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28.1 Introduction and General Aspects

Rhinoplasty is one of the mostly performed facial aesthetic procedures. The surgeon, who is dealing with facial aesthetics, tries to achieve an aesthetic harmony with the surrounding facial features and preserve the nasal function and support. To achieve these results, nasal osteotomy must be done successfully [1]. In general nasal osteotomy is used to reposition and to reshape the nasal bones. Repositioning of the nasal bones usually relocates the bones more medially by moving the base of the nasal bone from its junction with the frontal process of the maxilla. Reshaping usually corrects excessive convexity. Among osteotomy, lateral nasal wall osteotomy has an important role. Lateral osteotomy in rhinoplasty is commonly used to close an open nasal roof after hump resection, to correct asymmetric lateral wall, to strengthen the deviated bony framework, and to narrow the nose [2–4].

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Several techniques for producing lateral nasal osteotomies have been described in the past century, yet no consensus has been established regarding the optimal method [5]. The selection of technique and instrumentation is often the surgeon's preference and experience but must also depend on some factors like predictable control, precision, reproducibility, and association with minimal potential for complications [3]. To accomplish a successful osteotomy, the surgeon must be able to mobilize the bones and to ensure stability after the surgery. Mobilization can be adequate if the fracture is complete. This can be done either by osteotome or manually. Manual fractures create greenstick fractures, which are less predictable but tend to be more stable. In rhinoplasty, the anatomy and the function of the nose must be studied and understood completely. So a complete and detailed workout of the nose anatomy and function is essential in rhinoplasty operations. To perform a successful osteotomy, the surgeon should consider the intrinsic anatomy (thickness, size, and attachments of the nasal pyramid), instrumentation, surgical approach, and the patients' expectations. Good preoperative evaluation of these factors will yield a perfect result.

28.2 Anatomy

28.2.1 Bone and Cartilage Framework

The bony framework of the nose is composed of paired nasal bones that articulate with each other in the midline and to the frontal bone superiorly.

The region where the nasal bones and the frontal bone articulate is known as the nasion. The lateral attachment of the nasal bones is the ascending process of the maxilla. Nasal bones also articulate with the perpendicular plate of the ethmoid bone in the posterior midline region. These bones together form the bony vault of the nose. It is also important to note that the bones that form the nose vary in thickness; nasal bones are thick superiorly and in the midline along the nasal dorsum and thin laterally, and thickness increases more laterally over the maxilla. This variability of thickness affects the success and the location of osteotomy. Nasal septum supports the nose along its entire length. Inferiorly nasal bones overlap the cephalic portions of the upper lateral cartilages to support the cartilaginous vault of the nose. The paired upper lateral cartilages are continuous with the nasal septum medially. The angle between the upper lateral cartilages and the nasal septum is the internal nasal valve. The cartilages are fused with the frontal process of the maxilla by fibrous tissue. The paired lower lateral cartilages form the nasal lobule and the nostrils, which are supported by nasal septum and nasal spine medially and small accessory cartilages laterally.

28.2.2 External Landmarks and Soft Tissues

The soft tissues over the bony vault are namely skin, subcutaneous tissue, superficial musculoaponeurotic system, and the periosteum. The shape of the nose is composed of the bony vault as well as the soft tissues over the bones. Two lateral walls, dorsum, and nasofrontal angle define the upper third of the nose. Nasofrontal angle is the deepest and the most inferior portion of the nasal dorsum, whereas the nasion is the junction point of nasal bones to the frontal bone. The radix or root of the nose corresponds to the junction of the nasal and frontal bones, and this should be located at the level of the supratarsal crease. Rhinion is the junction point of the nasal bones inferiorly to the upper lateral cartilages. The nasal bones and the cartilages of the nose are

covered by soft tissue and skin that differs in thickness in different parts of the nose. The skin and subcutaneous tissue is thicker at nasofrontal angle, nasion, and supratip region and thinner over the rhinion, middorsal region, osteocartilaginous junction, and upper lateral cartilages and thins toward the nasal tip [6].

The soft tissues over the nasal bone are different in thickness, and taking this information into consideration is important to achieve straight appearance of the profile; one must leave a small hump at the junction of osteocartilaginous region to avoid a small saddlenose deformity after dorsal hump reduction. Nasal muscles lie deep to the nasal skin and subcutaneous tissue. The superficial musculoaponeurotic system (SMAS), which is composed of collagen fibers, surrounds these muscles, and main arteries and nerves of the nose are deep to SMAS. The dissection during rhinoplasty must be done deep to SMAS.

The periosteum lies between the bone and the soft tissue envelope. It may be helpful to raise the flap including the periosteum to achieve better camouflage and decrease the risk of postoperative trophic changes. Laterally the periosteum should be minimally elevated through the maxillary process to stabilize the bony fragments following lateral osteotomies.

It is important to note that the soft tissue and bony framework change with age. At a younger age the osteotomies may result in greenstick fractures, which makes it hard to mobilize the fractured segments. So in young patients, continuous osteotomies must be done to avoid greenstick fractures and to accomplish proper mobilization.

28.3 Evaluation

Patients who are candidate to a nasal aesthetic procedure should be evaluated by complete medical history first. Prior nasal trauma, nasal surgery, and nasal breathing problems should be noted. It is very important to define the deformities so that more suitable osteotomies can be performed. During the evaluation, the surgeon should visualize and palpate the nasal anatomy

and predict the underlying structures. During nasal analysis, the nose must be divided into three parts horizontally. The upper third represents the bony vault, mid-third represents the cartilaginous framework, and the lower third represents the tip region.

On anterior evaluation, the length, width, and deformities and deviations of the nasal bones must be noted. The width of the nasal dorsum should ideally be two-thirds of the width of the alar base, and the alar base should approximate the intercanthal distance.

Palpation of the nasal bones and maxilla is important to define any irregularity or displacement. The concavity or convexity of the bones must be noted as convex deformity may require an intermediate osteotomy. The height of the nasal bones should also be evaluated.

The nasofrontal angle (between glabella-nasion line and nasion-tip line) should be 115–130°. High radix-shallow nasofrontal angle or low radix-high nasofrontal angle should be managed individually. Intrasally evaluation is also important to define septal deformities, valve obstruction, or turbinate hypertrophy. Function of the nose must be restored while managing the aesthetic appearance.

28.4 Instrumentation

There are different types of osteotomes that can be used in lateral osteotomy. Generally the choice of the osteotome and the surgical approach depends on the experience of the surgeon. Narrow, wide, straight, curved, or guarded osteotomes can be used for this purpose. The blades may be 3 or 5 mm in width and the bodies may be straight or curved. Also guarded or unguarded osteotomes may be used. Unguarded narrow osteotomes can cause minimal soft tissue or mucosa injury, but experienced surgeons can use these instruments reliably. To accomplish percutaneous lateral osteotomy, 2-mm straight osteotome can be selected. In their study, Erişir et al. [7] described a novel osteotome with minimal postoperative hemorrhage and injury (Fig. 28.1). Kuran et al. [8] compared four different types of osteotomes regarding soft tissue injury. They found that the injury was less with the use of narrow osteotomes. Wide osteotomes may cause more soft tissue injury. But some authors use wide osteotomes because they believe that due to complete mucosal laceration, less postoperative swelling with intranasal bleeding could result [9]. When considering the shape of the osteotome body, it was found that performing high-to-low osteotomy was easier with curved osteotomes than

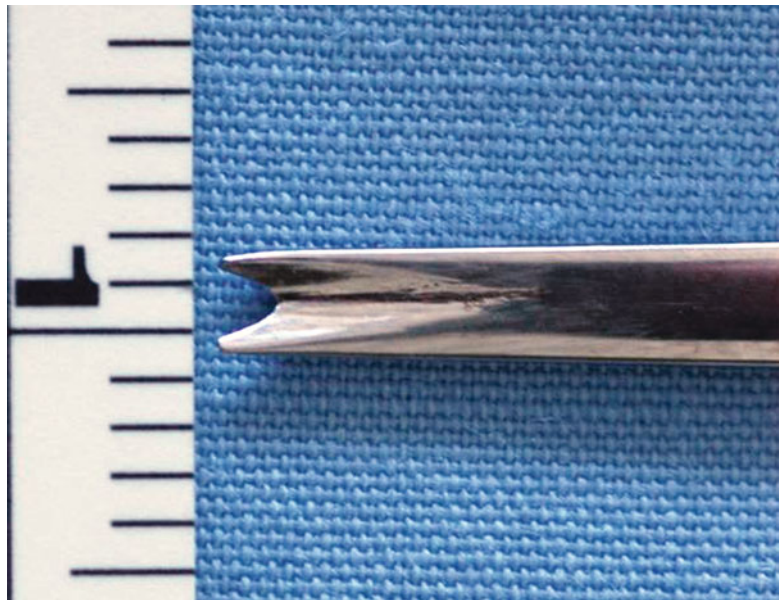


Fig. 28.1 A 2-mm V-shaped osteotome

straight osteotomes with nearly 40% less atypical fracture lines [8]. In another study, Becker et al. compared 2.5-mm and 3-mm guarded osteotomes to standard 4-mm guarded osteotome in performing endonasal lateral osteotomy; cut in a single-pass, high-low-high fashion, the intranasal mucosa was inspected for the presence of mucosal injury. They found that 2.5-mm osteotome was reliable and the least traumatic to soft tissue [5]. Also the pyramid thickness along the osteotomy pathway was measured and was found to be relatively thin (<2.5 mm). This finding also supported the use of small instruments for osteotomy [5]. Thomas et al. also concluded that the use of narrow osteotomes during endonasal osteotomy contributed to a reduction in the loss of nasal support and postoperative edema and ecchymosis [10]. Tardy and Denneny [11] also use 2- to 3-mm osteotome, supporting the idea that narrow osteotomes will maintain periosteal support and decrease the rate of bleeding, soft tissue disruption, and scarring. Murakami and Larrabee [4] analyzed lateral periosteal disruption and soft tissue injury by comparing the use of 4-mm guarded osteotomes for endonasal approach versus 2- or 3-mm unguarded osteotomes for the percutaneous approach. They found that the percutaneous approach created more irregular osteotomies but the endonasal approach produced more soft tissue trauma. Recently Mottura [12] described a double-guarded 4-mm straight osteotome for lateral osteotomy that enabled separation of external periosteum and mucoperiosteum while performing osteotomy.

For percutaneous osteotomy, a small (2-mm) unguarded osteotome is widely advocated. Some external soft tissue injury is unavoidable, but it may be controlled by the application of proper technique and by the selection of a small osteotome [5].

Guarded osteotomes that are used intranasally produce more bleeding than properly used percutaneous 2-mm osteotomes. Regardless of the soft tissue elevation or the position of the guard, guarded osteotomes cause more soft tissue trauma. These kinds of osteotomes produce linear laceration along the mucosa and cause more bleeding. Conversely the percutaneous osteotomes traumatize the mucosa less, resulting in less bleeding [13].

28.5 Historical Development

Joseph and his trainees popularized the early technique for lateral osteotomies. In their technique, they created a subperiosteal tunnel and used a saw to perform osteotomy, beginning at the most inferior portion of the pyriform aperture. Then the osteotomy cut was extended along the frontal process of the maxilla and ended at or beyond the nasofrontal suture (low-to-low osteotomy) [1, 4]. As the saw was causing loss of height of the nasal bones, the surgeons began to use osteotomes to perform an accurate cut. Later the patients were appearing to experience postoperative nasal airway obstruction due to excessive narrowing of the nasal cavities with the “low-to-low” technique. Webster et al. in 1977 [14] pointed out that a triangular bone should be left at the pyriform aperture just superior to the inferior turbinate and described the curved osteotomy. In this technique, the osteotomy was starting relatively high at the pyriform aperture, leaving a triangular bone. Then the cut was extended low onto the ascending frontal process of the maxilla and then was curving back high again to prevent the extension of the osteotomy into the frontal process (high to low to high). This modification of the technique preserved the airway by avoiding medial displacement of the lateral nasal walls. Also high osteotomy at the level of frontal process allowed for the preservation of the frontal process. In the cases with low osteotomy at the level of frontal process and infraction of the nasal bones, the radix was acting as a pivot and the segment beyond the radix was lateralizing and was creating the rocker deformity [1]. Conversely by ending the osteotomy high and by combining the lateral osteotomy with a medial osteotomy will avoid this deformity.

On the other hand, external osteotomy was performed in 1955 by Goria and was popularized by Straatsma [15, 16]. The authors who prefer this technique believe that perforating technique causes less mucosal tears and less intranasal complications and postoperative morbidities [17, 18].

28.6 Types of Osteotomies

28.6.1 Incomplete Osteotomy

Incomplete osteotomy is the fracture of the lateral nasal walls without the use of an osteotome. The fracture is usually performed manually. As the forces used to make an incomplete osteotomy are uncontrolled, the osteotomies are less controlled and less predictable. The main advantage of this kind of fracture is the stability due to greenstick fracture [19].

28.6.2 Complete Osteotomy

Complete osteotomy is the cut on the lateral nasal walls with an osteotome where all the fracture lines are cut. Osteotomes accomplish direct forces and produce clean cuts. The stability after the complete osteotomy depends on the nature of the bony interface along the osteotomy line and on the extent of attached soft tissues [19].

28.6.3 Linear (Single Cut) or Continuous Osteotomy

In this technique, the osteotome is used to make a bone cut along the nasal facial groove [20]. The path of the cut may follow high-low-high, low-low, or low-high pathway. The osteotomy is done in a continuous fashion, resulting in smooth cut edges.

28.6.4 Perforating Osteotomy

Using a sharp 2-mm straight osteotome, a series of perforations are placed along the desired fracture site using a transnasal or transcutaneous approach. In percutaneous approach, one or two osteotomy sites are marked on the skin, and perforations are created through these sites along the desired osteotomy route. Alternatively, the perforations can be placed intranasally. The perforating intranasal osteotomy can also be used to “push out” the nasal bones that have been medially displaced by previous trauma or surgery [20].

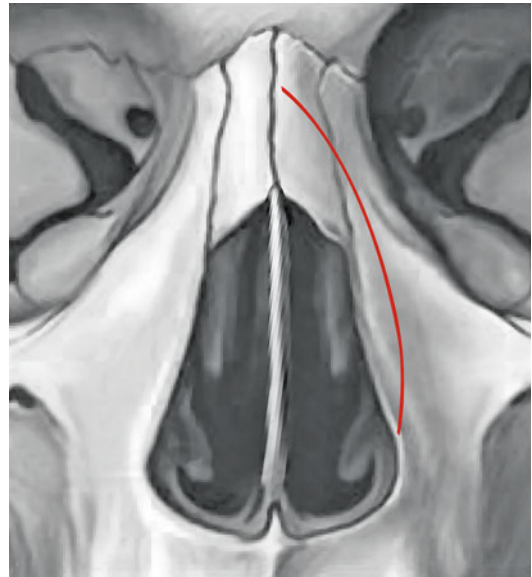


Fig. 28.2 Low-to-high osteotomy is made from the junction of the caudal edge of the nasal bones with the frontal process of the maxilla obliquely to the nasal dorsum near intercanthal line superiorly

28.6.5 Low to High

Low-to-high osteotomy is made from the junction of the caudal edge of the nasal bones with the frontal process of the maxilla obliquely to the nasal dorsum near intercanthal line superiorly (Fig. 28.2).

28.6.6 Low to Low

Low-to-low osteotomy is also made from the junction of the caudal edge of the nasal bones with the frontal process of the maxilla but courses along the base of the nasal bone more vertically and intersects the intercanthal line lateral to the dorsum. To achieve medial displacement of the lateral wall, a medial osteotomy must be done by medial orientation of the osteotome and continuing across the dorsum (Fig. 28.3).

28.6.7 High to Low to High

A modification of classical lateral osteotomies that is described is to preserve the airway by avoiding

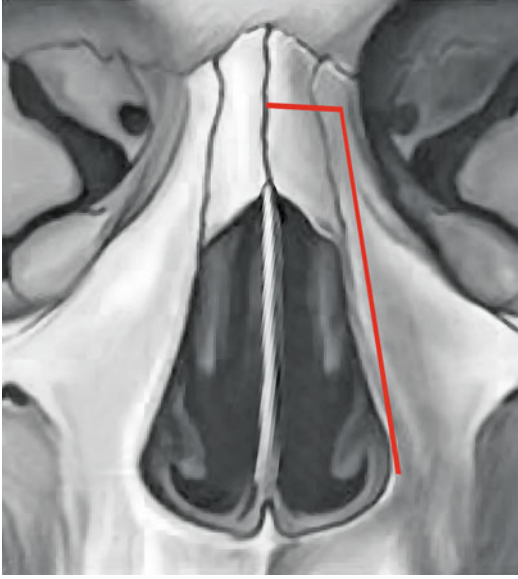


Fig. 28.3 Low-to-low osteotomy

the medial displacement of the inferior portions of the lateral nasal wall. The osteotomy is done in a curved fashion; the cut is started high at the pyriform aperture, preserving a triangular bone at the pyriform, extending low onto the ascending frontal process of the maxilla, and then curving back high to the dorsal part of the nasal bone to avoid extension into the frontal process. The lateral osteotomy runs from the most lateral point of the pyriform aperture to a point medial to the inner canthus of the eye, most commonly in a high-to-low-to-high path. In practice, this means a starting point 3–4 mm above the base of the pyriform aperture and adjacent to the head of the inferior turbinate.

28.6.8 Midlevel or Intermediate Osteotomy

Midlevel osteotomies are generally performed to straighten nasal bones with significant convexity or concavity. These osteotomies may also be performed to correct a deviated nose with one nasal bone that is significantly longer than the other side. The osteotomy is close to the suture line between nasal bone and the frontal process of the maxilla. The midlevel osteotomy connects points

between the base of the nasal bone and dorsum at the pyriform aperture and radix. The osteotomy is performed in the midportion of the nasal bone, parallel to the lateral osteotomy. It usually begins at the midportion of the nasal bone and continues to the pyriform aperture [20]. Then the osteotome is positioned more cephalated and the cut is continued to radix slightly over the intercanthal line. The osteotomy is often performed for convexity or concavity of the nasal bone, and in these cases, the osteotomy is generally performed at the apex of the curvature of the bone [1].

Intermediate or midlevel osteotomies may be performed in a continuous or perforating fashion. While performing the continuous intermediate osteotomy, the osteotome is placed at the caudal border of the nasal bone. The osteotomy is performed in a straight and continuous way. The perforating osteotomy is performed in an interrupted fashion. It can be done either percutaneously or intranasally, depending on the deformity [1]. The percutaneous osteotomy is performed for a convex deformity, and the bone is fractured medially. For concave deformity, the intranasal perforating intermediate osteotomy is generally performed. In this technique, the concave portion is dislocated laterally. The intermediate osteotomy is performed before the lateral osteotomy, which allows the stability to perform the osteotomy. It is advised that the intermediate osteotomy should be done before the lateral osteotomy because the motility of the bones after lateral osteotomy may complicate the intermediate osteotomy (Fig. 28.4) [1].

28.6.9 Double Osteotomy

This kind of osteotomy is the combination of midlevel osteotomy and the low-to-low lateral osteotomy. It is important that the midlevel osteotomy must be done before the base osteotomy to perform the procedure more easily due to stability of the basal attachment to the maxilla. The midlevel osteotomy should begin at the midportion of the nasal bone and be continued to the level just superior to the intercanthal line. As the base osteotomy continues superiorly, the cut intersects the cephalic portion of the midlevel osteotomy (Fig. 28.5).

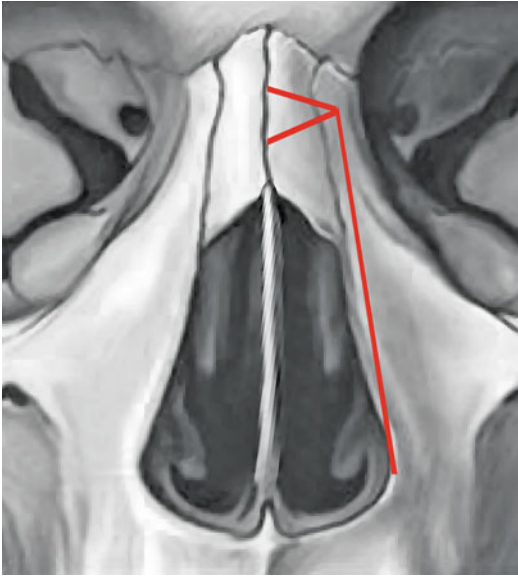


Fig. 28.4 Double osteotomy

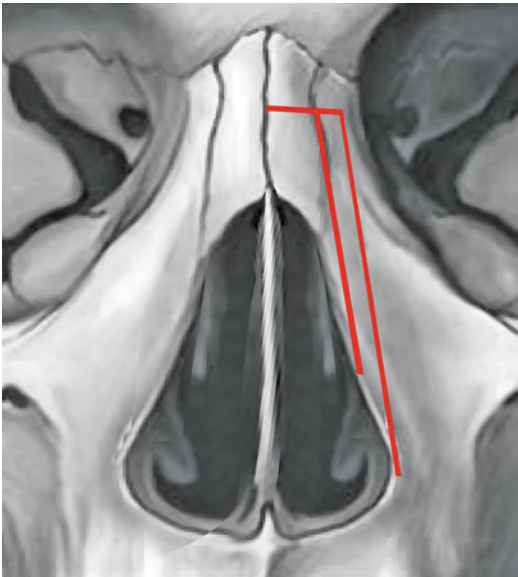


Fig. 28.5 Midlevel or Intermediate osteotomy

28.7 Indications of Lateral Osteotomy and Selecting the Appropriate Osteotomy Type

1. Repositioning the excessively wide base: The most common indication of osteotomy is medial repositioning of the lateral nasal bones

to narrow the base of the bony pyramid and to close an open roof after hump resection. In most cases, a low-to-high osteotomy is done for this purpose. This osteotomy makes precise and controllable cut on the nasal bone, producing a smooth line at the base of the pyramid.

2. Reducing excessive width of the nasal bone base near radix: To narrow an excessively wide cephalated bony base of the bony pyramid, low-to-low osteotomy can be used.
3. Reducing excessive convexity or closing an open roof with a narrow bony base: The lateral nasal bones are in convex shape in a medial to lateral direction. In cases with traumatic deformity in one side of the lateral wall (change of normal convexity to concavity due to traumatic fracture), the midlevel osteotomy is performed to the normal side to reduce the lateral convexity to match the other side.

In a nose with excessive vertical height and dorsal hump but narrow base, the resection of the hump would produce an open roof. To close the roof and to avoid narrowing of the nasal base, midlevel osteotomy can be used.

4. Correction of excessive base width and excessive convexity: Double osteotomy can be performed to correct the excessive convexity with correction of the base width. In double osteotomy, a midlevel osteotomy is combined to a low-to-low or low-to-high osteotomy [19].

28.8 Surgical Approach

The osteotomies can be done via internal or external routes. The main advantage of the intranasal approaches is the absence of an external scar. In intranasal techniques, more soft tissue elevation and restriction of osteotome direction by the alar rim often increase soft tissue trauma. Conversely the external approach is more flexible without any restrictions on osteotome direction. The only restriction of external approach is the visible scar on the skin, but this may be minimized with the use of narrow and sharp osteotomes.

28.8.1 Surgical Techniques in Endonasal Osteotomies

Lateral osteotomies may be performed in a continuous or perforating fashion. For continuous lateral osteotomies, a straight or curved guarded osteotome is generally used. A local anesthetic should be injected to both sides of the lateral wall to hydrodissect the soft tissues overlying the bone and also to assist with hemostasis. Next, a subperiosteal tunnel is created before the osteotomy is performed. This protects the periosteum from injury, allowing for decreased bleeding and subsequent swelling and ecchymosis [1]. Also the subperiosteal tunnels ensure proper stability after surgery [4]. The guard of the osteotome may be placed internally or externally. When the guard is placed internally, a submucosal tunnel is created along the nasal surface of the ascending process of the maxilla. The guard is placed beneath the mucosa, which is preserved, and the osteotomy is performed. This reduces swelling and provides increased stability of the fragment due to the reduced injury to the periosteum and mucosa [21]. When the guard is placed externally, the osteotomy may be performed with or without a subperiosteal tunnel overlying the external surface of the ascending process. The guard is placed on the external surface just superior to the inferior turbinate, and the osteotomy is performed. When the guard is placed externally, it may be used in a more controllable fashion as the tip of the guard can be palpated as it travels along the path of osteotomy. As the unguarded edge passes on the mucosal surface, it can lead to extensive injury to the internal nasal mucosa, allowing for decreased bleeding and subsequent swelling and ecchymosis [1]. A small incision is made in the nasal vestibule at the pyriform aperture just above the inferior turbinate, and the osteotome is inserted. The course of the lateral osteotomy begins at the level of the attachment of the inferior turbinate. According to the anatomy and the results to be achieved, a curved or straight course or high or low level of osteotomy is planned. In most cases, a high-low-high osteotomy is preferred that leaves a small triangle of bone at the pyriform aperture to preserve the lateral attachments of the suspensory ligaments. This helps to

preserve the nasal airway. After the initial cut, the osteotomy is continued along the nasal facial groove until it curves superiorly and anteriorly into the thinner aspect of the nasal bone at the level of the inferior orbit. The cut is then terminated around the level of the medial canthus. If it is carried higher into the thicker bone of the nasofrontal suture, a rocker deformity may result in which infraction of the nasal bone results in protrusion at the superior fracture site [22]. At the completion of the lateral osteotomy, the osteotome is turned inward to complete the fracture and displace the fragment internally. The back fracture that communicates the lateral and medial osteotomies may be performed as a transverse osteotomy, fading medial osteotomy, or fracture by digital pressure. The medial and transverse osteotomy or medial fading osteotomy is performed prior to the lateral osteotomy and inward fracture of the nasal bone fragment. The fracture by digital pressure is performed after the lateral osteotomy and the nasal bone fragment is then displaced internally. Periosteal elevation remains a matter of surgeons' personal preference; most of the authors do not elevate periosteum or only create a periosteal tunnel as the overlying soft tissues may a useful support for bony fragments, increasing the stability. Also not elevating the periosteum may decrease the incidence of airflow obstruction and of aesthetic irregularities [23].

28.8.2 Surgical Techniques of Percutaneous Osteotomies

Perforating lateral osteotomies are the alternative to continuous osteotomies. Applying some basic principles in perforating osteotomies can increase accuracy and decrease morbidities. The smaller the osteotome, the more effective the cutting force will be. The soft tissues over the lateral nasal wall should be elevated properly to avoid lateral nasal artery branches. The force to perforate the bone should not be excessive to perforate the nasal mucosa and enter the nasal cavity. This precaution decreases the bleeding and morbidity. With this technique, optimal low-to-high, medial, low-to-low plus medial, midlevel, and double

osteotomies can be performed. In percutaneous osteotomy technique, a sharp 2- or 3-mm osteotome can be used. Approximately 7–10 min before the osteotomy, the entry site and pathway should be injected subperiosteally along the lateral and medial aspects of the lateral nasal wall. A puncture is done at the junction of the nasal bone with the cheek skin along a line continuous with the nasolabial fold overlying the midportion of the planned osteotomy with a blade or with the tip of the osteotome. The skin incision is located midpoint between the medial canthus of eye and lowest point of the nasolabial groove at the nasal process of the maxilla. Then the 2- or 3-mm sharp osteotome is inserted through the incision. The osteotomy should begin on the midportion of the osteotomy line just anterior to the junction of the nasal bone with the maxilla. Then the skin is lifted and osteotome is put on the nasal bone near the dorsum and pushed all the way to the bone. Holding the osteotome against the wall, the osteotome is slid down to the desired osteotomy line at its midpoint. This maneuver displaces the angular artery away from the surgical field. With controlled mallet forces, cut on the lateral wall of the nose is created. Then osteotome is retrieved from the perforated bone and put closely over the bone again inferiorly to the pyriform aperture. Interrupted but closely adjacent (2–3-mm) punctures are performed in cephalic and caudal directions. For more mobility, each puncture may be combined with each other in a continuous fashion. At the cephalic end of the osteotomy, the cut is continued across the midline to prevent uncontrolled back fracture and avoid triangular spicule at the dorsum. There is no need to advance the osteotomy superior to the intercanthal line [19]. With gentle manual pressure, nasal bone is repositioned medially. If the gentle pressure does not fracture the bone, the surgeon should not apply force but should find the place resisting the reposition and reperform the osteotome cut on that point. By doing this, undesirable and uncontrolled fractures are prevented.

Cases with excessively collapsed bony pyramid due to previous surgery or trauma can also be managed by transnasal percutaneous lateral osteotomy or “inside-out” lateral osteotomy. The

perforations are placed intranasally and the nasal bones are pushed out to mobilize the nasal bone laterally and to widen the vault and open the airway [1, 20]. The perforations can also be carried out with a 2-mm unguarded osteotome. The entry site is intranasal at the pyriform aperture and the perforations are made in every 2–3 mm along a mirror-image pathway.

Tardy and Denny [11] described the use of the micro-osteotome to perform precise endonasal perforating osteotomies with minimal damage to the periosteum and intranasal mucosa. Percutaneous osteotomies do not require mobilization of the soft tissues, and the osteotomy can be placed exactly to the desired place. They make it possible to position and conduct the osteotome exactly along the line desired [13]. Consequently trauma, bleeding, postoperative ecchymosis, and edema are less, and due to partial interruption of the periosteum, the stability is more [3, 13]. Anatomic and clinical studies indicate that the external perforated technique results in a more controlled fracture with less intranasal trauma [3]. Because the osteotomy is perforating, the resulting fracture is of a greenstick type, which guarantees the stability of the bone stumps and avoids their sinking [24]. Compared with the popular internal continuous method, the perforated technique preserves periosteal attachments to the bone, which decreases the amount of dead space, reduces subluxation and airway compromise, and provides greater stability of the bony vault after manipulation [25].

The main drawback of the percutaneous technique is the visible scar on the face. But studies showed that the external approach was producing excellent cosmetic results at the puncture sites in the skin [26] and the cutaneous scars were virtually invisible a month after surgery [13].

28.8.3 Sequence of Osteotomies

During rhinoplasty, each surgical step must be done in a sequential manner. The sequence of the osteotomies will vary depending on the deformity that the surgeon wishes to correct. The sequence of the osteotomies is based on some principles [19]: For external osteotomies,

the osteotomy should begin in thicker and more stable area and proceed to thinner and less stable area. For the low-to-high osteotomy, the most stable portion is the area where the frontal process of the maxilla unites to the nasal bone. The pyriform aperture is thinner and the bone thickness is variable more superiorly. The osteotomy should begin in the midportion, extend caudally to pyriform aperture, and return to the stable area and then to the cephalic portion superiorly. In low-to-low osteotomy, the same sequence should be followed for the lateral cut. At the cephalic end, the medial osteotomy should begin from medial to lateral to join the lateral osteotomy. When performing double osteotomy, one should always perform the midlevel osteotomy first while the more stable base of the lateral nasal wall is still intact. After the midlevel osteotomy, lateral osteotomy must be done [19].

In general the medial osteotomy will be performed first as a straight or fading continuous osteotomy, depending on the surgeon's preferences and treatment goals. If an intermediate osteotomy is required, this is performed after the medial osteotomy but before the lateral osteotomy to allow for stability of the nasal bone during the osteotomy. The lateral osteotomy is then performed and the mobilized segments are placed into the desired position [1]. The timing of the osteotomies within the time frame of the entire rhinoplasty procedure may vary depending on the surgeon's preference as well as the deformity being treated [1]. In the case of a severely deviated nose, the surgeon may wish to perform the osteotomies first to allow for the midline positioning of the bony septum and nasal bones, thus allowing for the ultimate alignment of the middle and lower thirds from the now midline bony vault. In these cases, sequence of osteotomies is performed in the following order [1]:

1. The medialized nasal bone should be mobilized first with a medial, intermediate (if necessary), then lateral osteotomy.
2. The medialized nasal bone is then displaced laterally to allow space for the midline repositioning of the deviated septum.

3. A straight medial osteotomy is then performed on the opposite side into the nasal root, which is used as a fulcrum to reposition the septum in a midline position.
4. The intermediate (if necessary) and lateral osteotomy is then performed on the opposite side, and the nasal bone is placed into an appropriate position.

When the septum is not severely deviated and the osteotomies are being performed to narrow or widen the bony vault without reorientation, the osteotomies may be postponed to the end of the procedure. By this way, the surgeon may apply pressure on the osteotomies, and immediate splinting of the nose may decrease the overall edema and bleeding associated with osteotomies. If the osteotomies are performed earlier in the case, the surgeon may still hold pressure to reduce the swelling and bleeding; however, the resultant edema is inevitable. The soft tissue swelling may interfere with the surgeon's ability to evaluate the necessary structural changes that should be made to achieve the desired aesthetic result. Therefore, it is often best to delay the osteotomies until the completion of the procedure whenever possible [1].

28.9 Complications

Rhinoplasty is a difficult operation and requires a three-dimensional manipulation of nasal structures with limited access [27]. The outcomes depend on the surgical skill and some patient factors like skin and subcutaneous tissue thickness. Generally the complications of rhinoplasty may be divided as intraoperative and postoperative complications. The postoperative complications may also be subdivided as early and late complications. Early complications are hemorrhage, hematoma, infection, periostitis, edema, ecchymosis, skin problems, and septal perforations [27]. Late complications generally involve abnormalities of the nasal tip, cartilaginous vault, and bony vault [27]. The complications of lateral osteotomy, especially early complications like hemorrhage, infection, edema, and ecchymosis, are the same for all the steps of rhinoplasty operations, but some complications like

overmobility of the infrafractured bones are unique to the lateral osteotomy. Complications associated with lateral osteotomy are hemorrhage, prolonged edema and ecchymosis, nasal obstruction due to narrowing, and aesthetic deformity and asymmetry [2, 3, 14, 25].

Trauma to the intranasal soft tissue structures like mucosal tears may lead to destabilization, bleeding, and prolonged edema and ecchymosis [2]. To minimize the trauma from lateral osteotomy, the selected technique should be performed with proper osteotomes to maintain sufficient mucosal and periosteal preservation [2]. Intraoperative injuries to the nasal tissues are uncommon [28]. Excessive destabilization or improper replacement of the fractured bones may result in collapse of the nasal bones, causing visible asymmetry and deformity. Adjacent internal valve collapse negatively affects the airway. If this is noted, an elevator should be used to replace the bones to their appropriate position [28].

Bleeding is the most common postoperative complication of the rhinoplasty operations. This usually occurs either during the first 48 h or at 10–14 days postoperatively. Some precautions before and during the operation may decrease the risk of postoperative bleeding. Aspirin and any herbal supplements should be discontinued 10 days before the procedure [29]. Preoperative injection using local anesthetic mixed with epinephrine into the subcutaneous tissue and topical oxymetazoline or cocaine application on the mucosa may decrease intraoperative and postoperative bleeding risk. Also dissection in the correct tissue planes, that is, maintaining dissection in the submucoperichondrial plane, avoids reaching the nasal superficial musculoaponeurotic system (SMAS) [28]. Bleeding is most likely to occur at the transfixion incision or anterior septal mucosal incisions. Proper closure of these incisions at surgery will minimize this complication [27]. The second most common time for postoperative bleeding occurs from the 10th to 14th day, most likely because the maturing clot separates from the incision. If the bleeding occurs from the anterior nose, the exact point should be identified and treated using direct vision. Early light bleeding can be managed by either oxymetazoline, or ice

with digital pressure, or a combination of both [28]. Severe bleeding may require anterior and posterior nasal packs. Persistent bleeding may rarely require hospitalization and treatment in the operating room [27].

Hematoma at the nasal dorsum may displace the nasal tissues, can produce excessive scar tissue, and affects the normal healing mechanisms. Hematomas of the dorsal skin can also be produced during removal of the cast. Septal hematomas may occur after rhinoplasty operations that can cause nasal blockage and septal perforations if not treated properly [27].

Infection after rhinoplasty operations is rare. The patient will typically present with regional erythema and cellulites. This condition should be differentiated from allergic reactions and proper antibiotics should be started. Abscesses are also rare. Small and localized abscesses can occur along the incision lines or in areas where surgical debris has collected, and can be treated with incision and drainage along with appropriate antibiotics [27]. The most frequent organism causing these infections is *Staphylococcus aureus*, and antibiotics like trimethoprim/sulfamethoxazole, clindamycin, or levofloxacin can be used for treatment [30]. Toxic shock syndrome has been reported in cases of nasal packing. As the cavernous sinus is very close to the operation site, basal meningitis may develop rarely [31].

Edema and ecchymosis following rhinoplasty are the expected consequences. The amount of swelling usually depends on patient factors and may be reduced by using steroids perioperatively. Generally edema resolves within 6–12 months, and the final result may be appreciated [29]. Following lateral osteotomies, the incidence of periorbital edema and ecchymosis is high and may last for 2–4 weeks. The use of a smaller unguarded osteotome may decrease this complication [11].

Deformities on the bony vault can be noted after lateral osteotomies. Improper placement of the osteotomy along the lateral nasal wall may lead to complications. A low osteotomy may cause nasal obstruction when the fragment is displaced medially into the airway [1]. A high osteotomy that is placed above the thick nasofacial sulcus

may become palpable and visible under the thinner nasal skin that is located above the sulcus [1]. An incomplete osteotomy may result in incomplete displacement of the nasal bones and may cause deviation of the bony vault [1]. Following lateral osteotomy, hyperostotic bone may form usually due to improper elevation and tearing of the periosteum along the osteotomy [1].

If the osteotomy is carried into the frontal process and the nasal bones are infrafractured, the segment beyond the radix may lateralize, causing the rocker deformity [1]. To solve this problem, a percutaneous transverse osteotomy should be performed to move the nasal bone independently of the nasal root [1].

Excessive elevation of the soft tissues beyond the osteotomy line may cause overmobility of the fractured segment and may lead to difficulty in maintaining position. In these cases, percutaneous sutures and a piece of Merocel from the nasal cavity may secure the flail segment [1]. Damage to intranasal mucosa may result in synechiae between the lateral nasal wall and the septum, causing nasal obstruction. These adhesions may be split and a piece of Silastic may be placed for 2–3 weeks to prevent re-formation of the synechiae [1].

Conclusions

Lateral osteotomy is the crucial step in rhinoplasty that must be executed correctly. Unequal and improper lateral osteotomies may lead to asymmetry of the bony vault, open roof deformities, and persistent bony ridges. Maintenance of a periosteal layer is critical in splitting mobile nasal bones and camouflaging minor bony irregularities. Many different osteotomes have been offered so far for lateral osteotomies, but we think that V-shaped 2-mm osteotomes reduce the risk of postoperative edema and ecchymosis and guide up cephalically to the medial oblique osteotomy with the best cosmetic results. The authors suggest low curved osteotomy line without periosteum elevation, the use of micro-osteotomes, medial oblique osteotomies, and bone cuts rather than fracturing in lateral osteotomies.

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