REVIEW

Crooked nose: An update of management strategies

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Abstract Importance: Crooked nose has always been a surgical challenge for surgeons. It is of essential importance to achieve both functional and aesthetic improvements.

Objective: Various techniques have evolved through times to attain correction of the deviated nose. This work is devoted to review updates in management strategies of crooked nose.

Methods: Description of various techniques available for nasal reconstruction of crooked nose.

Conclusions: Deformities of the deviated nose can be quite different from patient to patient, and that there is no one method that can be used for every deviated nose. Correction requires a complete understanding of the three-dimensional pathology and the time-related changes that develop as healing occurs.

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1. Introduction

The crooked nose had always been a common feature of the North African specially the Egyptian nose. Ramses the Second, the third Egyptian pharaoh of the Nineteenth dynasty had been portrayed many times with a long crooked nose.
The trait continues in the modern ages especially with the current turmoil and the Arab spring clashes resulting in an increased number of traumatic crooked noses.

The term “crooked nose” is commonly used for all of the clinical conditions involving deviation of the nasal pyramid from the median line. This pathology is frequently found in clinical practice today as a result of blunt trauma from sports injuries or road accidents. Neglected or partially reduced nasal fractures usually result in a crooked nose associated with surface depressions and irregularities. A nose that has depressed elements may appear crooked even though the structures are not actually deviated away from the midline the so-called “pseudo-crooked” nose. Crooked nose also may occur as a congenital or idiopathic deformity. Sometimes nasal septal deformities occurs during child delivery are estimated to be 1.25–23% of newborns. Forceps-assisted or breech delivery often is mentioned as the etiology of injury.1–4

The consequences for the patient are severe in both functional and aesthetic terms, as great difficulty in nasal respiration is always combined with unsightliness that cannot be hidden. Still more important than the social aspect of the crooked nose is its psychological impact on the person concerned. In our world, as we are all well aware, the face plays the crucial role in social relations as it is the first thing people see upon meeting.5

The trauma results in extrinsic and intrinsic forces. The extrinsic forces are those exerted on the septum by deviated nasal bones, upper lateral cartilages, and connections with the vomer, ethmoid and maxillary crest. The intrinsic forces can be the result of imperfect growth of the septal cartilage or from trauma altering the tissue ultrastructure, after which the deviated cartilaginous tissue always retains an inherent tendency to revert to its initial position. The resulting deviation can be linear I-shaped, C-shaped, or S-shaped. One side of the dorsum in a C-shaped crooked nose is concave, but the other side is convex. The dorsum and tip in an I-shaped crooked nose (linear) are shifted to one side of the vertical midline of the face.5,6

Precise analysis of the crooked nose is the first step in determining optimal management strategies. However, prior to addressing the nose, facial asymmetries must be elucidated and considered. To analyze the face, a vertical line is drawn from the exact midpoint between the medial canthi, and a horizontal line is drawn that passes through both medial canthi. From these two reference lines, facial asymmetries become obvious.7,8

Nasal analysis begins with noting the deviation of the nose from the midline of the face. Beginning with the upper third of the nose, the width of the bony pyramid is assessed as is the length of the nasal bones. The length of each nasal bone should be assessed individually because asymmetric nasal bones will require asymmetric hump reduction to prevent foreshortening of the more vertically oriented nasal bone on the side of the convexity.9

A study by Munroe in 1994 of over 125 patients for whom asymmetric/deviated noses were the reason for rhinoplasty revealed 5 broad categories of facial asymmetries; (a) Left–Right difference in facial width, (b) Left–Right difference of left–Right orbital level, (c) Rotation displacement of upper jaw/piriform aperture, (d) Isolated lateral placement of piriform aperture, (e) Non-horizontal alar base, (f) More pronounced facial asymmetry sometimes associated with cheek flattening and slanting of the whole midface to one side. A spectrum of progressively severe asymmetries finally involves cranio-facial malformations such as palatopharyngoschisis and hemifacial microsomia which are beyond the scope of this article. Patients with the above mentioned asymmetries must be informed that it is impossible to achieve great results in terms of nasal axis correction before any corrective surgery.8,10

While bony asymmetry is an important cause of deviation, it is usually well addressed with osteotomies and reduction, and it is not discussed in this article. Analysis continues with evaluation of symmetry of the middle third of the nose. One attempts to determine the relationship of the upper lateral cartilage with the nasal bones, particularly if there is any narrowing, step-off deformity, or skewing. Scarring or warping in the middle vault is also assessed. The lower third of the nose includes the medial, middle, and lateral crura of the lower lateral cartilages. Asymmetry from septal deformity in this area is appreciated by skewing of the tip-defining points from the horizontal. The caudal edge of the septum may be apparent because it protrudes into one nostril or the other. The lower lateral cartilages may have intrinsic deformities that lead to asymmetry. Internally, the septum is analyzed for deviations, particularly those deflections that are high dorsal or caudal. Of high importance in this region is the area of the internal nasal valve, which is formed by the caudal free edge of the upper lateral cartilage, the septum, and the nasal floor. Any angle at less than 10° may result in nasal airway obstruction.1,7

2. Repair algorithm

The division of the nasal pyramid into three sections, the upper, middle, and lower thirds, is useful to determine the sector in which the deformity predominates in relation to the anatomical structures concerned, which can be the nasal bones and the nasal processes of the upper maxillary in the upper third, the middle nasal vault (cartilaginous septum and upper lateral cartilages) in the middle third, and the caudal septum and lower lateral cartilages in the lower third.

Systematic facial analysis and evaluation of the dorsum are critical to correcting a deformity of this type. Such an analysis is complicated by the fact that most faces, on close examination, are vertically or horizontally asymmetric. As such, aligning the nose perfectly with one side or half of the face may not make it symmetric with respect to the other side. Perhaps the only consistent reference point for a frontal or anterior-posterior (A-P) photograph is the center point between the medial canthi on the nose with the head in the Frankfort plane. A straight line is drawn from pupil to pupil. The center point between the medial canthi is marked. From this point, a straight midline vertical line is dropped intersecting the glabella, nasal dorsum, tip, columellar base, nasal spine, philtrum, upper incisors, and menton.1,7

2.1. Upper third of the nose

2.1.1. Closed reduction

In the early traumatic crooked nose, nasal bone fracture is the main cause of twisting the nasal axis. Nasal bone fractures are classified into four types. Type I fracture is unilateral thin bone fracture. Type II fracture is bilateral thin bone fracture. Type III fracture is bilateral fracture including thin and thick bone.
Type IV fracture includes the neighboring bone fractures. Each type is subdivided into ‘s’ and ‘o’ according to the presence and absence of septal fracture. Because reduction relies on the mobility of the fractured bony segments, the procedure must be performed before rigid osseous union has occurred and this could be performed by a closed reduction. If the bones do not mobilize easily, early osseous union might have occurred. In most cases vigorous digital pressure will re-fracture the bones and allow movement of the bony nasal vault. The surgeon might choose to perform osteotomies to create controlled fracture lines.

It should be considered that the cause of inadequate bony vault mobilization is a high bony septal deviation that impedes nasal bone movement. In such cases the bony septum must be returned to the midline. Another option is to abort the procedure, wait several months for more solid bony union, and then perform an open reduction with controlled osteotomies.

2.1.2. Open reduction

Open reduction of nasal bone fractures allows for a more precise placement of osteotomies to achieve the most symmetric reduction. The goal of osteotomies is to create mobile bony segments that can be returned to a favorable anatomic position and orientation. This type of reduction should be performed at least 6 months following the initial trauma.

When the septum is normal; osteotomies alone might correct the defect; however, when the relationship between the upper lateral cartilages (ULCs) and septum is distorted osteotomies alone will be less likely to correct the deformity. The surgeon should tailor the osteotomy type to the deformity and to the patient’s bony anatomy. If an inwardly collapsed nasal bone is contributing to the airway compromise, it will be important to use an osteotomy technique that will not further destabilize the bones and worsen the situation (Fig. 1).

Sometimes we may use the greenstick fracture which is the result if lateral osteotomies alone are performed because there remains a bony bridge from the end of the lateral osteotomy to the root of the nose. Greenstick fractures are not ideal because they maintain a spring-like tendency, resulting in a return of the bony pyramid to its original configuration in the postoperative period. Unilateral osteotomies can be performed in certain situations but it is mostly more common to use medial and lateral osteotomies. In severe cases of deviation, a cross-root osteotomy can be performed. In this maneuver, a 2-mm osteotome can be used to make perforated percutaneous osteotomies in a horizontal fashion across the nasion, or just inferior to the nasal root. This series of perforations should connect the most cephalic aspect of the lateral osteotomies. This maneuver should provide tremendous mobility when combined with medial and lateral osteotomies. The bony dorsum can then be manipulated and molded with the opposite hand into place. This maneuver is usually used when medial and lateral osteotomies are insufficient in providing the mobility required for straightening.

2.2. Lower two thirds

The good scenario is that in some traumatic crooked nose deformities the attachment of the ULCs to the nasal bones will allow the middle vault and tip to move into favorable position with bony vault repositioning hence no need for cartilaginous correction (Fig. 2).

In dorsal deviations, camouflaging techniques aim to create the illusion of a midline position or straightening. This could be achieved by filling in depressions with thin cartilage wafers. A crooked nasal dorsum may be hidden by only grafts which may extend over the whole length of the dorsum. Grafting procedures aim to achieve volume enhancement rather than architectural shifts thus avoiding post-operative instability. In general camouflaging techniques are more conservative, less destabilizing and more predictive but patient selection is of great importance. Isolated dorsal cartilaginous septal deviations will manifest as middle vault asymmetry. The convex side might demonstrate internal valve narrowing, dynamic middle vault collapse, and airway obstruction. Subtle or moderate deflections are treated effectively with the placement of sutured-inplace spreader grafts between the dorsal margin of the cartilaginous septum and the ULCs (Fig. 3A–D).

Relocation of a dislocated septum back onto the crest is important. If needed, the caudal septum should be sutured...
to the periosteum at the nasal spine to prevent lateral migration. As the septum goes so goes the nose stress the importance of septal correction. Severe deformities or deviations of the dorsal and caudal septum (which determine to a large degree nasal shape and position) require extensive septal manipulation facilitated by individualized exposure. A hemi transfixion or even open transcolumnellar approach with a complete bilateral mucoperichondrial elevation may be needed. Sometimes surgical techniques for realignment (suture fixation, locking and cartilage shaving) combined with weakening (resection, through and through incisions, scoring and morselization) and subsequent reconstruction (suture approximation, dorsal and caudal battens) reflect the emphasis of preservation of cartilaginous tissue.

Numerous techniques described in the literature involve the use of sections, incisions and morselization to modify the cartilaginous portion of the dorsal pillar of the septum and straighten the nose. Unfortunately, these methods often prove unsuccessful due to the “memory” of the deviation and to excessive weakening of the supporting pillar leading to the collapse of the nasal dorsum.

Considerable progress toward the correction of dorsal deviations came with the use of spreader grafts. The original technique devised by Sheen in 1984 involved positioning a rectangular strip of cartilage on either side of the dorsal septum harvested from the central part of the same. This method served fundamentally to strengthen the middle nasal vault during risky rhinoplasties, and hence prevent post-operative collapse. It also proved immediately useful in functional terms by broadening the angle of the internal nasal valve, and thus increasing the respiratory airflow.\(^{(17)}\) (Fig. 3A–D)

While using spreader grafts, Toriumi and Ries suggested positioning a spreader graft on the concave side in C-shaped deviations both to restore the respiratory function and to harmonize the aesthetic line from the brow to the nasal tip. In the cases of linear deviation of the nasal pyramid, it is instead necessary to position the spreader graft on the side opposite to the deviation, where there is a gap between the septum and the upper lateral cartilages. In both the cases, the use of spreader grafts makes it possible to secure lasting correction of the deviation and camouflage any residual crookedness. While Rohrich supports the technique of unilateral spreader graft, Guyuron advocates the use of bilateral spreader grafts to firmly secure the septum in position and counter any future deviations caused by the residual septal cartilage memory. Finally, Byrd suggests the use of a “septal extension graft” in place of spreader graft on the concave side to control the projection and rotation of the nasal tip\(^{(13,18–20)}\).

One technique offering good results involves extracorporeal reshaping of the nasal septum and grafting it back onto the nasal pyramid. Extracorporeal septoplasty for the correction of the severely deviated caudal septum was first reported by Gubisch in 1995. He described complete removal of the entire cartilaginous septum, which he then straightened and returned to the nose. He described the areas of fixation to secure the newly reconstructed septum back into the native nose. The first area of fixation is the caudal end of the nasal bones, where the cephalic dorsal septum is reattached. He accomplished this by suturing the reconstructed septum to the upper lateral cartilage or by placing a transcutaneous U-suture. The second point of fixation is the maxillary crest, where the posterior septal angle is reattached. He accomplished this by drilling a hole through the nasal spine and suturing the newly reconstructed neocaudal septum down to the maxillary crest.\(^{(21–24)}\) (Fig. 4).

Anterior septal reconstruction (ASR) is a more conservative approach to extracorporeal septoplasty that was proposed to preserve the dorsal support, designed to concomitantly address the nasal obstruction and external contour deformities. Rather than removing the entire cartilaginous septum, as described for standard extracorporeal septoplasty, a dorsal strut is preserved. This strut is at least 1.5 cm along its anteroposterior axis. The vertical height of the remnant is maximal at the keystone area;
measuring at least 1 cm. Preservation of this attachment to the nasal bones is of utmost importance in maintaining the dorsal profile and for support of the ASR graft. Dorsal onlay grafting is not regularly used in this technique. The ASR graft is placed on the concave side of the midvault (ie, the side opposite to the midvault deviation) and acts as a spreader graft and splint for the dorsal remnant.25

In 2003, Boccieri proposed the “septal crossbar graft” to correct the crooked nose. In practice, a rectangular graft of cartilage taken from a straight portion of the septum is embedded in the dorsal septum like a bar behind a door to prevent opening from the outside. The surgical technique involves the execution of a classical septoplasty, leaving in place an L-shaped structure of at least 15 mm in thickness, and the harvesting of a straight strip from the septum about 3–6 mm in height. The next phase is the insertion of the crossbar graft between the two incisions of the dorsal pillar on the concave side of the deviation.26,27

Nasal Splinting is an excellent technique that uses a septal graft on the concave side of the septal deviation to splint the septum. This maneuver prevents future septal deviation with an addition of a strength to a potentially weak septum. The increased septal thickness was found not to affect the nasal airway (Fig. 5A–D).

Facial asymmetry affects all facial components not only the visible nasal axis, among many deformities occurring within

Figure 5  (A) Female patient with a severe traumatic deviation of the nose S-Shaped. (B) Intraoperative open rhinoplasty with severely deviated septum Grade IV with dorsal deviation and caudal dislocation. (C) Intraoperative correction of the dorsal septal deviation and the caudal dislocation using unilateral septal grafts for splinting of the deviated septum. (D) An image of the same patient few months post operatively showing correction of the crooked nose.

Figure 6  (A) Male patient with traumatic deviation of the nose C-Shaped with facial asymmetry that involved the deviation of the upper jaw to one side which is the left side in this condition. (B) Intraoperative view of the severely deviated septum Grade IV deviation. (C) Intraoperative correction of the dorsal septal deviation and the caudal dislocation using unilateral septal grafts for splinting of the deviated septum. (D) An image of the same patient three months post operatively showing correction of the crooked nose as the nasal axis became straight but the facial asymmetry still exists that interferes with the patient satisfaction.

Figure 7  (Left) Lateral view of an iatrogenic nasal saddling. (Right) Lateral view of the same patient using conchal graft for correction of the nasal saddling.

the asymmetry spectrum is the upper lateral cartilage abnormalities. Facial asymmetry in most of cases affects the growth of the upper lateral cartilages and hence creates hidden deformities that must be considered in crookedness repair. The asymmetric growth also may produce uneven thickness, consistency, curvature, and elastic recoil of the upper lateral
cartilages. Ignoring this asymmetry may have a marked impact on the outcome of any rhinoplasty operation, especially in the management of crooked noses. A recent study states that approximately 30% of the cases with a visible crooked nose had a straight septum with asymmetric upper lateral cartilages which required appropriate correction to decrease postoperative residual or recurrent mid-vault deviation.

Correction of saddle nose constitutes one of the most controversial aspects of rhinoplasty. The first element of concern is the reconstruction materials used to correct saddle nose. We use cartilage derived from various sites depending on the shape and number of grafts required: septum, concha or rib, as cartilage is an easily harvested material that can be easily modeled to form fine, anatomical grafts to correct superficial irregularities, or very large grafts to fill large defects. The majority of cases we have seen presented a moderate stage of saddle nose, responsible for aesthetic as well as functional complaints. Conchal cartilage appears to be more suitable. It can be easily harvested, preferably via a simple anterior approach with a minimal scar. Almost all of the concha can be harvested without incurring any esthetic or functional sequelae (Figs. 7 and 8).

In severe saddling costal cartilage was the graft of choice with excellent results despite its reputation for a tendency to resorption and deformity over time. The use of synthetic or homologous cadaver grafts is rejected by most teams for the treatment of saddle nose, as many cases of extrusion and infection have been reported (Fig. 9A–C).

3. Conclusions

The crooked nose is still a difficult challenge even to expert surgeons. Progress in surgical techniques has made it possible to employ procedures that are more radical than in the past, and capable of eliminating the most common complications, such as insufficient treatment, structural weakening and relapse. We refer in particular to the use of extracorporeal septoplasty, spreader grafts and the septal crossbar graft, which offer satisfactory and long lasting results, but must be combined with sophisticated manual skills. This is in no way to rule out the supplementary use of other less invasive procedures to obtain even better results, such as small onlay grafts of the morselized cartilage. The use of the mentioned techniques is the tool to straighten the nose or deliver the desired illusion of a straight nose. The most important result of these techniques is that they do not impair but improve the nasal function and preserve a patent airway.

The present study does not claim to be innovative, but was designed to describe adapted therapeutic management based on a specific anatomical and functional analysis. Many methods for correcting the deviated nose have been described. It is obvious from the literature that the deformities of the deviated nose can be quite different from patient to patient, and that there is no one method that can be used for every deviated nose. Correction requires a complete understanding of the three-dimensional pathology and the time-related changes that develop as healing occurs.

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ii. We do not have any financial interests with companies or other entities that have interest in the information in the Contribution (e.g., grants, advisory boards, employment, consultancies, contracts, honoraria, royalties, expert testimony, partnerships, or stock ownership in medically-related fields).
iii. Indication of no financial disclosures; all patients were treated in the university hospital as part of a routine management that all patients receive without the need of an extra material or financial support.

Conflict of interest

None.

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