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# Principles and Techniques of Post-Traumatic Rhinoplasty: A Review of the Literature

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## Abstract

Post-traumatic rhinoplasty is the surgical treatment of the complex functional and aesthetic sequelae of nasal trauma. Correcting a post-traumatic nose is a challenging task, requiring the surgeon to employ a range of techniques and grafts to adequately address the deformities observed. The results of our research show that restoring pre-traumatic form and function remains complex, although many guidelines have been established to refine and optimize the management of the after-effects of nasal trauma. But it is achievable with the right techniques. The objective of our review is to highlight the various post-traumatic nasal sequelae, describe the fundamental principles in the field of post-traumatic rhinoplasty and provide the surgeon with the various existing surgical techniques and strategies so that he or she can make an appropriate choice for the patient.

## Keywords

Nasal Trauma, Sequelae, Post-Traumatic Rhinoplasty, Deviation, Saddle Nose

## 1. Introduction

Post-traumatic rhinoplasty, known as secondary rhinoplasty, is a surgical procedure that treats the sequelae of nasal trauma to improve the function and shape of the post-traumatic nose [1]. It is particularly difficult and unpredictable due to the added variables of initial trauma, septal deformities, as well as frequent complaints of airflow obstruction on the part of the patient [2].

The nose may appear straight and well-corrected on the operating table, but may re-deviate during healing. For this reason, in our practice, we strongly advise patients with severely deviated or post-traumatic noses that multiple proce-

dures may be required and the likelihood of complete correction is often limited or impossible [3].

Associated peri-nasal, periorbital and fronto-cranial deformities can aggravate the situation of the patient who believes that it is entirely due to a nasal deformity. The surgeon must be prepared to look for such deformities [4]. It is often these non-nasal deformities that, if left uncorrected, will lead to an unsatisfactory result even if there is adequate improvement of the post-traumatic nasal deformity [5].

The aim of this chapter is to describe approaches to the treatment of patients with post-traumatic nasal deformity.

## 2. Sequelae of Nasal Trauma

The most common complications following trauma, with or without surgical correction, are aesthetic deformity and nasal obstruction. Repairing such complications is complex, as it involves all aspects of the nose: bone, cartilage and soft tissue.

Long-term post-traumatic complications are inevitable, but it is important to be aware of these complications in order to provide the best possible treatment [6].

### 2.1. Morphological Sequelae

According to various publications, the incidence rate of post-traumatic nasal deformities varies from 9% to 62% [7].

#### 2.1.1. Nasal Deviation

Defined as a displacement of nasal structures from the midline.

When assessing the deviated nose, it is important to determine the components involved in the external deviation. The deformity may involve the bony nose, the cartilaginous bridge, or both. Facial CT scans help us to determine the components involved, as illustrated in **Figure 1**, which reflects a nasal deviation due to two components (**Figure 1**) [8].

The nose is divided into vertical thirds (upper, middle and lower) and each third is examined in relation to the midline [9].

If the origin is bony, the projection of the nasal pyramid is deviated to the side opposite the trauma. The tip of the nose remains in place, and the septum follows the displacement of the bony canopy, resulting in an obtuse angle with a vertex opposite to the trauma.

If cartilaginous in origin, they are responsible for displacement of the lower two-thirds of the dorsum and the tip of the nose [10].

Depressions, bumps and nasal width (either too wide or too narrow) can further complicate them.

They can be classified into three types: simple (rectilinear/globally deviated) illustrated by (**Figure 2**); or complex "S" or "C" shaped illustrated by (**Figure 3**) [11].

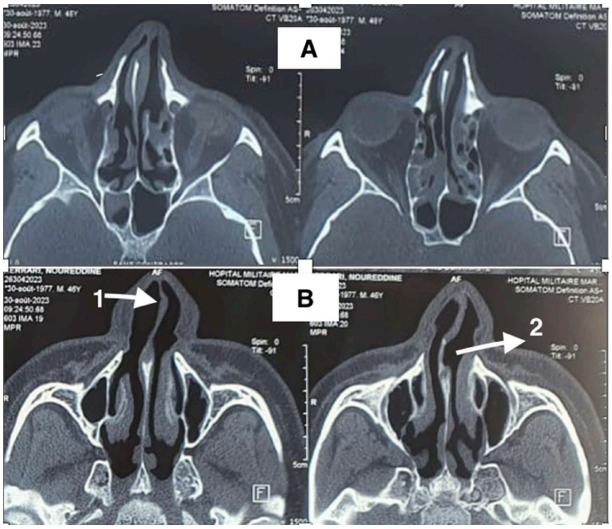


**Figure 1.** Axial section showing post-traumatic septal deviation (A: bone window, B: parenchymal window) (1: septal cartilage, 2: perpendicular ethmoidal blade).

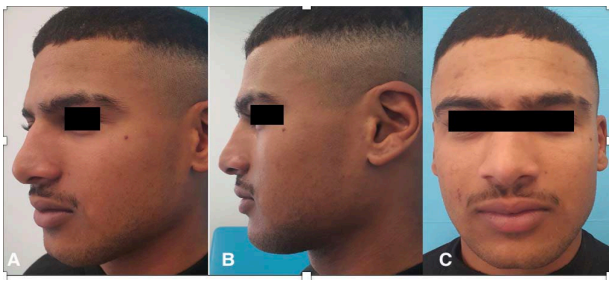


**Figure 2.** Simple nasal deviation (A oblique, B profile, C face).

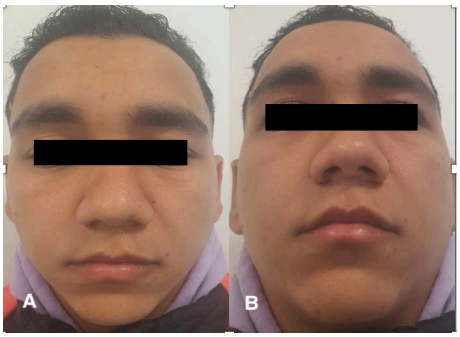


**Figure 3.** Nasal deviation in a C shape (A: front, B: bottom view).

### 2.1.2. The Compressed Nose

A direct frontal impact to the nose produces a telescopic injury in which the bony segments widen or shift in both directions. Consequently, although there is usually limited deviation of the nose, there is often retro-displacement of the bony and cartilaginous dorsum with widening of the bony nasal pyramid. **Figure 4** illustrates the compressed nose of our patient who suffered a frontal impact resulting in widening of the nasal pyramid with nasal saddle.

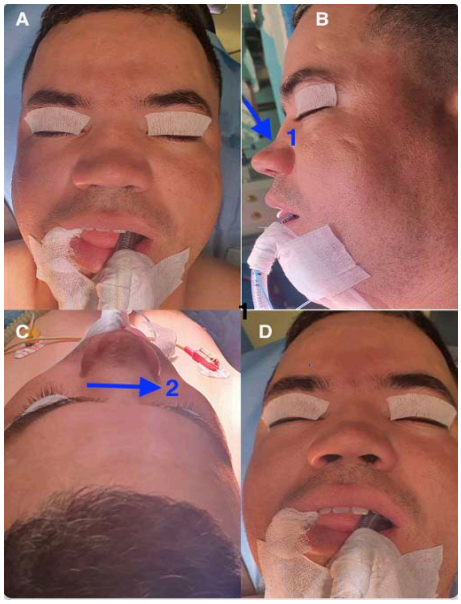


**Figure 4.** Compressed nose with widening of the nasal pyramid associated with ensellurement (A face, B profile, C top view, D bottom view) (1 saddle nose, 2 widening of the nasal pyramid).

Typically, internal nasal examination shows a severely deformed and telescoped septum [8].

### 2.1.3. Saddle Nose

This is a collapse of the middle arch in relation to the tip and dorsum. This depression is caused by a decrease in the structural support of the cartilaginous (lateral septum and cartilage) or bony (bony dorsum) framework at the level of the soft tissue envelope of the nose [12].

Progressive loss of septal integrity results in a characteristic saddle-nose deformity, with depression and flaring of the middle arch, loss of support and overrotation of the tip, decreased vertical projection, columella retrogression and widening of the nasal base [13].

Palpation of the nasal dorsum reveals a lack of resistance in its bony and cartilaginous parts.

In functional terms, the internal and external nasal valves are affected, leading to significant difficulties in breathing [14].

### 2.1.4. Posttraumatic Nasal Deformities with Associated Peri-Nasal Deformities

A patient with a history of nasal trauma also has other associated mid-facial deformities. The patient is often unaware of the deformities, and focuses on the external nasal deformity and/or associated functional disturbances.

These deformities can include structural malposition of the midface (maxillary deviation, which can contribute to nasal base offset) and other problems such as pseudotelecanthus, enophthalmos, orbital malposition and frontocranial

deformities [8].

As shown in (**Figure 5**), a patient with severe sequelae of facial trauma: telechathus and enphthalmos, maxillary recession, enophthalmos and telecanthus responsible for widening of the nasal root. The management of this patient must take into account all these deformities.

Because of these anomalies, the result of rhinoplasty may be unsatisfactory. Identification of these perinasal and periorbital deformities should be carried out preoperatively, and consideration given to simultaneous surgical repair.

## 2.2. Functional Sequelae

### 2.2.1. Nasal Obstruction

The overall rate of nasal obstruction was 10.5% +/− 5.3%.

Nostril permeability is impaired by: stenosis resulting either from displacement of an unstable fracture, or imperfect reduction during original manipulation; mucous synechiae; septal damage in the form of dislocation and, more rarely, septal perforation; collapse of the internal nasal valves and/or lateral wall. Less frequently, instability of the external nasal valve can also lead to nasal obstruction [4].

The clinical diagnosis of obstruction is sometimes difficult, as it is determined to some extent by the patient's subjective feelings about all his or her activities.

Even the rudimentary but widely used sniff test can show large differences in the ease of air passage through the nose on consecutive examinations [15].

CT scans allow analysis of the entire nasal cavity for posterior lesions.

Consequently, an assessment of functional deformity is essential.

### 2.2.2. Septal Perforation after Trauma

A potential long-term complication following septal trauma is perforation of the nasal septum. Although septal perforations are often discovered during routine consultations, they can lead to symptoms such as nasal obstruction, nasal congestion, epistaxis, chronic purulent discharge or other nasal symptoms. The presence of a septal perforation can lead to chronic rhino-sinusitis [5].

### 2.2.3. Diplopia

The overall diplopia rate is 3.1% [7].

### 2.2.4. Nasolacrimal Obstruction and Epiphora

The overall rate of epiphora after nasal trauma is 3.1%.

Epiphora is the result of residual obstruction of the lacrimonasal duct.

### 2.2.5. Sinus Infection

Nasal obstructions are responsible for sinusitis or mucoceles, with the risk of oculo-orbital and/or endocranial infectious complications [5].

### 2.2.6. Olfactory Disorders

The overall rate of olfactory disorders in patients with nasal bone fractures (with or without other fractures) is 37.7% +/− 11.3%.

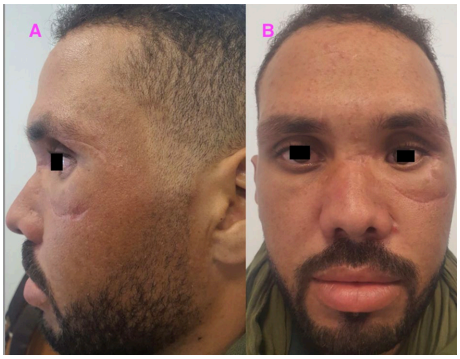


**Figure 5.** Complex nasal deformity with periorbital and perinasal deformity (A profile, B face).

No significant association was found between the type of fracture and the presence of olfactory disorders [7].

A simultaneous alteration in taste has been reported.

Impaired olfaction can be explained by:

- *Nerve damage*: Tearing or trauma to olfactory nerve fibers can occur in fractures of the nose and skull base.
- regeneration of olfactory nerve fibers may be blocked by the formation of scar tissue and gliosis [16] [17].
- *Nasal tract injuries*: Direct injury, edema, mucosal hematoma and scarring of the olfactory epithelium all contribute to impaired olfactory function. Trauma to the nasal passages can block airflow to the olfactory cleft region and impair olfactory function. In this case corrective surgery can help restore olfactory function [16].
- *Cerebral lesions*: Cerebral contusions, particularly in the olfactory bulb and orbital frontal pole region, are a frequent cause of post-traumatic olfactory loss [16].

People with impaired olfactory function may be unable to detect important warning signs such as gas leaks, volatile chemical fumes and fires, and put themselves at increased risk of serious injury or death.

## 2.3. Psychological Consequences

Facial appearance plays an important role in social cognition. Therefore, facial asymmetries in people with nasal deformities are likely a source of emotional and social distress [18].

The often violent mechanism of the injury, the changes in appearance, the altered self-perception and self-confidence can have a significant impact on daily life. The main sequelae are [19]:

- Post-traumatic stress disorder: includes repeated reliving of the trauma in intrusive *memories* ("flashbacks"), dreams or nightmares, with avoidance of activities and situations reminiscent of the trauma.
- *Hypervigilance*, increased startle response and insomnia.
- Anxiety and *depression* are often associated, and suicidal ideation is com-

mon.

- *Negative* character changes affect almost all injured people.
- Sexual *problems* are particularly common. They feel "ugly" and unattractive, so facial damage always has an impact on sexuality.

Symptoms last for more than 4 weeks, and can often last for years.

Psychological consequences are difficult to identify and may go unnoticed in a busy clinic, not least because surgeons focus their skills on immediately visible or "fixable" problems [20].

## 3. Principles of Repair of Post-Traumatic Nasal Deformities

### 3.1. Preoperative Assessment

The interview with the patient should provide information on:

- Mechanism of injury.
- Direction and force of impact.
- Presence of nasal obstruction.
- Distinguish between aesthetic deformities resulting from the injury and those that predate it.
- Clarify the patient's expectations: correction of nasal obstruction or aesthetic changes.
- Nasal examination to identify specific anatomical sites of injury and formulate a surgical plan:
  - On the frontal view, the symmetry and width of the nose must be assessed.
  - On the lateral view, the relative projection of the radix, bony dorsum, cartilaginous dorsum and nasal tip must be taken into account.
- *Intranasal* inspection or even endoscopic examination to determine the position and shape of the nasal septum.
- Note *thickness* and quality of nasal skin.
- Take *photographs*.

Repairing deformations involves the following steps:

1) exhibition;
2) septal reconstruction;
3) hump removal;
4) osteotomies;
5) topping-up procedures;
6) appropriate internal and external splint.

### 3.2. Bump Removal

We remove the hump after repairing the septum using the submucosal tunnels previously created.

The hump is removed extra-mucosally. We use a chisel or a rasp, depending on the amount of bone to be removed.

Extreme caution is required when removing the hump in cases of deviated nose due to skeletal asymmetry.

Resection of the hump takes place in two stages, involving the cartilaginous part and the bony part:

- Chondrotomies are performed using contra-angle scissors. The triangular cartilages are sectioned along the axis of the dorsum up to the lower edge of the nasal bones. Septal chondrotomy is performed at the same level as triangular cartilage chondrotomy.
- Osteotomy of the clean bones and the perpendicular ethmoid blade extends the chondrotomy to the frontal notch.

We consider that the ideal resection is made in a single block, encompassing part of the septum, triangular cartilage and proper nasal bones. The bone resection can be completed and regularized using a rasp.

If the hump is discrete or the nasal bones are short, we prefer to use only the rasp for bone resection.

### 3.3. Nasal Deviation

- It may be a question of isolated deformities, whether bony or cartilaginous, although in most cases these two components are pathophysiologically responsible for the deviation [9].
- The aim of osteotomies is to create mobile bone segments that can be realigned into a favorable anatomical position and orientation. These maneuvers rely primarily on the tactile sense rather than direct visualization.
- In the majority of situations, medial osteotomies are performed to establish a predictable dorsal fracture site, necessary for lateral osteotomies. However, this becomes superfluous when removal of the bony hump creates a sufficiently large open bone roof. A narrow, straight, unprotected osteotome is positioned at the level of the rhinion, close to the junction of the bony septum and the nasal bones. A mallet is used to strike the osteotome and induce a controlled fracture in the cephalic direction. It is crucial that the osteotomy fades 15˚ to 20˚ laterally to avoid the nasofrontal region [21].
- Lateral osteotomies are then performed, starting on the side opposite the deviation to achieve the appropriate bony cut, then performed on the side of the deviation. An incision is made approximately 3 to 4 mm above the base of the piriform aperture, just above the anterior insertion of the inferior cornet. The instrument is driven 90˚ into the edge of the pyriform opening, using a mallet. The osteotomy path then follows an up-down-up (anterior-posterior-anterior) direction. Below the medial canthus, the instrument is directed backwards towards the medial osteotomy [11].
- The intermediate bone between the medial and lateral osteotomies is then fractured in a controlled manner by rotating the osteotome along its axis.
- When lateral osteotomies are performed, the entire bony vault must be moved into a slightly overcorrected position [2].
- It is often necessary first to correct a bony septal deviation in order to allow the displacement of the bony pyramid.
- In cases of marked concavity or convexity of the nasal bones, intermediate

osteotomies may be required to normalize the lateral bone contour. It is crucial to perform the intermediate osteotomy before the lateral osteotomy, directing it towards the area of maximum concavity or convexity. The trajectory must be parallel to the planned lateral osteotomy.

- When a strong septal deviation is present, it is impossible to move the nasal bones and superior lateral cartilage by osteotomy alone. Thus, attempts to achieve a straight external nasal arch through exclusive osteotomies may prove unsuccessful [22].
- Sometimes, after successful mobilization and reduction by osteotomy, initially correcting the deviation, the deformity may recur. This may be due to: further contraction of fibrous tissue; very posterior septal deviation; some authors refer to this as nasal memory.

### 3.4. Saddle Nose

Different reconstruction materials are used in rhinoplasty, we distinguish between [14]:

*Alloplasts*

- Silicone implants are widely used for back augmentation. Their limitations are: they are surrounded by a fibrous capsule that does not integrate with adjacent tissues and are therefore susceptible to displacement and deformation, they have a higher rate of extrusion and infection.
- Leather and ivory are non-toxic, non-allergenic alloplastic materials that are easy to sculpt and sterilize, and would resist resorption and rejection, but in the event of infection they are prone to extrusion. In addition, their hard surface is a limitation as it gives the nose a hard consistency and can shift in the event of trauma.
- polytetrafluoroethylene foam can be used successfully.

*Autografts*

- An autograft uses the patient's own tissue for reconstruction. Donor sites include septal, auricular and costal cartilage, calvaria and iliac bones.
- Septal cartilage is most commonly used for its rigidity and ease of harvesting, but it often cannot be fixed in saddle nose deformities without further compromising the integrity of the septal support wall.
- Conchal and costal cartilage give good results. Our team prefers to use costal cartilage to repair saddlebags because of its rigidity.
- Autologous grafts used for the repair of nasal septum perforations associated with saddle nose deformities include fascia temporalis, septal cartilage and bone, pericranium, mastoid bone and perichondrium, tragal cartilage and perichondrium, ethmoidal bone, iliac crest, conchal cartilage and skin grafts.

*Homografts*

- Homografts are harvested from cadaveric sources. They are subjected to gamma irradiation of 30,000 to 40,000 Gy to sterilize and reduce the antigenicity of the graft, thus ensuring good tissue compatibility and resistance to

infection. Other advantages: no donor-site morbidity.

*Xenografts*

- The use of xenografts harvested from non-human sources has met with little success in nasal augmentation. The authors described the use of porcine intestinal submucosa as an interposition graft between bilateral mucoperichondral advancement flaps to close nasal septal perforations.

*Reconstruction options*

- A fundamental principle of reconstruction is to re-establish septal support by repairing septal defects or creating a stable beam. Existing upper and lower lateral cartilage, as well as new cartilage grafts used for the wings and tip, can then be attached to this stable support structure. This reconstitutes the nasal arch and tip, contributing to harmonious nasal aesthetics [22].
- If the septal support wall is lowered but remains solid, restoration of the dorsal profile can be performed without concern for reconstruction of the septal support. Corrections require the use of support grafts.
- In general, autografts are preferred for dorsal augmentation. Cartilage grafts from the septum, concha or rib have been used, but their disadvantage is the possibility of displacement and palpable irregularities, particularly if the skin is thin [4].
- If septal cartilage is to be used, septal support must be maintained by harvesting quadrangular cartilage behind a line connecting the bony-cartilaginous junction and the nasal spine. This beam is supported by two columns: the remaining quadrangular cartilage and bone septum at cephalic level, and a true columellar pillar at caudal level. When present, perforations of the nasal septum must be corrected with bilateral mucoperichondral flaps and interpositional grafts.
- If significant septal support integrity is lost, the dorsal contour can only be effectively restored once a new support structure has been established. Traditional one-stage approaches involve iliac crest, calvarial cartilage or costal cartilage grafts attached to the bony dorsum and a dorso-caudal septal/columellar abutment.

An adequate nasal lining is essential for the survival of these grafts.

We treat persistent columellar retrogression by adding a columellar abutment.

Tip misalignments are corrected by advancing and suturing the medial ridge to the columellar abutment. When additional projection is required, tip grafts are used. Once the structural framework has been established and work on the tip performed, dorsal augmentation can be performed in a second stage. Fascia alone, cartilage or cartilage wrapped in fascia can be placed along the back to achieve the desired contour.

Collapse of the lateral nasal wall can be corrected with additional cartilage grafts designed to support the internal and external nasal valve.

- Catastrophic loss of nasal support, lining and skin coverage necessitates the use of forehead flaps or free flaps. Our team often uses a prosthesis to ensure

excellent cosmetic camouflage.

### 3.5. Compressed Nose

- This is a retro-displacement of the bony and cartilaginous dorsum, accompanied by widening of the bony pyramid of the nose. Severe telescopic deformity of the nasal septum is also present [22].
- In such situations, the key to adequate restoration lies not only in mobilizing the cartilage and bone segments, but also in increasing dorsal structural support. Thus, these lesions generally require some form of dorsal augmentation in addition to structural realignment. It is therefore essential to be prepared for the use of an augmentation graft, whether from conchal or costal cartilage, bone, or using alloplastic implant materials.
- Although septal cartilage is the preferred choice, ear or rib cartilage can be considered as an alternative if required.
- Our team used rib cartilage because of its rigidity in two patients with nasal compression. The aesthetic result was good, with satisfied patients.

### 3.6. Post-Traumatic Nasal Deformities with Associated Peri-Nasal Deformities

- These are most often structural malpositions of the mid-face (in particular a deviation of the maxilla, which can contribute to an offset of the nasal base and consequently a deviation of the nose).
- Other deformities may be responsible for nasal deformities, such as enophthalmos, malposition of the orbit and fronto-cranial deformities, and soft tissue deformities such as scars.
- Carefully performed reconstructive rhinoplasty can be considered in these patients, although overall results can sometimes be unsatisfactory. It is therefore essential to identify these peri-nasal deformities during preoperative evaluation, and the possibility of simultaneous surgical correction should be considered.
- Unfortunately, this type of procedure frequently involves complex surgical approaches and can result in additional morbidity.
- It is important to bear in mind that complete correction of these deformations is often limited, if not impossible.

## 4. Conclusions

Post-traumatic rhinoplasty restores the post-traumatic nasal deformity to an optimal state in order to restore the fundamental functions of the nose.

Moreover, post-traumatic rhinoplasty must always incorporate aesthetic considerations, so that the surgeon can respond to the patient's desire to regain both a natural face and normal nasal function.

## Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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