the bones); the small spur on the residual superior portion of the nasal bone at the nasofrontal junction can be rasped
• the bony triangle above the intercanthal line is virtually impregnable, and narrowing it requires rongeuring the bony web

• medial osteotomy with outfracture of the superior attachment of the nasal bones is not desirable because it produces an unintended angling of the open dorsum and curved fracture lines following a curved osteotomy; if the fracture line at its cephalad end does not reach the nasal dorsum, a bony bridge can persist and cause a rocker effect, levering outward after the nasal bones are moved inward

• with infracture of the nasal bones after lateral osteotomy without medial osteotomy, the bones do not spring back into their original position as long as the site of greenstick fracture is the thin upper portion of the nasal bones and not the upper heavier portion; transverse fractures pass through the body of the nasal bones and not through the naso-frontal suture line

• potential problems of the low-to-low osteotomy with greenstick fracture are incomplete fracture or spicule formation in the cephalad portion; if this does not fracture readily, a 2-mm osteotome can be inserted through a stab incision in the glabellar or canthal area to complete the fracture line

• if the low-to-low osteotomy leaves a wide cephalic portion of nasal bone, direct transverse osteotomy with a small osteotome through a stab incision is more precise than medial osteotomy and outfracture or greenstick fracture

Rohrich et al.\textsuperscript{161} found that the external perforated osteotomy technique produced consistent results in rhinoplasty with minimal postoperative complications. The osteotomies should be designed to cut through intermediate or transitional zones of bony thickness, such as along the lateral nasal wall. A comparative, endoscopic study in cadavers\textsuperscript{162,163} confirmed the superiority of external osteotomies in minimizing intranasal trauma: mucosal tears were seen in 11% of external perforated osteotomies versus 74% of internal continuous osteotomies.

Harshbarger and Sullivan\textsuperscript{164} studied the bony thickness and fracture patterns of the medial nasal osteotomy. The authors drilled 1-mm holes along the left nasal bones in 17 cadavers and found that bone thickness gradually increased from caudal to cephalic and from lateral to medial, leaving a natural cleavage plane. The right hemi-noses had medial osteotomies at 0° or 15° from the midline and were combined with low-to-low lateral osteotomies and then digital greenstick infracture. The 0° osteotomies produced contour irregularities and rocker-like deformities. The 15° medial osteotomy produced reliable, controlled infracture with adequate narrowing.

Gruber et al.\textsuperscript{165} provided a classification of broad nasal bones that emphasizes the distinction between dorsal and nasal base width. The authors reported that reduction of the nasal dorsal width is facilitated by a medial oblique osteotomy alone without lateral osteotomy if it is placed at the lateral aspect of the apex of the open roof after a humpectomy.

Gryskiewicz and Gryskiewicz\textsuperscript{166} studied 75 patients who underwent rhinoplasty and required nasal osteotomy. The authors compared the perforating method of nasal osteotomy with a 2-mm straight osteotome versus the continuous technique with a 4-mm curved, guarded osteotome. Each patient received one technique on one side of the nose and the other technique on the opposite side. The osteotomies were performed through an internal transnasal or an external percutaneous approach. Evaluation at 3, 7, and 21 days after surgery showed that ecchymosis and edema were less on the side with perforating lateral osteotomies with the 2-mm straight osteotome than on the side with the continuous osteotomy with the curved osteotome.

Gryskiewicz\textsuperscript{167} also found that scars resulting from external percutaneous osteotomies were imperceptible in 94% of patients but that on a few occasions, a small visible scar was apparent. The author emphasized the importance of thorough cleaning of the chisel between cases to avoid traumatic tattooing.

Castro et al.\textsuperscript{168} recommended use of a modified Joseph saw on a reciprocating handpiece for basal and
superior nasal osteotomies. A fixator anchors the saw on a single axis that allows sawing without resistance and averts multiple bone cuts. Giampapa and DiBernardo\textsuperscript{169} reported their preference for a dual-plane, curved reciprocating saw for low-to-high osteotomies to make precise lateral transverse osteotomies and avoid a medial osteotomy. Kim and Kim\textsuperscript{170} described their technique for endoscopically assisted osteotomies with a reciprocating saw through bilateral intraoral incisions in the gingival sulcus. It is anecdotally known that despite these advances in instrumentation, most rhinoplastic surgeons still prefer to use osteotomes in the nose.

**TIP-LOBULE COMPLEX**

The size, shape, and position of the alar cartilages relative to the ULC, septum, and soft-tissue envelope determine the conformation of the tip-lobule complex. When the tip-defining points of the dome fall at or below the profile line of the nasal dorsum, analysis of the facial and nasal measurements is needed to determine the status of the tip. When tip projection is adequate, reduction of the dorsum satisfies the aesthetic requirements. When tip projection is inadequate, attempts to increase tip projection are appropriate.

The most difficult aspect of rhinoplasty is to surgically manipulate the tip-lobule complex so as to achieve predictable results. Primary deformities of the tip and supratip area are formidable problems initially, and secondary deformities resulting from inappropriate surgical manipulations are even more difficult to correct.\textsuperscript{11}

A carefully planned and executed operation preserves the normal anatomy of the nose as much as possible. Techniques for the correction of various tip deformities were detailed by Rees,\textsuperscript{99} Sheen and Sheen,\textsuperscript{100} Janeke and Wright,\textsuperscript{117} Peck,\textsuperscript{127} Petroff et al.,\textsuperscript{140} and Rich et al.\textsuperscript{141} Janeke and Wright emphasized the importance of preserving tip support during rhinoplasty by safekeeping the following:

- the dense connective tissue between the lateral crura and the sesamoid cartilages
- the junction of the medial crura with the caudal septum
- the aponeurosis between the upper and lower lateral cartilages

\textbullet{} the interdomal ligament formed by a congregation of dense connective tissue between the domes of the lower laterals

A minimum of 5 mm of intact lateral crural cartilage must be left in place at the caudal margin to support the weight of the soft tissues and maintain tip projection.\textsuperscript{71}

The most important elements of nasal tip projection are the medial crura, their attachments to the caudal septum, and the presence of additional cartilage grafts between the medial crura themselves or beneath the crural feet. Petroff et al.\textsuperscript{140} evaluated 51 patients who underwent primary rhinoplasty. Tip projection was measured preoperatively, intraoperatively, and 6 months postoperatively. Nasal tip projection increased an average 1.5 mm after injection of local anesthetic solution. When either a cartilage-delivery or cartilage-splitting approach was used, most of the support mechanism of the nasal tip was weakened or totally disrupted. Lowering the cartilaginous dorsum and shortening the caudal septum had a profound effect on the postoperative position of the nasal tip. Regardless of the preoperative goal, actual nasal tip projection decreased postoperatively in a majority of patients unless steps were taken to increase the length and strength of the medial crural segment. Of these, 70\% had full transfixion with excision of various amounts of caudal septum. Disruption of the caudal septal attachments not only correlated with a higher incidence of decreased tip projection, but the quantitative loss was 2.8 mm, compared with an overall average of 1.8 mm. When the preoperative goal was to maintain nasal tip projection, the success rate was 28\%. When the preoperative goal was to increase nasal tip projection, the overall success rate was 57\%, but most underwent procedures that increased the strength of the medial crural segment. When the preoperative goal was to decrease tip projection, the success rate was 87\%.

Rich et al.\textsuperscript{141} reviewed 100 cases of nonaugmenting rhinoplasty to measure the effect of lower lateral cartilage excision on nasal tip projection. Three technical variants were used: 1) cephalic resection of the LLC, 2) vertical dome division, and 3) suture approximation of the medial crura (modified Goldman tip) when the cartilage was sectioned. Despite overall good to excellent results, the authors noted a measurable loss of tip projection in all
except one patient.

Byrd et al.\textsuperscript{172} presented a report of a subset of patients who were retrospectively identified as being at high risk of losing tip projection, shape, and rotation during rhinoplasty. Their noses were characterized by a weak midvault, a plunging tip with pollybeak deformity, retracted alae, and weak lower lateral cartilages. These patients had been treated with a floating columellar strut, yet 19 of the 20 patients lost nasal tip projection. Armed with this information, a second group of 20 patients who had similar features were treated prospectively with septal extension grafts, and nasal tip projection was either maintained or increased in all except one. The authors recommended anterior septal extension grafts for controlling projection, shape, and rotation of the nasal tip during open rhinoplasty in these high-risk patients.

Hubbard\textsuperscript{173} reported similar techniques using direct fixation of the medial crura to the septum or septal extension grafts to secure the nasal tip. He noted minimal variance postoperatively. Rohrich and Griffin\textsuperscript{174} presented a classification of asymmetric deformities of the columella and nasal tip and recommended methods of surgical correction (Fig. 14).

These reports prompted the following questions. Does the loss of nasal tip projection during rhinoplasty account for the poor correlation between dorsal resection and overlying soft-tissue response? Can we create the appearance of tip projection after rhinoplasty by lowering the dorsum and rotating the tip despite a measured reduction of true projection? Are we really achieving the desired nasal tip projection, or are we modifying the dorsum simply to create the desired tip-dorsal profile line?

**Suturing Techniques**

Many of the supporting structures to the tip are interrupted during standard rhinoplasty, and it frequently is necessary to increase tip definition at time of surgery.\textsuperscript{171} Kridel et al.\textsuperscript{175} reported a tongue-in-groove technique in which the medial crura are advanced upward and back and the denuded caudal septum is placed into a surgically created space between them. This method corrects excessive columellar show and maintains correction after straightening a caudally deviated septum. It is also indicated for controlling nasal tip rotation and projection while preserving the integrity of the lobular cartilaginous complex. The technique can be combined with either the external or endonasal rhinoplasty approach.

Kridel et al.\textsuperscript{171} showed the value of sutures in enhancing nasal tip rotation and projection and illustrated the correction of wide, bulbous, amorphous tips in 50 patients using a suture technique they called *lateral crural steal* (LCS) through an open rhinoplasty approach. The concept behind LCS is to increase the length of the medial crura at the expense of the lateral crura. The suture technique depends on a stable nasal base, which is created by securing the medial crura to each other, proceeding from the base of the columella to the nasal tip. If the medial crura are buckled or weak, a strut of septal cartilage is placed in the columella for additional strength. Plumping grafts are inserted to achieve the desired nasolabial angle. Once the middle crural complex is stabilized, the lateral crura are advanced medially and each is sutured first to its medial crus and then to its counterpart on the opposite side with a mattress suture across the tip complex (Fig. 14).\textsuperscript{174} As the lateral crura are shortened, the tip is relocated superiorly and anteriorly. If tip rotation is not desired, the lateral crus can be freed from its lateral fibrous attachments and vestibular skin so that it can move independently.

Foda and Kridel\textsuperscript{176} evaluated the effect of two cartilage-modifying techniques on their effects on nasal tip projection and rotation. With the LCS technique, the lateral crura are advanced onto the medial crura, resulting in an increase in length of the medial crura and shorter lateral crura. With the lateral crural overlay (LCO) technique, the lateral crura are shortened by vertically transecting them and overlapping the cut edges. Computer imaging was performed on 30 patients seeking primary rhinoplasty mainly for nasal tip repositioning. The external approach was used in all cases. LCS resulted in an increase in both nasal tip projection and rotation. LCO resulted in substantially greater tip rotation but decreased tip projection. The authors concluded that LCS is indicated when a moderate increase in nasal tip projection and rotation is desired and that LCO is reserved for patients with severe tip under-rotation associated with over-projection.

Tardy et al.\textsuperscript{177} reviewed long-term outcomes of transdomal suture techniques on the nasal tip. The
techniques preserve the integrity of the nasal tip (e.g., an intact caudal segment or complete strip of alar cartilage) while reorienting its elements. The transdomal suture is indicated for broad, trapezoidal nasal tips with which the alar cartilages typically are firm and strong, with a broader than normal arch to the dome segment connecting the intermediate and lateral crura. The triad of anatomic findings—firm, broad, divergent alar cartilages; thin skin; and delicate alar sidewalls—should suggest the option of transdomal suture for nasal tip sculpturing.

Tebbetts placed sutures to shape and stabilize the tip by controlling the multiple “force vectors” that influence the tip complex. He reported maintaining the structural integrity of the alar rim strips; shaping and positioning the lateral and medial crura in a reversible, nondestructive manner; minimizing variables by decreasing the need for a visible graft to shape the tip complex; applying sutures judiciously and precisely; and specific sequences for every maneuver.

Regalado-Briz studied 52 patients who underwent an open rhinoplasty technique that used a modification of the suture technique presented by Tebbets. The cephalic portion of the lateral crus was preserved, and lateral crural resection was limited to the most medial aspect. Suture shaping was used to stabilize and control tip morphology. Byrd emphasized the importance of controlling the

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**Figure 14.** Algorithm for surgery of the asymmetric nasal tip. *(Reprinted with permission from Rohrich and Griffin)*
projection and rotation of the domes to establish an aesthetic tip-dorsum relationship.

Daniel\textsuperscript{182,183} presented a two-part review of a simplified three-stitch, open-tip suture technique for primary and secondary rhinoplasty. The technique consists of the following: 1) a strut suture to affix the columellar strut between the crura, 2) bilateral dome-creation sutures to create tip definition, and 3) a dome equalization suture to narrow and align the domes.

Hugo et al.\textsuperscript{184} presented a suture technique for replanting the medial crura in the hooked nose. The medial crura are detached from the septum and from each other, the tip is elevated and rotated to increase projection, and the medial crura are reattached to the septum.

Behmand et al.\textsuperscript{185} tracked the evolution of the major tip suture techniques. Guyuron and Behmand\textsuperscript{186} discussed the sequencing and multiplanar effects of nine tip suture techniques.

Daniel\textsuperscript{187} analyzed the large nostril-to-small tip disproportion “deformity.” He argued against the traditional basal view and the “ideal” ratio of two-thirds to one-third, proposing instead a lateral view analysis and a nostril:tip length ratio of 55:45 or 60:40. He recommended a three-suture tip technique with columellar strut graft and alar base resections to restore this relationship. In his discussion of the Daniel article, Sheen\textsuperscript{188} stated that he prefers tip augmentation with cartilage grafts to achieve the same end.

Scoring or Crushing Techniques

McCollough and English\textsuperscript{189} discussed various modifications of the alar cartilages designed to increase tip projection, all of which involve weakening by scoring or crushing the portion of the lateral crus immediately lateral to the dome and the middle or intermediate crus immediately below the dome. A horizontal mattress suture is used to pull the tip-defining points centrally and to carry the alar cartilages medially, narrowing the lobule and increasing the vertical height of the tip-defining points. These maneuvers are most applicable when the tip-lobule complex is broad and the excess width can be aesthetically converted into vertical projection.

Resection Techniques

Goldman\textsuperscript{190} reported that he divides the lateral crus lateral to the dome to narrow the lobule and to add projection to the tip. The method borrows from the lateral crus to augment the height of the medial crus (Fig. 15).\textsuperscript{171}

With the modification presented by McLure,\textsuperscript{191} no vestibular skin is included with the segment of the lateral crus that is rolled medially and a septal cartilage strut is added between the medial crura for support. A small separation is maintained between the repositioned lateral crura to simulate a double nasal dome.

The effects on the nasal tip of resecting the alar cartilages in the dome, intermediate crus, and medial crus are illustrated in Figure 16. These are radical solutions to the problem of the drooping nasal tip, and in thin-skinned individuals, they are apt to leave visible irregularities.

Kamer and Cohen\textsuperscript{192} presented a method of excising a central horizontal strip of alar cartilage to elevate the tip, increase tip projection, and rotate the tip superiorly while preserving structural integrity of the arch. The defect created during the resection is closed by rotating the caudal segment of the lateral crus cephalad and affixing it to the still-stable cephalic margin. The authors recommended the technique for noses that have a wide dome and a drooping tip.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{image.png}
\caption{Suture technique for increasing projection of the nasal tip. (Modified from Kridel et al.\textsuperscript{177})}
\end{figure}
Massiha\textsuperscript{193} described a similar technique involving elliptical horizontal excision and repair of the alar cartilage in open rhinoplasty to correct cartilaginous tip deformities. With this technique, an elliptical excision is made in the central segment of the lower lateral cartilage in a horizontal correction and the upper and lower edges of the remaining cartilage are repaired with 5-0 nylon sutures. The technique seems to be identical to that presented by Kamer and Cohen.\textsuperscript{192} Figure 17 illustrates the potential effects on the nasal tip of resecting the cephalic border of the alar cartilages and caudal septum.

Adamson et al.\textsuperscript{194} presented a report of 116 consecutive patients who underwent open rhinoplasty and vertical dome division. Patients undergoing surgery early in the series underwent cartilage resection and suture reapproximation, whereas those undergoing surgery later underwent dome division, overlap, and suturing. Vertical dome division is recommended for the correction of lobule asymmetry, retrodisplacement, wide domal arch, and a hanging infratip lobule. An important consideration with the cartilage-overlap technique is reduction in nasal tip projection. If a loss of tip projection is not desired, tip grafts or other methods to enhance tip projection are needed.

**Figure 16.** Effect on tip projection from resection of the lateral crura at two points.

**Figure 17.** Effect of tip projection from resection of the lateral crura at the dome (A), the intermediate crura (B), and the medial crura (C).

**Grafts to the Tip**

Grafts to the lobule complex can improve tip projection when manipulation of the existing cartilage alone fails. A cartilage graft is inserted within a limited soft-tissue pocket under some degree of tension to produce angulation at the columella-lobule junction,\textsuperscript{195} projection and angularity at the dome area,\textsuperscript{127,195} or support of the medial crura-columella to prevent settling.\textsuperscript{81,82}
Sheen\textsuperscript{195} reviewed his 20-year experience with grafts to the nasal tip, which he thinks are best suited for primary rhinoplasties. He divided his experience into three parts, paralleling the evolution of nasal tip grafting to current standards. Over the years, sources of graft materials have included the septum, ear, rib, vomer, and ethmoid. Septal cartilage grafts have evolved from a single columella-lobule contour graft to multiple small septal cartilage fill grafts, sometimes crushed or bruised to avoid angularities and to improve definition. Ear cartilage is a distant second choice to septal cartilage because of its tendency to shatter when manipulated. Sheen reserved rib cartilage grafts for cases involving complex reconstruction of the entire nasal skeleton. Because of progressive resorption of vomer and ethmoid bone grafts for the tip, Sheen used them only as buttresses to hold overlying septal cartilage grafts.

The most persistent complications of tip grafts in the series presented by Sheen\textsuperscript{195} were malposition and undesirable angularities. Tip grafts can shift their position and cause a number of problems. Grafts that are displaced laterally cause asymmetry; those that migrate upward cause tip blanching or over-projection; and if displaced downward, they protrude from the columella. Oversized grafts can also compromise the vascular supply to the skin of the lobule. Sheen emphasized the need for thorough preparation and precise wound closure to keep infections to a minimum.

Cárdenas-Camarena and Guerrero\textsuperscript{196} reported an 8-year experience with cartilage grafts in nasal surgery, encompassing 83% from the nasal septum, 12% from the ear, 3% from the alar cartilages, and 2% from the rib. Grafts were placed between the medial crura in 64%, as Sheen tip grafts in 28%, in the nasal dorsum in 19%, as spreader grafts in 8%, as Peck grafts in 8%, and in the rim in 3%. Reoperation to achieve the desired result was required in 8%.

Bateman and Jones\textsuperscript{197} reviewed outcomes of augmentation rhinoplasty using autologous cartilage grafts in 103 patients followed for an average of 3 years. The revision rate during the follow-up period was 15.5%. The same surgeons’ revision rate in 311 rhinoplasties without grafts during the same period was 4%. The authors concluded that rhinoplasty with cartilage graft is associated with a significantly higher revision rate than when no graft is required.

Constantian\textsuperscript{198} noted that 77% of patients undergoing primary rhinoplasty and 80% of patients undergoing secondary rhinoplasty in his practice required grafting mainly to improve lobular contour, not tip projection. He described the distant effects of dorsal grafts and tip grafts in rhinoplasty and outlined his techniques for achieving the effects. Grafts affect nasal length, symmetry, ethnicity, and dorsum-tip relations. Constantian\textsuperscript{199} subsequently elaborated an alternative cartilage-bearing tip graft technique with which small amounts of autologous donor material are used to augment only those lobular segments that require increased contour or support. The technique evolved in response to the high number of patients with inadequate donor cartilage for traditional shield-type grafts and in response to the observation that by enlarging the lobule, tip grafts can create undesirable postoperative disproportions in some patients. The revision rate in 405 rhinoplasties (40% primary, 60% secondary) was 14%.

Peck\textsuperscript{200} reported using rectangular onlay grafts of septal or auricular cartilage that are placed overlying the domes. A tight pocket helps keep the graft in position, but, if necessary, the graft can be stabilized with a pullout suture. Much like Sheen tip grafts, Peck onlay grafts can displace, distort, or partially resorb, and it is difficult to judge intraoperatively the appropriate degree of projection desired. The result is that the tip often is over- or undercorrected.

Peck et al.\textsuperscript{201} described an 18-year experience with the umbrella graft in rhinoplasty. The graft consists of a vertical cartilaginous strut between the medial crura and a horizontal onlay graft overlying the alar domes. The umbrella graft was used in 22% of 1252 mostly secondary rhinoplasties. The revision rate for the umbrella graft was 5%, and the most common complication was visible cartilage. In his discussion of the article by Peck et al., Rohrich\textsuperscript{202} stated that nasal tip support usually depends equally on the length and strength of the paired lower lateral cartilages, which in turn are supported by the suspensory ligaments connecting the domes and the fibers that connect them with the ULC.

Baker and Courtiss\textsuperscript{203} noted that parchment-thin skin is a common problem associated with secondary rhinoplasty. The authors suggested that an onlay graft of temporalis fascia is the most satisfactory method of
covering the underlying osseocartilaginous framework or cartilage grafts in patients who exhibit this condition. The surgical results in six patients with temporalis fascia grafts are reviewed. A biopsy of the temporalis fascia and cartilage graft confirmed the long-term viability of the fascia and its underlying cartilage.

Anderson\textsuperscript{96} reported a preference for a strut of cartilage from the septum placed between the medial crura, from the level of the upper border of the nostrils downward, almost to the premaxilla. Millard\textsuperscript{204} recommended anterior septum-columellar struts extending from the premaxillary area to the nasal tip. Dibbell\textsuperscript{205} described the use of a Bowie knife-shaped strut to increase tip angularity and projection, particularly in noses associated with cleft lip. The potential disadvantages of strut grafts are a widened columella, a tent-pole effect with blanching at the nasal tip, leaning of the tent pole, and visibility of the graft through the skin.

Arden and Crumley\textsuperscript{206} reviewed their clinical experience with and indications for combined placement of columellar struts, shield grafting, and caudal septal grafts. Patients most likely to require combination grafts are those with lobular hypoplasia or tip under-projection. The authors advocated a columellar strut sutured to the medial crura and septal midline when a transfixion incision is required. They noted that shield grafts are particularly useful in highlighting tip architecture in the Asian, Hispanic, Mestizo, or black nose and in revision rhinoplasties with which tip scarring or existing alar cartilage structures prohibit natural skin redraping. For lengthening the nose, caudal septal grafts are used, but the limiting factor is the amount of available lining. Porter et al.\textsuperscript{207} advocated a contoured auricular projection graft for nasal tip projection in Asian and black noses.

Orak et al.\textsuperscript{208} presented a report on an extra-supported tip graft for the treatment of bulbous nasal tips. The technique involves an A-shaped tip graft supported with a columellar strut, both inserted into small separate pockets (Fig. 18).

Gunter and Rohrich\textsuperscript{209} introduced alar spreader grafts for correction of the pinched nasal tip. The grafts are shaped like bars or flat triangles and are carved from autogenous septal or auricular cartilage. The spreader graft is inserted between and deep into the remaining lateral crura to force them apart, propping up the caved-in segment of the pinched tip.

De Carolis\textsuperscript{210} reported using an infradome graft to improve dome reshaping in rhinoplasty. The technique places under the domes two parallel strips prepared from the resected alar cartilages. The grafted cartilages block the plication suture, which averts excessive pinching of the domes and enhances stability.

McCollough and Fedok\textsuperscript{211} described the technique of lateral crural turnover graft for correction of the concave lateral crus. Adham and Teimourian\textsuperscript{212} reported mobilizing and advancing the lateral crura toward the alar rim. The alar cartilages are reshaped, and the domes are grafted with stacked disks of cartilage (individual dome-projecting grafts). Adham\textsuperscript{213} later modified the procedure by camouflaging the stacked disk grafts with LLC trimmings (from the cephalic edge) to avoid a boxy look.

Hamra\textsuperscript{214} noted that he prefers crushed cartilage grafts to alar domes after reduction rhinoplasty via the open approach. The tip is reduced through dome division and suture reconstruction. Contour deformities are avoided by overgrafting the divided domal segments with a crushed onlay graft.

\textbf{Will:}
1. Reduce tip fullness and increase definition of dome projecting points
2. Rotate tip cephalad

\textbf{Might:}
1. Decrease tip projection
2. Hitch or raise alar margin
3. Weaken support of nostril arch

\textbf{Figure 18.} Effect on tip support and projection from resection of a cephalic strip of lateral crura.
Guyuron et al.\textsuperscript{215} introduced a subdomal graft for management of the pinched nasal tip. The graft is placed into a subdomal pocket extending from one dome to another (8–10 mm long × 1.5 mm wide × 1.5 mm thick). The technique was successfully applied in 53 primary rhinoplasties and eight secondary cases of pinched nasal deformity or asymmetric domes.

Hamra\textsuperscript{216} opted for dome excision, side-to-side cartilage repair, and crushed cartilage overlay graft to improve tip contour. This is a simple method with which to treat tip deformities and reduce tip projection when the angle of divergence is normal.

Bujia\textsuperscript{217} studied the viability of chondrocytes in crushed, uncrushed, and cut cartilage grafts. More cartilage cells (70%–90%) are damaged by crushing than by cutting, which leaves most cells viable and able to proliferate.

Pereira et al.\textsuperscript{218} assessed the availability of block conchal cartilage for total reconstruction of the ala in a cadaveric model. “…from the lamina tragi, isthmus, and cavum conchae, en bloc resection is possible with characteristics of form and dimension similar to those of the homolateral alar cartilage.”

Fanous and Webster\textsuperscript{219,220} recounted their experience with Mersilene tip implants (Ethicon, Somerville, NJ) or the correction of tip deformities in 98 patients. Indications were recession, boxiness, asymmetry, thick or thin skin, upward or downward turn, and a bifid tip. Mersilene mesh is soft, pliable, and easily shaped and can be invaded by surrounding connective tissue, which affixes the implant firmly in place and prevents displacement.\textsuperscript{220}

Despite this favorable report, readers should be circumspect in their use of alloplastic materials in the nasal tip. Aside from the potential for tissue ingrowth and scar, an alloplast rejection reaction would have catastrophic consequences in this critical area of the nose. Autogenous sources of tip grafts, such as nasal septum and ear cartilage, are undeniably superior in nasal reshaping.

**Broad or Boxy Tip**

A nasal tip that looks boxy or bulbous rather than triangular from the basal view is the product of either an increased angle of divergence of the medial crura or a wide arc in the dome segment of the lateral crura. Tasman and Helbig\textsuperscript{221} measured the distance between the domes and the skin thickness over the LLC before and after transdomal suture tip plasty. The distance between the cartilaginous domes correlated with tip width before surgery. After surgery, the degree of tip refinement correlated with preoperative skin thickness but not with interdomal distance. These data provide further evidence that tip definition surgery is limited by thick soft tissues.

Rohrich and Adams\textsuperscript{222} proposed an algorithm for the management of nasal tips: type I, angle of divergence is >30°; type II, domal arc between tip-defining points is >4 mm; type III, both conditions are present (Fig. 19). The technique involves limited domal and cephalic trimming and then transdomal and/or interdomal suturing. The endpoint is reached when the distance between tip-defining points is 5 to 6 mm. Gruber and Friedman\textsuperscript{223} presented a discussion of the rationale for use of sutures in the correction of broad or bulbous tips: the transdomal suture (to narrow the individual domes); the interdomal suture (to bring symmetry, to add tip strength, and sometimes to narrow the tip complex); the lateral crural mattress suture (to reduce lateral crural convexity); and the columella-septal suture (to prevent tip droop and to adjust tip projection).

**Division Techniques**

Goldman\textsuperscript{190} narrowed the square tip by completely transecting the lateral crura and vestibular skin. A modification of this approach divides the lateral crura outside the dome area, with or without division of vestibular skin.\textsuperscript{224} The medial crura can then be sutured near the dome, or the lateral crura can be rotated medially and sutured to gain further projection anteriorly. McKinney and Stalnecker\textsuperscript{225} described their modification of the Goldman technique for bulbous tips in thick-skinned individuals with both normal and overly projecting dome points. Unless the skin of the nose is very thick, transection techniques produce a more triangular tip at the expense of a single dome point, the distinct possibility of pinching or kinking the alar rim, and visible asymmetries.

**Scoring Techniques**

Unlike transection, scoring usually maintains the integrity of the cartilage and hence support of the tip, with less visibility of the cut cartilage edges. McCollough and
English discussed an alternative to the Goldman technique that consists of scoring the cartilage medial and lateral to the dome and bringing the lateral crus medially with horizontal mattress sutures. This centralizes the dome segment while avoiding the break or step-off that typifies the Goldman tip. The technique is recommended for use in wide, bulbous, or under-projecting tips.

Peck reported achieving a triangular tip through wide mobilization of the lateral crura with resection of their distalmost segment and scoring of the dome area. Sheen and Sheen described narrowing the broad or boxy tip by interdigitating partial scoring cuts in the dome and medial crura. Hamra modified the technique for repositioning the lateral crus described by Sheen by creating a subcutaneous pocket and sutting the medial crura together. The dissection is simpler, undermining is easier, and the procedure can be done through an open or closed approach. The technique is indicated for patients who have cephalically positioned lateral crura showing the “parentheses” deformity on frontal view. In these cases the tip frequently is flat and broad, the alar rim is notched, and the basilar view shows a square perimeter.

**Over-projecting Tip**

Over-projection of the nasal tip—the “Pinocchio nose”—results from excessive length of the medial and lateral crura. Procedures designed to reduce the over-projecting tip involve full-thickness resection of either the medial or lateral crura, or scoring of the dome-medial crura junction, with or without resection of the lateral crura. Goldman and Tardy et al. analyzed the over-projecting tip. They found that overdevelopment of the caudal quadrangular cartilage tends to “tent” the tip away from the face and can tether the upper lip, producing an indefinite nasolabial angle. This can occasionally create

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**Figure 19.** Management algorithm for the boxy nasal tip. *, Domal resection and suture reshaping in excessively wide domal arch (>6 mm); resilient lateral crura included. (*Reprinted with permission from Rohrich and Adams.*)
abnormal exposure of the maxillary gingiva, especially during smiling. Correction begins by lowering the cartilaginous profile, releasing the tip from the abnormal influence. Almost every case required weakening tip support and overall reduction of the overdeveloped components. After complete transfixing incision, the tip immediately settled back.

Any procedure that transects the rim of the alar cartilage can alter the smooth arch of the nostril and produce sharp edges, a notch, or step deformity. To minimize the potential complication, it is essential to precisely realign and suture the transected cartilage ends and to keep intact as much of the nasal lining as possible.

Neu230 reported that he addresses the Pinocchio tip by rolling the lateral crura medially and creating new, less prominent domes while preserving the natural bowing of the alar arch. If necessary, any extra length can be excised at the footplates, which causes caudal rotation of the tip.

Smith and Smith231 reported reducing the over-projecting tip through an open rhinoplasty technique that transects and raises a columellar flap, which carries the crura of the alar cartilage within. Tip sculpting is limited to cephalic trimming of the lateral crura.

Gryskiewicz232 described resecting columellar skin to avert an iatrogenic hanging columella after reducing an over-projected tip. The optimal indication for this technique is when tip setback is >3 mm.

**Surgery on the Columella, Nasal Spine, and Lip**

The columella-lip angle is directly influenced by the configuration of the nasal spine and caudal septum. When a person is smiling, the upper lip pulls back and the caudal border of the septum and nasal spine appear to protrude downward, sharpening the columella-lip angle. Aston and Guy233 reviewed techniques for resection of the caudal border of the septum and the nasal spine. Figure 20 illustrates the effects of these maneuvers on the columella-lip angle.

![Figure 20. Effect on the columella-lip angle of resection of the caudal septum and nasal spine. (Modified from Aston and Guy.233)](image-url)
Over-resection of the caudal septum or nasal spine can produce an excessively obtuse septolabial angle (“pig nose”), an acute septolabial angle with a plunging tip (“witch’s nose”), a retracted columella, or a flat upper lip that seems excessively long (“ape lip”). Webster et al. discussed the anatomy of the columella and analyzed the aesthetics of the nose regarding surgical techniques for correcting deformities of the lip-columella junction, including tissue subtraction, tissue addition, and sliding procedures.

Cachay-Velasquez advocated a Rowen-Boyd resection of the depressor septi nasi muscles to correct the rhinogingivolabial syndrome: drooping nasal tip, short upper lip, and increased exposure of the maxillary gums, particularly when smiling. Resection is continued through an extension of the transfixion incision and frequently is accompanied by partial resection of the caudal septum and nasal spine. The postoperative results reflect the change induced in the columella-lip angle and between the tip and upper lip.

Rohrich et al. studied the role of the depressor septi nasi muscle in rhinoplasty and described three anatomic variations. An active depressor septi muscle can accentuate a drooping nasal tip by shortening the upper lip on animation. The authors recommended muscle release and transposition through a sublabial intraoral incision during rhinoplasty to improve the tip-upper lip relationship.

De Benito and Fernandez Sanza reported resecting the columella and nasal depressor muscles to improve the nose-lip relationship and the smile. The resection eliminates the downward movement of the nasal tip with smiling.

Lawson and Reino described reduction columelloplasty, which involves full-thickness excision of a diamond-shaped piece of tissue from between the feet of the medial crura. The incision is continued down through the skin, depressor septi muscle, and adjacent soft tissue. When the defect is closed, the splayed medial crura are brought together, increasing the nasolabial angle, modifying the shape of the nares, and increasing projection of the nasal tip.

Pessa suggested selective resection of the levator alae (levator labii superioris alaqui nasi) muscle to correct the acute nasolabial angle and prominent nasolabial folds and to improve asymmetries in nasal base position. Cadaveric dissections have shown that the levator alae muscles originate at the frontal process of the maxilla and insert into the lateral alae and orbicularis oris muscles. The angular artery and vein lie medial and superficial to the muscle and serve as a reliable guide to its position. The infraorbital nerve is lateral to the levator alae muscle and lies beneath the levator labii superioris muscle, approximately 7 mm below the orbital rim. The principal action of the levator alae muscle is to elevate the alar base, producing a sneer or snarl. As the alar base is elevated, the nasolabial angle becomes acute and the medial nasolabial fold becomes accentuated. The muscle is approached through a subciliary incision, a skin-muscle flap is elevated, the orbicularis oculi muscle is dissected inferiorto free it from the orbital rim, and dissection proceeds medially to the groove between the maxilla and nasal bones, where the levator alae muscle is located and identified. A 0.5- to 1-cm-long segment of muscle is resected. Alternatively, muscle resection can be accomplished through a buccal sulcus incision.

Foda reviewed his results after a minimum of 1 year in 360 consecutive “droopy tip” rhinoplasties using three alar cartilage modification techniques. He found LCS to be most effective for under-projected tips. LCO worked best in cases of over-projected tips. The tongue-in-groove technique was best suited for tips with adequate projection.

Guyuron studied abnormalities of the footplate of the medial crura and how their surgical correction influences the outcome of rhinoplasty. In a prospective series of 20 consecutive primary rhinoplasties, the author found the distance between the medial footplates to be 7.5 to 15 mm (average, 11.4 mm). The length of the footplates was 4 to 7.5 mm (average, 5.8 mm).

In a retrospective review of 295 consecutive rhinoplasties, footplates were altered in 76 cases. In cases of over-projecting tip and divergent footplates, the lateral portion of the footplates was partially resected and then approximated. If the tip was under-projecting or had normal projection, the divergent footplates were approximated without resection. When the subnasale and the base of the columella protruded, the soft tissue between the footplates was removed. When the footplates
diverged, the columellar base and nasal spines were retracted but the soft tissues were left undisturbed so as to narrow the columella and advance it caudally.

**Lengthening the Short Nose**

The short nose is characterized by lower-than-normal distance from the nasofrontal angle to the tip-defining points and an overly wide nasolabial angle with increased nostril show. Gunter and Rohrich described a technique that lowers the tip-defining points by detaching the lateral crura from their attachments to the ULC, suspensory ligament, and septum (Figs. 21 and 22). The release effectively rotates the alar cartilages caudally, lowers the dome, decreases projection of the tip, and lengthens the distance between the nasofrontal angle and the tip-defining points. As tip projection decreases, the illusion of nasal length increases. The technique is best suited for patients who have a short nose with an over-projecting tip.

Lee et al. described lengthening the postoperative short nose with a combination gull-wing conchal composite graft and rib costochondral dorsal onlay graft as a replacement for the missing nasal lining and cartilage and to reinforce the framework, respectively. Wide degloving of the outer skin envelope is recommended to cover the entire nasal length without tension.

The problem with this method of reconstruction is the failure to differentially project the nasal tip above the plane of the reconstructed dorsum. The outcome of this technique is a somewhat under-projecting tip with pollybeak deformity fullness. A more aesthetic result can be obtained by incorporating columellar support to raise the nasal tip above the plane of the dorsum.

Naficy and Baker illustrated five techniques for lengthening the short nose:

- the flying buttress graft, which is made up of a single spreader graft or paired spreader grafts secured to the columellar strut
- caudal septal grafts
- tip grafts of various shapes
- radix grafts to elevate the nasion
- interposition grafts between the upper and lower lateral cartilages

![Figure 21. A, Aesthetically short nose. NFA, nasofrontal angle; TDP, tip-defining point. B, Lengthening an aesthetically short nose with inferior rotation of the lower lateral cartilages. (Reprinted with permission from Gunter and Rohrich.)](image)
Ha and Byrd revisited their experience with septal extension grafts: extended spreader grafts, paired batten grafts (below the junction of the septum and ULC), and direct extension grafts (directly affixed to the anterior septal angle when cartilage supply is limited). Despite the tremendous versatility of the grafts in primary and secondary rhinoplasty, the authors cautioned against supratip and/or midvault widening and excessive lengthening from “over-extension.”

Guyuron and Varghai reported lengthening the nose with a tongue-and-groove technique and three pieces of appropriately shaped septal cartilage. The technique combines bilateral spreader grafts beyond the septal angle with a columellar strut while avoiding rigidity of the tip. The authors presented a report of 20 of 23 patients enjoying good to excellent results during 12.5 years but warned that the technique is labor-intensive and requires sufficient cartilage.

Juri recommended conchal cartilage grafts in the nasal tip in conjunction with wide cutaneous undermining and wide mucosal lining undermining for the treatment of the iatrogenically retracted tip and short nose. In the article, he detailed the method of precisely shaping the cartilage grafts.

Hamra treated 15 patients with surgically shortened noses by means of infratip cartilage grafts. A two- or three-tier cartilage graft from septal or conchal donor site is sutured to the caudal edge of the medial crura. According to the author, the success of this operation was partly because of increased inelasticity of skin among the older patients in the series.

To lengthen the nose, Gruber suggested releasing the septal mucoperichondrial lining and ULC from the LLC. A batten graft is attached to the septum, which in turn holds the tip cartilages in a more caudal position. The most common complication is inadequate lengthening.

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Tension Nose

Excessive growth of the quadrilateral cartilage results in a high nasal dorsum with anterior and sometimes inferior displacement of the nasal tip cartilages: a tension nose. Johnson and Godin reviewed 50 consecutive primary rhinoplasty candidates and noted that 46% had some manifestation of tension deformity. The authors recommended an open approach to reduce the excessive elements of septal cartilage and anterior nasal spine. Cartilage grafts and sutures can then be used to re-project the domes. Tardy et al. offered a different perspective on the same anatomic deformity.

PHYSIOLOGICAL AIRWAY

Howard and Rohrich summarized the nasal anatomy and physiology in nasal airway obstruction. Primary air flow is through the middle meatus (Fig. 23). Resistance to air flow is structurally related to hypertrophic
turbinates, valvular incompetence, septal deviation, and intranasal masses. Constricted points along the way increase the velocity of air flow and can generate negative pressures that collapse the internal and external nasal valves (Fig. 24). The appropriate treatment of the obstructed nasal airway depends on its cause. Medical management often is recommended for nonstructural rhinitis. When the airway obstruction is caused by turbinate disorders, a deviated septum, or incompetent internal or external nasal valves, surgical treatment is required.

TURBINATES

Jackson and Koch reviewed controversies in the management of hypertrophic inferior turbinates, with emphasis on surgical treatment. Ophir analyzed the results of total inferior turbinectomy after 1 to 7 years in 38 patients: 84% reported subjective relief of nasal obstruction, and 92% had wide clean nasal airways shown by rhinoscopy. Objective airflow measurements in 32 patients showed increased patency in all, including three patients who still complained of nasal obstruction. No atrophy of the nasal mucosa or chronic infection occurred. The author recommended total inferior turbinectomy for patients with obstructing inferior turbinates.

Courtiss and Goldwyn looked for undesirable long-term sequelae in 25 patients who had resection of obstructing inferior nasal turbinates at least 10 years earlier. They found no incidence of dry nose syndrome and concluded that bilateral subtotal resection of the inferior turbinates is the treatment of choice for nasal obstruction caused by hypertrophied turbinates.

Surgery on the inferior turbinates should be considered along with septal straightening when

Figure 23. Primary inspiratory current is an arched pathway through the middle meatus. (Reprinted with permission from Howard and Rohrich.)

Figure 24. A and B, Two views of the boundaries of the internal and external valves. Internal nasal valve angle is normally 10° to 15°. (Reprinted with permission from Howard and Rohrich.)
attempting to relieve nasal obstruction. Pollock and Rohrich\textsuperscript{258} reported their experience with 408 patients with obstructed airways who were successfully treated with adjunctive inferior turbinate resection. The authors preferred performing full-thickness excision of the anterior one-third to one-half of the inferior turbinate. Long-term follow-up revealed no evidence of atrophic rhinitis or untoward sequelae.

Rohrich et al.\textsuperscript{259} reported a preference for submucous resection (SMR) of hypertrophic inferior turbinates, which, in their series, was associated with fewer complications of bleeding, mucosal crusting or desiccation, or recurrent obstruction. The anterior one-third to one-half of the bony segment is resected with this technique. No atrophic rhinitis was reported.

Smith et al.\textsuperscript{260} reported a technique describing resection of the pyriform aperture in patients with residual obstructive symptoms after inferior turbinate resection with or without septal surgery. The medial aspect of the prominent nasal process of the maxilla at the pyriform aperture is removed via an endonasal approach. The authors reported a subjectively substantial improvement in nasal airways, including resolution of inspiratory alar collapse, with this technique.

**NASAL VALVES**

Constantian\textsuperscript{261} analyzed the functional effects of alar cartilage malposition. Rhinoplasty with resection of the cartilaginous dorsal roof or alar cartilages is the most common cause of acquired incompetence at the internal and external valves. The external nasal valve is presumed to be the mobile nasal ala at the introitus of the vestibule that is normally supported by the lateral crus. External valvular incompetence ensues from malposition of the alar cartilage. Graft support to the lateral wall of the nostril is recommended to minimize this complication.

Teichgraeber and Wainwright\textsuperscript{262} presented a report of 27 patients with nasal obstruction who were treated over a 3-year period. Of these, 14 had involvement of the internal valve only, two had involvement of the external valve alone, and 11 had involvement of both valves. The cause of the obstruction was previous surgery in 13 patients, trauma in eight, and a congenitally narrow nose in four. Surgery consisted of nasal valve repositioning and cartilage grafting through an open approach. The valves were reconstructed with spreader grafts, lateral crural spanning grafts, crural onlay and sidewall grafts, and columellar struts used singly or in combination (Figs. 25–27).\textsuperscript{262} Treatment was successful in 24 of 27 patients. The authors suggested strategies to prevent nasal valve collapse during rhinoplasty.

![Figure 25. Site and number of cartilage grafts used in reconstructing the nasal valve area. (N = 27). (Reprinted with permission from Teichgraeber and Wainwright.\textsuperscript{262})](image)

![Figure 26. Bilateral spreader grafts (septal cartilage), columellar strut (septal cartilage), resection of the cephalad 1 mm of the lower lateral cartilages, lateral crural spanning graft (septal cartilage), and bilateral turbinoplasties. (Reprinted with permission from Teichgraeber and Wainwright.\textsuperscript{262})](image)
Stucker and Hoasjoe\textsuperscript{263} reviewed the treatment of 56 patients who had nasal valve obstruction. Follow-up duration ranged from 18 months to 13 years. Treatment consisted of open rhinoplasty with valve and sidewall stabilization with a dorsal conchal cartilage graft bridging the ULC and alar cartilage. Rhinomanometry in 24 patients showed objective improvement postoperatively.

Sheen\textsuperscript{106} noted that internal valvular incompetence occurs when the angle between the caudal edge of the ULC and the septum is $<15^\circ$, such as after resection of the midvault roof. Sheen recommended the use of spreader grafts placed submucosally between the dorsum and ULC to widen the ULC-septum angle. Byrd et al.\textsuperscript{137} presented their algorithm for the use of spreader graft options in patients at risk for internal nasal valve dysfunction: high and narrow dorsum, weak middle vault, short nasal bones, or preoperative internal valve dysfunction (Fig. 28).

Schlosser and Park\textsuperscript{264} quantified changes in a cross-sectional area of the nasal valve after placement of spreader grafts and flaring sutures in six cadaver heads. The average minimal area increased by 5.4% with spreader grafts, by 9.1% with flaring sutures, and by 18.7% with combined spreader grafts and flaring sutures. On a scale of 1 (complete obstruction) to 10 (complete patency), the mean nasal patency scores improved from 3.4 to 6.5 with the combination of spreader grafts and flaring sutures. A follow-up article by Park\textsuperscript{265} emphasized the clinical application of flaring sutures to enhance the repair of dysfunctional nasal valves.

Guyuron et al.\textsuperscript{266} introduced the upper lateral splay graft to widen a narrow internal valve. The splay graft spans the dorsal septum but is deep to the left and right ULC. Excessive widening of the caudal portion of the dorsum is possible with imprudent use of the technique. Sen and Iscen\textsuperscript{267} described the spring graft, which is a modification of the splay graft. Two alar resected cartilage grafts are sutured together and placed deep to the ULC as a strengthened spring to prevent midvault collapse and internal valve incompetency. In contrast to the splay graft, the spring graft does not cause excessive widening of the caudal portion of the dorsum. Al-Qattan and Robertson\textsuperscript{268} reviewed acquired nostril stenosis with related airway obstruction occurring secondary to a shortage of vestibular lining and discussed techniques designed to replace the vestibular lining and widen the introitus.

Menger\textsuperscript{269} described an endonasal procedure for widening and strengthening the lateral component of the external nasal valve area. The technique consists of placing permanent submucosal spanning sutures between the piriform aperture and the distal part of the lower lateral cartilage, providing superolateral rotation of the lateral crura and additional support for the lateral nasal wall.

**NASAL SEPTUM**

Deformities of the nasal septum sometimes produce internal nasal obstruction without external deformity, external deformity without airway obstruction, or internal airway obstruction and external deformity. The surgical correction of internal or external septal deformities must strike a balance between preserving dorsal support of the nose on the one hand and obliterating the visible or functional abnormality on the other. The correction of complex deformities often necessitates both SMR and some form of septoplasty.

Episodes of staphylococcal bacteremia resulting in metastatic infection have occurred in association with nasal septoplasty, suggesting the possible need for antimicrobial prophylaxis. Silk et al.\textsuperscript{270} reviewed the records of 50

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure27.png}
\caption{Bilateral spreader grafts (homograft irradiated cartilage), columellar strut (homograft irradiated cartilage), right lower lateral cartilage graft (ear cartilage), and lateral crural spanning graft (septal cartilage). (Reprinted with permission from Teichgraeber and Wainwright.\textsuperscript{262})}
\end{figure}
healthy patients who had blood cultures drawn before and during the procedure. Although 50% had colonization of the nasal mucosa by Staphylococcus aureus, none of the blood cultures showed bacterial growth. The authors concluded that staphylococcal bacteremia during nasal septoplasty is a rare occurrence that does not warrant antimicrobial prophylaxis.

Yoder and Weimert\textsuperscript{271} analyzed the infection rate in 1040 patients who underwent septal surgery without prophylactic antibiotics. Minor nasal infections developed postoperatively in five patients (0.48%), and all responded to orally administered antibiotic therapy. The authors concluded that the risk of infection after nasal surgery without antibiotic coverage is minimal.

**SMR**

SMR of an obstructive septal deformity was first described by Killian\textsuperscript{272} in 1905. Currently, the basic principles of subperichondrial dissection and resection of the obstructing cartilage remain largely unchanged. Dingman and Natvig\textsuperscript{273} noted that the Killian SMR is seldom indicated. They stated that if performed, it should preserve at least 1 cm of the dorsal margin and 1 cm of the caudal portion of the septal cartilage.

Bernstein\textsuperscript{274} presented a list of indications for SMR, including midseptal obstructive deformities. After conservative excision of the most severely obstructing portions of the septum by SMR, the remaining cartilage usually is realigned by septoplasty techniques.
Septoplasty

Edwards reviewed the rationale for septoplasty. Simple midseptal deflections (which can be successfully managed by SMR) comprise only 25% of cases, whereas caudal dislocations account for approximately 65%. Complicated deformities make up the rest. According to Edwards, SMR results in inadequate correction of these more complicated deformities, three-fourths of which are best treated by septoplasty.

In 1950, Converse recommended vertical scoring of the residual dorsal strut of the septum to correct persistent deviations of the dorsum. Fry later described “interlocking stresses” in nasal septal cartilage that could be relaxed by scoring the cartilage. Numerous modifications of scoring techniques have since evolved, along with procedures combining resection and scoring.

Gruber and Lesavoy advocated closed septal osteotomy to realign the bony septum (perpendicular plate of the ethmoid, vomer, and vomerine ridge). An intranasal fracture is created with a long nasal speculum. All 32 patients in their series had fracture of the vomer and perpendicular plate of the ethmoid. The vomerine ridge (premaxilla area) was fractured in 69%. This resulted in dramatic straightening of the bony septum in 82% of patients.

Combined SMR and Septoplasty

Noting that a timid surgical attack of the deviated septum can result in persistent deformity, Johnson and Anderson recommended a more aggressive approach consisting of resection of an inferior strip of septum next to the nasal spine so that the septum can swing freely toward the midline. The authors advocated total or near-total transection of the dorsal strut to correct a deviation while preserving intact mucoperichondrium on the convex side. The septal strut is stabilized with transseptal mattress sutures to prevent collapse after division. Medial and lateral osteotomies to reposition the nasal bones complete the procedure. Any residual deformities of the dorsum can be camouflaged with morcellized autogenous cartilage grafts.

Byrd et al. proposed an algorithm for correction of the crooked nose through an open approach. Anatomic correction consists of total release of the cartilaginous septum from the LLC and ULC and cartilaginous and bony septal resection to free the dorsal and caudal septum. Scoring is avoided, and the curvature is corrected by repositioning the septum and control sutures aided by batten and extended spreader grafts. The nasal tip routinely is secured with a combination of batten and spreader grafts to preserve tip projection. Osteotomies are modified to deal with specific deformities in the bony skeleton.

de la Fuente and Martin del Yerro stated that they prefer bilateral mucoperichondrial-mucoperiosteal dissection of the septum from its caudal edge to the most posterior deviated part. They reported that it provides easy septal resection in a good surgical field. A dorsocaudal L strut is preserved when possible, but if involved in the deviation, it can be resected and reconstructed with dorsal and columellar grafts.

Cannistrá et al. advocated an endonasal technique with full release of the septum from the ULC. Rees noted that when a high bony deviation is associated with marked distortion of the cartilaginous septum, the surgeon is challenged to completely alleviate the septal deformity and simultaneously correct the external bony vault deflection without totally excising the septum. For severely deviated noses, Rees recommends total removal of the entire bony and cartilaginous septum extramucosally and replacement as a free graft. This is a somewhat risky procedure if the lateral osteotomy and infracture turn out to be less than perfect.

In 1995, Gubisch described complete removal of the septum with subsequent replantation after correction of deformity in 1012 patients. All septal replants healed primarily. The complication rate was 2.2%. The main problem with the technique was difficulty in reconstructing the dorsum and stabilizing the replant.

Sheen and Sheen noted that a midline septum can be irrelevant to the objectives of septal surgery (i.e., patent airways and a nose that appears straight). Sheen reported that he opts for a conservative approach involving careful resection of portions of the obstructing septum, which are subsequently crushed and replaced as camouflage grafts to mask the deviations. Constantian described resecting the dorsum in the area of deviation until the dorsal edge is close enough to the midline to disguise the remaining asymmetry.
Jugo\textsuperscript{286} advocated total septal reconstruction through an external approach. He reported gaining access to the septum between the alar cartilages along the nasal dorsum. After removal of the entire septum, the straight cartilage from the center is used to reconstruct the ventral-caudal and ventral-cranial septum. The deformed cartilage is straightened by crushing and is replaced back into the posterior septal space. Five girls and 19 boys, ages 5 to 14 years, were treated this way, and the author reported no alterations of growth necessitating reoperation.

Gunter and Rohrich\textsuperscript{287} reviewed the management of the deviated nose and advocated simultaneous correction of the septum and bony pyramid when both structures are involved. The authors proposed extensive alteration of the septum but a conservative approach to the external nasal framework. Total septal reconstruction entails mobilization of all deviated structures, including the ULC, and reconstruction of the deviated L strut along the dorsum, if necessary. The mucoperichondrial attachments should be disturbed as little as possible to preserve dorsal support to the nose. Planned precise osteotomies are performed on the nasal bones.

Rohrich et al.\textsuperscript{288} grouped nasal deviations into three basic types: caudal septal deviations, concave dorsal deformities, and S-shaped dorsal deformities with deviation of the bony pyramid. Management includes open exposure of all deviated structures, release of all involved attachments, straightening the framework while maintaining a sturdy L-strut, restoring long-term support with buttressing septal batten or spreader grafts, turbinate reduction, if necessary, and precise osteotomies (Fig. 29).\textsuperscript{288}

Guyuron and Behmand\textsuperscript{289} discussed the diagnosis and management of caudal nasal deviation by independently assessing the components of the caudal nasal structures: septal deviations, asymmetric growth of the lower lateral cartilages, anterior nasal spine tilting, and medial crural footplate asymmetry. The authors recommended specific techniques to address each of these potential sources of deviation.

Boccieri and Pascall\textsuperscript{290} addressed the crooked nose with septoplasty, full-thickness incisions, and a unilateral cartilage spreader graft, referred to as a crossbar graft, that splints the concave surface of the deviated septum. The surgeon must avoid degloving the contralateral surface or interrupting the anatomic continuity of the L-shaped septal strut.

Conservative approaches to septal deviation use onlay grafts to mask the deformity, but subsequent resorption or displacement of the grafts can produce dorsal irregularities. In turn, radical procedures for septal straightening risk losing dorsal support to the nose, with subsequent collapse of the nasal bridge and saddle deformity. A thorough knowledge of nasal anatomy and physiology is the key to proper correction.

**Figure 29.** Operative plan is component dorsal reduction, septal cartilage resection, and septal L-strut straightening with inferior full-thickness 50% cuts. Suturing the L-strut to the upper lateral cartilages restores support. Bilateral low-to-low percutaneous osteotomies can be performed to narrow the nasal base. \textit{(Reprinted with permission from Rohrich et al.\textsuperscript{288})}.\textsuperscript{290}
Septal Perforations

Teichgraeber and Russo\textsuperscript{291} described the management of septal perforations performed in 25 patients, 22 of whom were treated surgically. The perforations ranged from 1.5 to 2.5 cm and were located on the posterior border of the quadrilateral cartilage near the vomer-ethmoid junction. Operative correction included external rhinoplasty with septal and intranasal mucosal flaps and an autograft of mastoid periosteum or temporalis fascia and was successful in 19 (86%) of the 22 patients.

Kridel et al.\textsuperscript{292} used acellular human dermal allograft in the repair of septal perforations in 12 patients. Eleven had complete closure of the perforation. The repair was considered successful if, at examination 3 months later, the right and left mucoperichondrial flaps were entirely healed. The authors stated that this technique yields satisfactory results similar to those obtained with temporalis fascia, mastoid periosteum, or pericranium.

Schultz-Coulon\textsuperscript{293} reported bilateral closure using bridge flap techniques in 54 patients, with an overall success rate of 93.7%. Closure was supplemented with autologous cartilage from residual septum, rib, or auricle. Morre et al.\textsuperscript{294} reported a similar technique with equally good results. A “cross-stealing” technique for closure of septal perforations was presented by Mladina and Heinzel.\textsuperscript{295} The surgery consists of turn-in flaps based on the margins of the septal perforation from either side of the septum.

Romo et al.\textsuperscript{296} proposed a graduated approach to the repair of nasal septal perforations tailored to the size and location of the perforation:

- Perforations up to 2 cm in diameter were closed in 93% of patients by an extended external rhinoplasty and bilateral posteriorly based mucosal flaps.
- Larger perforations (2–4.5 cm) were closed in 82% of patients by a two-stage technique and midfacial degloving to immediately advance posteriorly based, expanded mucosal flaps. A $1 \times 3$ cm tissue expander was first inserted in a submucoperiosteal pocket on the nasal floor.

Foda\textsuperscript{297} reported a one-stage repair of septal perforations up to 4 cm in diameter, which he performed in 20 patients. The repair consisted of bilateral intranasal mucosal advancement flaps bridged by a connective tissue interposition graft through an external rhinoplasty approach. Complete closure of the perforation was achieved in 90%, and 80% experienced resolution of preoperative symptoms. Ribeiro and da Silva\textsuperscript{298} reviewed their experience repairing septal perforations with bilateral intranasal submucoperichondrial and submucoperiosteal advancement flaps with an interpositional sandwich graft. This method was successful in 257 of 258 cases for correcting perforations ranging from 1.0 to 3.5 cm in diameter. The graft consisted of temporal deep fascia with cartilage folded over in a sandwich fashion.

Guyuron and Michelow\textsuperscript{299} proposed an algorithm for the management of intraoperative nasal septal tears and perforations based on their experience with 98 patients. Small, nonopposing perforations are allowed to heal spontaneously. Opposing tears ranging from 1 to 2+ cm are repaired on one side by inserting a straight piece of septal cartilage, and then the mucoperichondrium is repaired on the other side.

ALAR RIM

The alar rim is a common site of patient dissatisfaction, either because of preoperative deformity or postoperative complication. Gunter et al.\textsuperscript{300} described the ideal alar-columella relationship and classified discrepancies in these proportions. In aesthetically pleasing noses, the highest point of the alar rim is located midway between the transverse levels of the columella-lobule angle and the tip-defining points. As seen on a lateral view, the nostril is oval; the alar rim forms the superior nostril border and the roll of the columella forms the inferior border (Fig. 30).\textsuperscript{300} Abnormal variants can have a hanging or retracted columella, a hanging or retracted ala, or a combination of these.

In profile, the nostril rim should be cephalad and parallel to the columella. When this balance is disturbed, or if raising the columella will shorten the nose excessively, the alar rim(s) might have to be raised, too. Matarasso et al.\textsuperscript{301} reported diagnosing a hanging columella when the septal mucosa is visible on profile, with or without a retracted caudal alar rim and regardless of the nasolabial angle. When unusually wide medial crural cartilages
contribute to the deformity—as was the case in 15% of their series—balance can be restored by excising a C-shaped crescent of cartilage from the cranial border of the medial crura through a direct approach.

McKinney and Stalnecker³⁰² discussed three techniques for achieving a proper columella-ala relationship: 1) excising the skin of the nose, 2) trimming the lateral crura along the cephalic or caudal border, and 3) resecting nasal lining. Decisions relating to these choices are discussed in the article.

Ellenbogen and Blome³⁰³ advocated raising the high point of the alar rim by 3 to 5 mm from the caudal margin of the columella. Indications for raising the alar rim are a cleft nose with anterior webbing, asymmetric nostrils, small or round nostrils, and a hanging sigmoid ala. In the event of a hanging columella, the alar rim might have to be lowered to correct the high-arched nostril. Ellenbogen³⁰⁴ also reintroduced the concept of lowering the alar rim by incising the alar margin along its free length and unfurling vestibular mucosa caudally. A graft of septal or auricular cartilage is placed between the two layers of mucosa at the proposed new alar height and held in place with through-and-through sutures.

Gunter and Friedman³⁰⁵ described the lateral crural strut graft (Figs. 31 and 32) for use in patients with alar rim retraction (Fig. 33), alar malposition, alar collapse (Fig. 34), concave lateral crura (Fig. 35), and/or boxy tip (Figs. 36 and 37). This versatile cartilage graft typically is placed in anatomic position between the lateral crura and the vestibular lining. The authors described their technique and provided illustrative examples of the clinical indications.

Figure 30. In a normal alar-columellar relationship, the greatest distance from the long axis of the nostril to either the alar rim or the columella should be 1 to 2 mm (AB = BC = 1 to 2 mm). (Reprinted with permission from Gunter et al.³⁰⁰)

Figure 31. Lateral crural strut graft. The graft is sutured to the deep surface of the lateral crus. (Reprinted with permission from Gunter and Friedman.³⁰⁵)

Figure 32. Left, Area of vestibular skin undermining for placement of the lateral crural strut graft. Right, Relationship of graft to undermined region. (Reprinted with permission from Gunter and Friedman.³⁰⁵)
Rohrich et al.306 presented a review of alar rim deformities and the surgical options for their correction (Table 2). The authors advocated the use of alar contour grafts or nonanatomic alar rim grafts (septal cartilage) for patients with mild to moderate congenital alar retraction, for those undergoing primary rhinoplasty who have a propensity for alar notching, for those undergoing secondary rhinoplasty patients who have minimal or no vestibular lining loss, and for those with malposition of the lower lateral cartilages. The authors included details of the surgical technique (Fig. 38).
Guyuron discussed his approach to various alar rim abnormalities, such as convexity, concavity, retraction, and hanging ala. He utilized lateral crural spanning sutures, posterior transaction of the lateral crura, or transdomal sutures to correct convexity. Concavities are corrected with lateral crural strut or alar rim grafts. Mild alar retraction is also corrected with alar rim grafts. Guyuron proposed an internal V-Y advancement flap for severe retraction and provided technical details. For hanging alar deformity, the author reported a preference for vestibular lining excisions.

Other authors have suggested different methods for correction of alar retraction. Tardy and Toriumi proposed composite grafting of the alar rim. Tellioglu and Cimen suggested a turn-in folding of the cephalic portion of the lateral crus to support the alar rim. Constantian also advocated liberal use of composite auricular cartilage grafting for alar rim deformities in patients undergoing secondary and tertiary rhinoplasty, based on his experience in 100 consecutive patients. He described an “axially oriented” auricular cartilage graft spanning the alar base and sill for the correction of vestibular stenosis with alar collapse. Gruber described the use of an intercrural batten graft that extends from the caudal edge of the ULC to the cephalic margin of the LLC to push the lateral crus and alar rim caudally.

Tardy et al. described a technique for alar reduction and sculpture that is based on a detailed analysis of the anatomy of the alae and nostril floor.

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**TABLE 2**

Surgical Indications and Options for Alar Deformities

<table>
<thead>
<tr>
<th>Technique</th>
<th>Degree of Alar Retraction Corrected (mm)</th>
<th>Graft Location</th>
<th>Efficacy for Lining Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alar contour graft</td>
<td>≤2</td>
<td>Alar rim</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>2–4</td>
<td>Between lower lateral cartilage domes</td>
<td>+</td>
</tr>
<tr>
<td>Lateral crural strut graft</td>
<td>&lt;4</td>
<td>Beneath lower lateral cartilage medially to pyriform aperture laterally</td>
<td>++</td>
</tr>
<tr>
<td>Composite graft</td>
<td>&gt;4</td>
<td>Variable (alar rim area)</td>
<td>+++</td>
</tr>
</tbody>
</table>

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*Figure 38.* A, Open approach with stairstep columellar incision and infracartilaginous incision. B, Proper placement and shape of the alar contour graft immediately above the alar rim and spanning the alar notched area are key to a successful outcome. *(Reprinted with permission from Rohrich et al.)*
Alar modifications are indicated when there is flaring, bulbosity, or excessive width of the nasal base or when tip retroposition at surgery produces excessive alar flare. Of importance is the site and angle of insertion of the alae into the face. A cephalic location of the alar-facial junction can create a high-arched appearance to the alae, exposing an excessive amount of columella. In extreme cases, this variant produces a snarl-like appearance. Caudal insertions of the alae into the face create the appearance of a disproportionately large and bulbous lobule and sometimes alar hooding. The authors give indications for internal nasal floor reduction, alar wedge excision, alar flap, and sliding alar flap.

Millard\textsuperscript{314} presented a discussion of alar margin sculpturing techniques through external incisions. Planas and Planas\textsuperscript{315} reviewed the use of external excisions for correcting variations in the shape of the nostrils in rhinoplasty. Matarasso\textsuperscript{316} approached alar rim excision through an “internal technique” to core out excess alar tissue through an alar base incision. Subsequently, the author limited the indications for this approach to deformities of the lower third of the rim.\textsuperscript{317}

Oktem et al.\textsuperscript{318} described a lower cartilage Z-plasty for treating alar cartilage malposition. The alar cartilage is divided obliquely into anterior and posterior segments at a point located 15 mm lateral to the nasal dome. The posterior crural segment, which is secured to the pyriform aperture, is transposed cephalically in a Z-plast manner to attain the desired position of the anterior lateral crural segment. This technique has the advantage of not requiring additional cartilage and does not violate the posterior alar rim, which allows for preservation of the fine movements of the alar muscles. In addition, tip projection can be adjusted by fixing the anterior crural segment in a posterior and overlapping manner if nasal tip over-projection is present or in an anterior position with no overlapping in under-projection cases.

SECONDARY RHINOPLASTY
The incidence of postsurgical nasal deformities requiring secondary correction varies from 5% (the best that experienced surgeons achieve, according to Rees et al.\textsuperscript{319}) to 12% (Smith\textsuperscript{320} presented a report of 221 patients). Rogers\textsuperscript{321} offered a comprehensive discussion of postsurgical deformities and the procedures for their correction. The reader is also referred to a review of techniques presented by Webster,\textsuperscript{322} a retrospective presented by Peck,\textsuperscript{323} and a chapter on secondary rhinoplasty written by Sheen and Sheen.\textsuperscript{100} Sheen and Sheen\textsuperscript{100} asserted that the key to effective secondary rhinoplasty is accurate diagnosis of the deformity. He listed five “ground rules” for the management of postsurgical nasal anomalies, as follows:\textsuperscript{100,103}

- Defer surgery until there is final resolution of tissue edema (at least 1 year).
- Have a well-defined aesthetic concept.
- Make a proper diagnosis.
- Limit the dissection.
- Use only autogenous material.

In general, surgical correction of secondary deformities must be more conservative than the primary operation. The surgeon should resist the temptation to repeat errors of over-reduction. In the words of Millard,\textsuperscript{324} “Once the nose goes wrong, too often an irreversible chain reaction is set in motion—as the surgeon frantically excises again and again.”

Sheen\textsuperscript{103} discussed the secondary correction of supratip fullness, total disharmony of all nasal parts, a dorsum that is too low after grafting, a snub nasal tip from over-resection of the dorsum and under-resection of the caudal septum, and residual high septal deviation. He presented a technique for grafting the nasal tip\textsuperscript{104} that is also helpful in secondary rhinoplasty. For cases in which the middle vault has been excessively narrowed and the caudal borders of the nasal bones are visible through the skin, Sheen\textsuperscript{106} recommended spreader grafts to reestablish an open angle between the ULC and the dorsal septum. The author correlated reconstruction of the middle nasal vault with improvement in nasal physiology and enhanced airway capacity.

Peck\textsuperscript{323} discusses some common deformities in secondary rhinoplasty, as follows:

- Lack of tip projection from lack of alar cartilage-dome projection
- Lack of tip projection from lack of septal support of the nasal tip-pyramid complex
- Saddle deformity
- Supratip deformity
- Alar deformities
- Deformities of the ULC and nasal bones
- Deformities of the columella and short nose
- Deformities of the nasolabial angle
- Thick, rigid tip
- Persistent Pinocchio tip

Peck\(^{323}\) reported using a conchal cartilage tip graft when there is lack of tip projection from inadequate dome projection and a conchal cartilage intercrural graft when the lack of tip projection is due to insufficient dorsal support. Peck’s choice for reconstructing the septum in saddle nose deformity is first, a layered septal cartilage graft and second, a bone graft harvested from the ilium, rib, or calvarium. Marin et al.\(^{325}\) preferred rib cartilage grafts for correction of contour deformities and functional problems caused by previous operations. The authors argued that that it has a lower resorption rate and higher strength compared with auricular cartilage, irradiated cartilage, and alloplastic materials. A detailed description of their rib cartilage harvesting techniques is described.

Based on his experience, Peck\(^{323}\) determined that the supratip deformity is most commonly caused by a high supratip septal cartilage. For correction, the author recommended lowering the dorsum as a unit to include the septum and the left and right ULC. The second most common cause of supratip deformity is inadequate removal of the fibrofatty tissues. The third most common cause is inadequate sculpting of the alar cartilages. A supratip deformity can also result from overzealous lowering of the nasal pyramid in the presence of thick, rigid skin, in which case a columnellar strut or dome-tip graft might be indicated.\(^{323}\)

Guyuron et al.\(^{326}\) noted supratip fullness in 9% of patients undergoing primary rhinoplasty and in 36% undergoing secondary rhinoplasty. With primary rhinoplasty, the deformity was caused by inadequate tip projection (pseudo-deformity), an over-projecting caudal dorsum, a combination of both, or cephalically oriented LLC. With secondary rhinoplasty, the deformity was caused by under-resection or over-resection of the caudal dorsum, over-resected midvault, under-projected tip (pseudo-deformity), or any combination of these. The authors concluded that it might be possible to prevent supratip deformity by properly resecting the caudal dorsum, avoiding dead space, restoring adequate projection to the nasal tip, and approximating the supratip subcutaneous tissues to the underlying cartilage with a supratip suture.

Alar notch deformities most often occur secondary to resection of vestibular lining or transection of the alar cartilages. Deformities of the ULC and bone generally are corrected by onlay grafts of septum or conchal cartilage.\(^{322}\)

According to Peck,\(^{323}\) the most common cause of a crowded lip is a septum that is too long and has literally grown onto the upper lip. Resection of the caudal end of the septum usually is all that is needed for correction.

The recessed nasolabial angle is corrected by insertion of a septal or conchal cartilage graft to build up the base and open the angle. A tight frenulum can be corrected by V-Y advancement of the frenulum.\(^{323}\)

The thick, rigid tip generally is associated with sebaceous skin that will not drape or contour onto the skeletal framework. In these instances, Peck\(^{323}\) recommended augmentation of the tip. He corrected the persistent Pinocchio tip by amputation of the cartilages and reconstruction with onlay graft from the concha.

Parikes et al.\(^{327}\) analyzed their experience with 1221 consecutive rhinoplasties, 170 (14%) of which were revision procedures. Most secondary problems occurred in the lower third of the nose: polly beak (33%), bossa (26%), and excessive dorsal resection (24%).

On the basis of his experience with 56 cases of secondary deformity after primary open rhinoplasty, Daniel\(^{328}\) recommended a closed technique when augmentation is the solution and an open approach when structural correction is required. The risks of skin necrosis and poor scarring are similar with either technique. The stigmata of open primary rhinoplasty include the following: 1) a depressed and visible scar, 2) destruction of the soft-tissue facets in the nostril apices, 3) columellar deformities with associated nostril asymmetry, and 4) excessive tip or supratip defatting. These can and should be avoided, and Daniel offered suggestions for eliminating them.
Neu described a “segmental” approach to secondary rhinoplasty for mild to complete loss of alar cartilages and a treatment algorithm based on the severity of the deformity. His technique of cartilage grafting in these difficult cases is detailed and illustrated in the article.

Turegun et al. used a thin saddle-shaped porous polyethylene implant to overcome aesthetic and functional deformities in secondary rhinoplasty. The rigid structure of this implant allows functional improvement of the airway and correct surface asymmetry by filling the defects. No extrusion was noted in this study.

SADDLE NOSE DEFORMITY
Stuzin and Kawamoto used cranial bone grafts to correct the post-rhinoplasty saddle nose deformity. The subperiosteal pocket extends well into the piriform aperture and along the lateral nasal walls and nasal floor. Mucosal advancement is sometimes indicated. In addition, patients with nasal foreshortening often require a strong cantilever bone graft to augment the dorsum, lengthen the nose, increase tip projection, and support the columella.

Erol elevated the nasal dorsum with a pliable graft of diced cartilage wrapped in Surgicel. Although the graft seems more suitable for fill than for structural support, the author reported achieving good results in 2365 patients over 10 years.

In the event of end-stage deficiency of the nasal skeleton, Posnick et al. recommended full-thickness cranial bone grafts and rigid internal fixation through a coronal incision. The dorsal graft often must extend down to the tip for a well-chiseled contour and good tip definition. The authors warned against grafts that are too wide and that excessively broaden the nasal dorsum and urged care in sculpting the nasofrontal junction.

Powell and Riley analyzed the 4-year results of 850 calvarial bone grafts to the nose in 170 patients. Most graft sites showed partial resorption ranging from insignificant to 30%. Areas of maximum resorption and contour change were at the nasal dorsum and lateral posterior mandible. Excellent contour was achieved and maintained in all except a few cases. Although the authors endorsed the use of calvarial bone grafts in facial skeletal reconstruction and in the nasal dorsum, their study showed the nose to be a site of potentially greater bone resorption than other areas of the face.

Jackson et al. reviewed the long-term outcomes of 363 cranial bone grafts used in nasal reconstruction. Split-thickness grafts were applied in 85% of the cases and full-thickness grafts in the remainder. The authors reported satisfactory results in the vast majority of cases. Shipchandler et al. described a technique creating an L-shaped strut graft from a split calvarial bone that provides dorsal support while increasing tip projection. The results showed maintenance of the tip projection and absence of graft infection, resorption, and migration. Hodgkinson argued that bone grafts should not extend to the nasal tip but stop at the septal angle; augmentation of the nasal tip should be accomplished with cartilage grafts from other sites. We agree with this view; differential support of the tip produces aesthetic projection of the tip above the dorsal plane.

Kridel and Konior reviewed the fate of 306 irradiated costal cartilage homografts to the nose, 122 of which were used on the nasal dorsum, 40 for primary rhinoplasty, and 82 for revision rhinoplasty. Complications included infection around the graft in 3% to 4%, graft resorption in 3% to 4%, graft mobility in 4%, and cartilage warping in 3%. The overall complication rate was approximately 10%. Four patients in the primary rhinoplasty group eventually needed revisional nasal surgery for additional augmentation. To date, this is the largest published series of irradiated costal cartilage homografts specifically used for nasal reconstruction.

Daniel described the use of an osseocartilaginous autologous rib graft for dorsal contour in combination with a rigid cartilaginous strut to support the tip and reinforce the columella. The method of harvest and reconstruction are well illustrated. In a discussion of the article by Daniel, Byrd described his technique for carving portions of the 10th and 11th ribs as nasal grafts (Fig. 39). In a cadaveric study, Kim et al. confirmed that meticulous concentric carving results in less warping than does eccentric carving.

Waldman reported his experience with Gore-Tex for augmentation of the nasal dorsum in 17 patients when autogenous sources were not available. The Gore-Tex grafts were inserted during open rhinoplasty, and all patients received some type of columellar support. During follow-up examinations from 12 to 36 months, Waldman noted
no operative or postoperative complications. One implant was removed 5 months after insertion because of excessive augmentation.

Godin et al.\textsuperscript{342} analyzed the postoperative course of 137 patients—69 primary rhinoplasties, 68 revision rhinoplasties—who received augmentation with Gore-Tex patches. Follow-up duration was from 6 to 80 months (average, 25 months). The authors reported that three (2.2\%) of 137 grafts became infected and were removed. One graft was removed 5 months postoperatively because of excessive augmentation. None of the patients who underwent implant removal required subsequent augmentation. All 137 patients were pleased with their results. Technical points that were thought to be important to the success of the procedure are as follows:

- For dorsal grafts, the implant usually was boat shaped.
- All implant edges were carefully beveled. The graft was cut to the width of the nasal bones at the nasion, gradually widened toward the rhinion, and tapered to a sharp point at its caudal end.
- The dissected pocket should easily accept the graft without rolling or bunching.
- The graft should run the entire length of the dorsum to avoid steps or notches in profile.
- The graft is soaked in saline containing a broad spectrum antibiotic and is secured with 5-0 polypropylene suture.
- Overcorrection is not necessary considering that resorption of Gore-Tex implants has not been observed.

An update\textsuperscript{343} of the series presented by Godin et al.\textsuperscript{342} included 309 consecutive patients with 52\% primary and 48\% secondary rhinoplasty cases. During follow-up of 5 months to 10 years, the graft infection rate was 3\% overall: 1\% primary and 5\% revision. The grafts became infected in three patients with perforated nasal septums and had to be removed. The authors considered septal perforation to be a contraindication for nasal Gore-Tex implantation.

Owsley and Taylor\textsuperscript{344} reviewed their use of Gore-Tex for nasal augmentation in 106 patients (87 on the dorsum) and reported, “Postoperative follow-up has revealed a stable implant material with no complications relating to the graft material.”

Jang et al.\textsuperscript{345} investigated the histological changes associated with Gore-Tex removed during aesthetic revision rhinoplasty. Gore-Tex samples implanted for long periods of time were associated with decreased thickness, structural changes, micro-calcifications, foreign body reactions, and, surprisingly, tissue ingrowth beginning as early as 1 week after insertion.

Straith\textsuperscript{346} reviewed the long-term (average, 15 years) outcome of Silastic implants for the correction of saddle-nose deformity in five patients. A careful dissection, watertight closure, antibiotic irrigation, and implant design that avoids pressure on thin vestibular membranes are credited for the good results.

Peled et al.\textsuperscript{347} conducted a meta-analysis of the use of alloplastic materials in rhinoplasty. The authors concluded that alloplastic implants have acceptable complication rates and can be used when autogenous materials are unavailable or insufficient. They also reported that Medpor or Gore-Tex might offer a slightly better outcome than silicone.

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Jung et al.\textsuperscript{348} reported their extensive experience with silicone nasal augmentation. Silicone implants were noted to induce calcification when inserted for a prolonged period of time, causing long-term morphological changes.

Daniel\textsuperscript{349} proposed a new saddle nose classification based on the presenting deformities and method of treatment. He presented a new subgroup, which he designated the septal saddle deformity secondary to weakening or loss of septal cartilage instead of the classical dorsal over-resection.

The forgotten element in successful correction of posttraumatic saddle nose is nasal lining. For an in-depth discussion of this topic, the reader is referred to SRPS volume 10, number 12.\textsuperscript{350}

\section*{ADJUNCTIVE PROCEDURES}

\subsection*{Resection of the Alar Base}

Sheen and Sheen\textsuperscript{100} classified alar bases according to relative proportions of vestibular and external skin. Weir,\textsuperscript{351} in 1892, corrected excessively flaring or wide nostrils by resecting the alar bases. Sheen and Sheen\textsuperscript{100} later modified the technique presented by Weir by retaining a medial flap on the wedge excision. This refinement provided a more natural, continuous nostril sill and reduced the alar notching produced by the scar of the Weir procedure.

\subsection*{Paranasal Augmentation}

Guerrerosantos\textsuperscript{352} reviewed augmentation of the paranasal and anterior maxillary area with autogenous fascia and cartilage. Graft designs and positions were detailed. The procedure is recommended as an adjunct to orthognathic surgery and for primary and secondary rhinoplasties.

\subsection*{Mentoplasty}

In 1965, Millard\textsuperscript{204} discussed adjunctive procedures in corrective rhinoplasty, including wedge excision of the alar bases and resection of the alar margins to narrow the width of the nose and correct alar flare, insertion of a columellar strut graft of septal cartilage to elevate the tip, and introduction of a chin implant through an intraoral approach. According to Millard, augmentation mentoplasty is indicated in approximately 15\% of rhinoplasty cases.

Rish\textsuperscript{353} proposed a simple and effective method for determining who would benefit from chin augmentation. Using photographs of the patient in profile with the Frankfort line parallel to the floor, a vertical line is dropped perpendicular to the Frankfort horizontal plane and through the lower lip. If the chin does not reach this line, the patient is probably a candidate for augmentation mentoplasty.

Davis\textsuperscript{354} classified chin deformities as macrognathic, retrognathic, and microgenic. Microgenia and occasionally retrognathia are the only conditions in which chin augmentation is appropriate. He uses primarily Silastic chin implants and stresses proper placement over the pogonion, as low as possible over the point of the chin, where the bone is dense and less likely to resorb than if the implant is placed higher on the mandible. If augmentation >8 mm is required, a simple chin implant is unlikely to provide satisfactory results, in which case a mandibular osteotomy or sliding genioplasty is indicated.

Two studies\textsuperscript{355,356} documented resorption of the mandibular cortical surface after placement of solid chin implants. Although essentially a radiographic finding and usually self limiting, this cortical resorption nevertheless has prompted the development of softer prostheses.

Simons\textsuperscript{357} reviewed the history of mentoplasty. The author described an extraoral surgical approach and discussed other adjuncts to rhinoplasty, including chin reduction, orthodontia, makeup, and hair styling.

\subsection*{Endoscopic Sinus Surgery}

Slafani and Schaefer\textsuperscript{358} examined the effect of concurrent endoscopic sinus surgery on the postoperative course of cosmetic rhinoplasty. The findings suggested that the presence and treatment of sinonasal disease prolongs the patient’s recovery from cosmetic rhinoplasty and correlates closely with the degree of preoperative sinus disease. The authors recommended a two-team approach and that the endoscopic sinus surgery be performed first. The cosmetic rhinoplasty should be performed only if excellent hemostasis is present and violation of the anterior skull base or medial orbit on the part of the sinus surgeon is not of concern.
COMPLICATIONS

In 1964, Klabunde and Falces\textsuperscript{359} surveyed 300 unselected cases of cosmetic rhinoplasty and noted an overall complication rate of 18%, although 95% of patients were satisfied with the results. Intraoperative or early postoperative complications included the following:

- operative hemorrhage
- septal perforation
- anesthesia-related problems
- postoperative hemorrhage
- postoperative infection

Late complications consisted of the following:

- persistence of edema or ecchymosis
- excessive scar
- vestibular webbing
- hypesthesia

A later retrospective study of 200 rhinoplasties, conducted by McKinney and Cook,\textsuperscript{360} disclosed considerably lower incidences of infection, hemorrhage, and secondary revisions in the intervening 17 years. The overall complication rate was approximately 6% (4% if chin complications were excluded), and 12% of patients required revisions. Despite the improved surgical outcome, patient satisfaction declined to 90%. Dissatisfied patients were more likely to be female, in their 40s, and not physician referrals.

Teichgraeber et al.\textsuperscript{361} reviewed 259 consecutive rhinoplasties and noted a 5% incidence of serious complications, defined as hemorrhage (five cases), perforation (four cases), infection (three cases), and pneumocephalus (one case). All these patients had undergone concomitant septal or turbinate surgery.

Padovan and Jugo\textsuperscript{362} reviewed the complications of external rhinoplasty in their practice over a 14-year period. Intraoperative complications included excessive bleeding (>250 mL) in 1%, and cuts on the caudal border of the LLC and tears of the columellar skin, which occurred rarely but were annoying. The most common early postoperative complication was failure to achieve the desired aesthetic or functional goal in 5% of patients, approximately half of whom requested secondary correction. The authors recommend the following measures to avoid complications in open rhinoplasty:

- meticulous surgical technique
- proper set of instruments
- hypotensive anesthesia
- careful screening for coagulation disorders
- no surgery during the menstrual period or during times of aspirin intake
- careful patient selection and increased caution in hypertensive patients
- routine use of broad-spectrum antibiotics and steroids
- careful placement of nasal packs only in the anterior half of the nasal cavity
- no narrow, straight osteotomes

Andrews et al.\textsuperscript{363} performed a prospective randomized study comparing the efficacy of prophylactic versus postoperative antibiotics in cases of septorhinoplasty. The authors found no significant difference in infection rates between the prophylactic and postoperative groups, strengthening the evidence for antibiotic administration before nasal surgery.

Piltcher et al.\textsuperscript{364} conducted a randomized clinical trial. They concluded that hypopharyngeal packing is ineffective in preventing nausea and vomiting after nasal surgery.

Corticosteroids

Hoffman et al.\textsuperscript{365} noted certain advantages to the use of steroids during rhinoplasty. In a randomized double-blind study of 29 patients, the authors documented less postoperative edema of the eyelids and nose and fewer ecchymoses when steroids were administered. Patients who received steroids also had less discomfort postoperatively.

In a randomized double blind prospective study of 20 male patients, all of whom had undergone osteotomies as part of their rhinoplasties, Berinstein et al.\textsuperscript{366} measured
the effect of a single preoperative dose of 10 mg of dexamethasone on postoperative edema. Contrary to expectations, these patients experienced more edema than those who did not receive the corticosteroid.

Shafir et al.\textsuperscript{367} reported the case of a 37-year-old woman who underwent rhinoplasty, including septal correction, with injection of small amounts of long-acting Depo-Medrol to either side of the nasal bridge. Within seconds of the last injection, the patient lost vision in the ipsilateral eye and had no pupillary reflex. A diagnosis of central retinal embolus and choroidal occlusion was made, and routine treatment for vascular occlusion of the bulb was immediately initiated. Despite these measures, the patient remained blind in that eye.

In a review of the literature in 1981, Mabry\textsuperscript{368} found 10 cases of blindness occurring after steroid injections. In 1994, the author reported zero visual complications in his own series of 13,000+ intranasal steroid injections. The pathomechanism is thought to be microemboli of the steroid suspension that occlude one or more of the retinal or choroidal vessels.

A prospective study conducted by Ozdel et al.\textsuperscript{369} showed no significant difference in psychological well being between a group receiving 10 mg of dexamethasone preoperatively and a control group. In addition, the authors reported that periorbital edema was significantly reduced for the first 2 postoperative days in the group receiving steroid.

Gürlek et al.\textsuperscript{370} conducted a prospective controlled randomized double blind study of the effects of different regimens of corticosteroids on 40 patients undergoing open rhinoplasty with osteotomies. A clinically statistically significant difference in ecchymosis and edema was noted between the placebo and the high-dose methylprednisolone groups.

Totonchi and Guyuron\textsuperscript{371} compared arnica, an herbal medication, and steroids in the management of post-rhinoplasty ecchymosis and edema. Their prospective study suggested that both arnica and steroids can be effective in reducing edema. However, arnica does not provide any benefit when evaluating the extent and intensity of ecchymosis.

Nasal Packing, Stents, Splints, and Dressings

Guyuron\textsuperscript{372} assessed the role of nasal packing in septorhinoplasty and concluded that patients who received packing were less likely to develop recurrent septal deviation and synechiae and more likely to experience an improved nasal airway postoperatively. Significant improvement in airflow was documented in 96% of the patients who received nasal packing compared with 64% of those who did not ($P < 0.05$).

Reiter et al.\textsuperscript{373} disagreed with Guyuron.\textsuperscript{372} On the basis of their analysis of 75 consecutive nasal procedures completed without packing, Reiter et al. recommended through-and-through suturing of the entire septal flap, small caliber osteotomy, meticulous closure of all intranasal incisions, and proper application of conforming dressings as alternatives to packing.

Camirand et al.\textsuperscript{374} reviewed the course of 812 patients who had neither internal packing nor external immobilization after rhinoplasty. None showed early bone or septal displacement, and swelling, bruising, pain, epistaxis, and synechiae was not increased compared with patients who received packing. It is not clear from their report whether any patient in their series had undergone turbinate surgery, which would have increased the risk of synechiae. Submucosal hematoma and septal necrosis were nonexistent. Nevertheless, it is anecdotally known that most rhinoplasty surgeons thing that external conforming dressings are of benefit in controlling postoperative edema.

A randomized prospective trial by Lubianca-Neto et al.\textsuperscript{375} evaluated the time of nasal packing in relation to hemorrhagic complications after nasal surgery. Of 104 patients in the study, half had packing for 24 hours and the other half for 48 hours. No statistical difference was observed between the two groups in terms of hemorrhagic complications. Hypertension was the only prognostic factor for postoperative bleeding.

Guyuron and Vaughan\textsuperscript{376} evaluated the efficacy of septal stents for maintaining patency of the airway after septorhinoplasty. Subjective ratings of airway improvement were very similar regardless of whether patients had received stents. The number of patients who complained about discomfort in this small sample was higher in the nasal stent group, as were the rates of partial, residual, and recurring septal deviation.

Awan and Iqbal\textsuperscript{377} conducted a prospective randomized study comparing the incidence of
postoperative complications in patients undergoing septoplasty with and without nasal packing. The authors found that patients within the nasal packing group experienced significantly more postoperative pain, headache, epiphora, dysphagia, and sleep disturbance. When examined 7 days postoperatively, no significant difference between the two groups was noted in the incidence of bleeding, septal hematoma, adhesion formation, or local infection. The authors concluded that nasal packing is not only unnecessary but is a source of patient discomfort, especially during its removal.

**Airway Changes**

Constantinides et al. studied the long-term outcome of open cosmetic septorhinoplasty and its effect on nasal airflow in 27 patients. Plethysmographic findings showed improvement in 23 patients and worsening in four. Subjective impressions of nasal patency did not correlate well with objective measurements. The authors concluded that patients with normal nasal resistance values might suffer long-term asymptomatic increases in nasal resistance values after cosmetic open septorhinoplasty.

**Risk of Nasal Fracture**

Guyuron and Zarandy noted an incidence of nasal bone fracture after rhinoplasty of 0.624 fractures per year (24 of 1121 cases over 8 years). In contrast, the National Center for Health Statistics cites a 0.021% annual rate of nasal bone fracture. It is clear that the incidence of nasal bone fracture occurring after rhinoplasty is higher than that of nasal bone fracture in the general population.

**Sense of Smell**

Kimmelman evaluated the olfactory capacity of 93 patients before and after nasal surgery, including ethmoidectomy, polypectomy, Caldwell-Luc, reduction of nasal fracture, and septorhinoplasty. The author reported improvement in 61 patients and decline in 32. No correlation was shown with age, sex, type of operation, or anesthetic. Shemshadi et al. reported that 87.5% of the patients undergoing open rhinoplasty had anosmia at 1 week postoperatively, with the remaining exhibiting at least moderate levels of hyposmia. At postoperative week 6, 85% of the patients experienced some degree of hyposmia. The authors concluded that a time interval of 6 weeks to 6 months is required to revert to baseline olfactory function after open rhinoplasty.

Pade and Hummel conducted a prospective study to analyze the outcome of olfactory function after nasal surgery in 775 patients. The authors observed an improvement in the sense of smell in 13% and 23% of patients undergoing septal and sinus surgery, respectively. A postoperative decrease in olfactory function was identified in 7% and 9% of patients undergoing septal and sinus surgery, respectively. Decrease in olfactory function occurred mostly in patients with good sense of smell preoperatively; therefore, this group should be counseled appropriately regarding the potential risks of nasal surgery.

**Toxic Shock Syndrome**

Reports of toxic shock syndrome (TSS) occurring after nasal surgery deserve special attention. Between 1980 and 1983, the incidence of TSS after nasal surgery was 16.5 per 100,000 patients, which is proportionately higher than for the general population of menstruating women. In all cases, the onset of symptoms was rapid and consisted of fever, nausea, vomiting, diarrhea, erythroderma, and hypotension; the wound did not appear grossly infected. The causative organism was a species of Staphylococcus capable of producing a potent exoprotein, TSS toxin-1 (TSST-1). Topical and systemic antibiotics did not seem to offer any protection against the disease. No predisposing factors were identified, and there was only a weak correlation with surgical technique. Patients who develop TSS tend to receive splints more often, and all have nasal packing, but so do 98% of all nasal surgery patients. In short, to this day, we do not know why some patients contract TSS after rhinoplasty and most do not.

**THE NON-WHITE NOSE**

The basic approach to the non-white nose involves elevation (augmentation) and narrowing of the dorsum, increasing tip projection and definition, and narrowing of the wide nasal base and alae. Hoefflin reported his experience with geometric sculpting of the thick and poorly defined nasal tip common in Black, Hispanic, and Asian patients. Tip definition and refinement to create the
illusion of a thinner nose can be accomplished through the following procedures: 1) geometric tip defatting on the central and lateral areas; 2) triangular alar cartilage reduction; 3) placement of an ultra-supportive, pea pod-shaped graft in the nasal tip; and 4) alar base reduction.

The Asian Nose

Most rhinoplasty surgeons find that their Asian and white patients share similar concepts of the ideal nose. Asian noses frequently lack adequate tip projection, nasal length, and dorsal height and projection. Widened alar bases, caudal tip rotation, short columella, and thickened alae are also common findings. Suh et al., using reconstructed computed tomography, objectively evaluated the size of the internal nasal valve in Asians. The study found that the internal nasal valve in Asians measures $21.6^\circ \pm 4.5^\circ$ and is substantially larger that what has been reported for white patients. The following points should be considered when contemplating rhinoplasty on an Asian patient:

- Thick, sebaceous nasal tip and columellar skin can limit the amount of lobule refinement that can be achieved.
- Patients tend to prefer intranasal or closed approaches.
- The scars of transcolumellar incisions might remain visible, with notching or hypertrophy.
- Patients generally opt for procedures without grafts because of their aversion to external scars.
- Septal cartilage availability is questionable.
- Flat or absent nasal dorsa might require extensive dorsal augmentation.

Alloplastic augmentation through closed techniques has been advocated over more traditional open rhinoplasty techniques with autogenous materials. The safety and efficacy of alloplastic materials remains controversial.

Falces et al. presented a review of specific techniques designed to create Western features in Asian and Black noses. Flowers addressed rhinoplasty in Asian noses and listed indications and limitations of alloplastic materials for dorsal augmentation.

Parsa reported the use of autogenous split calvarial grafts for nasal augmentation in Asian noses based on his experience with 62 patients followed for up to 8 years. Most noses could be satisfactorily augmented with a single-layer split calvarial graft, but some required multiple layers. The complication rate was 8%, including three minor seroma-hematomas at the graft donor site, one complete bone resorption, and one overcorrection that necessitated secondary revision.

Endo et al. used ear cartilage grafts for augmentation of the nasal dorsum in 1263 Japanese patients. Follow-up duration ranged from 6 to 20 months. Complications occurred in 4% of patients, and the most frequent and severe problem was graft malposition. Local infection developed in six patients but was controlled with antibiotics. The authors concluded that ear cartilage graft is the best alternative for dorsal nasal augmentation in Japanese patients.

Deva et al. reported a 10-year experience with silicone augmentation rhinoplasty. A dorsal-columellar strut prosthesis was most commonly used. Of 422 patients (412 of whom were of Asian ethnicity), 5.5% experienced major complications requiring removal of the implant within the first 30 days. The causes of implant removal were displacement, hemorrhage, prominence, and supratip deformity. An additional 4.3% of patients required later removal, mainly for excessive prominence or displacement. Only two (0.5%) patients had implants removed because of extrusion. No infections occurred. The satisfaction rate was 84%, and those who were dissatisfied wanted further augmentation of the nose. The authors purported that the main cause of extrusion is over-augmentation, that an augmentation threshold exists beyond which the complication rate rises dramatically. They discussed implant selection in relation to nasal morphology and desired augmentation and maintained that silicone nasal rhinoplasty is safe for selected patients.

Zeng et al. reported 406 cases of silicone augmentation rhinoplasty. Complications were related to depth of implantation and character of overlying tissue. The authors concluded that subperiosteal implantation is superior to subfascial implantation. The published complication rates in other series of dorsal nasal augmentation with silicone implants vary.

Clark and Cook described their technique of
immediate nasal reconstruction with irradiated homograft costal cartilage after extrusion of alloplastic nasal implants in 18 patients. One complication (warping) required graft removal. The authors stated that the procedure might be a reasonable alternative to staged reconstruction because it avoids soft-tissue scarring and contracture. They discussed typical sites of extrusion for Silastic (nasal tip), Supramid, and Gore-Tex (nasal valves, nasal sidewall, rhinion) implants. Jung et al.\textsuperscript{398} recommended autogenous cartilage grafts from the seventh rib over alloplastic materials for dorsal augmentation >8 mm.

Jang et al.\textsuperscript{399} reviewed their experience of combining crushed cartilage and processed fascia lata (Tutoplast) for dorsal augmentation in 113 Asian patients. With a mean follow-up period of 26.6 months, complications were encountered in four patients (3.5%). The complications included overcorrection, graft resorption, and dorsal irregularities. A patient satisfaction rate of 85% was reported, and eight patients (7%) underwent revision rhinoplasty secondary to dissatisfaction with the nasal tip shape, graft resorption, and overcorrection of the nasal dorsum.

In a retrospective study, Park et al.\textsuperscript{400} analyzed post-rhinoplasty deformities in Asian noses. The authors reported that 89% of revision rhinoplasty is performed to correct upper-third deformities, which predominantly result from inadequate insertion or dislocation of the augmentation graft material. Most of the upper-third deformities were treated with a rasp, camouflage graft, and expanded polytetrafluoroethylene augmentation.

Other autogenous and alloplastic materials for dorsal augmentation are discussed in the “Saddle Nose Deformity” and “Dorsal Augmentation and the Nasofrontal Angle” sections presented earlier in this monograph.

The Black Nose

Ofodile et al.\textsuperscript{401} analyzed 201 black American noses and noted three distinct groups on the basis of anatomic features: the African (44%), the Afro-Caucasian (37%), and the Afro-Indian (19%). The nasal dorsal contour went from mostly concave in the African group to predominantly convex in the Afro-Caucasian and Afro-Indian groups. African noses were shortest and widest, Afro-Caucasian narrowest, and Afro-Indian longest. The alar cartilages tended to be small and thin in the African group and large and thick in Afro-Indian noses.

Rees,\textsuperscript{99,402} Bernstein,\textsuperscript{403} Kamer and Parkes,\textsuperscript{404} Santana,\textsuperscript{405} and Song et al.\textsuperscript{406} reviewed techniques of rhinoplasty in blacks. Santana\textsuperscript{405} advocated correction of alar base flaring without alar base excision. Through a Caldwell-Luc incision, the soft tissues in the middle third of the face are undermined subperiosteally and sutures are placed across the alar line and are tightened in the midline. This narrows the alar bases somewhat and elevates the columella. The authors report no recurrence of flaring. Song et al.\textsuperscript{406} discussed the use of cantilevered costal cartilage grafts for nasal dorsal augmentation in 19 black patients. They detailed the techniques for graft harvest, design, and placement.

Rohrich and Muzaffar\textsuperscript{407} presented a discussion of the classic anatomic features of black noses (Table 3). The authors rejected the notion that the alar cartilages are smaller or weaker than in white noses and attributed the lack of tip projection to the relatively obtuse angle between the medial and lateral crura with underdevelopment of the nasal spine. The many techniques for increasing tip projection, increasing tip definition, dorsal augmentation, and correction of alar base abnormalities are reviewed. The authors advised liberal use of tip grafts, alar base excision, and dorsal augmentation, with cautious use of nasal osteotomies.

Porter and Olson\textsuperscript{408} offered an anthropometric analysis of the black female nose, with a classification of nostril morphology and norms. For example, the columella-to-lobule ratio is 1.5:1, the nasolabial angle is 86°, and the alar width-to-intercanthal distance ratio is 5:4.

The Hispanic Nose

Ortiz-Monasterio and Olmedo\textsuperscript{409} described an approach to rhinoplasty in Mestizo noses and later, Ortiz-Monasterio and Micenele\textsuperscript{410} reviewed the use of augmentation techniques in non-white noses. The authors’ preferred source of graft material for augmenting the dorsum was septal cartilage; rib cartilage was a second choice. Septal cartilage was also favored over auricular concha for grafts to the nasal tip. Most patients require augmentation of the
dorsum, columella, and tip and alar base resection. Daniel\textsuperscript{410} proposed a classification system for Hispanic nasal morphology, as follows (Table 4):

- **Type I (Castilian):** high radix and dorsum and relatively normal tip projection
- **Type II (Mexican-American):** low radix and bony dorsum, normal cartilaginous dorsum, and depressed tip
- **Type III (Mestizo):** low radix, normal dorsum, depressed tip projection, and thickened nasal ala/tip

The author’s surgical approach to rhinoplasty varied with the type of deformity: a functional reduction rhinoplasty for Type I noses; a “finesse” rhinoplasty for Type II; and a “balanced” rhinoplasty for Type III. He also emphasized conservative dorsal reduction for Type II and III noses, radix grafting for Type II, and lobular soft-tissue reduction with alar base and/or sill excisions for Type III.

**The Middle Eastern Nose**

This ethnic group possesses characteristic morphological features that exist on a spectrum between the black and white noses. Rohrich and Ghavami\textsuperscript{411} retrospectively analyzed the morphological traits in patients of Middle Eastern origin. Their findings identified a combination of specific nasal traits, including thick sebaceous skin (excess fibrofatty tissue), high wide dorsum with cartilaginous and bony humps, ill-defined nasal tip, weak thin lateral crura relative to the skin envelope, nostril-tip imbalance, acute nasolabial and columellar-labial angles, and a hyperdynamic (droopy) nasal tip. The authors presented an open rhinoplasty approach to address the nasal imbalance. The approach requires soft-tissue debulking; substantial cartilaginous framework modification; tip refinement, rotation, and projection; low osteotomies; and depressor septi nasi muscle transection and transposition.

**THE COCAINE NOSE**

Slavin and Goldwyn\textsuperscript{412} noted the potential problem of cocaine users presenting for rhinoplasty. In their series of 13 patients who had used cocaine, fewer than half were properly identified as cocaine users during initial consultation. The preoperative rhinoscopic findings that should alert a physician to cocaine use are visible perforation, microscopic evidence of granulomas, inflammation, and necrosis. Surgical complications related to cocaine use include localized septal collapse, delayed mucosal healing, and inadequate correction of septal deflection. The authors concluded that SMR and septoplasty should be avoided in patients with a known history of intranasal cocaine use.

Millard and Mejia\textsuperscript{413} discussed their approach to reconstruction of cocaine-damaged noses. Cocaine causes vasoconstriction of the intranasal mucosal blood vessels and, with continuing ischemia, mucosal necrosis ensues. The exposed cartilage can succumb to chondritis and septal perforation to varying degrees. The authors support the use of local mucosal flaps for smaller perforations. For more severe deformities, including complete midvault and/or tip collapse, staged reconstruction is required. The authors recommended the use of bilateral nasolabial flaps for soft-tissue reconstruction and then staged rib cartilage grafting of the tip and dorsum 3 months later.

Guyuron and Afrooz\textsuperscript{414} reviewed the different surgical methods with which to correct cocaine-related nasal defects. They emphasized that reconstruction of massive septal perforation is unnecessary because the nasal shape can be restored without repair of this defect as long as infection is avoided.
### TABLE 3
**White and Black Noses**

<table>
<thead>
<tr>
<th></th>
<th>White Nose</th>
<th>Black Nose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skin</td>
<td>Thin</td>
<td>Thick</td>
</tr>
<tr>
<td>Fibrofatty layer</td>
<td>Thin</td>
<td>Thick</td>
</tr>
<tr>
<td>Alar cartilage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Size</td>
<td>Large</td>
<td>Large</td>
</tr>
<tr>
<td>Support</td>
<td>Strong</td>
<td>Strong</td>
</tr>
<tr>
<td>Alar base</td>
<td>Slight alar flaring</td>
<td>Excess alar flaring, increased intermalar distance</td>
</tr>
<tr>
<td>Nasal pyramid</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nasal bones</td>
<td>Long</td>
<td>Long and flattened</td>
</tr>
<tr>
<td>Base</td>
<td>Narrower</td>
<td>Wide</td>
</tr>
<tr>
<td>Dorsum</td>
<td>Thin</td>
<td>Broad and depressed</td>
</tr>
</tbody>
</table>

### TABLE 4
**Anatomic Characteristics and Recommended Surgical Procedures for Hispanic Noses**

<table>
<thead>
<tr>
<th></th>
<th>Type I Castilian</th>
<th>Type II Mexican American</th>
<th>Type III Mestizo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radix</td>
<td>High to normal</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Dorsum</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bony</td>
<td>High</td>
<td>Low</td>
<td>Normal</td>
</tr>
<tr>
<td>Cartilaginous</td>
<td>High</td>
<td>Normal</td>
<td>Normal</td>
</tr>
<tr>
<td>Tip</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Projection</td>
<td>Normal</td>
<td>Decreased (−1)</td>
<td>Decreased (−1)</td>
</tr>
<tr>
<td>Volume</td>
<td>Increased (+1)</td>
<td>Normal</td>
<td>Increased (+3)</td>
</tr>
<tr>
<td>Width</td>
<td>Wide (+1)</td>
<td>Normal</td>
<td>Very wide (+3)</td>
</tr>
<tr>
<td>Skin</td>
<td>Variable (+1/−1)</td>
<td>Variable (+1/−1)</td>
<td>Thick (+3)</td>
</tr>
<tr>
<td>Base</td>
<td>Variable</td>
<td>Normal</td>
<td>Wide</td>
</tr>
<tr>
<td>Operation</td>
<td>Functional reduction rhinoplasty</td>
<td>Finesse rhinoplasty</td>
<td>Balanced rhinoplasty</td>
</tr>
</tbody>
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REFERENCES


77. Honigman RJ, Phillips KA, Castle DJ. A review of psychosocial outcomes for patients seeking cosmetic


154. Elahi MM, Jackson IT, Moreira-Gonzalez A, Yamini D. Nasal augmentation with Surgicel-wrapped diced cartilage:


226. Hamra ST. Repositioning the lateral alar crus. *Plast

227. Lipsett EM. A new approach to surgery of the lower cartilaginous vault. AMA Arch Otolaryngol 1959;70:42–47.


342. Godin MS, Waldman SR, Johnson CM Jr. The use of


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