Broad Nasal Bone Reduction: An Algorithm for Osteotomies

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Background: A persistent problem with nasal bone osteotomies is inadequate reduction of the width of the nasal dorsum. In addition, an algorithm as to which osteotomy to use has not been fully explored.

Methods: Nine cadavers received a medial oblique osteotomy (15 to 30 degrees off midline) following a humpectomy in six. On one side, the osteotomy was performed on the medial side of the apex of the open roof. On the contralateral side, it was performed on the lateral side of the apex. The osteotome was then pried posteriorly. The resultant hemidorsal widths were compared. Clinically, 53 patients were classified into the following: type I, broad nasal base (lateral osteotomy only); type II, broad nasal base and broad dorsum (lateral and medial oblique osteotomy); and type III, broad dorsum only (medial oblique osteotomy only).

Results: The reduction in hemidorsal width was greatest when the osteotome was placed on the lateral side of the apex (t test, $p < 0.008$). The improved width reduction was attributable to the slippage of the lateral nasal bone under the dorsal hood of the nasal bone. A lateral osteotomy did not have to be performed to reduce the dorsal width alone. After 15 to 32 months, nasal bone width was satisfactory in all but three cases, one of which required a revision.

Conclusions: Reduction of the nasal dorsal width is facilitated by a medial oblique osteotomy alone if it is placed at the lateral aspect of the apex of the open roof. A classification of broad nasal bones is given that emphasizes the distinction between dorsal width and nasal base width and suggests which osteotomy to use. (*Plast. Reconstr. Surg.* 119: 1044, 2007.)

The medial oblique osteotomy has largely resolved problems relating to reducing the width of the dorsal nasal bone and avoiding spicule formation that can occur following the classic medial osteotomy.[1–10] One of the most successful of the various medial oblique osteotomy techniques is that of Tardy et al.[8] Its success has been further elucidated by detailed cadaver bone measurements demonstrating that there is a natural cleavage plane at approximately 15 degrees off the midline.[11,12] When the osteotomy is executed in approximately the direction of the natural cleavage, or lateral to it, the resultant nasal fracture occurs with the least effort and with the least likelihood of spicule or rocker formation.

However, a few problems occasionally plague nasal bone osteotomies. These include an inability to (1) consistently reduce the width of the nasal dorsum (as opposed to the nasal base) either independently or in conjunction with reduction of the nasal base; (2) precisely control the slope of the nasal bone; and (3) consistently avoid having to move the osteotomized nasal bone into its ideal position without having to apply excessive digital force.[13] Mild to moderate digital pressure is not necessarily a problem, but severe force clearly runs the risk of creating a fracture line where it is not intended and possibly sudden collapse of the nasal bone. Clearly, when forceful pressure is necessary, it implies that the type of osteotomy that was performed was not as successful as it could have been.

One of us anecdotally noticed during a personal variation of the medial oblique osteotomy that when the osteotome was placed at the medial side of the open roof deformity, the nasal bone often failed to migrate medially. If it did migrate medially, the resultant reduction in dorsal width was not necessarily as much as had been desired. However, if the osteotome was placed on the lateral side of the open roof deformity, the nasal bone migrated medially (with consequent reduction in the dorsal width) al-

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most invariably, often without a lateral osteotomy having to be performed.

The study was designed to examine the medial oblique osteotomy more carefully, to determine precisely how it should be executed to obtain maximum width reduction and the most consistent results. Finally, these results have been incorporated into an algorithm for broad nasal bones that suggests what type of osteotomy should be used and under what circumstances.

LABORATORY EXPERIMENT

Materials and Methods

Nine adult Caucasian cadaver noses were skeletonized. Six of the nine cases exhibited a dorsal hump that was removed, leaving an open-roof deformity. The osteotome could be placed at the medial or lateral aspect of the open-roof deformity (Fig. 1, *left*). In three of the nine cases, there was no significant bony hump, but the dorsum of the nasal bone was quite broad. Although these noses have no open roof, there is still an apex where the nasal bone and bony septum meet. In these cases, the upper lateral cartilage could be partially dislocated from its attachment to bone to permit the insertion of an osteotome into the apex of the normal gap between the nasal bone and upper lateral cartilage. The osteotomy was placed at either the medial or lateral aspect of the apex (Fig. 1, *center* and *right*).

On one side of the nose of every cadaver (chosen arbitrarily and at random), a medial oblique osteotomy (approximately 15 to 30 degrees off the midline) was performed on the medial side of the apex. On the contralateral side, it was performed on the lateral side of the apex. The osteotome was driven in until the familiar change in sound was heard. Without dislodging the osteotome, it was then forcibly pried posteriorly (much as is commonly done for lateral osteotomies by means of the internal approach, but in the opposite direction). So doing allowed a slight gap to develop at the caudal end of the osteotomy site (Fig. 2). The nasal bone then (but not always) tended to migrate medially. If it did not do so, some mild digital manipulation was applied. The resultant reduction in hemidorsal width (at the caudal end of the nasal bone) was then measured to the nearest millimeter.

In five of the same nine cases, a lateral (low-to-low) osteotomy was then combined with the medial oblique osteotomy (placed at the lateral aspect of the apex) to ascertain the benefit of the latter on nasal bone control. Without dislodging the osteotome, it was then forcibly pried anteriorly (much as is done for the medial oblique osteotomy, but in the opposite direction). So doing allowed a slight gap to develop at the caudal end of the osteotomy site (Fig. 3). The two osteotomies were performed in such a way that there was an approximately 2- to 5-mm distance between the cephalic ends of the osteotomy sites (Fig. 4, *above, left*). The result was that the nasal bone was still attached cephalically, much like a "hanging chad." The lateral nasal bone was then grasped with a forceps and manipulated (pulled caudally and ro-

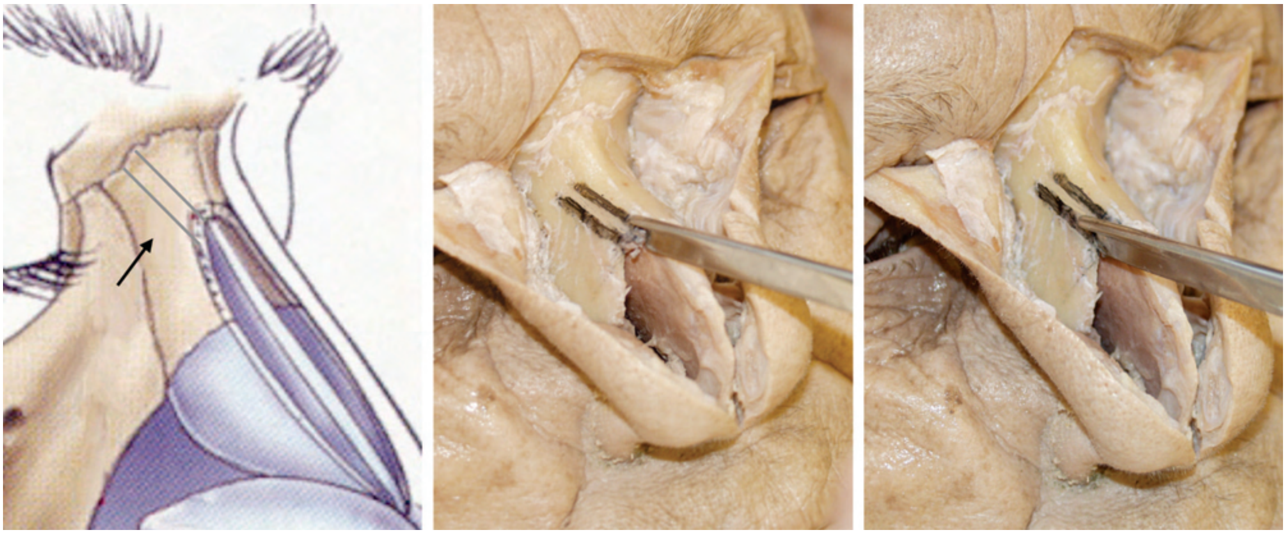

Fig. 1. The apex of the open roof is located at the junction of the nasal bone and bony septum. The surgeon has a choice as to place the osteotome at the medial or lateral side of the apex (*left*). The *arrow* points to an osteotomy site on the lateral aspect of the open roof. Some cadavers had no actual open roof, but all had an apex at the junction of the nasal bone and bony septum where the osteotome could be placed at either the medial (*center*) or lateral (*right*) aspect of the apex.

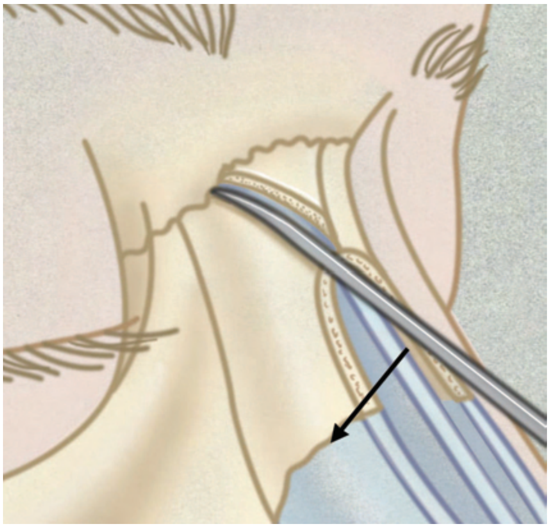

Fig. 2. Without dislodging the osteotome, it was then forcibly pried posteriorly (much as is commonly done for lateral osteotomies by means of the internal approach, but in the opposite direction). So doing allowed a slight gap to develop at the caudal end of the osteotomy site.

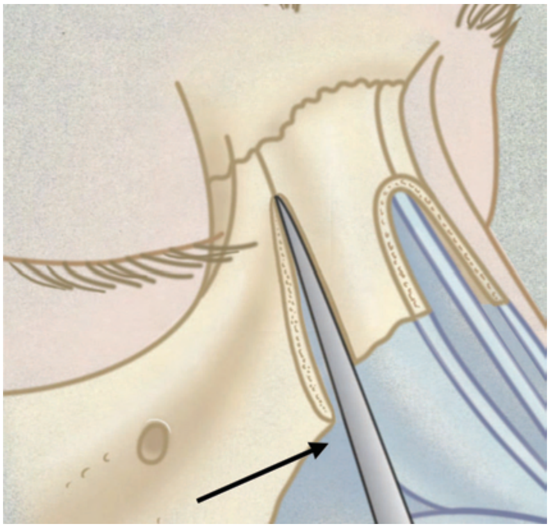

Fig. 3. Without dislodging the osteotome, it was then forcibly pried anteriorly (much as is done for the medial oblique osteotomy, but in the opposite direction). So doing allowed a slight gap to develop at the caudal end of the osteotomy site.

tated) to see how much maneuverability was possible.

Results

Execution of the medial oblique osteotomy alone (in the absence of a lateral osteotomy) resulted in a reduction of the dorsal width. The reduction was attributable to the slippage of the lateral nasal bone under the hood of the nasal bone (Fig. 4, *above*, *right*, and *below*). As a result of the slippage of the nasal bone beneath the hood, however, a slightly sharp ridge could be seen and palpated, representing the lateral aspect of the "hood." When the medial oblique osteotomy was performed on the medial side of the open roof, it did not always result in a reduction of the hemidorsal width. When, however, the medial oblique osteotomy was performed on the lateral side of the open roof, it invariably resulted in a reduction of the dorsal width.

In each of the nine cadavers, the hemidorsal width of the nasal bones that received a medial oblique osteotomy on the lateral side of the apex was less than or equal to that following an osteotomy performed on the medial side of the apex (Table 1). When the osteotomy was on the medial side of the apex, the reduction ranged from 0 to 3 mm (mean, 1.3 mm). In three of the nine cases, no reduction of dorsal width resulted. When the osteotomy was on the lateral side of the apex, the reduction ranged from 2 to 4 mm (mean, 2.7 mm). Statistical analysis confirmed a significant difference between the two groups (t test, $p < 0.008$).

On closer examination of the five cadavers that received both medial oblique and lateral osteotomies (low-to-low), it was noted that the cephalic ends of the osteotomy sites were within 2 to 5 mm of each other. The net result was that the entire nasal bone acted as a unit that was hinged at the cephalic end. That made it possible to grasp the nasal bone with forceps and manipulate its slope.

CLINICAL EXPERIMENT

Patients and Methods

The following classification (and algorithm) for the reduction of broad nasal bones was formulated (Table 2). A type I nose is one that exhibits a broad nasal base only (Fig. 5, *left*). A lateral (low-to-low) osteotomy only was used. A type II nose is one that exhibits a broad nasal base and broad dorsum (Fig. 5, *center*). A lateral (low-to-low) osteotomy and a medial oblique osteotomy were used. A type III nose is one that exhibits a broad dorsum only (Fig. 5, *right*). The latter nasal type is uncommon but more likely to be seen following a previous rhinoplasty in which lateral osteotomies had been performed with either overcorrection of the width of the nasal base and/or failure to correct the dorsal width, leaving relatively parallel nasal bones. A medial oblique osteotomy only was used. Admittedly, the classification could have been extended to include nasal bones that are narrow at the cephalic (na-

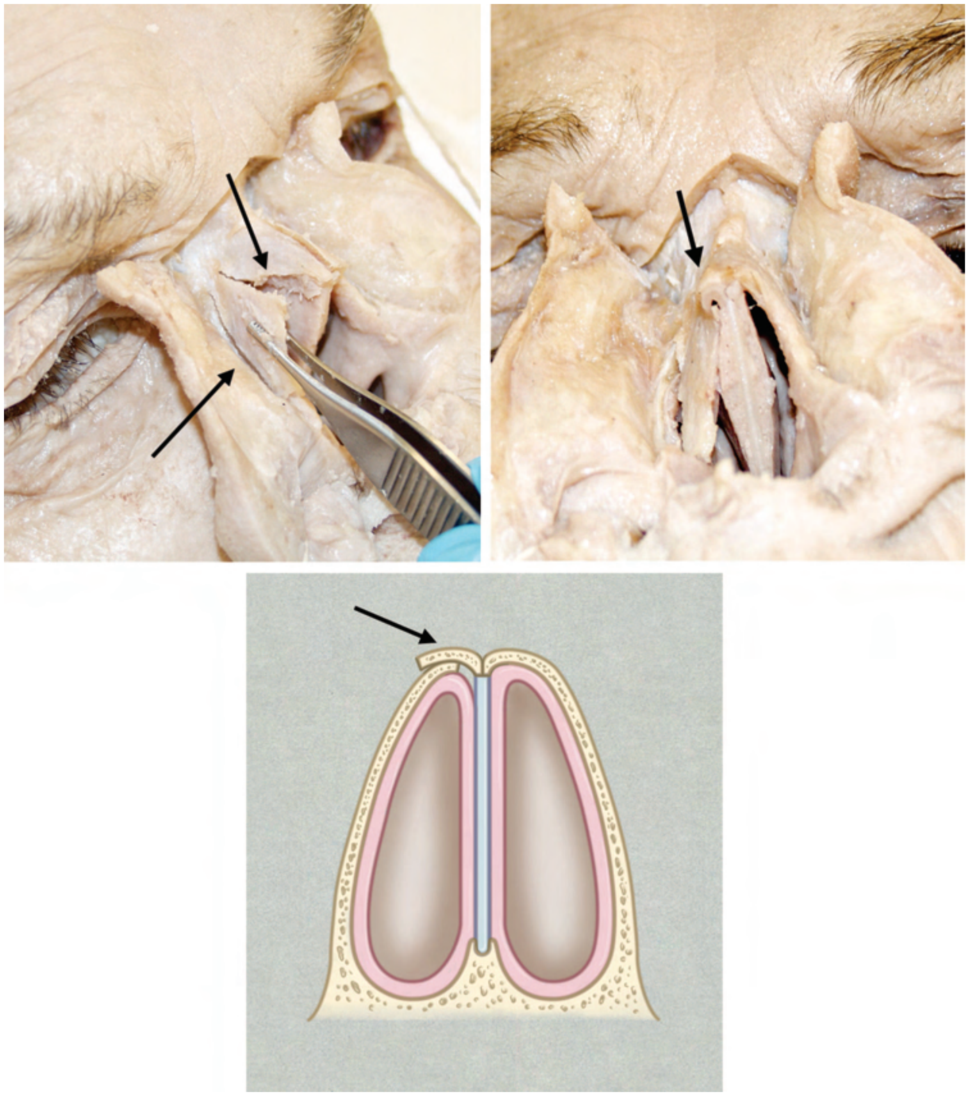

Fig. 4. The forceps is grabbing a triangular nasal bone that was created by a lateral osteotomy and a medial oblique osteotomy. The two osteotomies were performed in such a way that there was an approximately 2- to 5-mm distance between the cephalic ends of the osteotomy sites. The result was that the nasal bone was still attached cephalically, much like a hanging chad (*above*, *left*). Execution of the medial oblique osteotomy alone (in the absence of a lateral osteotomy) resulted in a reduction of the dorsal width as indicated by the *arrow* (*above*, *right*). The reduction was caused by the slippage of the lateral nasal bone under the hood of the nasal bone. The *arrow* points to the "hood" (*below*).

sion) end and become broad at the keystone end, and nasal bones that are broad from the cephalic to the keystone end. However, for purposes of simplicity, only these three general categories were considered.

Technique of Medial Oblique Osteotomy

The nasal skin is marked with the intended line of osteotomy (Fig. 6, *left*). It is directed toward a location halfway between the medial canthal ligament and the nasion. The best osteotome is one that is 3 mm or less in thickness. Prior studies[14,15] have indicated that osteotomies wider than 3 mm are much more prone to tear the periosteum and result in bleeding. A slightly curved 3-mm osteotome is placed at the lateral aspect of the open-roof deformity. The direction was expanded from 15 to 30 degrees because a 30-degree direction empirically allows the cephalic end of the fracture line to be close to the cephalic end of the lateral osteotomy fracture line if the latter osteotomy was also required. If a humpectomy is not performed and there is no actual open-roof deformity, the osteotome is in-

Table 1. Amount of Dorsal Width Reduction as a Function of Osteotome Location in the Open-Roof Deformity

Cadaver	Laterally Located Osteotome	Medially Located Osteotome
1	2	0
2	2	0
3	3	2
4	3	1
5	4	3
6	2	2
7	3	0
8	3	2
9	2	2
Mean	2.7	1.3

Table 2. Classification of Nasal Bone Widths

Type	Base	Dorsum
I	Broad	—
II	Broad	Broad
II	—	Broad

serted into the junction between the nasal bone and upper lateral cartilage.

In the open approach, it is possible to see the lateral aspect of the open roof (Fig. 7, *left*), place the osteotome precisely at that location, and see exactly what these osteotomies are doing to the bone. So doing may require a little more soft-tissue elevation off the nasal bone than usual (Fig 7, *right*). However, it is always worth seeing exactly what was done to the bones and noting their precise width following the osteotomies. In the closed approach, the technique is executed by placing the osteotome up against the bony septum and then sliding it laterally to what is perceived to be the lateral aspect of the open-roof deformity. The osteotome is driven in. It is then pried posteriorly (opposite in direction to that of the lateral osteotomy) in an incremental fashion (Fig. 2). So doing allows a slight gap to develop at the caudal end of the osteotomy fracture line. The dorsal edge of the nasal bone then (but not always) tends to migrate medially. If it does not do so, mild pressure with a closed forceps or finger against the midportion of the nasal bone will allow it to slide under the hood. It may also be necessary to drive the osteotome in further (until the familiar change in sound is heard). The process of applying mild pressure in a medial direction is then repeated. Because the lateral nasal bone tends to slide under the roof of the dorsum, a dorsal edge often becomes palpable. That edge is then rasped. So doing smoothes the dorsal edge and contributes slightly to narrowing the dorsal width.

Technique of Lateral Osteotomy

The nasal skin is marked with the intended line of osteotomy (Fig. 6, *center*). A straight osteotome is used here. The method of executing the lateral osteotomy is optional. Whether it is performed intranasally, intraorally, or from the external percutaneous approach,[16,17] the important issue is what technique is most comfortable for the surgeon. The senior author (R.G.) prefers the buccal sulcus approach (Fig. 7) simply because any blood that might result tends to exit the mouth incision rather than the nose. The low-to-low lateral osteotomy is also preferred because it minimizes any palpable step-off

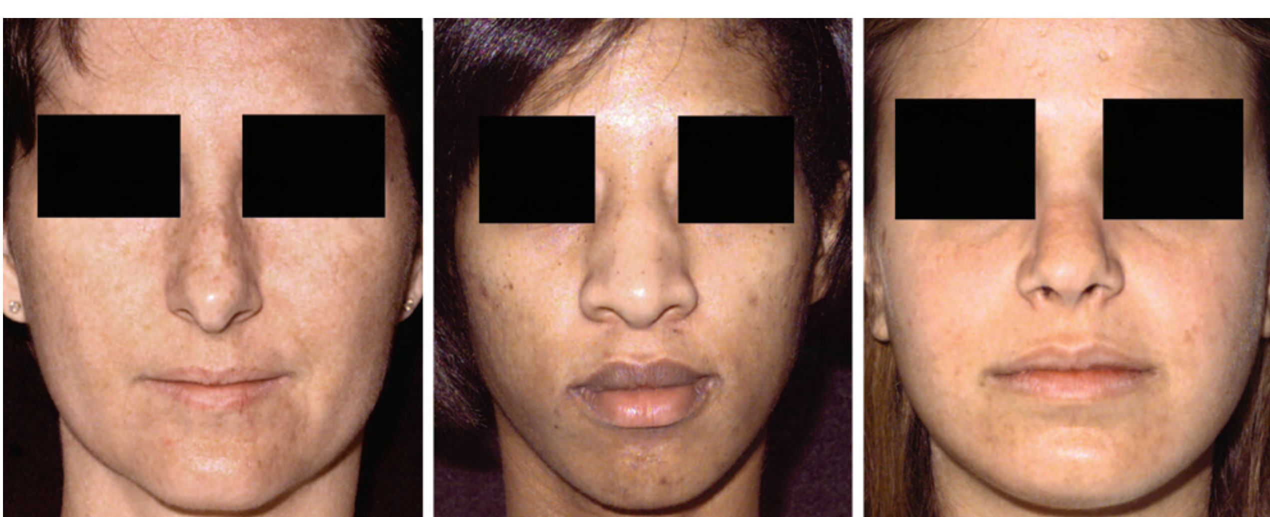

Fig. 5. Classification of broad nasal bones into type I (broad base only) (*left*); type II (broad base and broad dorsum) (*center*); and type III (broad dorsum only) (*right*).

Fig. 6. The nasal skin is marked with the intended line of osteotomy: medial oblique only (*left*); lateral osteotomy (*center*); medial oblique and lateral osteotomy with a 2- to 5-mm gap at the cephalic end of the intended lines of osteotomy (*right*).

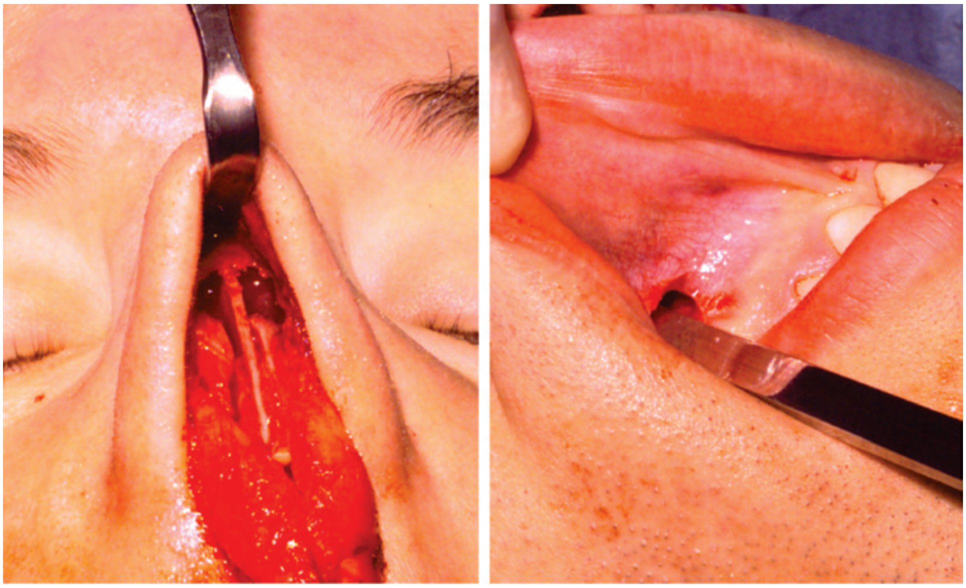

Fig. 7. The senior author prefers the buccal sulcus approach simply because any blood that might result tends to exit the mouth incision rather than the nose. The low-to-low lateral osteotomy is also preferred because it minimizes any palpable step-off deformity and allows one to move the largest segment of nasal bone over (*left*). One distinct advantage of the open approach is the ability to see exactly what these osteotomies are doing to the bone. So doing may require more soft-tissue elevation off the nasal bone than is ordinarily done for a humpectomy (*right*).

deformity and allows one to move the largest segment of nasal bone over. After driving the osteotomy cephalically until a change in sound is heard, the osteotome is pried anteriorly (Fig. 3). So doing creates a gap at the caudal end of the fracture site and allows the nasal bone to migrate medially. The more the osteotome is pried, the more the bone tends to migrate medially. Almost always after this prying maneuver, digital manipulation of the nasal bone is not necessary.

Technique for Both Osteotomies

The intended osteotomy lines are drawn such that a 2- to 5-mm gap is located at their cephalic ends (Fig. 6, *right*). This reflects the size of the bone attachment to the skull. The medial oblique osteotomy is performed before the lateral osteotomy. If it is not, the nasal bone tends to rotate externally (i.e., the dorsal edge migrates laterally instead of medially because the nasal base is migrating medially as a result of the lateral osteotomy). The end result, ideally, should be a nasal bone that is attached cephalically by a 2- to 5-mm piece of bone. The nasal bone is ideally a hanging chad. By having this small cephalic attachment, the nasal bone is relatively stable and will not collapse. A forceps placed through the nostril is used to grasp the caudal end of this chad and manipulate it into the desired position (Fig. 8). So doing makes it possible to control the actual slope of the nasal bone and the width of the nasal base. If for any reason the medial oblique follows the lateral osteotomy, the osteotome tapping should be extremely gentle to overcome the tendency to rotate externally.

Results

The algorithm was used in 53 cases (type I, 27 cases; type II, 20 cases; type III, six cases) with a follow-up of 15 to 32 months. Nasal bone width reduction was satisfactory in all but three cases (type I, one case; type II, two cases), one of which required a secondary osteotomy. The patient in Figure 9 exhibits type I nasal bones that only require lateral osteotomy. The buccal sulcus approach was used for a low-to-low osteotomy. The frontal view shows the improvement at 17 months. The patient in Figure 10 exhibits type II nasal bones that require both lateral osteotomy and medial oblique osteotomy. The buccal sulcus approach was used for the low-to-low osteotomy. However, the same result could have just as easily been achieved with the internal or external cutaneous approaches. The frontal view shows the improved result at 22 months. The patient in Figure 11 exhibits a type III deformity in which the width of the nasal bone base is normal but the dorsum is too wide. A medial oblique osteotomy only was performed. The frontal view shows the improvement at 19 months. Had a lateral osteotomy also been performed, there would have been a good chance that the nasal base would have been inadvertently narrowed.

DISCUSSION

Narrowing the nasal dorsum might appear to be a mundane, easily accomplished task, particularly if there is an open-roof deformity. In fact, a low-to-high osteotomy that terminates in the cephalic end of the open roof is, indeed, a highly successful and replicable method with which to move the lateral nasal bone medially and close the roof. However, that technique does not address the broad bone cephalic to the apex of the open roof. Only those techniques that extend the osteotomy cephalic to the apex of the open roof have an opportunity to reduce bony width closer to the

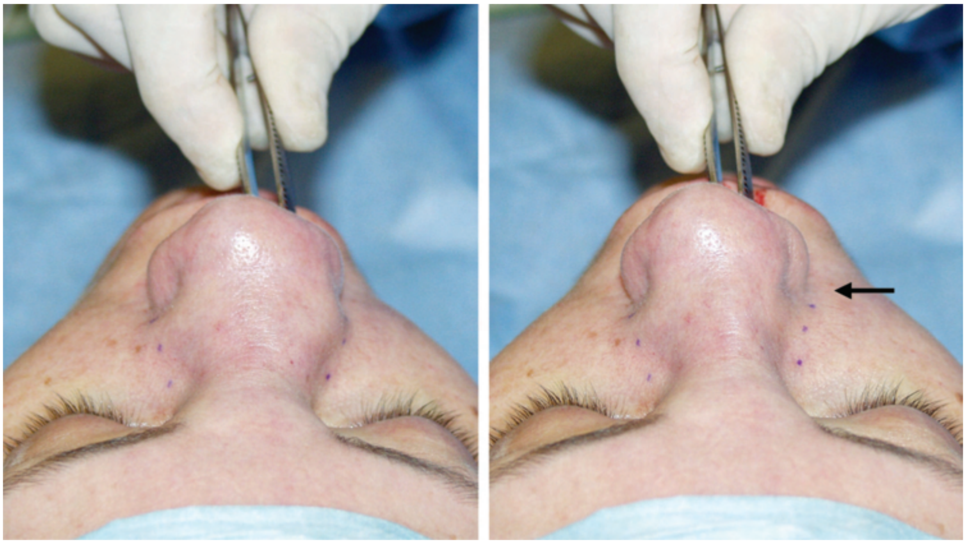

Fig. 8. A forceps placed through the nostril is used to grasp the caudal end of this chad and manipulate it into the desired position (*left*). So doing makes it possible to control the actual slope of the nasal bone and the width of the nasal base (*right*).

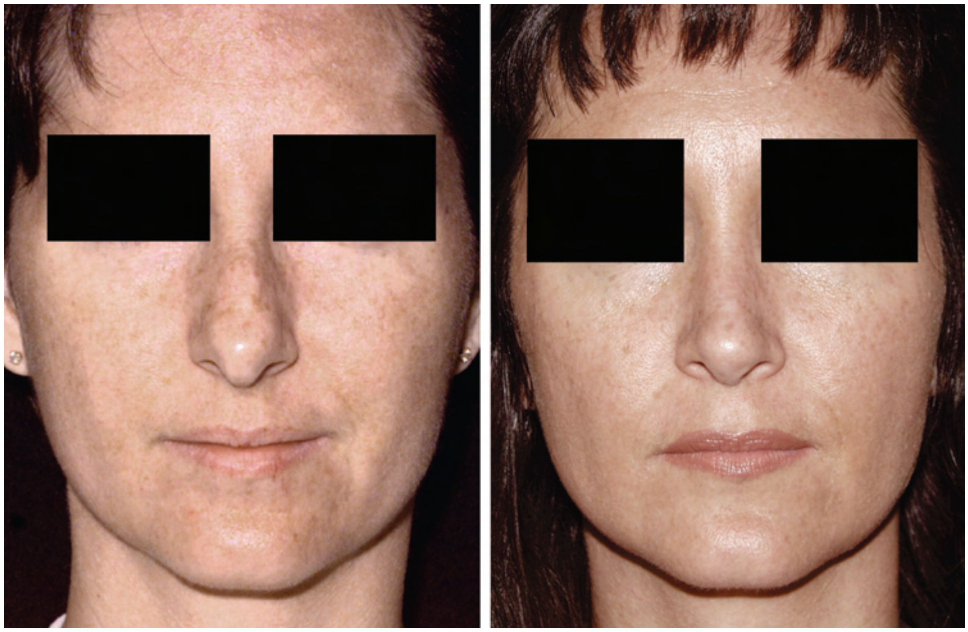

Fig. 9. This patient exhibits type I nasal bones (broad nasal base only) that required a lateral osteotomy (*left*). The buccal sulcus approach was used for a low-to-low osteotomy. The frontal view shows the improvement at 17 months (*right*).

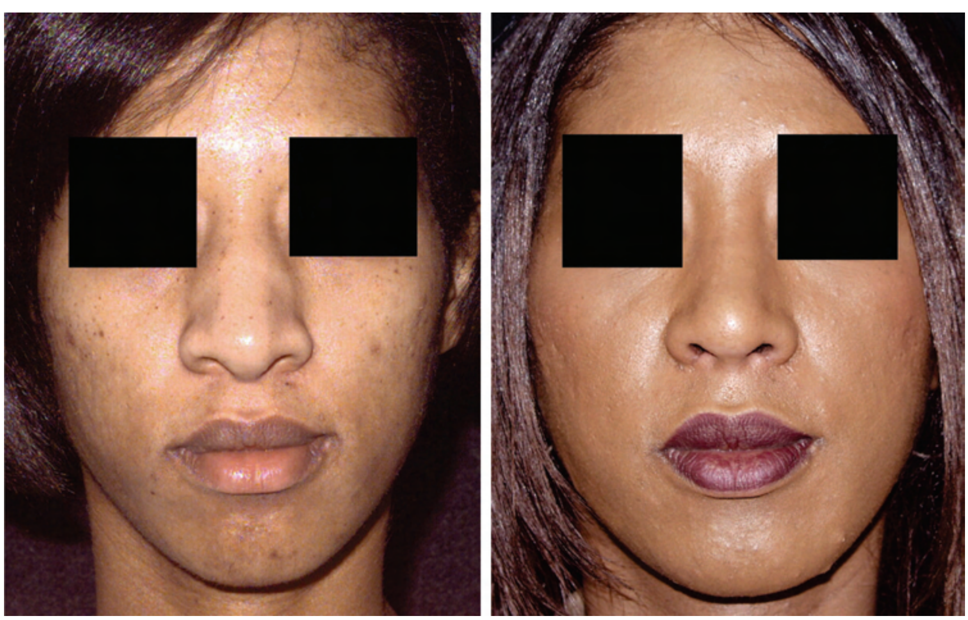

Fig. 10. This patient exhibits type II nasal bones (broad base and dorsum) that required both lateral osteotomy and medial oblique osteotomy (*left*). The buccal sulcus approach was used for the low-to-low osteotomy. However, the same result could have just as easily been achieved with the internal or external cutaneous approaches. The frontal view shows the improved result at 22 months (*right*).

root of the nasal bones. Many such techniques have been described,[1–10] notably that by Tardy et al.,[8] and do provide for complete mobilization of the nasal bone. However, we do believe it is important that, if possible, the medial oblique and lateral osteotomies do not meet at the cephalic end. Having a small bony attachment at the cephalic end provides additional security. This principle of creating a hanging chad of bone is not new. Gunter et al.[18] recommended that the ce-

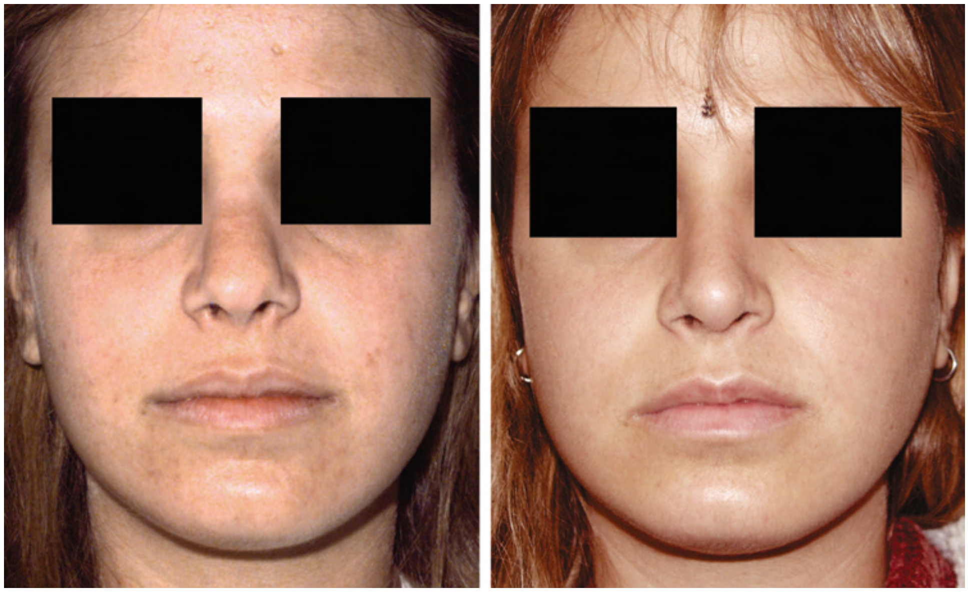

Fig. 11. This patient exhibits a type III deformity (broad dorsum only) in which the width of the nasal bone base is normal but the dorsum is too wide (*left*). A medial oblique osteotomy only was performed. The frontal view shows the improvement at 19 months (*right*).

phalic ends of the medial oblique and lateral osteotomies be separated by a few millimeters.

One might argue that by placing the osteotome flush up against the bony septum (rather than at the lateral aspect of the dorsum), one has better control of where the osteotome goes. In some sense, that is true. However, the resultant fracture would go where it is not desired, into the "no-man zone,"[11,12] which may result in rocker formation and bleeding. Moreover, a fracture line flush up against the bony septum (even if angled at 30 degrees) simply does not allow for the creation of a dorsal hood under which the nasal bone can migrate. As for the possibility of greater deformities by taking the lateral path rather than the more stable medial path, we have not seen that to be the case. Also, the resultant ridge that occurs when the nasal bone migrates under the hood is only a problem if one fails to rasp it down. Fortunately, it is easily palpable, without the risk of dislodging any of the bones. If it were not rasped, dorsal irregularity could result. Excessive narrowing of the nasal dorsum is unlikely because prying the nasal bone posteriorly with the osteotomy is done incrementally. After each prying motion, the nasal bone is felt to see how narrow the dorsum has become. We have not experienced overcorrection.

The low-to-low lateral osteotomy was preferred in this study because it minimizes any palpable step-off deformity and allows one to move the largest segment of nasal bone medially. Admittedly, there is always the risk of a slight compromise of the airway with the low-to-low approach[19]; therefore, there may be some patients with a tight nasal passage for whom a high-to-low lateral osteotomy may be preferred. The buccal sulcus approach was used in this group of patients, but the internal pyriform approach would work just as well. With the osteotome in place, it is possible with either method to pry the bone anteriorly, which loosens the bone, allowing it to migrate medially. The external percutaneous approach does not permit a prying maneuver.

Alternative methods for dealing with disproportion between the nasal base and nasal dorsum, such as augmenting the dorsum or narrowing the base, may be performed but were not part of this particular study. In addition, a broad dorsum may be broad only relative to the nasal base. The wide dorsum that type III patients exhibit could, in principle, be treated by out-fracturing the base. However, our limited experience with that technique has not been successful. Moreover, the problem with type III patients is usually that the nasal base is a satisfactory width relative to the lower half of the nose, whereas the dorsum is absolutely broad relative to other features of the nose, thereby demanding absolute reduction of the dorsal width.

Before the advent of this algorithm, the medial oblique osteotomy was used infrequently. Instead, the low-to-high osteotomy was commonly used and it did reduce the width of both the dorsum and the base (at least up to the level of the cephalic end of the open roof). To reduce the width of the nasal dorsum, the medial osteotomy was used[20] in which a saw removed a segment of bone between the nasal bone and bony septum. At the time, it appeared to be a logical method for reducing the dorsal width. However, the saw (which entered the no-man zone) caused some bleeding, which led to postoperative swelling and subsequent fibrosis. Despite satisfactory dorsal bone width reduction intraoperatively, postoperative reduction was not necessarily maintained, perhaps because of the subsequent fibrosis or instability of the nasal bones. This is in contrast to the medial oblique osteotomy described that allows for the nasal bone to be locked in place (under the hood). Since using the new combined medial oblique osteotomy and lateral osteotomy, it has been possible to replace the low-to-high lateral osteotomy completely. It has also been possible to obtain independent reduction of the nasal dorsum. The result has been a dramatic increase in our use and need for the medial oblique osteotomy.

CONCLUSIONS

Finally, it should be mentioned that the osteotomy result of three of the patients was not ideal. One of the three required secondary osteotomy. Despite the increased control with the method we have described, there remains some chance that fracture lines do not go exactly where desired. Fortunately, the incidence of this type of problem has been reduced in our experience, and this study should stimulate further advances in nasal bone manipulation.

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