Resident Manual of Trauma to the Face, Head, and Neck

First Edition

AMERICAN ACADEMY OF
OTOLARYNGOLOGY–
HEAD AND NECK SURGERY
FOUNDATION

For more information, visit our website at www.entnet.org.

eBook Format: First Edition 2012.

ISBN: 978-0-615-64912-2

Preface

The surgical care of trauma to the face, head, and neck that is an integral part of the modern practice of otolaryngology–head and neck surgery has its origins in the early formation of the specialty over 100 years ago. Initially a combined specialty of eye, ear, nose, and throat (EENT), these early practitioners began to understand the inter-relations between neurological, osseous, and vascular pathology due to traumatic injuries. It also was very helpful to be able to treat eye as well as facial and neck trauma at that time.

Over the past century technological advances have revolutionized the diagnosis and treatment of trauma to the face, head, and neck—angiography, operating microscope, sophisticated bone drills, endoscopy, safer anesthesia, engineered instrumentation, and reconstructive materials, to name a few. As a resident physician in this specialty, you are aided in the care of trauma patients by these advances, for which we owe a great deal to our colleagues who have preceded us. Additionally, it has only been in the last 30–40 years that the separation of ophthalmology and otolaryngology has become complete, although there remains a strong tradition of clinical collegiality.

As with other surgical disciplines, significant advances in facial, head, and neck trauma care have occurred as a result of military conflict, where large numbers of combat-wounded patients require ingenuity, inspiration, and clinical experimentation to devise better ways to repair and reconstruct severe wounds. In good part, many of these same advances can be applied to the treatment of other, more civilian pathologies, including the conduct of head and neck oncologic surgery, facial plastic and reconstructive surgery, and otologic surgery. We are indebted to a great many otolaryngologists, such as Dr. John Conley's skills from World War II, who brought such surgical advances from previous wars back to our discipline to better care for patients in the civilian population. Many of the authors of this manual have served in Iraq and/or Afghanistan in a combat surgeon role, and their experiences are being passed on to you.

So why develop a manual for resident physicians on the urgent and emergent care of traumatic injuries to the face, head, and neck? Usually the first responders to an academic medical center emergency department for evaluation of trauma patients with face, head, and neck injuries will be the otolaryngology–head and neck surgery residents. Because there is often a need for urgent evaluation and treatment—bleeding and airway obstruction—there is often little time for the resident to peruse a reference or comprehensive textbook on such trauma. Thus, a simple, concise, and easily accessible source of diagnostic and therapeutic guidelines for the examining/treating resident was felt to be an important tool, both educationally and clinically.

This reference guide for residents was developed by a task force of the American Academy of Otolaryngology—Head and Neck Surgery (AAO-HNS) Committee on Trauma. AAO-HNS recently established this standing committee to support the continued tradition of otolaryngology–head and neck surgery in the care of trauma patients. An electronic, Portable Document Format (PDF), suitable for downloading to a smart phone, was chosen for this manual to facilitate its practical use by the resident physician in the emergency department and preoperative area.

It should be used as a quick-reference tool in the evaluation of a trauma patient and in the planning of the surgical repair and/or reconstruction. This manual supplements, but does not replace, more comprehensive bodies of literature in the field. Use this manual well and often in the care of your patients.

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Acknowledgments

This quick reference guide for resident physicians in trauma management reflects the efforts of many individuals in the American Academy of Otolaryngology—Head and Neck Surgery and a special task force of the AAO-HNS Committee on Trauma.

The editors would like to thank all of the authors who generously gave their time and expertise to compose excellent chapters for this Resident Manual in the face of busy clinical and academic responsibilities and under a very narrow timeframe of production. These authors, experts in the care of patients who have sustained trauma to the face, head, and neck, have produced practical chapters that will guide resident physicians in their assessment and management of such trauma. The authors have a wide range of clinical expertise in trauma management, gained through community and military experience.

A very special appreciation is extended to Audrey Shively, MSHSE, MCHES, CCMEP, Director, Education, of the AAO-HNS Foundation, for her unwavering efforts on behalf of this project, and her competent and patient management of the mechanics of the Resident Manual's production. Additionally, this manual could not have been produced without the expert copyediting and design of diverse educational chapters into a cohesive, concise, and practical format by Joan O'Callaghan, Director, Communications Collective, of Bethesda, Maryland.

The editors also wish to acknowledge the unwavering support and encouragement from: Rodney P. Lusk, MD, President; David R. Nielsen, MD, Executive Vice President and CEO; Sonya Malekzadeh, MD, Coordinator for Education; and Mary Pat Cornett, CAE, CMP, Senior Director, Education and Meetings, of the AAO-HNS/F. We also appreciate the administrative support of Rudy Anderson as AAO-HNS/F Staff Liaison for the Trauma Committee.

Since it takes a group of dedicated professionals to produce an educational and clinical manual such as this, all have shared in the effort, and each individual's contribution has been outstanding.

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Chapter 4: Midfacial Trauma

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I. Maxillary and Orbital (and Zygomatic) Fractures

Fractures of the midfacial bones are most commonly due to blunt trauma from falls, altercations, and motor vehicle accidents. While penetrating injuries certainly occur, they are less common, and are typically not addressed in discussions of fractures.

A. DENTAL TERMINOLOGY

1. Maxillae and Mandible

To clearly communicate about the anatomy and to discuss common fractures, it is necessary to provide some terminology commonly used to describe and classify these fractures. In addition, when discussing fractures that involve bones that hold teeth (i.e., the maxillae and mandible), it is important to understand the basics of occlusion.

a. Intercuspation

The maxillary and mandibular dentition interdigitate (called intercuspation) for the purpose of chewing food.

b. Crossbite

The maxillary arch is generally larger than the mandibular arch, so that the maxillary dentition is supposed to be more lateral and anterior (buccal and labial) than the mandibular dentition. When this does not occur, it is referred to as a "crossbite," which can occur unilaterally or bilaterally. If a crossbite is not premorbid, it can be the result of a trauma.

c. Overjet and Overbite

The "jetting" of the maxillary incisors forward of the mandibular incisors is called "overjet," which is a normal finding. The vertical extension of the maxillary incisors is also normal, and is called "overbite." Of course, both of these can be abnormal if the distances involved are excessive or less than optimal.

d. Angle's Classification

The overall relation between the maxillary and mandibular dentition is generally defined by Angle's classification, described as the "mesiobuccal cusp of the maxillary first molar fitting into the mesiobuccal groove of the mandibular first molar" on each side. (Keep in mind that since the normal maxillary arch is larger, the maxillary incisors sit anterior to the mandibular incisors, yet the maxillary molar sits slightly posterior to the mandibular molar.) Familiarity with what is normal is important when repairing fractures in this area.

B. MIDFACIAL ANATOMY

The midfacial structure includes left and right paired, mirror-image bones that make up the orbits, nasal structure, cheekbones, maxillae (which hold the upper teeth), and palate. Of course, multiple bones contribute to the orbital structure, including the maxilla, zygoma, sphenoid (both greater and lesser wing components), frontal, ethmoid, lacrimal, and palatine bones (Figure 4.1).

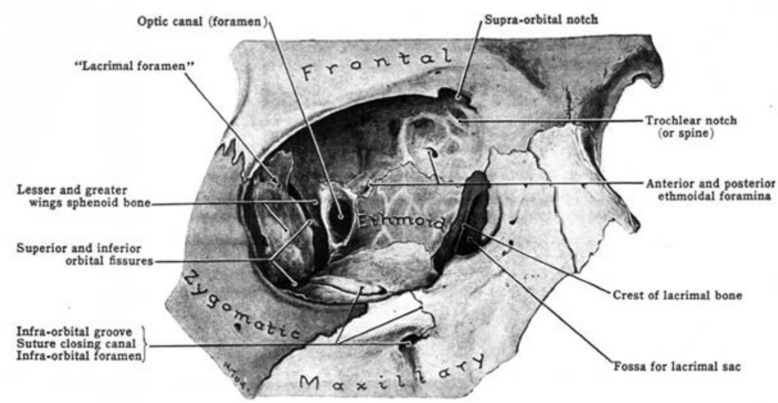


Figure 4.1

Illustration depicting orbital structure. Source: Agur and Dalley, Figure 518.

The bones of the face provide support for important physiologic functions, including support of the nasal airway and olfaction, support and protection of the globes and visual function, and support for the teeth and masticatory function. It has also been suggested that the facial bone structure includes strong areas (buttresses) that support the anatomy and provide the strength needed for masticatory function, and that these areas are separated by weaker areas that provide protection for important structures, such as the eyes and the brain (Manson, Stanley). (It has been theorized that the paranasal sinuses may function as "crumple zones" or shock absorbers that can protect the eyes, optic nerves, carotid arteries, and brain from some blunt traumas (Kellman, Kellman & Schmidt).) The midface is suspended from the skull base, and posteriorly, the pterygoid plates complete the midfacial structure.

1. Strong Areas of the Facial Bone

The strong areas of the facial bone transmit forces both vertically and horizontally. Repair of midfacial fractures requires restoration of continuity and structural integrity across these important supporting structures of the midface.

a. Vertical Buttresses

The vertical buttresses include bilateral medial and lateral buttresses that extend from the dentition superiorly, and posterior vertical buttresses that extend through the pterygoid plates to the skull base.

b. Medial Anterior Buttresses

The medial anterior buttresses extend from the alveoli along the strong pyriform aperture bone superiorly along the maxilla through the nasal bone to the frontal bone.

c. Lateral Buttresses

The lateral buttresses extend from the alveoli up along the zygomatico-maxillary junction and continue through the lateral orbital rim to the frontal bone laterally.

d. Anterior-Posterior Horizontal Buttresses

The anterior-posterior horizontal buttresses extend from the malar eminences bilaterally posteriorly along the zygomatic arches to the temporal bones.

e. Lateral-to-Lateral Horizontal Buttresses

There are two lateral-to-lateral horizontal buttresses: a superior buttress that extends from one malar eminence to the other across the inferior orbital rims and nasal bones, and an inferior buttress that extends across the inferior maxillae from one side to the other across the midline and includes the palate for strength extending posteriorly.

2. Maxillae

The maxillae are the paired bones that contain the maxillary dentition (teeth 1 to 16, counted from right third molar to left third molar). They provide support to the lateral nasal wall and nasal bones, as well as the inferior orbital rims. The maxillae house the maxillary sinuses. The second division of the trigeminal nerve (V2) passes into the maxillae from the orbit and exits anteriorly through the anterior maxillary wall, as the infraorbital nerve. The paired maxillae meet inferiorly in the midline.

3. Nasal Bones

The nasal bones project from the frontal processes of the maxillae and form the bony support of the upper portion of the nose (Figure 4.2). They connect the midface to the skull (frontal bones) anteriorly in the midline.

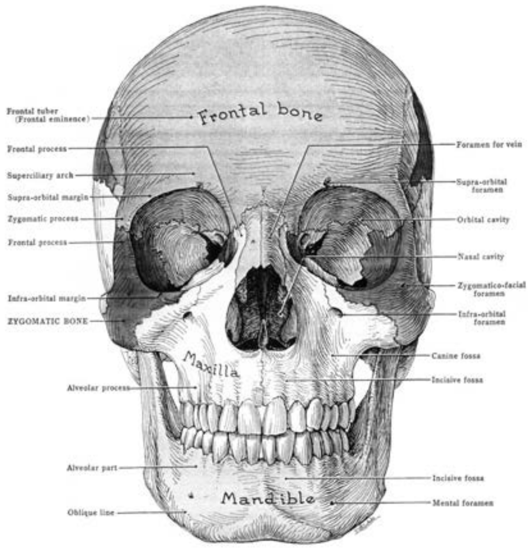


Figure 4.2

Illustration depicting frontal view of the skull. *Source: Agur and Dalley, Figure 459.*

4. Orbits

The orbits have a four-walled pyramidal shape, with the apex located medial and superior.

a. Lacrimal, Ethmoid, and Palatine Bones

The optic canal is at the apex and transmits the optic nerve. The medial wall is composed of the thick lacrimal bone, which supports the lacrimal sac; the thin lamina papyracea of the ethmoid bone; and, to a smaller extent, the palatine bone.

b. Sphenoid Bone

The medial wall of the optic canal is provided by the strong lesser wing of the sphenoid bone. The floor is composed primarily of the thin roof of the maxillary sinus.

c. Zygomatic Bones

Laterally, the zygoma anteriorly and the greater wing of the sphenoid posteriorly form the lateral wall. Superiorly, the frontal bone forms the much stronger orbital roof. The zygomatic bones have a complex three-dimensional structure, including the arch, which is a thin posterior extension that extends posteriorly from the lateral portion of the malar eminence, and abuts against the temporal bone, which contributes the posterior half of the arch. Though thin, the arch creates the lateral projection of the face.

d. Malar Eminence

The malar eminence forms the prominent cheekbone structure, and its posterior portion contributes important support to the inferolateral orbital wall. Displacement of the malar eminence often leads to significant displacement of the globe.

C. MIDFACIAL FRACTURES

1. Le Fort Series of Fractures

While numerous classification systems have been proposed, they are not necessarily precise. Few have matched the simplicity and user-friendliness of the old, but clinically useful, Le Fort system.

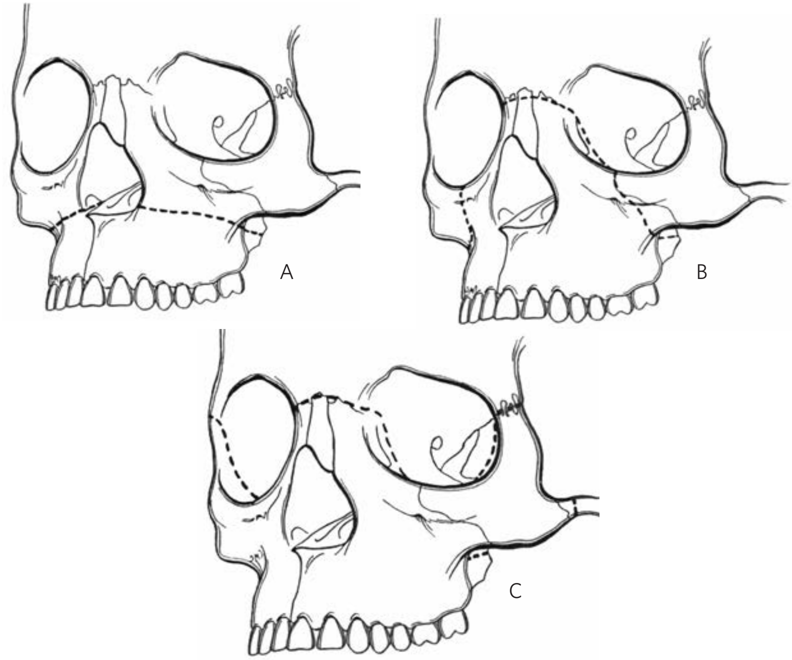
Around the end of the 19th century, René Le Fort, a French military surgeon, created a series of fractures by traumatizing cadaver faces. He noticed several patterns that seemed to occur that tended to separate the tooth-bearing bone from the solid cranium above. These patterns tended to occur at three general anatomic levels that have come to be known as Le Fort I, II, and III fractures (Figure 4.3). While few fractures precisely match the Le Fort definitions, these approximations are extremely useful in communicating the nature of an injury among physicians, and they are also useful in planning treatment planning. Le Fort I, II, and III basically define the level at which the bones holding the teeth are separated from the remaining bone above.

a. Le Fort I

The Le Fort I classification describes a fracture that extends across both maxillae above the dentition. It crosses each inferior maxilla from lateral to medial through the pyriform apertures and across the nasal septum. Posteriorly, it generally severs the pterygoid plates inferiorly. This frees the tooth-holding maxillary alveoli from the remaining facial bones above.

Figure 4.3

Illustration depicting: (A) Le Fort I, (B) Le Fort II, and (C) Le Fort III fractures. *Source: Kellman and Marentette, Figure 8-29.*



b. Le Fort II

The Le Fort II classification starts in the maxilla laterally but extends more superiorly into the orbital floor. It crosses the anterior inferior and medial orbits and crosses the nasal bones superiorly, or separates the nasal bones from the frontal bones at the frontonasal suture. It continues posteriorly across the nasal septum and pterygoid plates. It is commonly called the pyramidal fracture due to the pyramidal shape of the inferior facial fragment.

c. Le Fort III

Finally, the Le Fort III classification completely separates the facial bones from the skull, resulting in what is known as a complete craniofacial separation. It traverses the zygomatic arches laterally and the lateral orbital rims and walls, crosses the orbital floors more posteriorly, crosses the medial orbits (lamina papyracea), and is completed at the frontonasal junction. Posteriorly, like the Le Fort II, it traverses the nasal septum and the pterygoid plates, thus completely separating the facial structure from the skull.

2. Zygomatic Fractures

Zygomatic fractures have sometimes been called "tripod" or "quadrapod" fractures, due to the perceived three or four attachments of the zygoma to the surrounding bones—mainly, the frontal bone at the lateral orbital rim, the temporal bone along the zygomatic arch, and the maxillary bone along its broad attachment. The zygoma's broad lateral expanse near the pterygoid plates leads to the confusing nomenclature, since it can be considered a single attachment (tripod) or double attachment at the inferior orbital rim and zygomaticomaxillary suture (quadrapod). Either way, when these attachments are fractured, the malar eminence is generally displaced posteriorly, laterally, or medially. When the inferior orbital rim rotates medially, it is considered medially displaced; when it rotates laterally, it is considered laterally displaced; and when it is impacted posteriorly, it is considered posteriorly displaced. Obviously, the direction of displacement determines the approach to repair.

3. Orbital Fractures

Orbital fractures are usually described by the status of the walls and rims. A pure blowout fracture occurs when a wall is "blown out" without identifiable fracture of the rim. Floor fractures are both most common and most severe, presumably since there is ample space for significant displacement. Medial fractures are common but are typically less severe. Lateral wall displacement is generally associated with displacement of the zygoma, and roof fractures are uncommon.

D. DIAGNOSIS OF MIDFACIAL TRAUMA

Clinical assessment is always necessary, despite the ready availability of and need for computed tomography (CT) scans. While clinical evaluation will provide an indication of the fractures present, there is also the more important need to assess areas of function. As noted in Chapter 1, the primary and secondary evaluation of the patient, including neurologic function and assessment of the cervical spine, will precede the evaluation of the fractures in preparation for their repair.

1. Assessment of Vision

Assessment of vision is urgent. Though rarely indicated, visual loss due to pressure on the optic nerve may be helped by urgent optic nerve decompression. This is generally performed only when the patient arrived at the hospital with some vision, and the vision has decreased or failed to improve with high-dose steroids. It is also important to assess eye movement for evidence of extraocular muscle entrapment (and/or nerve injury). Most important, before considering surgical intervention around the orbit, an ophthalmological evaluation to rule out ocular and/or retinal injury is mandatory.

2. Assessment of Other Nerves

Other nerves should be assessed, including trigeminal nerve function in all divisions and particularly facial nerve function, since not only documentation but also the possibility of decompression or peripheral repair need to be considered when indicated.

3. Le Fort Fractures

Le Fort fractures are generally evaluated by assessing movement of the tooth-bearing maxillary bones relative to the cranium, making sure that the teeth themselves are not moving separately from the bone. The anterior maxillary arch is held and rocked relative to a second hand on the forehead. If there is movement of the maxillary arch and maxillae relative to the frontal bones, then a Le Fort fracture can be presumed. The level of movement may be difficult to detect, but the CT scan will sort that out.

4. CT Scan

Finally, the CT scan is the key to the diagnosis of midfacial fractures. In general, axial CTs are best for visualizing vertical bone structures, and coronal CTs are best for visualizing horizontal structures, though with modern CT algorithms and high-resolution scanning, both can be easily produced and should be utilized. The three-dimensional (3D) CT is helpful for creating a gestalt for the surgeon, but it is less accurate than the axial and coronal CTs from which it is created.

E. CONSIDERATIONS FOR REPAIR OF MIDFACIAL TRAUMA

Midfacial bones are repaired for two main reasons: to restore normal function and to restore normal facial contour (cosmesis). Before making the decision to proceed with repair, it is important that the patient (and/or family) understands the risks and benefits of the surgery, as well as the risks of not repairing the fractures.

1. Orbital Fractures

The main dysfunction for which orbital repair is performed is diplopia, which is usually due to muscle entrapment of one of the extraocular muscles, though it can occur as a result of significant globe malposition as well. Globe malposition can also cause significant cosmetic deformity.

2. Zygomatic Fractures

Zygomatic fractures may be another cause of globe dysfunction/malposition, because of the contribution of the zygoma to the orbital structure. More commonly, however, a displaced zygoma, particularly a depressed arch, may lead to impingement on the temporalis muscle, causing trismus and/or painful mouth opening and difficulty with mastication. More commonly, however, zygomatic fractures are reduced for cosmetic reasons. It is also common for patients to refuse repair, when the problem is only cosmetic.

3. Maxillary Fractures

Le Fort fractures can affect the position of the dentition and result in significant malocclusion. Because this will interfere with chewing, repair is very important.

F. APPROACHES TO REPAIRING MIDFACIAL TRAUMA

1. Orbital Fractures

A number of different options can be used when approaching orbital fractures, and each has its proponents and detractors. It is important to protect the cornea from trauma when utilizing these approaches. The common approaches to the orbital floor include:

a. Lower Lid Approaches

i. Subciliary Incision

This transcutaneous approach is generally placed 1–2 millimeters (mm) below and parallel to the lash line (Figure 4.4). The incision can be made through skin and muscle, and dissection can be carried out under the muscle to the inferior orbital rim. Alternatively, the incision can be made through skin, carried inferiorly for several mm, whereupon the orbicularis muscle is dissected away from the orbital septum, exposing the inferior orbital rim. Care must be taken to avoid damaging the thin

Figure 4.4

Illustration depicting the subciliary transcutaneous approach. *Source: Kellman and Marentette, Figure 3-45.*

skin. It is also important to avoid injury to the orbital septum, to minimize the risk of ectropion developing as a result of scarring.

ii. Infraorbital Incision

This incision is performed more inferiorly than the subciliary incision, usually at the junction of the lower lid and cheek skin. It is a very direct approach to the bone. However, the scar tends to be more visible, and if the dissection is continued laterally, there is a tendency for prolonged lower lid edema.

iii. Transconjunctival Approaches

Transconjunctival approaches avoid skin incisions. When they were introduced, it was hoped that lid malpositions would no longer be seen. However, although ectropion is less common with this incision, entropions are more common.

iv. Preseptal Incision

After incising the lid conjunctiva anterior to the insertion of the orbital septum, dissection is carried in front of the septum, which is followed to its attachment on the inferior orbital rim (Figure 4.5). Incision of the periosteum on the bone provides access to the orbital floor.

v. Postseptal Incision

The conjunctival incision is placed more posteriorly, closer to the fornix, though still on the lid conjunctiva (not the bulbar conjunctiva). Orbital fat is encountered, since the incision is behind the orbital septum (Figure 4.6). Incision is immediately turned inferiorly to reach the anterior portion of the orbital floor. (If care is not taken to aim inferiorly—and sometimes even a bit anteroinferiorly—then dissection will continue through the orbital fat further posteriorly into the orbit.

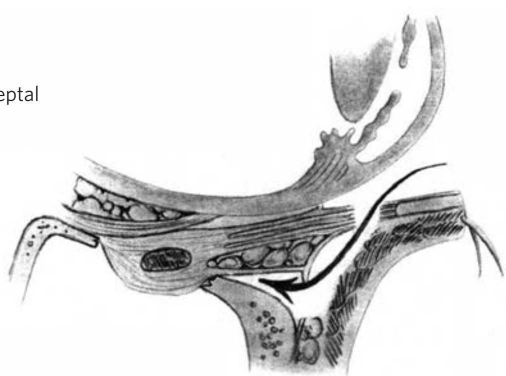


Figure 4.5

Illustration depicting the preseptal approach. *Source: Kellman and Marentette, Figure 3-42.*

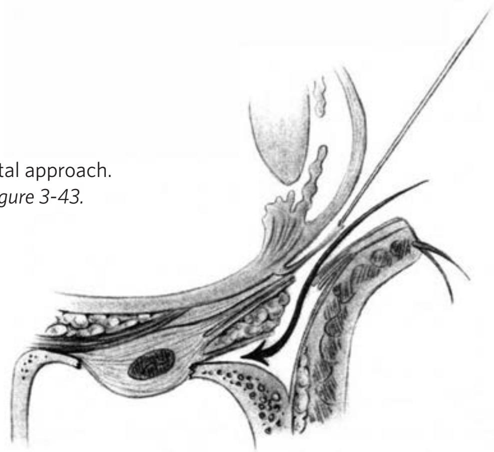


Figure 4.6
Illustration depicting the postseptal approach.
Source: Kellman and Marentette, Figure 3-43.

b. Transmaxillary/Transnasal Approaches
In the past transmaxillary approaches used direct visualization with a headlight. Today these repairs are performed using endoscopic assistance. However, this approach exposes orbital floor fractures from below, so it is not possible to see what is happening on the orbital side of the fracture.

c. Endoscopic Transmaxillary Approach
This approach involves making a window in the anterior wall of the maxillary sinus. Generally, a small plate may be placed and removed prior to making the bone cuts, so that the bony window can be replaced after fracture reduction has been achieved. The orbital floor is then visualized through the maxillary sinus.

d. Endoscopic Transnasal Approach
Access is more difficult with this approach, since visualization is limited by the pyriform aperture and nasal septum. However, the orbital floor can be visualized via a large middle meatal antrostomy.

e. Approaching the Medial Orbital Wall
i. External Incision
A vertical skin incision half way between the nasal dorsum and the medial canthus can be made and taken down through periosteum to bone. Elevation can then proceed posteriorly under the periosteum. Care must be taken to avoid damage to the lacrimal sac and the periosteum (note that the medial canthal ligaments are detached, but will reattach when the periosteum is allowed to reposition itself).

ii. Transconjunctival Incisions

- *Postcaruncular*—This incision is made vertically through the mucosa down to bone. The main problem with this incision is that it begins fairly posteriorly, thereby limiting access to the anterior third of the medial orbital wall.
- *Transcaruncular*—This incision is similar to the postcaruncular, except that it is performed a little more anteriorly.

iii. Endoscopic Transnasal

This approach is performed endoscopically through the ethmoid sinus. Care must be taken when opening the ethmoid bulla, since the orbital contents are in the sinus, and when the bulla is opened, the orbital fat is generally right there.

f. Approaching the Lateral Orbital Wall

i. Infrabrow Incision

Incisions through the brow are not recommended, since scars separate the hair follicles and become quite visible. An incision can be made either above or below the brow; however, for orbital access, incising below the brow is more direct.

ii. Upper Lid Skin Crease Incision

The upper lid crease (upper lid blepharoplasty) incision is preferred, since it hides nicely once it heals (Figure 4.7). The incision goes through the skin and orbicularis muscle, and then extends superiorly to the bone.

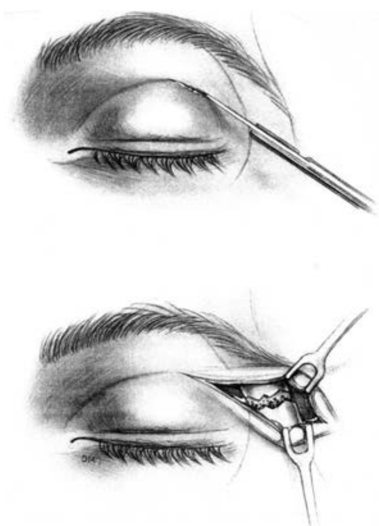


Figure 4.7

Illustration depicting the upper lid blepharoplasty incision. *Source: Kellman and Marentette, Figure 3-49.*

iii. Extended Lower Lid Transconjunctival (with or without Lateral Canthotomy)

The lower lid transconjunctival incision described above can be extended laterally, either (1) within the orbit (posterior to the lateral canthus), though this limits access anteriorly, or (2) preferably, by incising the lateral canthus, separating the upper and lower lid attachments and performing an inferior cantholysis. This can be extended laterally through the skin as needed for exposure of the lateral orbital rim. It is important to reattach the ligament to the lateral orbit inside and behind the rim at the end of the procedure.

iv. Extended Subciliary Incision

As with the transconjunctival incision noted above, the lower lid subciliary incision can be extended laterally as well.

g. Approaching the Orbital Roof

i. Lynch (External Ethmoidectomy) Incision

This incision begins half way between the nasal dorsum and the medial canthus. It then extends superiorly and laterally into the medial superior upper lid, beneath the brow. Periosteal elevation provides access to the medial superior orbit. Note that the trochlea of the superior oblique muscle is elevated with the periosteum, and care must be taken to avoid damage to this structure. Also note that lateral superior exposure can be obtained through the upper lid blepharoplasty incision described above.

II. Transcranial (Generally Coronal) Incision

The coronal incision can be elevated to a level below the superior orbital rims for access to the orbital roofs. Note that care must be used to avoid injury to the supraorbital neurovascular bundles.

2. Zygomatic Fractures

Many displaced zygomatic fractures can be reduced via a transoral approach to the zygomaticomaxillary suture. However, if there is too much displacement or comminution, an orbital exposure allows access to the inferior orbital rim and the lateral internal orbit, where the zygomaticosphenoid suture can be aligned.

- The lateral orbital rim can be exposed through either a brow incision or an upper lid crease incision.
- In the most severely displaced and comminuted fractures, exposure of the zygomatic arch may be necessary. This is generally performed via a coronal or hemicoronal incision.

- Isolated zygomatic arch fractures may be reduced without fixation in many cases. This is typically performed from a distance, using either a temporal (Gillie's) approach or a transoral (Kean) approach.

3. Maxillary Fractures

a. Le Fort Fractures

Most Le Fort fractures will require fixation at the lower maxillary level, to build a proper foundation for the remainder of the fracture stabilization. A sublabial transmucosal exposure provides excellent exposure of the front face of the maxillae bilaterally, allowing repair at the Le Fort I level.

b. Dental Arches

For any fractures involving the dental arches, arch bars are generally applied first to assist with reduction of the occlusion.

c. Nasofrontal Junction

Fractures at the nasofrontal junction are exposed via a coronal incision when necessary. Otherwise, a direct horizontal incision can sometimes be used when only limited exposure is needed for repair.

G. FRACTURE REDUCTION AND REPAIR

For maxillary and zygomatic fractures, the main goal of repair is to reestablish the correct bony architecture by repositioning the bones into their correct anatomical positions and fixating them in those correct positions. Fixation is most commonly performed using rigid fixation devices—typically plates and screws.

1. Zygomatic Fractures

For zygomatic fractures, the rotated fractures need to be corrected by rotation contrary to the rotation created by the injury. If the zygoma was impacted, then reduction requires direct pull counter to the direction of the impaction. This disimpaction technique involves placing a sturdy instrument, such as a Dingman elevator, beneath the malar eminence and applying a firm, but not excessive, distractive force. The instrument can be placed through an incision in the temporalis fascia from above or the mucoperiosteum from below.

Reduction is often monitored along the zygomaticomaxillary buttress intraorally. When the bone is adequate to ensure reduction, fixation along the zygomaticomaxillary buttress using an appropriate plate and screw will often suffice.

However, if there is comminution in this area, not only will reduction be more difficult to determine, but fixation will be more difficult as well. Additional reduction and fixation may be applied along the inferior orbital rim and along the lateral orbital wall at the zygomaticosphenoid junction. (Reduction here is very helpful, though fixation here is less common.)

The frontozygomatic area (lateral orbital rim) provides strong bone for fixation when necessary. If the zygomatic arch needs to be explored and repaired (which is less common, typically occurs only in severely displaced and comminuted fractures), fixation should be performed using either wires or the thinnest plates available, since plates in this area can be visible and can alter the facial width.

2. Maxillary and Extended Maxillary Fractures

a. Recreation of Correct Occlusion

Le Fort (maxillary and extended maxillary) fractures are repaired by first ensuring recreation of the most correct occlusion possible. When dentition is adequate, arch bars are the best means of ensuring correct occlusion, particularly in severe fractures.

b. Associated Mandibular Fractures

When mandibular fractures are associated with midfacial fractures, it is often necessary to first repair the mandible to provide a template for the maxillary dentition, particularly when the palate is split.

c. Fixation of Maxillary Fractures

If proper occlusion has been reestablished, the maxillary fractures can be fixed, so as to ensure that the proper occlusal relationship is maintained. This is in fact more critical than achieving an ideal visual appearance of “perfect” bony reduction along the fracture lines.

d. Le Fort Fractures

If a complex Le Fort III (i.e., craniofacial separation along with zygomatic and lower maxillary fractures) is repaired from the top down, fixation of the zygomas to the skull will change these complex fractures from a Le Fort III to a Le Fort I fracture, and repair of the nasofrontal junction and inferior orbital rims will convert the remainder to Le Fort I fractures.

Le Fort I fractures must be repaired along the strong medial and lateral vertical buttresses, as described earlier in section B.1 of this chapter. These areas provide the strong bone that will support both the screws and the forces of mastication that will be transmitted through these areas during function.

3. Blowout Fractures of the Orbits

Blowout fractures of the orbits present a somewhat different paradigm, in that the goal is directed less at fracture reduction (with the exception of the zygomatic component of an orbital fracture) and more at recreating the damaged orbital wall that is affected by the fracture. Therefore, repair generally includes reduction of any herniated orbital contents, followed by placement of some supporting material to hold the contents in place and restore the normal orbital wall contour. The material selected will depend on the surgeon's preference, and includes autograft bone and cartilage, as well as allograft and homograft materials.

H. COMPLICATIONS

1. Inadequate Reduction

The most common complication is less than adequate reduction. When this occurs in the maxilla, it will often result in a malocclusion. Failure to properly reduce the zygoma can result in significant alterations of facial and orbital shape, with both cosmetic deformity and globe malpositions likely.

2. Imprecise Reconstruction of the Orbit

Imprecise reconstruction of the orbit will generally result in a globe malposition—most commonly enophthalmos, though exophthalmos and hyperophthalmos occur frequently as well.

3. Globe Malposition

Diplopia can be the result of a globe malposition. However, diplopia is more likely due to residual entrapment of an extraocular muscle or a traumatic injury to an extraocular muscle or the nerve to one of these muscles (which would not be corrected by the surgery to reduce the fractures).

One of the ways to minimize the risk of a malreduction leading to a globe malposition postoperatively would be to perform an intraoperative CT scan, if available. Alternatively, the patient's head can be elevated 30 degrees on the operating table to assess the level of the pupils on both eyes. To identify diplopia due to inadequate release of entrapped tissue, intraoperative forced duction testing can be performed.

4. Eyelid Malpositions

Eyelid malpositions result from eyelid incisions used to repair orbital and facial fractures. This complication can be minimized by meticulous dissection of the lids, taking care particularly to avoid injury to the orbital septum.

5. Reduced Vision and Blindness

The most feared complication of orbital injuries and their repair is reduced vision and blindness. Fortunately, this is very rare. Nevertheless, as noted above, an ophthalmological evaluation should be performed prior to manipulating the orbital bones after trauma, to ensure no injury is present that would increase the risk of a feared ocular complication.

6. Scars and Hair Loss

Because less than ideal healing of any wound is possible, patients should be warned about scars and hair loss. Irregularization of coronal incisions can minimize scar visibility in patients who have low risk of male pattern baldness.

7. Nonunion

Nonunion appears to be quite rare with midfacial fractures, and is not usually discussed. The bones of the midface tend to heal, even when they have not been repaired. This is probably due to the minimal forces that are exerted on these bones during function. Implants can become colonized with bacteria and become a source of chronic, recurrent infection. When this occurs, they should be removed. Occasionally, bone resorption may be seen under or around an implant. Also, implants may extrude; this is most common with orbital implants, so patients should be warned of this possibility when nonautologous implants are used.

8. Dental Injury

Dental injury is always possible when working with fractures that are near the dentition. Great care should be exercised when placing screws to try to avoid injury to tooth roots. Arch bars can also cause loosening of teeth and gingival injury.

9. Cerebrospinal Fluid Leaks

Finally, CSF leaks may be the result of the initial trauma and/or the repair. CSF leaks should be addressed surgically, to ensure a safe separation between the sterile intracranial cavity and the naturally contaminated nasal and sinus cavities.

II. Nasal Bone Fractures

A. INTRODUCTION

Nasal fractures are a commonly encountered, and often isolated, form of facial fractures. The prominence of the nose on the face makes it the common recipient of injury. Despite the frequency in which nasal fractures are encountered, the consulting surgeon may be confused regarding which approach is best applied to a given patient. Choices range from no treatment at all, to extensive and comprehensive techniques applied in the operating room involving maneuvers used in septorhinoplasty. The timing of treatment may be just as confusing, as patients and referring physicians often expect for the consulting otolaryngologist to "set" the presumed broken nose immediately, when the actual extent of fractures and even deformity present may not be fully evident upon presentation. The following outline presents a guideline that resident physicians in otolaryngology–head and neck surgery may use to make sound decisions and to build practice patterns that can be refined with experience.

B. REVIEW OF ANATOMY

1. Bony: Paired Nasal Bones (Figure 4.8)

- Maxillafrontal processes laterally.
- Premaxilla inferiorly.
- Maxillary crest internally.
- Ethmoid-perpendicular plate.
- Lamina papyracea.
- Paired lacrimal bones.
- Nasal process of frontal bone.

2. Cartilaginous (Figure 4.8)

- Quadrangular (septal) cartilage.
- Paired upper lateral cartilages, contiguous with septal cartilage dorsally.
- Paired lower lateral (alar) cartilages, with medial and lateral crura ("legs").
- Sesamoid accessory cartilages (variable).

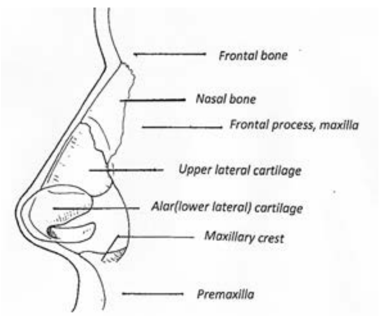


Figure 4.8

Nasal bony and cartilaginous anatomy.

3. Neurovascular (Figure 4.9)

- Lateral nasal and septal arteries, from facial artery (external carotid).
- Dorsal nasal artery, from ophthalmic artery (internal carotid).
- Sensory innervation from trigeminal nerve:
  - Root and dorsum from ophthalmic (V1).
  - Sidewall, mostly from maxillary (V2).

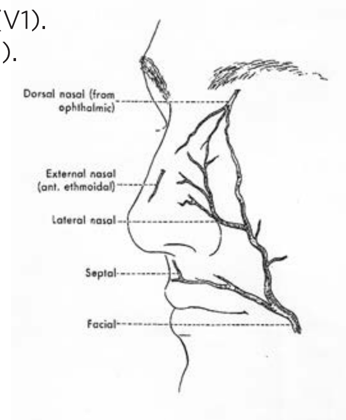


Figure 4.9
Nasal vascular anatomy.

4. Conformational

- Pyriform ("pear-shaped") aperture:
  - Bordered by nasal bones, maxilla.
- Soft tissue envelope.
- Skin externally (abundantly sebaceous) and internally, vestibule (hair-bearing "vibrissae").
- Mucous membrane lining internal to vestibule (border is *limen vestibuli*).
- Fibrofatty tissue works with cartilages and bone to maintain conformational integrity.
  - Upper vault, mostly bony, is rigid.
  - Lower vault, mostly cartilaginous, fibrofatty, is flexible, performs valve function.
  - Paired nostrils (nares) with intervening columella containing medial crura of lower lateral cartilages.

5. Orientational Terminology (Figure 4.10)

- Dorsal: toward "bridge."
- Cephalic: toward top of head.
- Caudal: toward mouth.

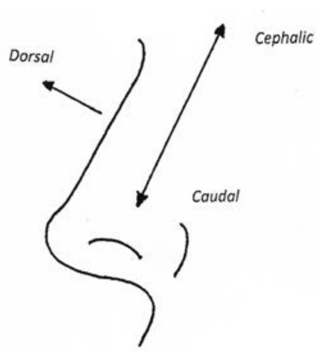


Figure 4.10
Nasal orientational terminology.

C. EVALUATION AND DIAGNOSIS

1. History of Trauma

- Usually blunt.
- Motor vehicle accident.
- Altercation.
- Sports (especially, but not always, contact).
- Falls (especially in elderly, debilitated).
- Injuring blow, usually delivered from one side or from front, occasionally from below, rarely from above.

2. Nasal Deformity, Causally Related to Occasion of Trauma

- Establish presence of deformity.
- Comparison with preinjury photos (e.g., driver's license).
- Delay definitive examination for 10–12 days, allowing swelling/bruising to decrease.

3. Simple Lateral Deviation (Figure 4.11)

- Of bony vault.
- Of cartilaginous vault.
- Of both.

4. Complex Deviation ("Twisted Nose") (Figure 4.12)

Figure 4.11
Simple lateral deviation.

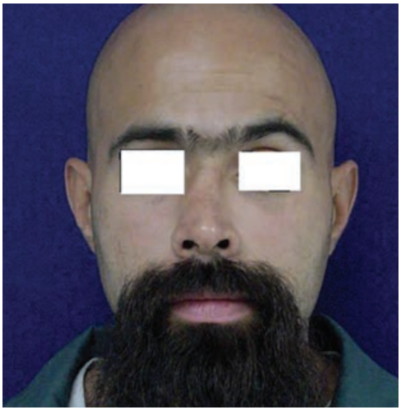


Figure 4.12
Complex deviation ("twisted nose").

5. Splaying/Widening of Nose (Figure 4.13)

6. Widening of Nasal Root, or Telecanthus

- May suggest orbital/ethmoid fracture, especially when acute swelling has subsided.

7. Nasal Function Alteration, Causally Related to Occasion of Trauma

- New, fixed nasal obstruction.
- Often, but not always, unilaterally.
- New olfactory deficit (anosmia).

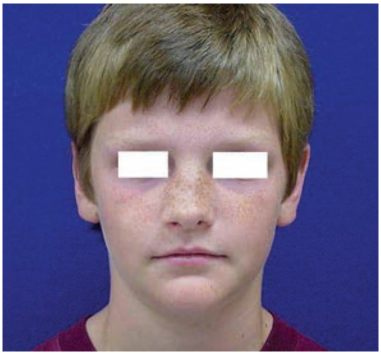


Figure 4.13
Splaying/widening of the nose.

8. Examination

- Attend to associated injuries, as applicable (e.g., cervical, cranial, facial).
- Examine eyes/orbits (pupils, globes, extraocular motion, visual acuity).
- Narrow consideration to nose when other injuries are identified or excluded.
- Preferably, conduct examination in the otolaryngology clinic with availability of good lighting and nasal examination instruments.
- Establish nature of external deformity, as above.
- Palpate for bony stepoffs, displacements, discontinuities.
- Palpate for mobility of fractured segments, comminution.
- Identify/characterize nasal soft tissue (skin) lacerations/avulsions.
- Apply anterior rhinoscopy, with added nasal endoscopy as required, to identify presence of:
  - Septal deformities, both cartilaginous and bony, especially stepoffs/telescoping deformities.
  - Septal haematoma.
  - Septal perforations.
  - Nasal lining lacerations.
  - Bleeding points, if continued acute bleeding is present.
  - Overall nasal airway patency.

9. Radiographic Studies, Including CT

- If referred from the emergency room or a minor emergency clinic, patient may arrive with studies in hand.

- Do not add to diagnosis/treatment, and need not be obtained, unless associated facial fractures are suspected.

10. Photography

- Take full 6-view series with standard composition, lighting, technique, and background: front, both laterals, both obliques, base.
- Take photos prior to any manipulation or surgical intervention, usually at the time the decision is made to intervene, if not when initially consulted.

D. MANAGEMENT

The central consideration in the management of nasal fractures is whether to offer closed reduction or open reduction (or no intervention at all). When and in what setting the decided-upon treatment should be rendered is an additional, but closely related, consideration. These decisions are based upon the findings at examination, and the desires of the patient. The surgical treatment of even obvious, severe deformity and high-grade nasal obstruction is, after all, elective, and may be undertaken, delayed, or refused by patient choice.

The decision of closed versus open reduction has been the subject of discussion and controversy in the otolaryngologic literature, and outcomes have been shown to be similar with regard to appearance, function, and patient satisfaction, when the treatment approach is well matched to the specific characteristics of the injury. Therefore, both treatment options will be presented with the setting in which they are best employed, according to this author's opinion and experience.

1. Closed Reduction

- Characterized by manipulation of fractured bones (and often cartilages), either with the fingers or with blunt instruments, without making incisions.
- Fast, safe, direct, minimally invasive.
- Good choice for simple deformities involving, in the main, just the nasal bones.
- Likelihood of successful reduction is greatest when not only deformity, but also mobility of fractured segments, can be demonstrated at examination.
- May be carried out under local anesthesia in the consulting rooms if a competent, well-informed, and properly motivated patient desires this direct, time- and money-saving intervention. With other patients, general anesthesia in the operating room may be best.
- May be employed as an initial, trial maneuver at operation when open reduction has been decided upon.

- Closed reduction of a fractured septum may also be attempted, but complex septal deformities may require open, operative treatment.
- Often the best choice for pediatric nasal fractures, but usually requires general anesthesia in the operating room.
- Often sufficient for comminuted nasal fractures.
- Should be undertaken as soon after accurate assessment is available, optimally within 3 weeks of injury.
- Securely tape and splint postreduction—no other fixation is employed.

2. Open Reduction (Figure 4.14)

- Characterized by operative manipulation of nasal fractures, with open access to fractured segments through incisions, usually intranasal.
- Requires general or local and monitored sedation anesthesia in the operating room.
- Ordinarily, fractured bony segments are made fully mobile by means of aggressive manipulation or osteotomies.
- More complex septal deformities, including perpendicular plate fractures, may be addressed and reconstructed simultaneously through a septoplasty approach.
- Good choice with complex, immobile, post-traumatic nasal deformities.
- Good choice for late treatment of post-traumatic deformities, where bony union has begun or progressed.
- Dorsal irregularities may be addressed with rasp or osteotome.
- Upper lateral cartilages may be released from the septum if the middle vault is deviated or twisted.
- Open rhinoplasty approach may be selected to address deformities of alae and tip.

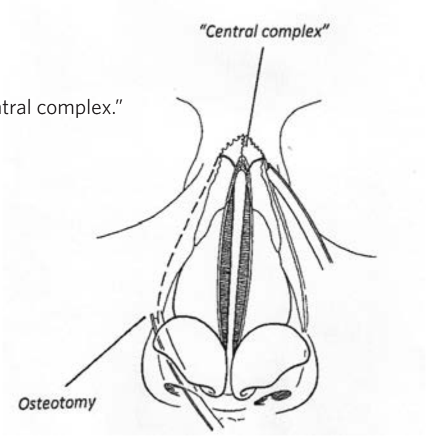


Figure 4.14
Osteotomies and "central complex."

- Since full operative mobilization of fractured segments will be carried out, procedure may be delayed. Treatment within 2 months of injury is advised, so mobilization may be done prior to full bony union.
- Securely tape and splint postreduction—no other fixation is employed.

E. GENERAL CONSIDERATIONS

1. Internal Fixation

In most cases of treatment of isolated nasal fractures, internal fixation is not employed.

2. Nasal Packing

Nasal packing is neither necessary nor desired in most cases. However, it may be judiciously employed under depressed fractures or concave deformities that cannot otherwise be maintained in reduction. Traditional nasal packing with ½-inch x 6-foot petrolatum gauze may be used, or a single cotton dental roll placed in a supportive position with an attached retrieval suture may work as well.

3. Lacerations of the Nasal Skin

Carefully close lacerations of the nasal skin as soon as possible. Lacerations may be reopened and used as access incisions.

4. Septal Hematomas

Septal hematomas, when identified, should be incised and drained. Clots may require direct irrigation and suctioning. Septal mucosa elevated by the haematoma may be reapproximated with an absorbable trans-septal quilting suture.

5. Lacerations of the Nasal Lining

If accessible, close lacerations of the nasal lining closed with absorbable sutures. Inaccessible lacerations that approach the full circumference of the nasal cavity may require stenting or packing to avoid nasal stenosis, but may otherwise require no closure.

6. Perioperative Antibiotics

Perioperative antibiotics are generally not necessary even in open fractures. However, postoperative broad-spectrum antibiotics, such as a first-generation cephalosporin, are indicated if nasal packing or internal splints are used, until they are removed.

7. Splints

Splints may be removed in a week. Retaping and resplinting may be considered.

8. Rest, Elevation, Ice, and Anodynes

Rest, head elevation, local ice application, and anodynes are indicated for the first 48–72 hours postreduction.

9. Postreduction Photos

Immediate postreduction photos are useful. Full 6-view photography is done at 6 weeks and at 6 and 12 months. Follow-up at 6 and 12 months is highly desirable.

F. COMPLICATIONS

The most important and frequently seen complication of treatment of nasal fractures is failure to achieve effective reduction and the desired improvement of the deformity and/or nasal obstruction, with subsequent need for revision. This outcome may be kept to a minimum by proper selection and timely application of a well-executed reduction technique, but cannot be altogether avoided. Care should be taken to clearly inform the patient *preoperatively* of this possibility. The postoperative appearance of this result may range from minimal residual irregularity, through no apparent improvement, to significantly worsened deformity.

Healing should be allowed to proceed for 6–12 months before being judged to be unsatisfactory. Often, the early appearance of irregularity or asymmetry will resolve as swelling subsides. That said, sometimes it may become apparent that reduction has failed, and significant external deformity or anatomic airway obstruction persists. In this case, reoperation may be undertaken at any time. Early reoperation *may* be associated with more mobile fractured segments, but full remobilization (open reduction) with osteotomies or cartilage incision or excision will likely be needed. Reoperation under these circumstances, therefore, may be scheduled according to patient and surgeon preferences.

Other infrequently seen complications include:

- Epistaxis.
- Septal perforation.
- Synechiae formation.
- Nasal obstruction.
- CSF rhinorrhea.
- Nonunion of fractures.
- Wound infection.
- Nasal skin sensory disturbances (numbness).
- Injury to sinuses and their outflow tracts (frontal, maxillary, ethmoid).
- Unfavorable scar formation of lacerations or surgical scars.

G. SUMMARY

The aim of the treatment of nasal fractures is to provide the patient afflicted with this injury the best aesthetic and functional result with a single procedure, if one is indicated. Careful examination under optimal circumstances sets the stage for precise selection of the best treatment, even though a daunting and often controversial array of options exists.

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