

The Management of Frontal Sinus Fractures

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Core Messages

- Frontal sinus fractures may be divided into those involving the anterior table and posterior table, with and without nasofrontal outflow tract involvement.
- Options for surgical management of frontal sinus fractures include reduction and fixation of anterior table fragments, frontal sinus obliteration and frontal sinus cranialization.
- With good technique, early and late complications can be kept to a minimum.

Introduction

Frontal sinus fractures offer significant challenges to surgeons and the treatment paradigm has been debated for many years. Acute concerns include protection of intracranial structures, identification of associated injuries and control of cerebrospinal fluid (CSF) leakage. The aesthetic forehead contour is an important consideration in repair. Past surgical modalities that removed the anterior bony frontal surface left life-long disfiguring defects and have been largely replaced by techniques that leave a smooth contour without visible scars. Concerns about aesthetic deformity, however, must yield to practices that will provide a “safe” sinus resistant to late complications. Long-term issues revolve around surveillance and management of late complications that can occur decades after the inciting injury. Traditional treatment paradigms were conceived before the advent of modern endoscopic and advanced imaging techniques, and focus on open techniques for fracture reduction and sinus management. Newer modified algorithms incorporate these technologic advancements with improved functional and cosmetic results.

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Anatomy

The frontal sinus is formed by pneumatization of anterior ethmoid air cells into the frontal bone during the fourth fetal month. The sinus begins its predominant phase of expansion from 5 years of age until adolescence, and is usually characterized by two asymmetric sinuses separated by a thin, bony septal plate. The frontal sinus often demonstrates variable pneumatization, with 4–15% of people showing developmental failure of one of the sinuses. The frontal sinus is in close proximity to several intracranial structures. The posterior wall forms the anterior wall of the cranial vault, and the floor of the frontal sinus contributes to the anterior superior roof of the orbit. The skull base abutting the posterior aspect of the frontal sinus is the cribriform plate. The nasofrontal outflow

tract is an hour-glass-shaped structure that drains secretions from the frontal sinus mucosa into the frontal recess. The frontal recess is bounded by the agger nasi anteriorly, the middle turbinate medially, the skull base posterosuperiorly, the ethmoid bulla posteroinferiorly, and the lamina papyracea laterally. The agger nasi cells are important landmarks for identifying this drainage tract. These cells are anterior ethmoid cells at the anterior aspect of the middle meatus that form the floor of the frontal sinus. To functionally enlarge the natural frontal sinus ostium, the surgeon must remove the posteromedial and superior walls of the agger nasi cell [6].

Tips and Pearls

- The frontal sinus fails to develop in 4–15% of people.
- The frontal sinus is in close proximity to several intracranial structures.
- The frontal sinus drains into the nasofrontal outflow tract, which is bounded by the agger nasi anteriorly, an important surgical landmark.

Epidemiology

Frontal sinus fractures are rare and occur in only 5–12% of maxillofacial traumas [16, 27, 28]. A study conducted at four separate level 1 trauma centers including 892 patients demonstrated that in patients with frontal sinus fractures the median age is 32 years and 88% are male [26]. Approximately 58% of frontal sinus fractures are associated with other facial trauma, including nasoorbital ethmoid fractures (34%), zygomaticomaxillary complex fractures (17%) and orbital wall fractures (27.5%) [12–14]. Forty-three percent of all frontal sinus fractures are isolated anterior table fractures, 7% are isolated posterior table fractures and 49% are combined anterior and posterior table fractures. Motor vehicle accidents account for most fractures (62%), with assaults (12%) and falls (11%) also having a fairly high incidence.

The extent of sinus pneumatization, direction of impact, and collision force influence the degree of injury. Nahum [33] reported the force required to fracture the frontal sinus to be 800–1600 lb, which is significantly higher than that of any other area of the skull. The forces required to produce frontal sinus fractures will often cause multiple craniofacial injuries. Posterior table fractures indicate severe injury and result in pneumocephalus in 25% of patients, CSF leak in 25% and extradural hematoma in 10% [14]. In addition, up to 59% of patients with frontal sinus trauma may present with concomitant orbital trauma [22, 35].

Diagnosis

The hallmark of frontal sinus fracture is frontal depression, often accompanied by forehead lacerations. A neurosurgical consultation is necessary if there is any concern for intracranial injury or suspicion of CSF leak [1]. Fractures involving the supraorbital foramen will result in hypoesthesia in the V₁ distribution. Often periorbital ecchymosis and edema is present. Abnormal vision or extraocular movement restriction warrants an ophthalmologic evaluation.

Although plain films have been used in the past to diagnose fractures of the frontal sinus, high-resolution thin-cut computed tomography (CT) is essential to the diagnosis and treatment of frontal sinus injuries in the modern era (Fig. 15.1) [27]. In addition to the standard axial and coronal images, sagittal reconstructions of the paranasal sinuses can enhance visualization of the nasofrontal outflow tract [20]. Although sagittal reformats can assist in further characterization of the drainage pathway (Fig. 15.2), their prognostic accuracy for eventual normal ventilation of the frontal sinus in the trauma setting is unknown. Certain findings on CT, such as nasoorbital ethmoid complex fractures and anterior skull base injury near the junction of the posterior table and the cribriform plate strongly suggest injury to the nasofrontal outflow [17].

Tips and Pearls

- High-resolution thin-cut CT is essential to the diagnosis of frontal sinus injuries.
- Sagittal reconstructions of the paranasal sinuses enhance visualization of the nasofrontal outflow tract.

Current Management Techniques

The main goals in the treatment of frontal sinus fractures are (1) protection of intracranial structures and control of CSF leakage, (2) prevention of late complications and (3) correction of aesthetic deformity. Frontal sinus fractures can be classified into fractures of the anterior table or the posterior table with or without associated nasofrontal outflow tract injury:

1. Anterior table fracture
 - (a) With or without displacement
 - (b) With or without outflow tract injury
2. Posterior table fracture
 - (a) With or without displacement
 - (b) With or without dural injury/CSF leak
 - (c) With or without outflow tract injury

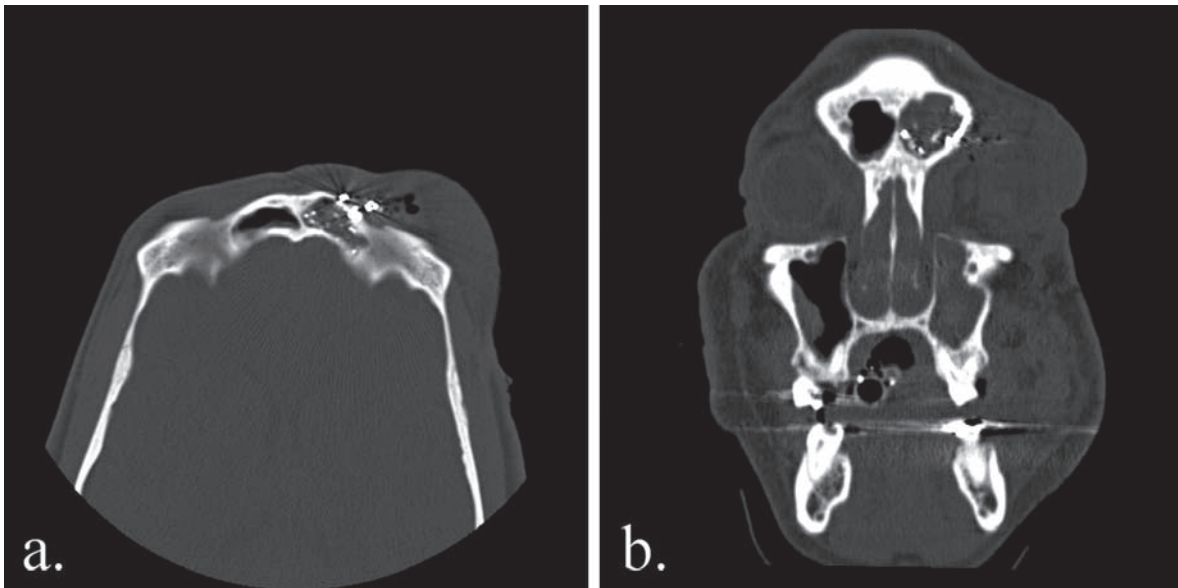
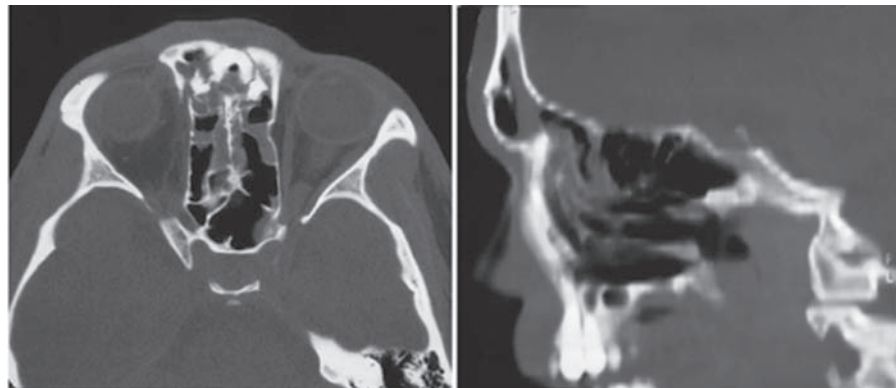


Fig. 15.1. Axial (a) and coronal (b) computed tomography (CT) images demonstrating opacification and metallic foreign

bodies in the left frontal sinus in a patient who sustained a gunshot wound to the frontal sinus

Fig. 15.2. Although not apparent in the axial view, the sagittal reformatted view demonstrates apparent anatomic patency of the frontal outflow tract despite blood and soft-tissue edema



Displacement is defined as greater than one table width. Posterior table fractures commonly occur in combination with anterior table fractures, and are frequently associated with dural or intracranial injury. Management of CSF leaks and dural tears will often dictate acute treatment. Surgical intervention of this high-risk region must provide a “safe” sinus that will resist future infectious complications.

Anterior Table Fractures

Low-energy frontal sinus trauma results in isolated, nondisplaced anterior table fractures. The treatment options can be summarized as follows:

1. Nondisplaced or minimally displaced: no treatment necessary

2. Displaced: open reduction and internal fixation for cosmesis
3. Involvement of the nasofrontal outflow tract
 - (a) Open reduction and internal fixation of anterior table and osteoplastic flap with obliteration
 - (b) Outflow tract reconstruction (not highly recommended)
 - (c) Observation and medical management with future endoscopic ventilation if necessary

The risk of mucosal entrapment and mucocele formation in this type of fracture is low and the aesthetic deformity is generally minimal. Surgical intervention is therefore often avoidable. However, depressed fractures of the anterior table must be reduced and fixed. Care should be taken to prevent entrapment of the mucosa within the fracture line. Access to the de-

pressed bony fragments can often be gained using an overlying laceration. Alternatively, brow or coronal incisions provide adequate exposure and are well camouflaged by the eyebrows and hair. The use of titanium miniplates in frontal sinus fracture fixation is a durable method of repair and has a very low complication rate [18]. Titanium is a high strength, corrosion-resistant material with low tissue reactivity that produces minimal artifacts on MRI and CT scanning [21, 44]. Recently, research has been directed at increasing the biointegration of titanium alloys using chemical and heat treatments [42]. A bony precipitate strongly adheres to the heat-treated titanium substrate and promotes living bone bonding.

Patients with isolated and minimally displaced anterior table fractures may be addressed endoscopically using a brow lift incision and subperiosteal dissection [43]. To assist with fracture reduction and plate fixation, additional small stab incisions are made in the brow and along forehead mimetic lines [34]. If exposure is suboptimal, the endoscopic approach can be converted to a traditional coronal incision. A study of endoscopic-assisted reduction of both simple and comminuted anterior table fractures found no complications at up to 28 months follow-up [3].

Repair of the comminuted anterior table requires additional fixation to restore the original contour. Titanium mesh is used to reapproximate and secure bone fragments. Infection rates with mesh implants are low [21]. Large defects can be reconstructed using split calvarial grafts taken from the parietal calvarium. If bone fragments within the sinus are of moderate size but contaminated, they are cleansed and soaked in povidone-iodine solution before further use [8, 32]; however, in the setting of extensive fragmentation with gross contamination or infection, a better option may be to obliterate the sinus.

Tips and Pearls

- Frontal sinus fractures depressed more than one table width must be reduced.
- Titanium miniplates are durable and are associated with a very low complication rate.
- Comminuted anterior table repair requires titanium mesh to reapproximate bone fragments.

Posterior Table Fractures

Fractures of the posterior table commonly occur in conjunction with anterior table fractures and require a separate treatment algorithm. The treatment options can be summarized as follows:

- Nondisplaced without CSF leak: observation
- Nondisplaced with CSF leak: conservative management of CSF leak with progression to sinus exploration if no resolution in 4–7 days
- Displaced (more than one table width): Sinus exploration, repair of dura, obliteration or cranialization depending on involvement of the posterior table
- Involvement of the nasofrontal outflow tract: obliteration or cranialization

Most surgeons advocate observation in those patients with uncomplicated (without nasofrontal outflow tract involvement, CSF leak or dural exposure), nondisplaced posterior table fractures [11]; however, nondisplaced posterior table fractures that result in significant CSF leakage require immediate repair. In addition, surgery is recommended for all displaced posterior table fractures (defined as displacement greater than one posterior table width) because the risk of dural injury is unacceptably high. Though direct dural repair may be considered in experienced hands, the majority of these sinuses should be cranialized.

Cranialization involves removal of the posterior table to create a common intracranial and frontal sinus cavity. Typically a coronal incision is used and a bifrontal craniotomy is made to obtain wide exposure of the area. The frontal lobe is gently retracted to isolate the posterior table. The posterior wall of the frontal sinus is resected and the mucosa lining the anterior wall is meticulously removed with a high-speed diamond burr to prevent mucocele formation. To separate the cranium from the nasal cavity, the nasofrontal outflow tracts are plugged using autogenous material such as fat, bone or muscle plugs. In patients with extensive comminution or cribriform injury, a pericranial flap can be used to augment the skull base and dural repair. Large concomitant defects of the anterior skull base and cribriform area may necessitate reconstruction with calvarial bone graft or titanium mesh in conjunction with an overlying pericranial flap. Anterior or posterior ethmoidectomies to remove traumatized cell partitions may be necessary to ensure sinonasal drainage to prevent cephalad infection.

Tips and Pearls

- Nondisplaced posterior table fractures may be observed, but in those with CSF leaks or displacement more than one posterior table width, cranialization should be strongly considered.
- Cranialization involves removal of the posterior table to create a common intracranial and frontal sinus cavity.

- A pericranial flap can be used to augment the skull base and dural repair.

Nasofrontal Outflow Tract Fractures

For decades controversy has surrounded management of fractures that involve the nasofrontal outflow tract. Unrecognized injury to the outflow tract can occur in one third or more frontal sinus fractures and commonly results in long-term sequelae [8, 27]. Treatment options include reconstruction of the drainage system, obliteration of the sinus or observation with medical management.

Prolonged stenting of the outflow tract has been advocated by Luce [24], but is associated with stenosis and is considered by many to have an unacceptable failure rate (30%) [39]. Alternatively, the Sewall-Boyd reconstruction may be attempted, which involves enlarging the nasofrontal outflow tract and relining the tract with a septal mucoperiosteal flap.

Most authors recommend obliteration of the sinus when injury to the nasofrontal outflow tract is suspected [14, 22, 27, 33, 35, 38] because this has traditionally been considered the safer long-term option [46]. Although most nasofrontal outflow tract reconstruction attempts have historically been plagued by stenosis, new endoscopic techniques may allow delayed nasofrontal outflow tract recanalization (endoscopic frontal sinusotomy) after a trial of medical management in highly selected patients (see “Endoscopic Management”) [40].

Tips and Pearls

- Unrecognized injury to the outflow tract can occur in one third of frontal sinus fractures and results in long-term sequelae.

Endoscopic Management

Advances in endoscopic equipment and modern imaging over the last two decades have allowed for an endoscopic treatment alternative to sinus ablation. Anterior table fractures involving the nasofrontal outflow tract have traditionally been treated by sinus obliteration. Historically, attempts at outflow tract reconstruction have been disappointing secondary to stenosis and subsequent sinus obstruction [39]. Recent endoscopic developments, however, may allow for delayed nasofrontal outflow tract recanalization through endoscopic frontal sinusotomy. A cohort of reliable and responsible patients may be offered surgery to restore the anterior table with expectant man-

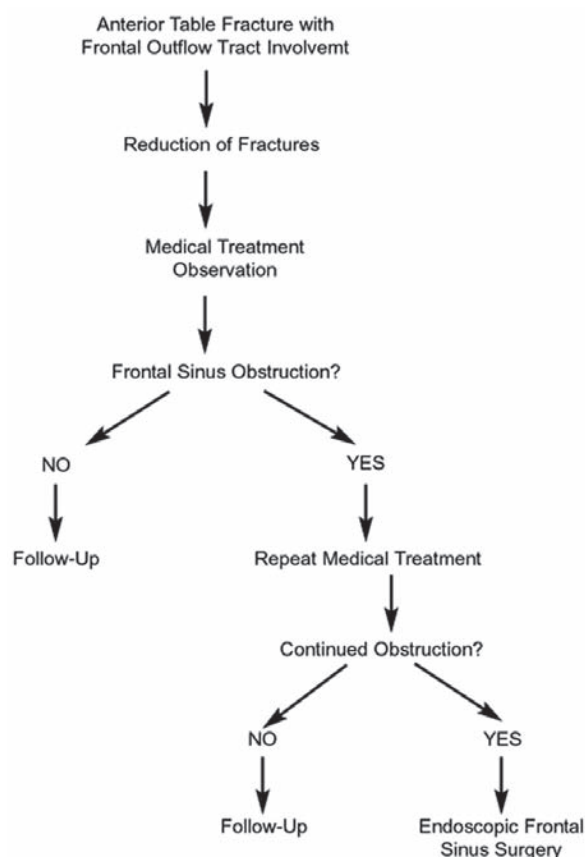


Fig. 15.3. Modified treatment algorithm for highly selected patients

agement of the outflow tract (Fig. 15.3). In these select, responsible patients, a trial of medical management may be undertaken. It should be emphasized that only patients who will dependably return for follow up appointments and periodic CT scans should be considered for conservative management, as delay in the recognition of complications may result in life-threatening consequences. These patients are treated with a prolonged course of broad-spectrum antibiotics (4 weeks) and oral steroids if there are no medical contraindications. Serial sinus CT scans at 1, 2, 4 and 6 months, and yearly thereafter are used to assess the frontal sinus for ventilation and restoration of mucociliary clearance [40]. Individuals failing two courses of antibiotics or those who suffer an infectious complication are considered for an extended endoscopic frontal sinusotomy procedure, including either the extended endoscopic frontal sinusotomy (Draf type II) or the endoscopic modified Lothrop procedure (Draf type III or frontal sinus drill-out) [10]. Often these individuals require computer-assisted image guidance for the surgeon to safely proceed with surgery. If the frontal sinus should fail after endoscopic frontal sinusotomy, or if the patient wishes to fore-

go endoscopic treatments, the time-honored ablative procedures may be undertaken.

In 2002, Smith et al. [40] reported a series of seven patients with displaced anterior table fractures and potential nasofrontal outflow tract injury by multiplanar CT scanning. Five of the seven patients experienced spontaneous sinus ventilation with conservative treatment. The two patients that did not ventilate had concomitant nasoorbital ethmoid fractures and were successfully treated with endoscopic frontal sinus surgery with 2 years follow-up. Chandra et al. [2] confirmed these findings in patients who presented with complications several years after conservative management of frontal sinus fractures. These complications included mucocèles in nine patients, chronic sinusitis in three patients and osteomyelitis in one patient. All patients underwent endoscopic frontal sinusotomy with image guidance and had no evidence of disease up to 3 years postoperatively. In experienced hands, the combination of medical therapy and endoscopic sinusotomy appears to be a safe and effective alternative to traditional ablative procedures.

Tips and Pearls

- Recent endoscopic developments allow for delayed nasofrontal outflow tract recanalization through endoscopic frontal sinusotomy.
- Reliable patients with outflow tract injuries may be managed expectantly.
- Responsible patients with nasofrontal outflow tract injury are treated with a prolonged course of antibiotics and oral steroids.
- Serial sinus CT scans are used to assess the frontal sinus for ventilation.
- If the frontal sinus fails to ventilate or if the patient wishes to forego endoscopic treatments, the time-honored procedures may be undertaken.

Frontal Sinus Obliteration

The most common method of frontal sinus obliteration today is the osteoplastic flap procedure. This method exposes the interior of the frontal sinus by elevating a flap of the anterior table hinged inferiorly on pericranium (osteoplastic flap) [15]. The mucosa of the frontal sinus is removed with a burr, and the duct is plugged with one of several different materials and sealed with fibrin glue. The ducts may be obliterated with autogenous bone graft, temporalis muscle plugs [15, 24] or pericranial or galeal flaps [25]. Complications of remucosalization and mucocèle formation are reduced when the nasofrontal duct mucosa is inverted into the nasal cavity [50]. The demucosalized sinus space is then obliterated with a choice of sever-

al materials to promote osteoneogenesis (see discussion below) [45] and the osteoplastic flap is then reduced and fixated.

A great deal has been written about the ideal frontal sinus obliteration material. Samoilenko discovered that the frontal sinus cavity becomes filled with serous fluid and is later replaced by osseofibrous ingrowth, a process termed osteoneogenesis. It is now commonplace to fill the denuded frontal space in order to provide a matrix that encourages osteoneogenesis. Numerous autogenous graft materials, including fat, pericranial fascia, muscle, cancellous bone and lyophilized cartilage, have been successfully used [36, 37]. Abdominal fat graft is the most commonly used material because it is autogenous, easily obtainable at the time of surgery and efficacious with a low complication rate [15]. Studies using MRI to follow patients treated with osteoplastic flap sinus obliteration using adipose revealed a mucocèle recurrence rate of approximately 10% [19, 23, 48]. In 1963, Montgomery [31] questioned the ability of the fat graft to persist in a bony cavity. In a cat model, he reported that a variable amount of fat persisted 1 year after implantation and that the amount of fibrosis or osteoneogenesis was negligible. The clinical result appears to be independent of the viability of the implanted fat [49].

Recently, alloplastic materials such as hydroxyapatite, cellulose, silicone and methyl methacrylate have also found use in frontal sinus obliteration. Hydroxyapatite cement is perhaps the most promising alloplastic material used for this purpose and has been shown to be effective, with no reported complications at a range of follow-up from 1 to 54 months [4, 41]. The multitude of materials for sinus obliteration attests to the fact that all have been used with some success. Indeed, the material placed in the sinus is not as important as the steps used to prepare the sinus cavity with the graft [30].

Although obliteration has been touted as the gold standard and safest method to treat the injured frontal sinus, there are many disadvantages, including facial scarring, frontal bone embossment, frontal neuralgia due to surgical injury of the supraorbital and supratrochlear sensory nerves, and donor site morbidity. In addition, the loss of physiologic ventilation of the sinuses hampers the use of radiographic studies in the evaluation of sinus disease. Patients may also complain of chronic frontal headache, which presents a diagnostic dilemma owing to limitations in radiographic evaluation of the sinus. Patients undergoing osteoplastic flap with autogenous adipose tissue obliteration display partial replacement of the fat graft with soft tissue (granulation and fibrosis) in most cases, and there are no consistent MRI features to distinguish recurrent sinusitis or early mucopyocèle formation from expected adipose graft remodeling [23].

Tips and Pearls

- To avoid the late complication of mucocoele formation, the sinus mucosa must be meticulously removed.
- It is equally important to invert the nasofrontal duct mucosa into the nasal cavity.
- Although abdominal fat is commonly used today, numerous graft materials, including pericranial fascia, muscle, cancellous bone, lyophilized cartilage, hydroxyapatite, cellulose, silicone and methyl methacrylate, have been successfully used.

Complications

The early complications occurring within the first few weeks include forehead pain, numbness and incisional tenderness [29, 51]. A CSF leak occurs in the early postoperative period in 3–10% of patients [5, 8, 9, 25, 47]. Clinically, CSF has a distinctively salty taste and if mixed with blood will form a “halo” when placed on absorbent cloth owing to the higher protein content [45]. Biochemical analysis of the fluid revealing β 2-transferrin confirms the diagnosis. Most CSF leaks will resolve with conservative management of antibiotics and a lumbar drain. If the leak persists, an exploratory surgery is warranted to prevent meningitis. Gerbino et al. [14] reported on two patients who suffered fatal meningitis in the immediate postoperative period. It is critical to recognize and treat this complication promptly.

Late complications occur months to years after the initial operation and include chronic sinusitis, osteomyelitis, subdural empyema, meningitis and mucocoeles. Mucocoeles are encapsulated collections of mucus that cause bony erosion and remodeling as they enlarge. They can erode into the nasal sinuses, orbit, and soft tissue of the forehead or even the anterior cranial fossa. They are generally asymptomatic until they are extensive and involving surrounding structures. Xie et al. [51] described their experience with frontal sinus trauma over a 30-year period. The authors found the rate of mucocoele formation to be the highest when anterior table (6%), posterior table (14%) and both anterior and posterior table (11%) without evidence of outflow tract injury were treated by observation. Chronic headache is also a common complaint after frontal sinus surgery [12]. A retrospective study of 11 patients who underwent cranialization for posterior table fractures demonstrated no major complications, but three of the 11 patients complained of headache [7].

Case Reports

Case 1

A 22-year-old woman presented following a motor vehicle crash in which she sustained an open, displaced anterior table frontal sinus fracture with associated nasoorbital ethmoid fracture. Fine-cut CT demonstrated these fractures and was highly suspicious for frontal sinus outflow tract fracture (Fig. 15.2). The patient underwent open reduction and internal fixation of the frontal sinus and NOE fractures using a forehead laceration for exposure. There was extensive comminution of the anterior table with small areas of bone loss. The bone fragments were meticulously reduced and fixated with miniplates. She was discharged home with a 4-week course of broad-spectrum antibiotics, nasal spray and close follow-up.

At the 4-week follow-up visit, she described pressure over the frontal region. Follow-up CT demonstrated opacification of the frontal sinuses with evidence of frontal outflow obstruction. Endoscopic evaluation revealed no purulence or significant inflammation in the middle meatus. Topical nasal steroid spray, prednisone taper and empiric antibiotic treatment was initiated for an additional 4 weeks. Follow-up CT demonstrated no improvement.

The patient was prepared for endoscopic frontal sinus surgery. High-resolution thin-cut multiplanar CT scanning was repeated to enable use of computer guidance. A modified endoscopic Lothrop procedure was performed (Fig. 15.4). Clinical follow-up with endoscopic examination and debridement was performed at day 6, day 13, and then weekly for 6 weeks. Medical therapy was maximized during the initial 6-week postoperative period, which included nasal saline irrigations, topical nasal steroid sprays, perioperative tapering dose of prednisone and culture-directed antibiotics. Endoscopic examination at 6 months revealed a widely patent nasofrontal communication. At 2 years follow-up, CT demonstrated excellent ventilation of the sinus with return of mucociliary clearance (Fig. 15.5). At 5 years follow-up, no clinical evidence of frontal disease is apparent.

Case 2

A 58-year-old man presented to the trauma center after sustaining massive head trauma in a motor vehicle accident. His injuries included a left comminuted depressed frontal bone and frontal sinus fractures with comminution of the left posterior table into the frontal lobe of the brain with associated intracerebral hemorrhage. He also had associated anterior cranial

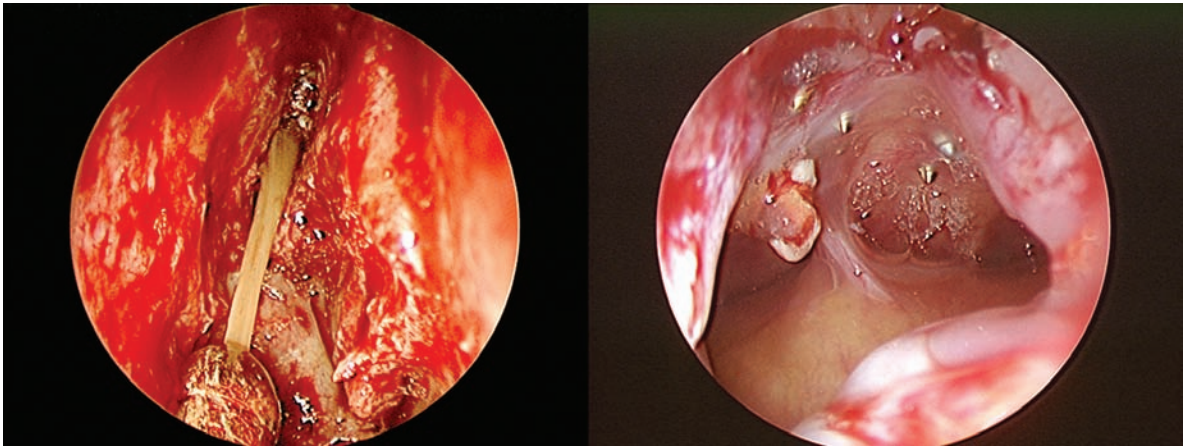


Fig. 15.4. Intraoperative view of the right frontal sinusotomy (with retained secretions) and the completed modified Lothrop procedure. The tips of the screws used in fixation of the ante-

rior table fracture can be seen penetrating the anterior wall of the frontal sinus

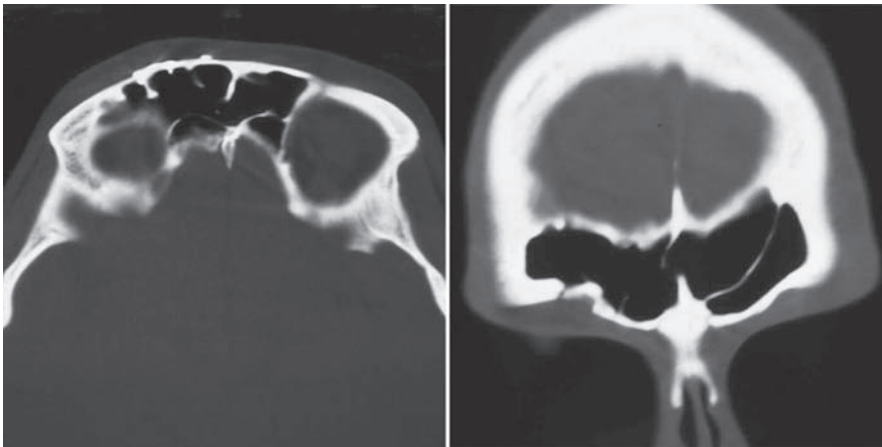


Fig. 15.5. CT views of the frontal sinus 2 years postoperatively, which is widely patent

fossa fractures of the left supraorbit and left ethmoid roof. At presentation, this patient was noted to have CSF which was emanating from the nostrils.

Once stabilized, the patient underwent a bilateral frontal sinus cranialization and skull base reconstruction for repair of his injuries. After bifrontal craniotomy using a standard coronal incision by the neurosurgical team, a 1.5 cm × 2 cm dural tear in the region of the midethmoid roof on the left side was identified and repaired in a watertight manner. A significant comminution of the left anterior cranial fossa was discovered in the posterior table of the left frontal sinus as well as in the left anterior and posterior ethmoid roofs (Fig. 15.6). A left partial ethmoidectomy was performed to ensure sinonasal drainage. The fractures had violated the frontal intrasinus septum, and therefore a bilateral frontal sinus cranialization was undertaken. The contiguous left cranialized frontal sinus and ethmoid defects resulted in a 2 cm × 5 cm skull base defect, which was repaired using onlay

titanium mesh followed by a pericranial flap and fibrin glue over the entirety of the bilaterally cranialized frontal sinus and left ethmoid roof defect. Next, the comminuted fragments of the frontal bone and anterior frontal sinus were reapproximated and fixed using titanium metal plates.

The patient did well postoperatively and was discharged on postoperative day 18. After 8 months, CT of the sinuses reveals an intact anterior skull base reconstruction with good ventilation of the remaining left ethmoid cells.

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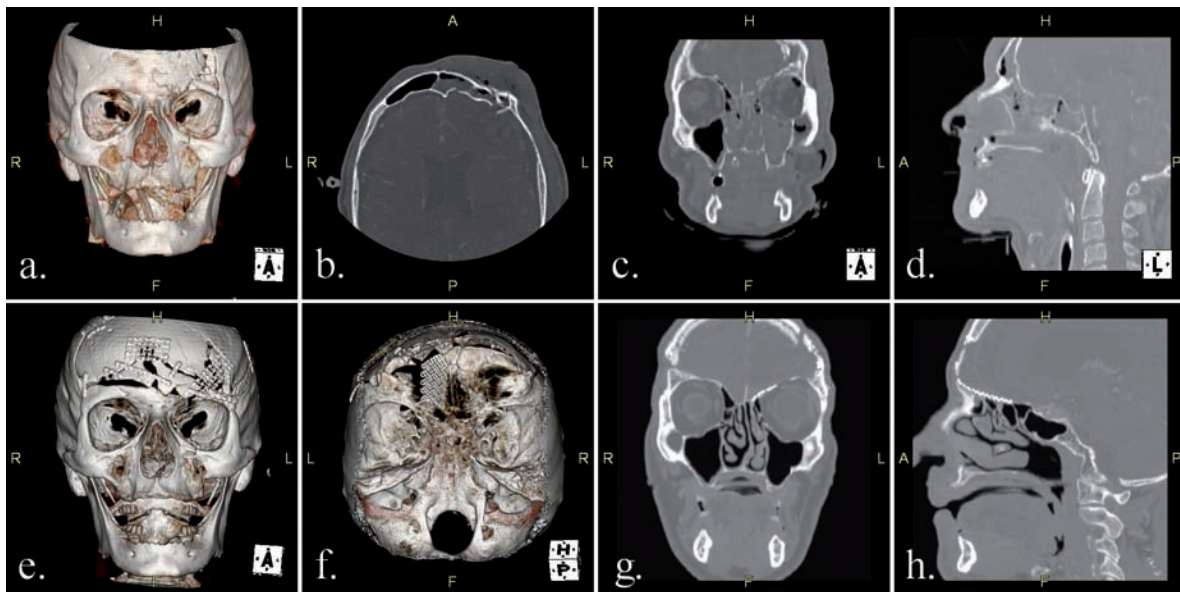


Fig. 15.6. a–d Preoperative frontal, axial, coronal, and sagittal views. e–h Postoperative frontal, posterior, coronal, and sagittal views. Note significant comminution of the left anterior skull base and ethmoid roof in association with left frontal

sinus fractures of the anterior and posterior tables. After bilateral frontal sinus cranialization and left partial ethmoidectomy, reconstruction was achieved with titanium mesh and a pericranial flap

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