

– FRONTAL SINUS

Chapter 15 – External Approaches to the Frontal Sinus

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The frontal sinus develops as an extension of the anterior ethmoid cells in the first 3 years of life. Pneumatization continues through childhood until the frontal sinus reaches its full dimensions by the second decade of life, although 4% of frontal sinuses fail to develop entirely.^[1,2] Pneumatization of the sinus is highly variable, as are its dimensions; however, the average adult frontal sinus is approximately 28 mm high, 24 mm wide, and 20 mm deep.^[2] The frontal sinus is usually asymmetric.^[2] It communicates with the nasal cavity through the nasofrontal recess, which drains into the middle meatus in a variable relationship with the hiatus semilunaris. The diameter of the nasofrontal recess varies from 2 to 10 mm.^[3]

The most frequent pathology of the frontal sinus is inflammatory in nature and it most commonly arises as a result of obstruction of the nasofrontal recess, which often reflects inflammatory disease in the anterior ethmoid sinuses and ostiomeatal complex.^[4] Benign tumors such as inverted papillomas, mucocoeles, and osteomas are occasionally encountered (Fig. 15-1). True neoplasms of the frontal sinus arising from epithelial cells or mucous glands situated in the mucosa are quite rare.^[5] It may, however, be involved by tumors that arise in adjacent areas of the sinonasal tract, skull base, or orbit. The frontal sinus is also an infrequent site of metastatic carcinoma.

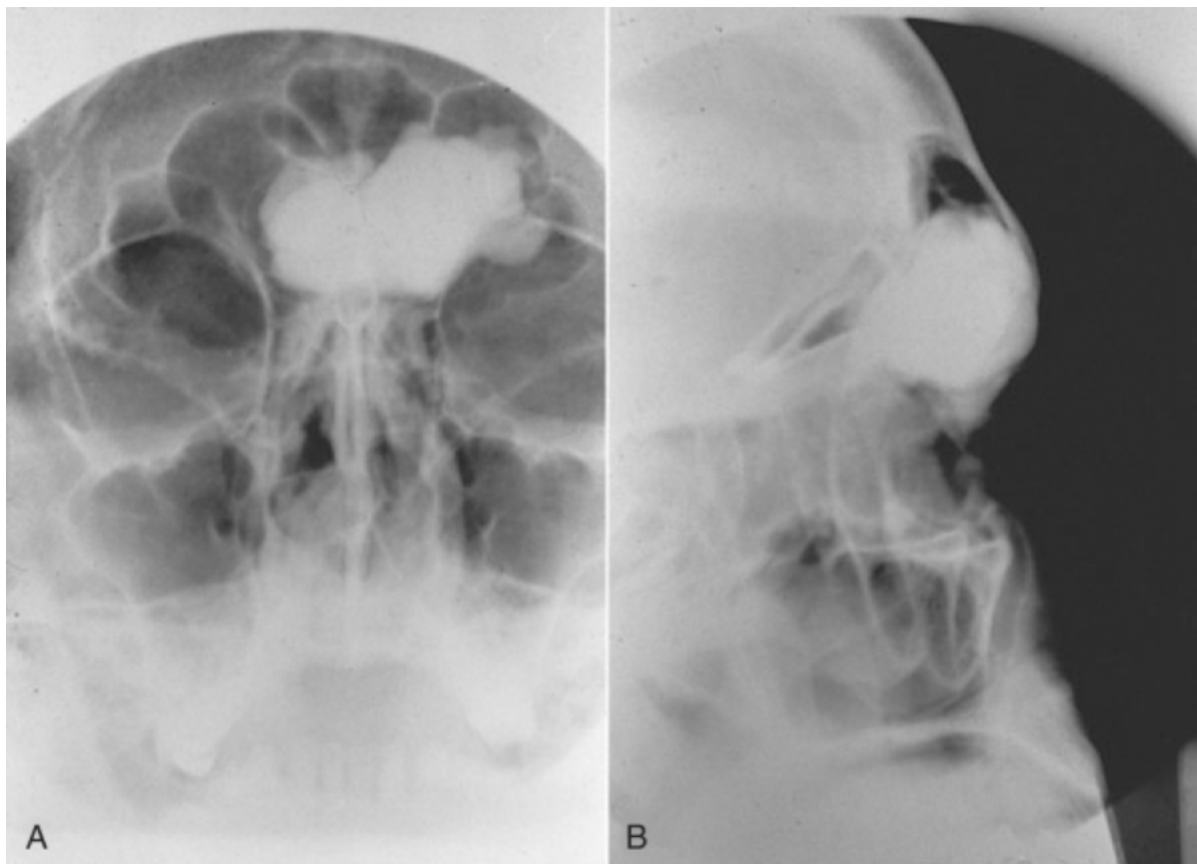


Figure 15-1 **A**, Anteroposterior radiograph demonstrating a large osteoma of the frontal sinus. **B**, Lateral radiograph confirming the position of the osteoma in the frontal sinus. This lesion was deemed inappropriate for endoscopic removal, and an open procedure through an osteoplastic flap was performed.

PATIENT SELECTION

Frontal sinusitis frequently occurs in the setting of acute upper respiratory infection or seasonal or chronic rhinitis.^[6] Acute frontal sinusitis is most often associated with pain that is characterized as dull or pressure-like and localized to the frontal, supraorbital, or retro-orbital areas. Unilateral involvement of the frontal sinus may give rise to unilateral symptoms. Associated nasal congestion and purulent rhinorrhea suggest pansinusitis. Initial therapy should be directed at eradication of the pathogen and improvement of drainage, which can most efficiently be achieved through the administration of appropriate antibiotics and the use of decongestants. In the setting of pansinusitis, improved drainage of the frontal sinus can be expected to occur with resolution of the inflammatory component in the area of the frontonasal recess, especially the anterior ethmoid air cells. In contrast, isolated frontal sinusitis is often a reflection of more serious obstruction of the frontal sinus and has the potential for both orbital and intracranial complications.^[7-10] Patients with isolated symptomatic frontal sinusitis (pain, fever, and headache) will benefit from hospitalization and the administration of intravenous antibiotics and corticosteroids. If symptoms fail to improve within 24 to 72 hours or if there is progression of the disease as characterized by signs or symptoms, surgical intervention is indicated. Patients with orbital or intracranial complications of frontal sinusitis should have the sinus drained promptly.

PREOPERATIVE PLANNING

The diagnosis of frontal sinusitis should be confirmed radiographically. The classic conventional radiographic finding in acute frontal sinusitis is demonstration of an air-fluid level (Fig. 15-2) or complete opacification. A computed tomography (CT) scan provides better assessment of the configuration and contents of the sinus by demonstrating the important anatomic relationships to the orbit and anterior cranial fossa, as well as improved understanding of the anatomy of the nasofrontal recess and the other paranasal sinuses (Fig. 15-3).



Figure 15-2 Anteroposterior radiograph demonstrating an air-fluid level in the frontal sinus. Note that the patient has left pansinusitis.

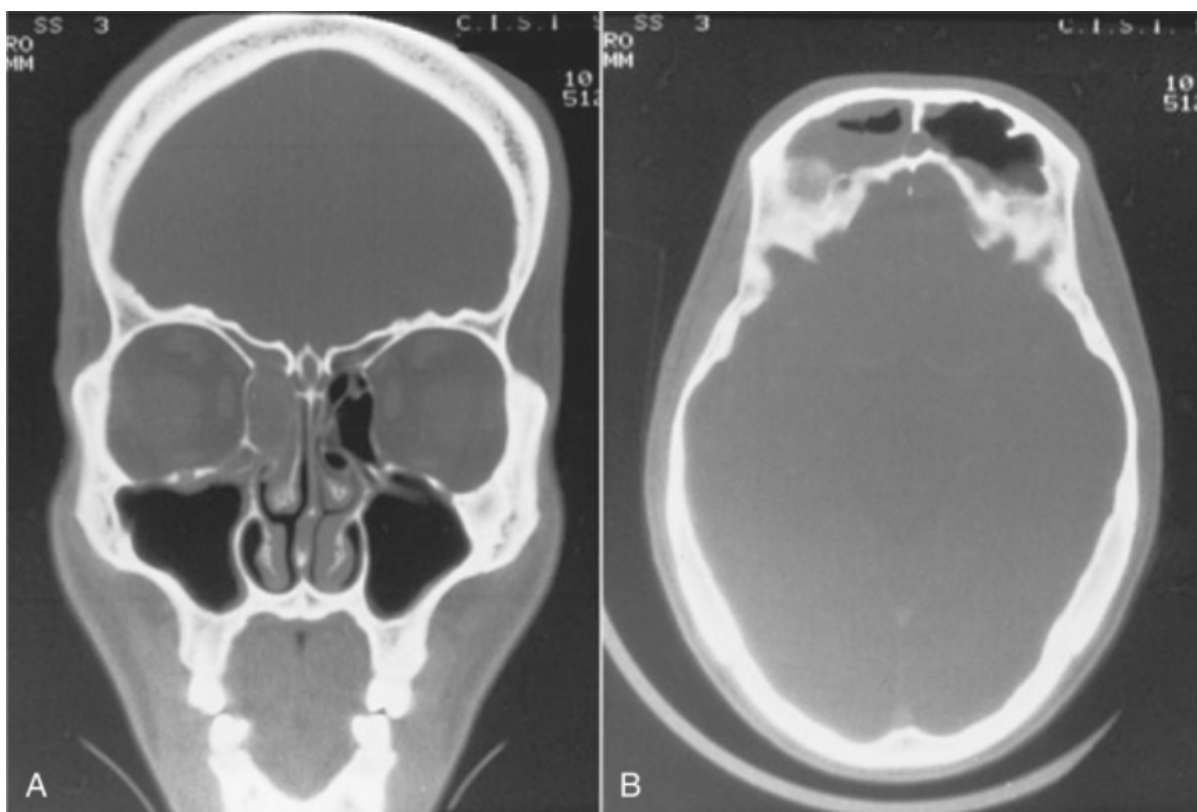


Figure 15-3 A, Coronal computed tomography (CT) scan demonstrating right-sided frontal opacification with involvement of the anterior ethmoid sinus. B, Axial CT scan displaying the air-fluid level in the right frontal sinus.

SURGICAL TECHNIQUES

Trephination

Trephination of the frontal sinus follows the same principles involved in drainage of an abscess found in soft tissue (Figs. 15-4 and 15-5). The procedure may be carried out under local or general anesthesia, depending on the condition of the patient and the personal preference of both the patient and surgeon. A 1-cm brow incision is made medial to the supraorbital nerve. The periosteum is elevated to expose the anterior wall of the frontal sinus. An estimate of the depth of the frontal sinus and its relationship to the orbit and anterior cranial fossa can be obtained through review of the CT scan. A cutting burr is used to drill into the frontal sinus. The position of the opening trephine must be properly planned to avoid inadvertent entry into the anterior cranial fossa. Several commercial trephination sets are currently available. They provide the ability to perform limited trephination through a very small incision. The same precautions apply, however.[11,12]

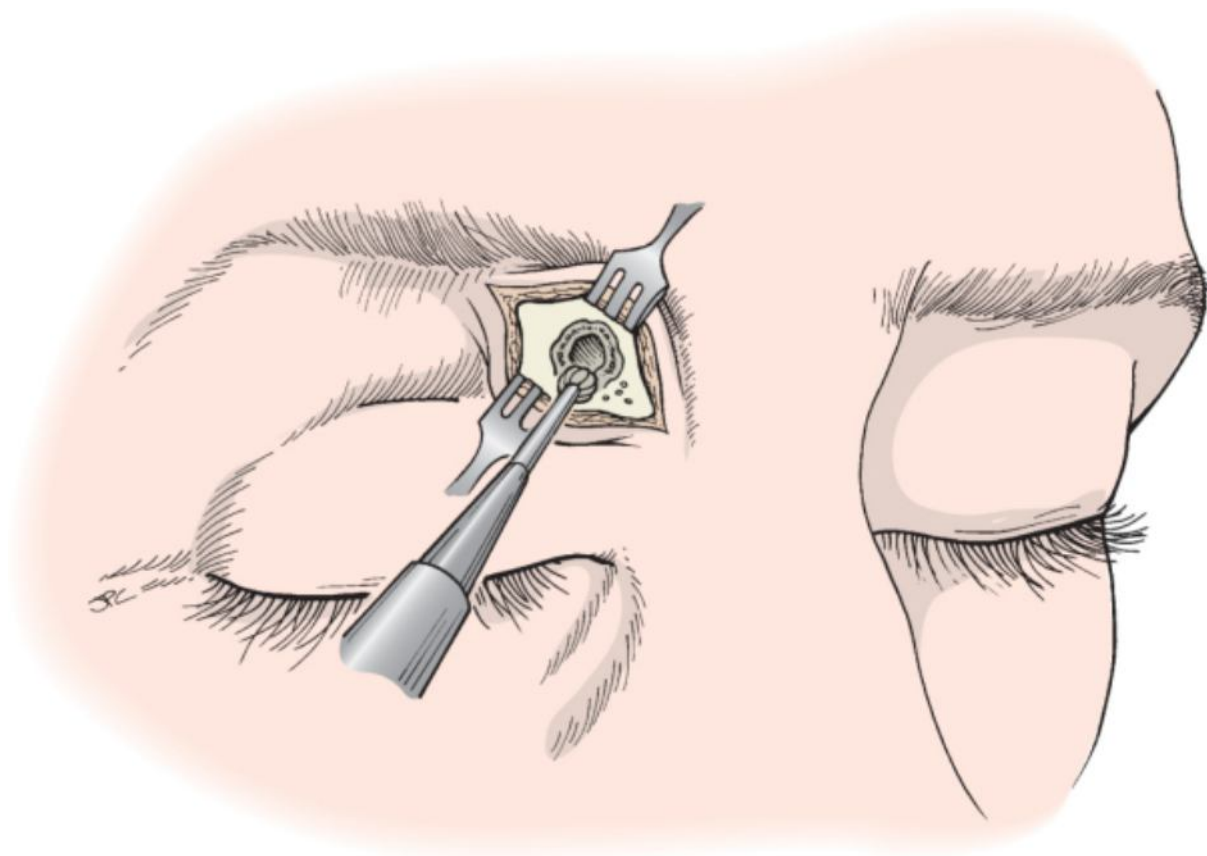


Figure 15-4 Trephination is performed through an incision made in the medial aspect of the brow. The floor of the frontal sinus is exposed and a drill is used to drain the sinus. The lateral wall of the nasal frontal recess is then removed to provide communication between the frontal sinus and the middle meatus.

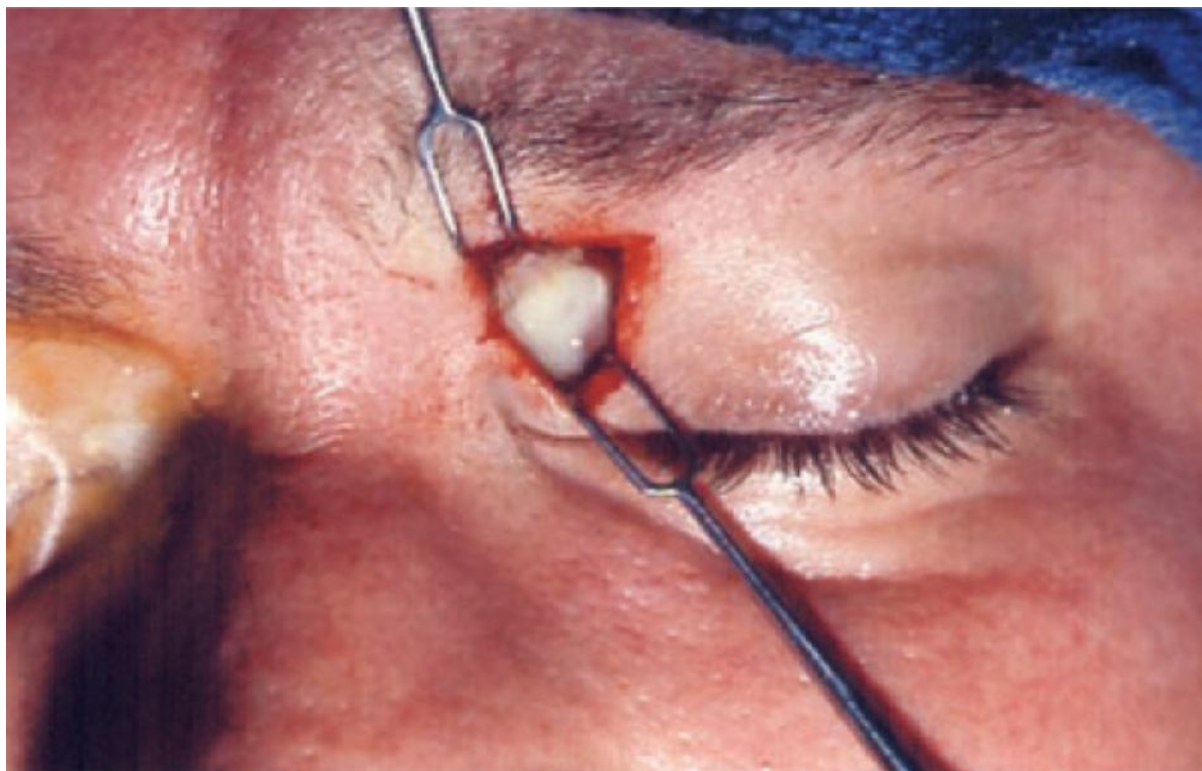


Figure 15-5 Trephination of the frontal sinus for acute frontal sinusitis.

Purulent secretions drained from the sinus should be submitted for Gram stain, culture, and sensitivity testing. The

sinus can be then copiously irrigated with normal saline solution containing broad-spectrum antibiotics. A catheter is then introduced through the trephine into the frontal sinus and brought out through the skin incision to permit irrigation of the sinus cavity postoperatively. The skin is closed around the catheter, which is then sutured to the adjacent skin. An eye patch may be applied if necessary.

Postoperative Management

Trephination relieves acute frontal sinusitis that fails to resolve with medical therapy. The strategy is to relieve the pressure symptoms, drain the purulent exudate, and then completely eradicate the infection with intravenous antibiotics. The mucosa of the nasofrontal recess is expected to return to its normal condition with restoration of normal sinus drainage. This process can be enhanced by irrigation of antibiotics solution through a catheter inserted into the frontal sinus. It is often useful to include 0.05% oxymetazoline to further decongest the mucosa, thereby promoting drainage. When repeated irrigation of the sinus results in freeflow of the irrigating solution through the nose, the catheter can be removed and the trephination allowed to close by secondary intention. Restoration of function in the nasofrontal recess frequently takes 7 to 10 days. Failure to respond may be an indication for definitive surgery to correct irreversible obstruction of the nasofrontal duct.

Frontal Sinusotomy with Fat Obliteration

Frontal sinusotomy provides a wide exposure that allows complete exenteration of all the mucosa of the frontal sinus while preserving its normal external contour.^[13–16] At the completion of the procedure, the nasofrontal ducts are obliterated with autologous tissue such as muscle, and the sinus is obliterated with abdominal fat.

A template of the frontal sinus is designed from a preoperative anteroposterior radiograph taken at 6 ft of distance (Caldwell's view) (Fig. 15-6). Because most patients have asymmetric frontal sinuses, it is important to properly identify the left-right orientation. Precise mapping of the frontal sinus may be performed with a surgical navigation device to avoid some of the problems related to a Caldwell view template.

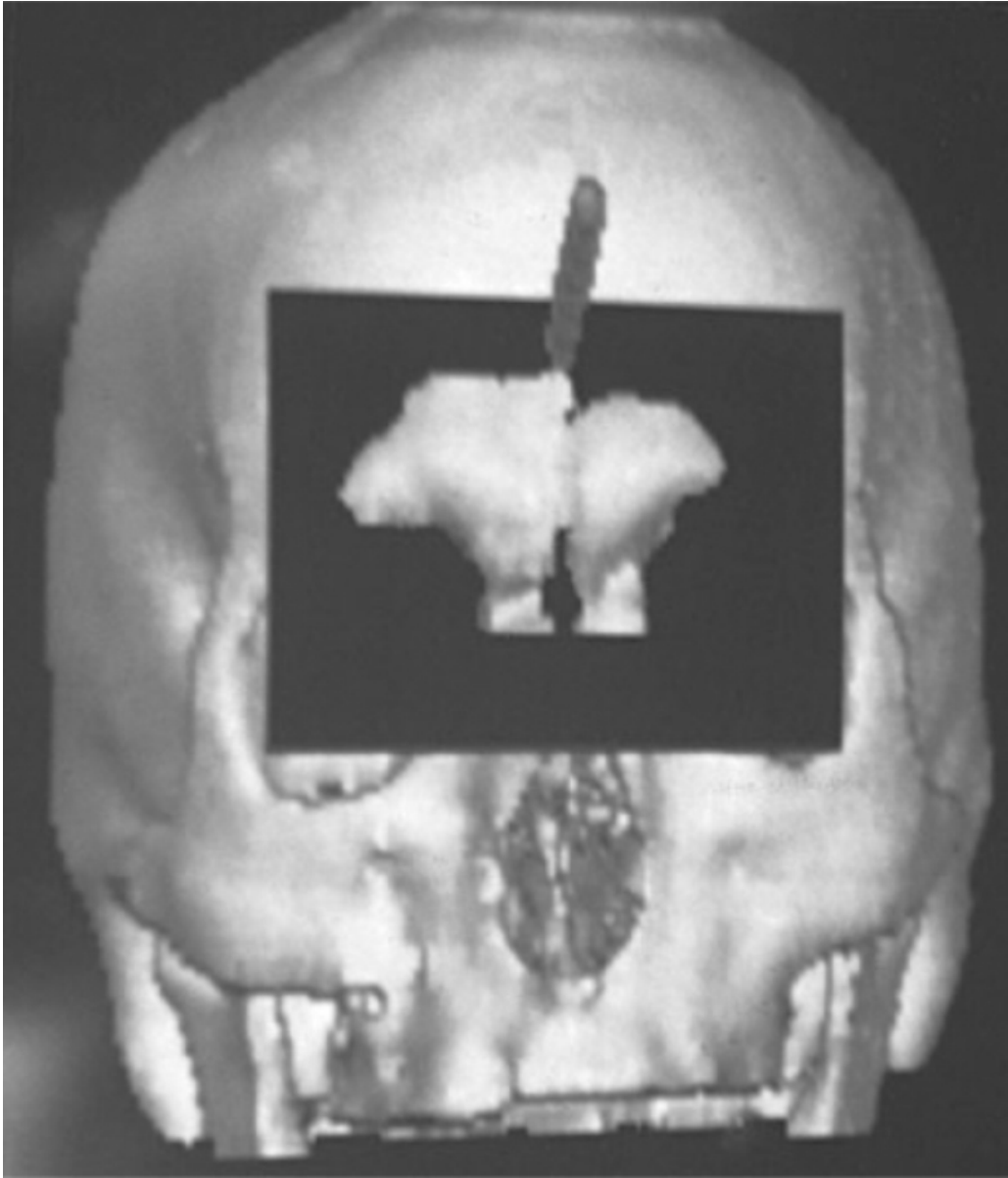
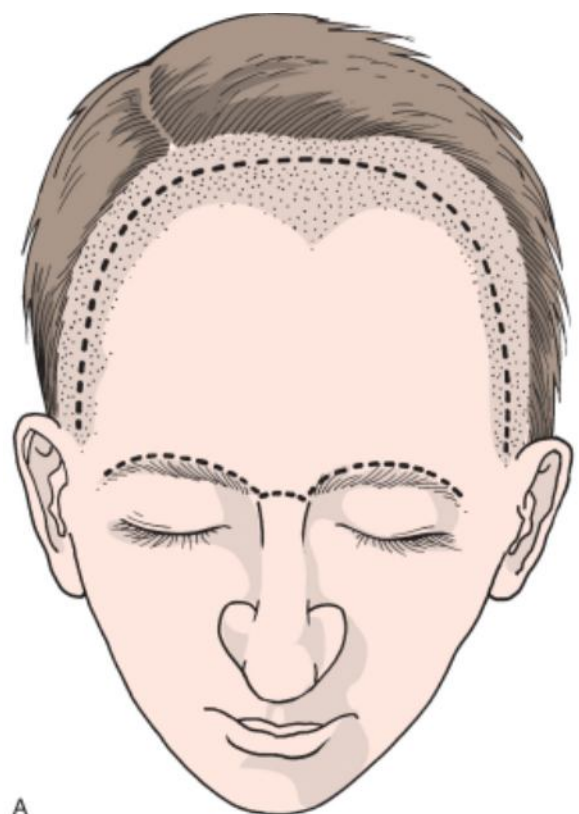


Figure 15-6 A template of the frontal sinus is made from an anteroposterior radiograph taken from 6 ft away (Caldwell's view). The template is used as an overlay to guide the surgeon in designing the osteotomy.

The anterior frontal bone can be exposed with a bicoronal incision placed above the hairline (Fig. 15-7). A gull-wing incision is cosmetically inferior and usually divides the supraorbital nerve, which results in troublesome paresthesias and numbness of the forehead postoperatively. The bicoronal incision affords a completely hidden scar without sensory denervation. The principal limitation is cosmetic and only in patients with male pattern baldness. Temporary tarsorrhaphy is performed as a safety measure.



A



B

Figure 15-7 **A**, Either a bicoronal flap or a brow incision may be used to expose the anterior frontal bone. **B**, Bicoronal flap used to remove a mucocoele of the frontal sinus.

The frontal bone should be widely exposed down to the supraorbital rims while taking care to avoid injury to the supraorbital nerves. With the supraorbital rims used as a landmark, the template is used to outline the configuration of the frontal sinus. Alternatively, the boundaries of the frontal sinus can be marked under the guidance of a navigation device. Leaving the periosteum attached to the bone (osteoplastic flap) is unnecessary for survival of the frontal bone and ruins the possibility of using a pericranial flap (Fig. 15-8).

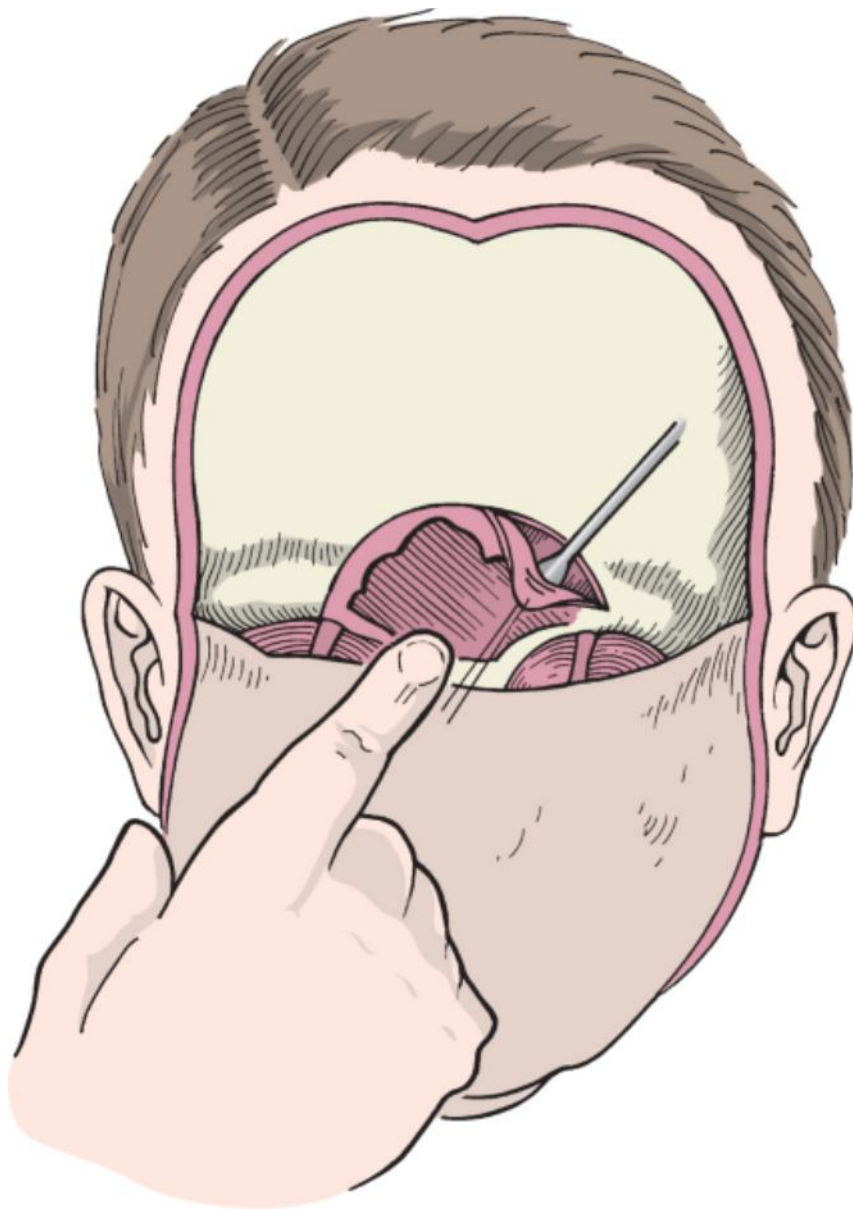


Figure 15-8 After the template has been used to demonstrate the extent of the frontal sinus, the pericranium is elevated and reflected inferiorly. In this way the pericranium can be used to reinforce the closure at the completion of the procedure.

A reciprocating, sagittal, or oscillating saw may be used to bevel the osteotomy while taking care to ensure that the frontal sinus and not the cranial cavity is entered (Fig. 15-9). The osteotomies may also be completed with a high-speed drill, but this usually results in greater bone loss at the edges of the osteotomies. The intersinus septum must be fractured with an osteotome or elevator after the bone flap has been fully separated from the orbital rim on either side. The bone flap is gently pried away from the skull, and the base of the flap is fractured. Specimens are obtained for culture and sensitivity testing, and the mucosa is removed from all the recesses of the frontal sinus. Magnification via the operating microscope, loupes, or endoscope is helpful to ensure that all the mucosa has been removed. This is important in preventing mucocele formation. The intersinus septum is removed with a rongeur, and other septa are taken down to bone with a curette or burr. A muscle plug taken from the temporalis muscle is used to completely obliterate the nasofrontal duct. The sinus may then be obliterated with an adipose tissue graft from the abdomen.

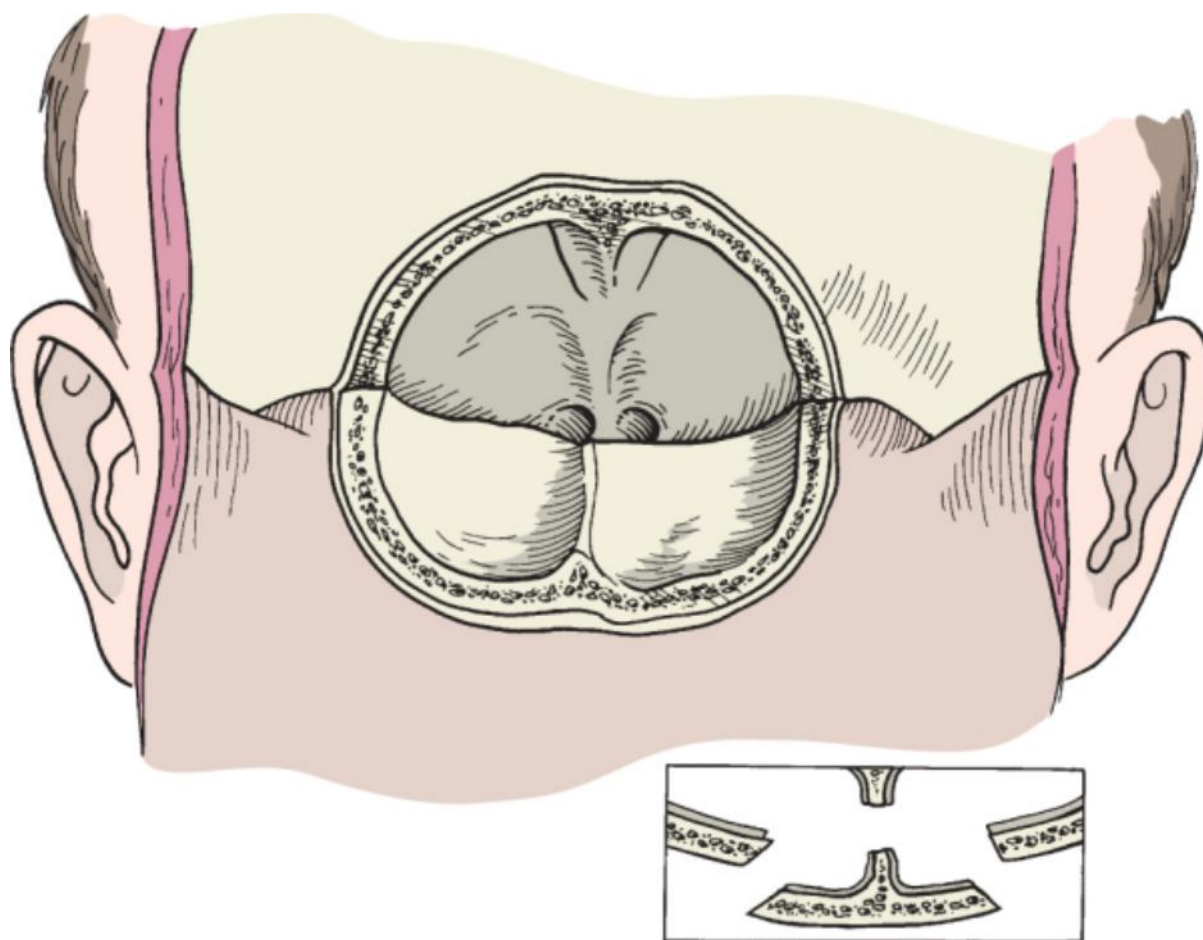


Figure 15-9 The osteoplastic flap is outlined with an oscillating saw. The osteotomy is beveled (*inset*) to ensure that the flap will fit securely when it is replaced at the completion of the procedure.

The bone flap (from which the mucosa has been removed) is returned to its anatomic site. Fixation of the flap is then undertaken with either fine wire or silk or with adaptation plates. The incision is closed in layers with a suction drain left in place. The eyelid sutures are removed, and a compression dressing is applied.

Postoperative Management

A compressive dressing is maintained for 48 to 72 hours postoperatively. Administration of antibiotics for longer than 24 hours is unnecessary unless acute infection was encountered during surgery. The drain is removed 24 to 48 hours after surgery. Some degree of periorbital edema and ecchymosis develops in virtually all patients. Maintaining a head-elevated position may be helpful in reducing periorbital edema. Patients may be discharged after drain removal. A proportion of patients continue to report headache, frontal fullness, and pain after frontal sinus obliteration. The diagnosis of recurrent frontal sinus disease after osteoplastic fat obliteration continues to be a difficult clinical problem.^[17] Modern imaging techniques may serve to help identify these problem cases for further treatment,^[18] and some of them may be salvageable by endoscopic techniques.^[19]

Lynch's Frontoethmoidectomy

The Lynch frontoethmoidectomy establishes communication between the floor of the frontal sinus and the anterior ethmoid cells, in effect marsupializing the most anterior of the paranasal sinuses with the middle meatus (Fig. 15-10).^[20] Its efficacy is based on re-establishment of the integrity of drainage of the frontal sinus into the middle meatus. Despite many adjunctive techniques developed to maintain patency of the nasofrontal duct, the Lynch procedure is associated with an unacceptably high degree of recurrence of frontal obstruction, mucocele formation, and sinusitis. It may be used in patients who are not candidates for an endoscopic Draf or Lothrop procedure because of anatomic limitations.

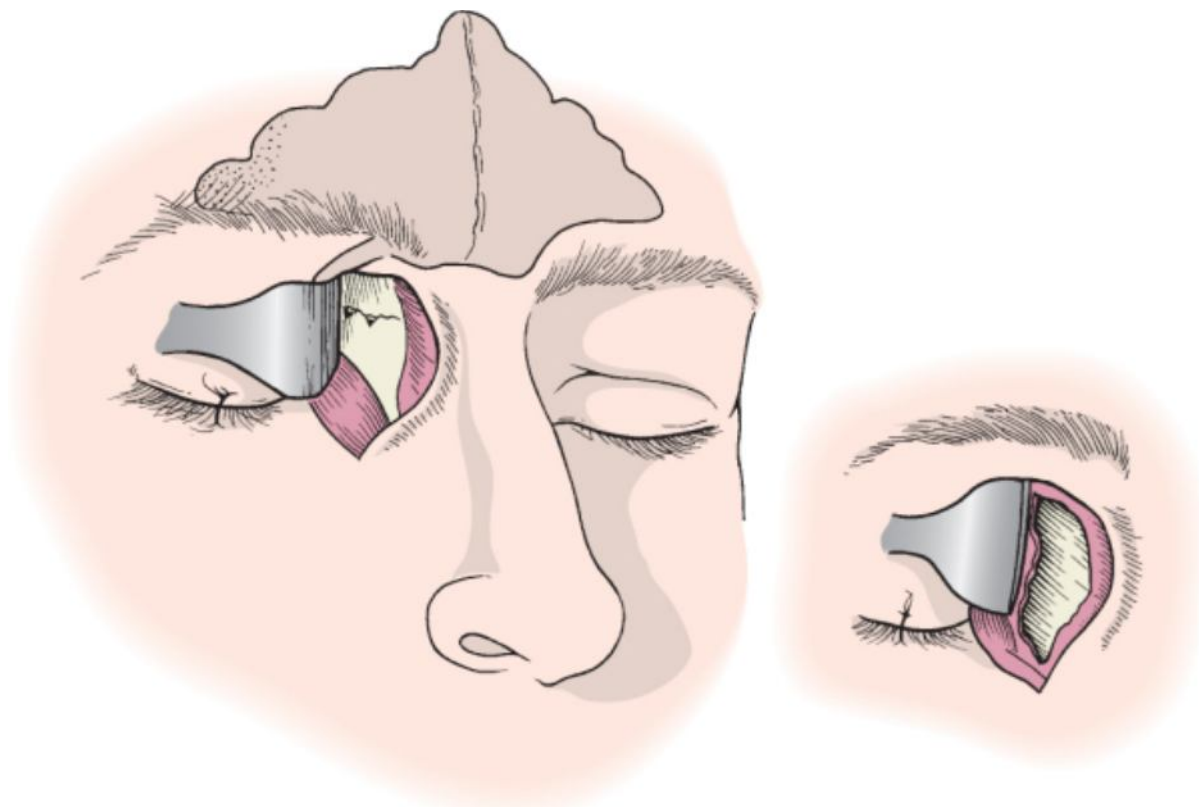


Figure 15-10 A and B, The Lynch frontoethmoidectomy establishes communication between the frontal sinus and the middle meatus. Success is predicated on the ability to establish a mucosal lined nasofrontal recess.

The procedure is done with the patient under general anesthesia. A temporary tarsorrhaphy is performed, and an incision is made above the medial aspect of the upper eyelid, curved, and then carried inferiorly down to the level of the medial canthus. The periosteum is elevated posteriorly, and a cutting burr is used to trephine the frontal sinus. A Kerrison- or Citelli-type rongeur is used to provide communication between the floor of the frontal sinus and the anterior ethmoid air cells, which are removed until free communication with the middle meatus is obtained. Diseased mucosa is removed from the frontal recess as completely as possible. An attempt must be made to reconstruct the nasofrontal duct with a nasoseptal mucosal flap. This is unnecessary when treating patients for fractures of the anterior wall of the frontal sinus or during removal of osteoma because the duct should not be traumatized and one would hope that it will return to its premorbid condition.

Postoperative Management

At the completion of the procedure, the eyelid sutures are removed and the cornea is irrigated with balanced saline solution. An ophthalmic ointment is applied to the incision. The patient should be maintained in a head-elevated position during this time to further reduce postoperative edema.

Once discharged from the hospital, the patient is seen as an outpatient for intranasal examination and débridement of crusts. After the first postoperative visit (7 to 10 days postoperatively), a program of intranasal irrigation with normal saline solution is instituted.

Ablation of the Frontal Sinus

When an acute or chronic pyocele of the frontal sinus results in osteomyelitis of the anterior wall of the frontal sinus, effective surgical therapy may require débridement of infected bone. This condition may be manifested as a subperiosteal abscess of the forehead (Pott's puffy tumor, Fig. 15-11). The frontal sinus may be ablated by complete removal of the anterior wall of the frontal sinus, with or without the supraorbital rims, by using a cutting burr to remove the bony protuberances. The sinus is prepared as for a fat obliteration procedure, except that the skin of the forehead is laid down smoothly on the healthy posterior table of the sinus. Exposure of the sinus is through a bicoronal incision as described previously. A suction drain is inserted, and a bulky compressive dressing is applied.



Figure 15-11 Pott's puffy tumor in a 27-year-old. Note the evidence of a mass in the forehead.

Reconstruction of the cosmetic defect should be postponed until it is ensured that the infectious process has been completely eradicated. In most circumstances, surgeons would wait 3 to 12 months before undertaking reconstruction.

Postoperative Management

Postoperative management of patients proceeds as for frontal sinus obliteration. Patients may be discharged from the hospital when the drain is removed if the healing is proceeding without complication and no evidence of infection is demonstrated by either erythema or a subcutaneous collection. The patient is instructed to keep the wound clean. It should be maintained dry until the fifth postoperative day, when the patient may shower or wash and gently pat the incision dry. Facial sutures are removed on the fifth postoperative day, whereas scalp sutures are ordinarily maintained for 10 to 14 days postoperatively.

COMPLICATIONS

Postoperative wound infection is unusual after surgery on the frontal sinus. At the time of surgery all purulent material and diseased mucosa are removed, osteomyelitic bone is resected, and the wound is irrigated to remove bone and infected debris and closed with drainage appropriate to evacuate serum and clot. Routine administration of perioperative antibiotics probably contributes to the low incidence of postoperative infection in these patients.

When a postoperative collection of blood or serum is identified, appropriate treatment consists of aspiration, a pressure dressing, and the administration of antibiotics.

If a cerebrospinal fluid leak is diagnosed, re-exploration may be necessary. The procedure may require either removal of the posterior wall of the frontal sinus to allow adequate exposure for repair of the dural tear or anterior fossa craniotomy. In either case, the dural tear must be repaired primarily or with a fascial graft, after which it must be isolated from the sinonasal tract. Ordinarily, this is undertaken through obliteration of the frontal sinus with adipose tissue.

In patients who have undergone an osteoplastic flap procedure, postoperative osteomyelitis of the anterior bone flap is encountered occasionally. This may reflect preoperative existence of a severe infection with extension to bone. This complication is best prevented by débridement of infected bone and maintenance of periosteal vascular supply to the anterior bone flap. Should osteomyelitis occur, administration of intravenous antibiotics is appropriate; however, this may be insufficient to control the problem, and wound exploration with débridement of the anterior bone flap may be required. Maintenance of the fat graft may improve the postoperative cosmetic result, but many

patients will require subsequent cranioplasty when the infectious complication has resolved.[21]

A patient undergoing elective surgery of the frontal sinus should be counseled that inadvertent entry into the anterior fossa is a well-described, though rare complication. When encountered, it is critical that the potential for dural injury be immediately evaluated and, when necessary, the dura repaired. In these circumstances, postoperative complications may be reduced or eliminated. Injury to the dural venous sinuses is more unusual but of greater potential significance. Similarly, this sort of complication can be minimized by immediate recognition and repair.

The last 10 years have seen an increase in all endoscopic procedures, and readers are directed to Chapter 16. The indications for any of the external procedures discussed in this chapter are progressively decreasing.[22–24]

PEARLS

- Success of external frontal sinus obliteration relies on meticulous technique with magnification.
- Image guidance–assisted templates are an alternative to the 6-ft Caldwell view.
- Tissue should be taken at surgery for culture to aid in postoperative therapy.
- A midforehead crease approach is aesthetically satisfactory in patients with a receding hairline.

PITFALLS

- Obliterative procedures do not allow assessment of symptoms with postoperative imaging studies.
- Persistent wound problems are unusual, and infected bone or a foreign body should be considered.
- Failure of obliterative frontal sinus surgery is infrequently salvageable with an endoscopic approach.
- Extensive dissection or cautery near the supraorbital neurovascular bundle will cause long-standing complaints of numbness.

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