Osteotomies—When, Why, and How?

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Abstract

An ideal nasal osteotomy should deliver precise, predictable, and reproducible cosmetic and functional results while minimizing soft-tissue trauma and postoperative complications. In addition to closing an open roof deformity after hump reduction, other common indications for osteotomies include the crooked nose and a wide bony vault. The literature has reported numerous and diverse osteotomy techniques as well as differences in timing of osteotomies. Each has its own merits and indications, and its proponents. In this article, we review the anatomy and nomenclature relating to osteotomies. We review the locations and paths of the osteotomies—lateral, intermediate, medial, and superior/transverse. We consider the percutaneous and endonasal approaches, as well as timing of osteotomies and other considerations. We also discuss technical considerations in the selection of instrumentation for osteotomies.

Keywords
- osteotomies
- open roof
- endonasal
- percutaneous

Rhinoplasty surgeons differ considerably on their choice of instrumentation, timing, and technique for osteotomies.[1–6] However, there is a general agreement that an ideal nasal osteotomy should deliver precise, predictable, and reproducible cosmetic and functional results while minimizing soft tissue trauma and postoperative complications.[7–9]

Resection of the dorsal hump is among the most common presenting requests of rhinoplasty patients.[10] This typically results in an open roof deformity, which requires osteotomies to reposition the nasal bones to close the open roof. Other common indications for osteotomies include the crooked nose and a wide bony vault.

Since Jacques Joseph's original description of nasal osteotomies, the literature has reported numerous and diverse osteotomy techniques. Each has its own merits and indications, and each has its proponents.

Timing of osteotomies varies among surgeons. While personal preference of the surgeon may play a role, the timing often depends on the surgical approach chosen and on the nature of the surgical changes being undertaken. In general, surgeons undertaking an endonasal approach tend to address the nasal tip first and the nasal bridge including osteotomies after, while surgeons undertaking an external rhinoplasty approach commonly address the bridge and bony dorsum including osteotomies earlier in the surgery and then perform the nasal tip surgery after.

In this report, we review the anatomy and nomenclature relating to osteotomies. We review the locations and paths of the osteotomies—lateral, intermediate, medial, and superior/transverse. We consider the percutaneous and endonasal approaches, as well as timing of osteotomies and other considerations. We also discuss technical considerations in selection of instrumentation for osteotomies[11] (►**Table 1**).

Anatomy

The external nasal anatomy may be considered in terms of vertical thirds—the lower third consisting of the nasal tip, the middle third consisting of the paired upper lateral cartilages, and the upper third generally comprising the bony vault (►**Fig. 1**). The bony vault consists of the nasal bones and the frontal process of the maxilla. The nasal bones articulate with each other medially, with the ipsilateral frontal process of the maxilla laterally, and with the ipsilateral frontal bone superiorly. Together, this complex forms the bony nasal dorsum. The length of the nasal bones varies among patients, with significant surgical implications. Cadaveric dissections on 30 hemifaces revealed a mean nasal bone length of 2.47cm

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Table 1 Common indications for osteotomies

1. Close an open roof after dorsal reduction
2. Straighten a deviated nasal dorsum (congenital or traumatic)
3. Narrow a broad nasal vault

(2.2–2.7 cm) from nasofrontal suture line to the caudal edge.[12] The nasal bones are on average 14-mm wide at the nasofrontal suture line, narrows to 10 mm at the sellion, and then widens to 13.5 mm caudally.[12,13] The nasal bones are thickest at the junction of the nasal and frontal bones (5–7 mm) and become thinner moving caudally toward the tip.

The most cephalic portions of the paired upper lateral cartilages and the cartilaginous septum attach to the undersurface of the caudal edge of the nasal bones. On average, 8.9 mm (4–14 mm) of the cephalic upper lateral cartilages and cartilaginous dorsum are covered by nasal bone in the midline. Together, this bony cartilaginous junction comprises the dorsal and lateral keystone areas, a critical structural support of the nose that must be respected during rhinoplasty.

Nomenclature

Osteotomies are generally classified according to their location along the nasal bones. Lateral osteotomies are those performed at the lateral portion of the nasal bone along the nasofacial junction. Medial osteotomies are performed at the medial edge of the nasal bone, separating them from the bony nasal septum.[13] Intermediate osteotomies run in a course roughly midway up the nasal sidewall paralleling the midportion of the lateral osteotomy path. Superior or transverse osteotomies connect medial and lateral osteotomies between the medial canthus and the apex of the nasal dorsum.[14]

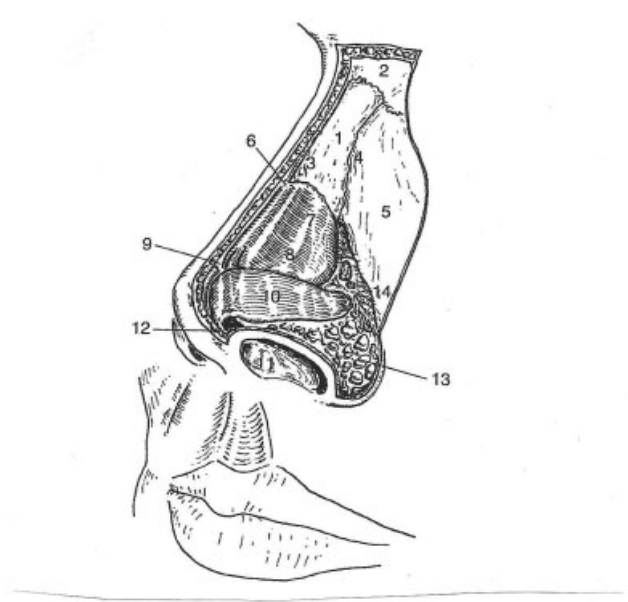

Fig. 1 Nasal anatomy: Oblique. 1, Nasal bone; 2, nasion (nasofrontal suture line); 3, internasal suture line; 4, nasomaxillary suture line; 5, ascending process of maxilla; 6, sellion (osseocartilaginous junction) (distinct from the rhinion which is the soft tissue correlate of the sellion); 7, upper lateral cartilage; 8, caudal edge of upper lateral cartilage; 9, anterior septal angle; 10, lower lateral cartilage, lateral crus; 11, medial crural footplate; 12, intermediate crus; 13; sesamoid cartilage; 14, pyriform aperture. (Reproduced with permission from Toriumi DM and Becker DG. Rhinoplasty Dissection Manual. Philadelphia, PA: Lippincott, Williams and Wilkins; 1999.)

Lateral osteotomies are further characterized by their path or trajectory along the nasal bones. Lateral osteotomy paths in particular reference three transition areas along the caudal to cephalic length of the nasal bone: the lower third near the pyriform aperture, the middle third, and upper third near the nasofrontal junction. Within each section, the osteotomy path can be either "high," reflecting a path that is more anteriomedial and closer to the apex of the bony vault, or "low" reflecting a path that is more posterolateral, closer to or within the nasofacial groove. The original description of lateral osteotomies by Joseph would be characterized as "low-low-low." The more commonly used osteotomy path is a "high-low-high" lateral osteotomy. This is discussed below.

Lateral Osteotomies

Lateral osteotomies are undertaken to narrow a widened bony vault, to close an open roof deformity (created after dorsal reduction), and to mobilize a deviated nasal pyramid. In general, lateral osteotomies are performed in the thinner aspects of the nasal sidewall, which can be found along the ascending frontal processes of the maxilla from the pyriform aperture to the radix.[13] Radiographic and anatomic studies have demonstrated the bony thickness in these areas of the nasal bones to be reliably between 2.5 and 3 mm, allowing for utilization of small osteotomes to produce predictable, minimally traumatic fracture patterns.[11,15,16]

Lateral osteotomies may be performed by either a continuous or perforating technique. In the continuous osteotomy, the osteotome is used to create a continuous cut through the bony side wall along the surgeon's desired path. Typically, this path follows the nasofacial groove along the transition zone of thinner bone at the nose–cheek junction. In the perforating technique, small postage-stamp style discontinuous osteotomies are made along the surgeon's path of choice. Once the lateral osteotomy is completed, mobilization of the nasal bone occurs via simple digital fracturing of the lateral and/or superior bony attachments, at times facilitated by combining the lateral osteotomy with a medial or superior/ transverse osteotomy, which frees the osteotomized nasal bone from its lateral and superior attachments.

Currently, the most common path for the lateral osteotomy is a "high-low-high" line (►**Fig. 2A, B**). This osteotomy path is initiated "high" on the pyriform aperture—slightly above the attachment of the inferior turbinate. The intent of this location is to preserve the opening of the nasal aperture to avoid compromising nasal function. Next, the osteotomy is continued cephalically along a "low" path within the nasofacial groove until it reaches the level of the inferior orbit. Finally, the osteotomy is curved superiorly and anteriorly in a "high" path into the thinner aspect of the nasal bone, terminating at the level of the medial canthus. The other lateral osteotomy paths—each with their advocates—are the low-low-high (►**Fig. 2C**) and low-low-low lines (►**Fig. 2D**).

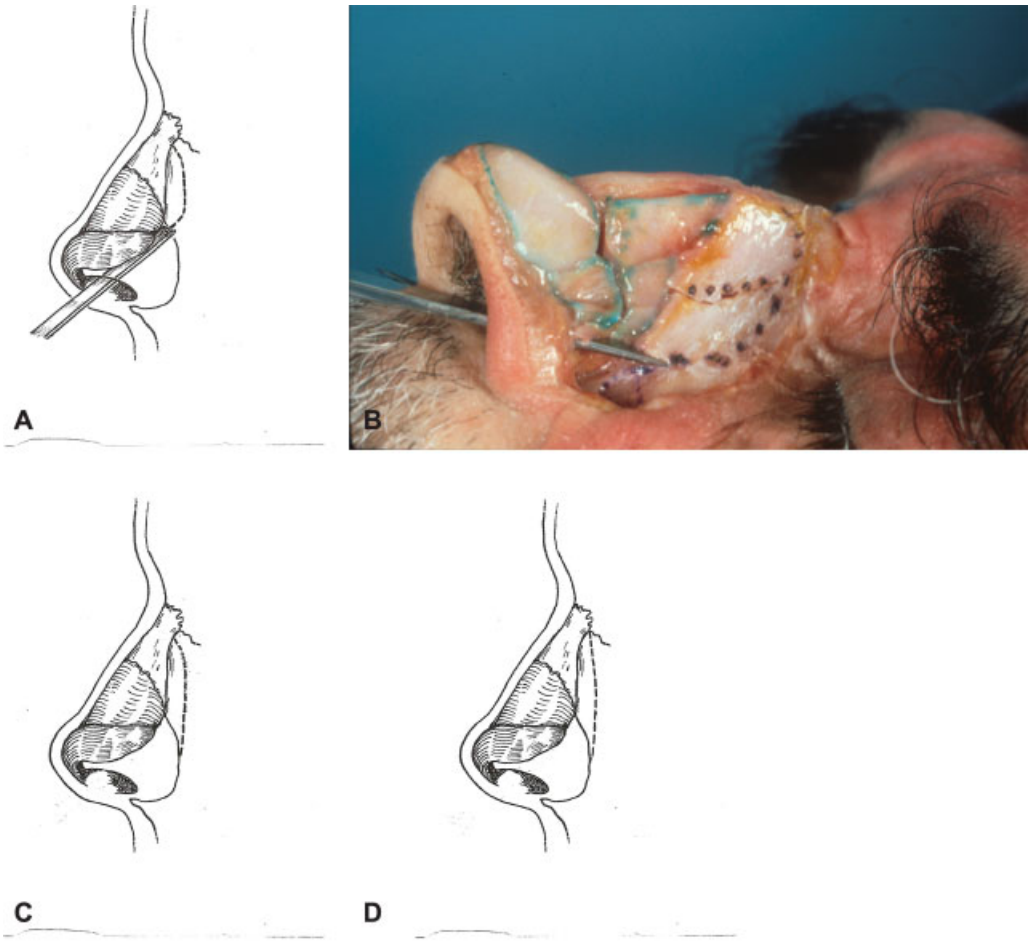

Fig. 2 (**A**) Lateral osteotomies should be started from a point 3 to 4 mm above the base of the pyriform aperture to a point adjacent to the inner canthus of the eye. Some rhinoplasty surgeons find it helpful to mark the proposed line of the osteotomy on the skin before injection and before executing the maneuver (reproduced with permission from Daniel G. Becker, MD, and Dean M. Toriumi, MD). (**B**) Cadaver showing intermediate and high-low-high lateral osteotomy (reproduced with permission from M. Eugene Tardy, Jr., MD). (**C**) Some surgeons favor a low-low-high osteotomy or a (**D**) low-low-low osteotomy.

Fig. 3 Some rhinoplasty surgeons find it helpful to mark the proposed line of the osteotomy on the skin before injection and before executing the maneuver. Medial, intermediate, and high-low-high osteotomies were marked on this revision rhinoplasty patient's skin prior to injection of local anesthesia.

After hump reduction, lateral osteotomies may be performed earlier or later in the surgery depending upon the surgeon's preference and commonly relating to the surgical approach undertaken. Some surgeons advocate drawing an outline of the proposed osteotomy sites on the patient with a marking pen as a guide (►**Fig. 3**). Lateral osteotomies should not be performed until after profile reduction has been performed because resecting the bony hump with an osteotome or rasp requires a stable base. The osteotomies mobilize the nasal bones which generally end the opportunity for further reduction of the dorsal height by osteotome or rasp. For the same reason, medial osteotomies should be performed prior to intermediate osteotomes, and these should be performed prior to lateral osteotomies. Each of these will be described in the following sections. That being said, surgeons who use the piezoelectric instrumentation report that this technology does allow further modification of the nasal bone after osteotomy when necessary.

Lateral Osteotomy—Intranasal

The high-low-high lateral osteotomy can be performed intranasally or percutaneously. Intranasal lateral osteotomies are performed through a vestibular incision at the lateral wall of the pyriform aperture just superior to the attachment of the inferior turbinate (►**Fig. 4**).

Fig. 4 Intranasal incision for lateral osteotomy, just superior to the attachment of the inferior turbinate.

A mucosal incision is made sharply with a scalpel or iris scissors and carried down to the level of the nasal bone. The periosteal attachments to the nasal bones are an important attachment and area of support for the nasal bones. Some surgeons elevate the periosteum off of the nasal process of the maxilla along the tract of the proposed osteotomy to an extent just large enough to accommodate the osteotome of choice.[2] These surgeons feel that this elevation helps to protect the periosteum during osteotomy. However, a recent study reported that periosteal elevation increased the severity of postoperative ecchymosis.[17] As stated previously, the average thickness of the nasal bone along the pathway of the high-low-high osteotomy is 2.5 to 3 mm. With this in mind, many surgeons feel that the use of a narrow 2.5 to 3 mm osteotome may protect the periosteum without the need for elevation[11,15,16] (►**Fig. 5**). Experienced surgeons may use unguarded osteotomes, although osteotomes with low profile guards designed to protect the nasal soft tissue are also favored and may reduce the incidence of soft tissue trauma.

The guard of the osteotome may also allow the surgeon to confidently engage the nasal bone. Large guards are favored by surgeons who like to palpate the guard, but they themselves may cause soft tissue trauma. Regardless of whether periosteal elevation is undertaken or guarded osteotomes are utilized, the important principle is the preservation of soft tissue and continuity of periosteal attachments.

Fig. 5 A 2.5- and 3.0-mm low-profile guarded osteotome for lateral osteotomies ("Becker Osteotome," MicroFrance, Saint-Aubin-le-Monial, France).

The nasal bones also have an intranasal lining. This may be elevated by hydrodissection with local anesthesia or by local dissection prior to osteotomy. This is felt to be advantageous, as preserving this lining results in reduced soft tissue trauma and also may provide some support.

To initiate the lateral osteotomy, the osteotome is introduced through the vestibular incision, and the edge of the pyriform aperture rim is felt with the blade. The blade is moved to the desired starting position on the pyriform rim. Once engaged on the pyriform rim, the osteotome is gradually advanced using a gentle two-tap technique. Initially, the osteotomy is angled in a posterior and cephalic direction until the nasofacial groove is reached. This completes the initial high portion of the lateral osteotomy.[18]

In contrast to Joseph's original low initiation, surgeons more commonly advocate initiating the lateral osteotomy 3 to 4 mm superior to the base of the pyriform aperture above the attachment to the inferior turbinate.[14] This preserves a triangle of maxillary frontal process bone at the base of the pyriform termed "Webster's triangle" to which attachments to the lateral suspensory ligaments reside. If the osteotomy is initiated along a low path and this triangle is not preserved, infracturing of the nasal bone may medialize the head of the inferior turbinate, resulting in stenosis at the internal nasal valve.[13] Notwithstanding this, some surgeons continue to advocate initiating the lateral osteotomy low on the pyriform aperture, which they feel allows for more efficient mobilization of the bony vault base.[19] With this in mind, each patient should have an individualized approach based on their facial profile, intercanthal distance, bony vault characteristics, ethnicity, gender, nasal airway, and desired outcome.[2]

Once the initial "high" portion of the lateral osteotomy is completed, the osteotome is adjusted so that the cutting edge travels along a "low" path within the nasofacial groove until it reaches the level of the inferior orbit. Care is taken to make this portion of the osteotomy sufficiently lateral along the nasal bone, as a lateral osteotomy that is performed too far medially may result in a bony step-off or staircase phenomenon that can be aesthetically noticeable and displeasing, particularly in thin-skinned patients.[20]

As a practical matter, from time to time this will occur. If the surgeon feels that the intended lateral osteotomy is too medial, the surgeon may consider it effectively to be an intermediate osteotomy. In that case, the surgeon can simply perform a new lateral osteotomy and avoid the above-noted potential complication.

To complete the lateral osteotomy, the path is curved superiorly and anteriorly in a "high" path into the nasal bone, terminating at the level of the medial canthus a few millimeters from the lateral end of the medial osteotomy (if performed).[14] In the course of the lateral osteotomy, a change in the location, feel, and sound occurs. The experienced surgeon has a special appreciation for the feel and sound of the osteotomy. The hardness of the bones differs among patients, and the experienced surgeon will generally notice these differences.

If the osteotomy is instead continued from the level of the inferior orbit along a "low" path into the thicker nasofrontal bone, the resultant infracture of the nasal bone may be more difficult to control and may result in a rocker deformity, in which medialization of the nasal bone results in protrusion at the superior fracture site.[13] Treatment of the rocker deformity, when it occurs, typically requires a percutaneous osteotomy.

In a rocker deformity, the high part of the osteotomy is extended too high, and the treatment is described earlier. Alternatively, the surgeon may find that the high part of the osteotomy did not extend high enough, that the fracture occurred short of the intended target. In this situation, there may be a sharp edge of bone superiorly that protrudes more lateral than the osteotimized bone, and this edge may be palpable. This may lead to a visible deformity if not addressed, and it may be well-addressed with a medial osteotomy. Great care must be taken however, as this creates an additional segment of free-floating bone. Maintaining the periosteal attachments is particularly important in this scenario.

Throughout the lateral osteotomy, the osteotome position and trajectory should be controlled by palpation using the nondominant hand, particularly when reaching the level of the medial canthus. This may help decrease the risk of iatrogenic lacrimal system disruption, which may occur when osteotomies are carried more cephalically into the thicker nasal bones.[21]

Once the lateral osteotomy is completed, this will result in a completed fracture from the superior end of the osteotomy site through the weakest line of the nasal bone. If a medial osteotomy or superior transverse osteotomy was also performed (described later), gentle digital pressure is generally sufficient to infracture the mobilized bony segment. If more than gentle digital pressure is required, reinsert the osteotome and evaluate the prior osteotomy line.

Lateral Osteotomy—Percutaneous

The percutaneous lateral osteotomy involves creating discontinuous perforations along the lateral aspect of the bony pyramid using a sharp osteotome that is inserted transcutaneously through the external nasal skin. Advocates of the percutaneous approach feel that it provides a more direct visualization of the path of the desired osteotomy, reduces the incidence of damage to vestibular mucosa, preserves the periosteal attachments of the nasal bones with increased support and reduced anatomical dead space,[22,23] and reduces the incidence of flail segment of fractured bone.[13]

In performing the percutaneous lateral osteotomy, a 2-mm stab incision is made in the middle of the line drawn for the lateral osteotomy. Often this stab incision can be performed with the 2-mm osteotome, engaged with a firm single tap. The periosteum is generally pushed aside with a sharp 2-mm micro-osteotome together with the vessels alongside the dorsum.[20] As with the maneuvers described earlier for a continuous approach, the intention is to preserve the periosteum to serve as an internal splint for the fractured bone. With a 2- or 3-mm osteotome, small perforating osteotomies are made along the planned lateral osteotomy line. Some surgeons advocate that the osteotome is oriented at an angle so that only one corner of the edge is in direct contact with the bone to precisely focus the force and minimize trauma. A change in both feel and sound at the location is achieved, and the osteotome is withdrawn from the bone but not from beneath the skin. Multiple discontinuous osteotomies are spaced 2 mm apart in the path desired (►**Fig. 6**).

As with continuous lateral osteotomies, the attachment of the inferior turbinate is left intact caudally, and cephalically the perforating osteotomy is brought to the level of the medial canthus in a "high" path along the nasal bone. Infracturing of the nasal bone follows by applying external digital pressure on the mobilized nasal bone medially.

Regardless of the technique employed, after the osteotomized segments have been appropriately positioned, the dorsum should be reevaluated to ensure no dorsal irregularities have been created.

In addition to the intranasal and percutaneous, alternative osteotomy approaches such as transpalpebral[24] and sublabial[25] have also been described. Proponents describe their usefulness for low access to the pyriform aperture,[2] although they should generally be reserved for unique indications beyond the scope of this article.

Intermediate Osteotomies

When performing reduction of a dorsal hump, and also when straightening a twisted nose, careful anatomic evaluation of the position and shape of the nasal bones is vital. It is important to

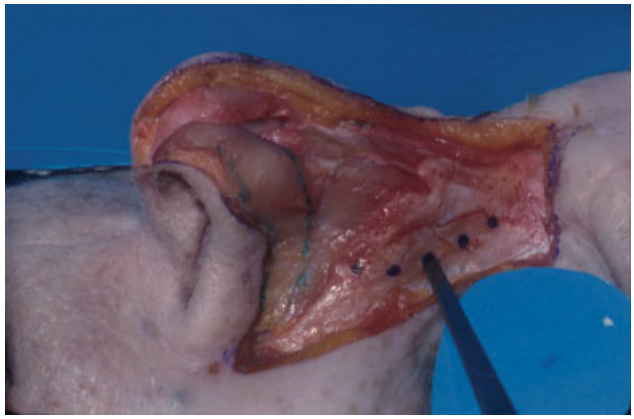

Fig. 6 In percutaneous lateral osteotomies, multiple discontinuous osteotomies are spaced 2 mm apart in the path desired.

Fig. 7 Intermediate osteotomy.

Table 2 Common intermediate osteotomy indications[14]

1. Narrow an overly wide bony vault
2. Correct the deviated nose with asymmetric sidewall lengths
3. Straighten an excessively concave or convex nasal bone

recognize that the nasal bones may be asymmetric, and that the nasal bone itself may have a deviation or bend in it that requires an additional or intermediate osteotomy. Strategically planned osteotomies that address the anatomic configuration of the nasal bones can not only close an open roof but can also improve a deviation of the bony vault.

Intermediate Osteotomy

The intermediate osteotomy is made medial to and essentially parallel to the path of the lateral osteotomy along the midportion of the nasal sidewall[13,14] (►**Fig. 7**). The concept is to divide the nasal bone into two distinct segments[2] (►**Table 2**).

The exact location of the intermediate osteotomy along the nasal sidewall depends on the surgical objective, and can be performed intranasally or percutaneously. Nevertheless, the intermediate osteotomy should be performed before the lateral osteotomy to preserve stable nasal bone on which to perform the subsequent lateral osteotomy. The intermediate osteotomy can be used to decrease the curvature of an excessively convex or concave nasal bone by reorienting the nasomaxillary complex into a more desirable shape.[26] The intermediate osteotomy is also useful to address deviations and asymmetries of the nasal bones. That being said, the addition of another osteotomy inherently creates some additional instability. This should be recognized and considered when deciding whether to perform an intermediate osteotomy.

Dorsal Preservation and Asymmetric Osteotomy

When the bony dorsum is convex, some surgeons advocate lowering the nasal vault in its entirety rather than the more commonly employed approach of excising the dorsal hump. This "dorsal preservation rhinoplasty" can be accomplished via either the "push down" or "let down" techniques (►**Fig. 8**). These techniques are based on the idea that the keystone area is a flexible, osseocartilaginous joint, and that by reducing its underlying cartilaginous septal support, the dorsum can be flexed and modified from convex to concave while preserving the integrity of both the keystone area and the continuity of the cartilaginous vault.[27]

In both the "push down" and the "let down" techniques, the entire bony vault is mobilized "en bloc" with separation of the nasal bony pyramid from the frontal processes of the maxillary bones and the nasal spine of the frontal bone. This requires complete lateral and transverse osteotomies.[20] These techniques both involve excising a strip of septal cartilage immediately below the dorsum. This creates a space that allows for lowering of the dorsum. The amount and shape of the subdorsal septal resection is critical, as it dictates the height and contour of the remaining septum, which in turn dictates the height and shape of the desired dorsal profile.

In the push down technique, complete lateral osteotomies are performed, followed by transverse osteotomies whereby the nasal bones are disarticulated from the frontal processes. The nasal bones are then pinched symmetrically between the index finger and thumb and the entire nasal bony pyramid is pushed in a downward movement into the nasal fossa. Subsequently, the lateral nasal walls slide medial to the frontal processes of the maxilla, and the bony-cartilaginous vault rests atop the remaining septal cartilage.

In the let down technique, triangular wedges of bone are excised from the frontal processes of the maxilla in addition to complete low lateral osteotomies. This allows for a greater degree of bony vault descent, and results in the bony pyramid resting atop the frontal process of the maxilla. The let down technique is generally preferred to the push down technique if the bony nasal pyramid requires greater than 4 mm of lowering.

The same principles can also be applied to the nose with an asymmetric bony dorsum. In the occasional case, a low-to-low osteotomy can be performed on the long side and complete lateral osteotomies on the shorter side, followed by an asymmetric push down rotating the nasal pyramid toward the longer side. Alternatively, a wedge of frontal process can be performed unilaterally, allowing the bony vault to be rotated and let down on toward the longer side.

Medial Osteotomy

A medial osteotomy is defined as a separation of the nasal bones and the bony septum.[13] Numerous configurations have been proposed in the literature, with the most commonly performed being medial fading/oblique and vertical (►**Table 3**).

The medial fading or oblique osteotomy is used to facilitate mobilization of the entire nasal bony sidewall and to help control infracturing at the upper portion of a lateral osteotomy[14] (►**Fig. 9**). The latter is particularly useful in patients with thick bones or wide bony root, and in the patient who has not had dorsal hump reduction. To perform the medial oblique osteotomy, the osteotome is first engaged on the caudal edge of the nasal bone just lateral to the medial

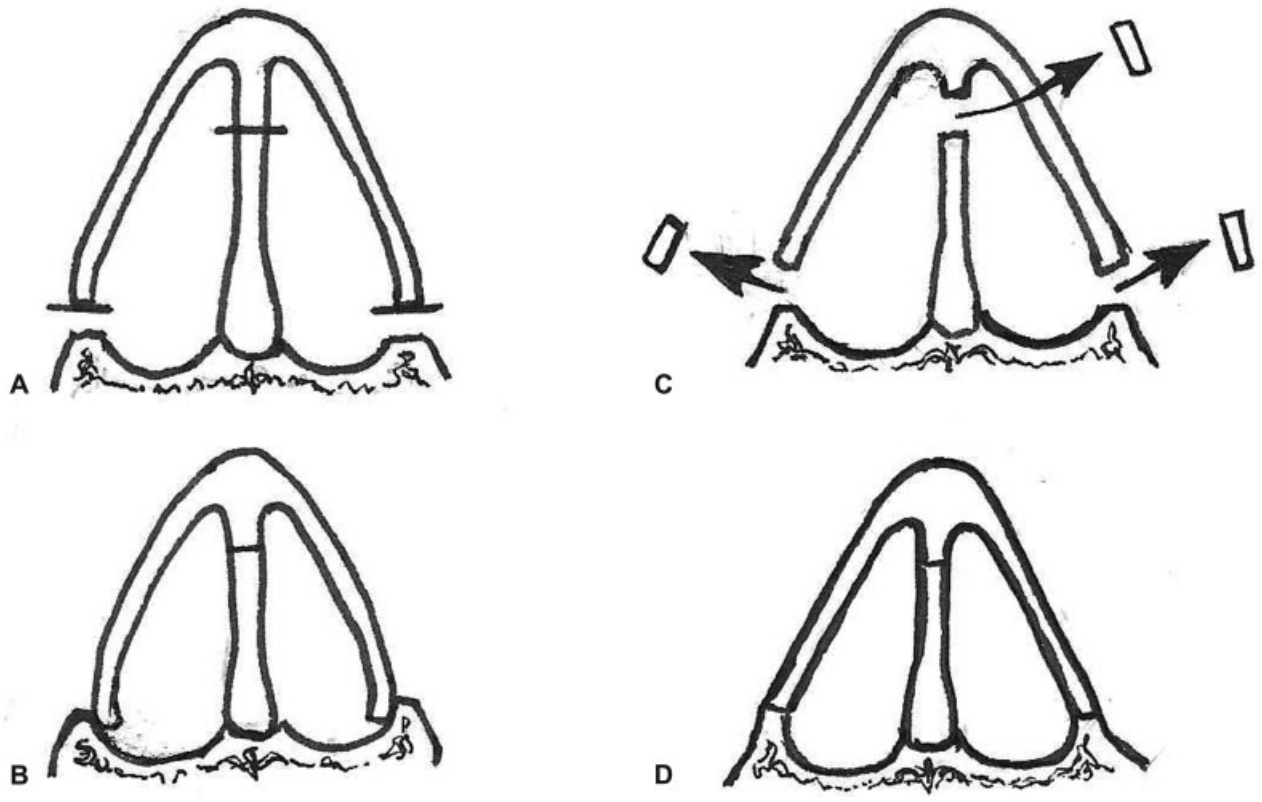

Fig. 8 In the push down technique, complete lateral osteotomies are performed, followed by transverse osteotomies whereby the nasal bones are disarticulated from the frontal processes. The nasal bones are then pinched symmetrically between the index finger and thumb and the entire nasal bony pyramid is pushed in a downward movement into the nasal fossa (**A**, **B**). In the let down technique, triangular wedges of bone are excised from the frontal processes of the maxilla in addition to complete low lateral osteotomies. This allows for a greater degree of bony vault descent, and results in the bony pyramid resting atop the frontal process of the maxilla. The let down technique is generally preferred to the push down technique if the bony nasal pyramid requires greater than 4 mm of lowering (**C**, **D**).

Table 3 Common medial osteotomy indications[13,14]

1. To facilitate mobilization of the nasal bony sidewall
2. To help control infracturing from the upper portion of a lateral osteotomy
3. To widen an overly narrowed bony vault

and the upper lateral cartilages which have been separated from the cartilaginous dorsum. Once the osteotomy is initiated, the path fades laterally in an oblique fashion toward the medial canthus, directed toward the apex of the lateral osteotomy path (if previously made). In doing so, the combination of the medial and lateral osteotomy may obviate the need for a superior/transverse osteotomy in many cases.

In contrast to the medial fading osteotomy, the medial vertical osteotomy is employed to widen an overly narrowed bony vault by creating a channel in which spreader grafts can be placed (►**Fig. 10**).[14] The medial vertical osteotomy begins in the same manner as the medial oblique. However, once the osteotomy has been initiated, the osteotomy is made in a vertical path toward the radix. Once the osteotome reaches the superior aspect of the nasal bone, the osteotome is twisted laterally along its long axis to create a channel in which a spreader graft can be placed. Care should be exercised not to extend the vertical osteotomy into the thicker

Fig. 9 The medial fading or oblique osteotomy.

frontal bone, which can prevent the lateral mobilization of the nasal bone and can lead to unintended postoperative ecchymosis. Care must also be taken during initiation of any medial osteotomy not to disrupt the keystone area, as destabilizing the septum from the underside of the nasal bone can result. This is especially relevant for revision cases or when prior septoplasty has been performed.[14]

Either path of medial osteotomy can be made intranasally or percutaneously. In the intranasal approach, the space provided by the already raised dorsal tunnel provides access

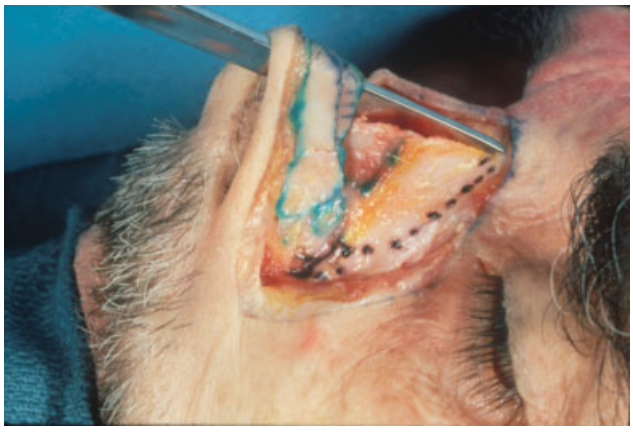

Fig. 10 The medial vertical osteotomy.

to the bony dorsum. In the external approach, the medial oblique osteotomy can be performed under more direct visualization.[20]

A dorsal hump reduction creates an open roof. In many cases, dorsal hump reduction will obviate the need for a medial osteotomy, although some authors promote extending an obliquely angled medial osteotomy from superior aspect of the bony reduction.[3] This may be considered essential in the severely deviated or wide dorsum to mobilize the entire bony sidewall.

Osteotome Selection

Osteotomes are available in a variety of sizes and shapes, including single- versus double-guarded osteotomes, curved versus straight osteotomes, and notched. The choice of osteotome style is most commonly based on surgeon's preference. The size of the osteotome is also commonly based on surgeon's preference. A publication by Becker et al[11] advocates for a scientific basis for the selection of osteotomes. In this work, the average bony thickness of the lateral nasal wall along the track of a high-low-high osteotomy was calculated in 56 patients via computed tomography. This was determined to be 2.47 mm (standard deviation, 0.47) in male patients and 2.29 mm (standard deviation, 0.40) in female patients. This data then lead to head-to-head clinical evaluation between the "standard" 4-mm low-profile guarded osteotome and prototyped 3- and 2.5-mm low-profile guarded osteotomes to assess both their reliability and the degree of intranasal trauma, as reflected by intranasal mucosal tears. Forty patients underwent rhinoplasty, for a total of 80 lateral osteotomies. In all cases, hydrodissection of the nasal mucosa was undertaken along the osteotomy site, and lateral osteotomies were accomplished with one pass. The 4-mm osteotome caused intranasal mucosal tears in 95% of osteotomies, the 3-mm osteotome in 34%, and the 2.5-mm in 4%. Early postoperative edema and ecchymosis were comparable among the groups. This report suggested that proper selection of osteotomes and attention to proper surgical technique produces a reliable, minimally traumatic lateral osteotomy through the intranasal approach. The 2.5-mm osteotome was reliable and the least traumatic to soft tissue of the osteotomes evaluated.

In addition to proper size selection, carefully maintained osteotomes, with sharp, even cutting surfaces, have also been demonstrated to both enhance precision and minimize soft tissue and bony trauma.[7–9,28,29] Bloom et al[9] reported that osteotomes dull quickly. In their study, resharpening did not provide quantitative benefits. If a dull osteotome is used, large segmental fractures of the bone can occur, as the force of the mallet strike is disseminated rather than focused at the cutting surface.[28] The authors proposed treating osteotomes as limited reuse instruments.

Piezoelectric osteotomes have recently been demonstrated to make controlled osteotomies while minimizing soft tissue trauma.[2,30,31] These devices emit energy at frequencies required for bony cuts, which are distinct from those necessary for soft tissue. These devices require wider surgical dissection. Piezoelectric osteotomes provide an additional instrument for consideration by the surgeon undertaking osteotomies.[32–35]

Conclusion

Nasal osteotomies are essential techniques in the armamentarium of the rhinoplasty surgeon for reshaping the bony nasal vault. In general, osteotomies are indicated to close an open roof deformity following dorsal reduction, to narrow a broad nasal dorsum, and to straighten a deviated bony vault.

Osteotomies are classified according to their location along the nasal sidewalls, their path or trajectory along the nasal vault, and the method of access to the nasal bones. The high-low-high path remains the most common in lateral osteotomies, although there is no evidence to support the sole use of any particular trajectory. Percutaneous lateral osteotomies are also commonly used, with supporters citing direct visualization of the path of the desired osteotomy and preservation of periosteal attachments. A fading medial oblique osteotomy helps to obviate the need for transverse osteotomy, although circumstances arise when a transverse osteotomy is required. Intermediate osteotomies are infrequently necessary, although particularly effective for decreasing the curvature of an excessively convex nasal bone.

Sharp, appropriately sized osteotomes are preferred to perform precise bone cuts and minimize trauma to unintended tissues. The senior author (D.G.B.) recommends treating osteotomes as limited reuse instruments, as dulling occurs quickly with use and resharpening does not appear to provide benefit.

Wide variation continues to exist regarding osteotomies and osteotomes, reflective of the fact that surgical management of the bony nasal vault is a complex and nuanced topic. With this in mind, a comprehensive preoperative evaluation and a detailed understanding of nasal anatomy is critical to performing nasal osteotomies. An approach tailored to the patient's specific anatomy offers the best opportunity to achieve their aesthetic desires while maintaining the nasal airway and reducing the risk of complications.

Conflicts of Interest
None.

References

1 Bloom JD, Immerman SB, Constantinides M. Osteotomies in the crooked nose. Facial Plast Surg 2011;27(05):456–466
2 VanKoevering KK, Rosko AJ, Moyer JS. Osteotomies demystified. Facial Plast Surg Clin North Am 2017;25(02):201–210
3 Gruber RP, Garza RM, Cho GJ. Nasal bone osteotomies with nonpowered tools. Clin Plast Surg 2016;43(01):73–83
4 Most SP, Murakami CS. A modern approach to nasal osteotomies. Facial Plast Surg Clin North Am 2005;13(01):85–92
5 Ozucer B, Özturan O. Current updates in nasal bone reshaping. Curr Opin Otolaryngol Head Neck Surg 2016;24(04):309–315
6 Wayne I. Osteotomies in rhinoplasty surgery. Curr Opin Otolaryngol Head Neck Surg 2013;21(04):379–383
7 Gryskiewicz JM, Gryskiewicz KM. Nasal osteotomies: a clinical comparison of the perforating methods versus the continuous technique. Plast Reconstr Surg 2004;113(05):1445–1456, discussion 1457–1458
8 Lee HM, Kang HJ, Choi JH, Chae SW, Lee SH, Hwang SJ. Rationale for osteotome selection in rhinoplasty. J Laryngol Otol 2002;116 (12):1005–1008
9 Bloom JD, Ransom ER, Antunes MB, Becker DG. Quantifying the sharpness of osteotomes for dorsal hump reduction. Arch Facial Plast Surg 2011;13(02):103–108
10 Tasman A-J. Rhinoplasty - indications and techniques. GMS Curr Top Otorhinolaryngol Head Neck Surg 2007;6:Doc09
11 Becker DG, McLaughlin RB Jr, Loevner LA, Mang A. The lateral osteotomy in rhinoplasty: clinical and radiographic rationale for osteotome selection. Plast Reconstr Surg 2000;105(05):1806–1816, discussion 1817–1819
12 Palhazi P, Daniel RK, Kosins AM. The osseocartilaginous vault of the nose: anatomy and surgical observations. Aesthet Surg J 2015; 35(03):242–251
13 Rohrich RJ, Adams WP, Ahmad J, Gunter JP. Dallas Rhinoplasty: Nasal Surgery by the Masters. 3rd ed. St. Louis, MO: Quality Medical Publishing, Inc;. 2014
14 Papel ID, Frodel JL, Holt GR, et al. Facial Plastic and Reconstructive Surgery; Management of the Bony Nasal Vault. 4th ed. New York, NY: Thieme Medical Publishers; 2016
15 Harshbarger RJ, Sullivan PK. Lateral nasal osteotomies: implications of bony thickness on fracture patterns. Ann Plast Surg 1999; 42(04):365–370, discussion 370–371
16 Kuran I, Ozcan H, Usta A, Bas L. Comparison of four different types of osteotomes for lateral osteotomy: a cadaver study. Aesthetic Plast Surg 1996;20(04):323–326
17 Ong AA, Farhood Z, Kyle AR, Patel KG. Interventions to decrease postoperative edema and ecchymosis after rhinoplasty: a systematic review of the literature. Plast Reconstr Surg 2016;137 (05):1448–1462
18 Toriumi DM, Becker DG. Rhinoplasty Dissection Manual. Philadelphia, PA: Lippincott Williams & Wilkins; 1999
19 Gruber RP, Garza RM, Cho GJ. Nasal bone osteotomies with nonpowered tools. Clin Plast Surg 2016;43(01):73–83
20 Becker DG, Palma P. Dorsal hump reduction and osteotomies. The Rhinoplasty Archive. . Published 2019. Available at: https://www.rhinoplastyarchive.com/articles/dorsal-hump-reduction-osteotomies. Accessed August 27, 2019
21 Lavine DM, Lehman JA, Jackson T. Is the lacrimal apparatus injured following cosmetic rhinoplasty? Arch Otolaryngol 1979;105(12): 719–720
22 Murakami CS, Larrabee WF. Comparison of osteotomy techniques in the treatment of nasal fractures. Facial Plast Surg 1992;8(04): 209–219
23 Rohrich RJ, Minoli JJ, Adams WP, Hollier LH. The lateral nasal osteotomy in rhinoplasty: an anatomic endoscopic comparison of the external versus the internal approach. Plast Reconstr Surg 1997;99(05):1309–1312, discussion 1313
24 Amar RE. Correction of the bony rings during the aesthetic rhinoplasty: apologia of the transpalpebral osteotomy. Aesthetic Plast Surg 1998;22(01):29–37
25 Ghassemi A, Riediger D, Hölzle F, Gerressen M. The intraoral approach to lateral osteotomy: the role of a diamond burr. Aesthetic Plast Surg 2013;37(01):135–138
26 Azizzadeh B, Reilly M. Dorsal hump reduction and osteotomies. Clin Plast Surg 2016;43(01):47–58
27 Saban Y, Daniel RK, Polselli R, Trapasso M, Palhazi P. Dorsal preservation: the push down technique reassessed. Aesthet Surg J 2018;38(02):117–131
28 Wolfe SA. On the maintenance and sharpening of instruments. Plast Reconstr Surg 2005;116(5, Suppl):89S–91S
29 Ransom ER, Antunes MB, Bloom JD, Becker DG. Quantifying osteotome sharpness: comparing the major manufacturers. Otolaryngol Head Neck Surg 2012;146(05):707–711
30 Pribitkin EA, Lavasani LS, Shindle C, Greywoode JD. Sonic rhinoplasty: sculpting the nasal dorsum with the ultrasonic bone aspirator. Laryngoscope 2010;120(08):1504–1507
31 Robiony M, Toro C, Costa F, Sembronio S, Polini F, Politi M. Piezosurgery: a new method for osteotomies in rhinoplasty. J Craniofac Surg 2007;18(05):1098–1100
32 Kurt Yazar S, Serin M, Rakici IT, Sirvan SS, Irmak F, Yazar M. Comparison of piezosurgery, percutaneous osteotomy, and endonasal continuous osteotomy techniques with a caprine skull model. J Plast Reconstr Aesthet Surg 2019;72(01):107–113
33 Wähmann M, Riedel F, Kovacevic M, Hopf A, Albers AE. Comparison of piezoelectric and conventional osteotomy in rhinoplasty: a systematic review [in German]. HNO 2019;67(02): 98–109
34 Ghavimi MA, Nezafati S, Yazdani J, et al. Comparison of edema and ecchymosis in rhinoplasty candidates after lateral nasal osteotomy using piezosurgery and external osteotomy. J Adv Pharm Technol Res 2018;9(03):73–79
35 Robiony M, Lazzarotto A, Nocini R, Costa F, Sembronio S, Franz L. Piezosurgery: ten years' experience of percutaneous osteotomies in rhinoplasty. J Oral Maxillofac Surg 2019;77(06): 1237–1244