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## Headache and Forehead Swelling in a 9-Year-Old Boy with Sinusitis

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### CASE PRESENTATION

#### Initial Presentation and History

A previously healthy 9-year-old boy presented to the emergency department for evaluation of swelling of the right eye, which had been present for 24 hours. His parents reported that he had an antecedent history of nighttime cough, frontal headache, and green nasal discharge for the 10 days prior to admission. Three days before admission, he developed a fever of 103.5°F. One day prior to admission, he developed periorbital swelling, erythema, and pain in the right eye when looking upwards. He was seen on the day of admission by his pediatrician, who prescribed oral trimethoprim-sulfamethoxazole. However, the swelling around his eye progressed, prompting his mother to bring him to the hospital later that evening. His past medical history was significant only for "sinus problems." He took no other medications, had no significant allergies, and his immunizations were current.

#### Evaluation and Initial Management

The patient's initial physical examination was significant for periorbital erythema and edema, the absence of maxillary or frontal sinus tenderness, and pain with lateral and superior gaze. Despite this pain, the extraocular movements were intact in all directions. A computed tomography (CT) scan of the orbits and sinuses revealed right-sided periorbital cellulitis, edema of the right superior oblique muscle, and extensive sinus disease (**Figure 1**). The patient was admitted to the hospital with a diagnosis of orbital cellulitis. Parenteral antibiotic therapy with ceftriaxone and clindamycin was initiated, and he was subsequently discharged from the hospital 5 days later on ceftriaxone and oral metronidazole with a plan to complete a 21-day course.

### Key Point

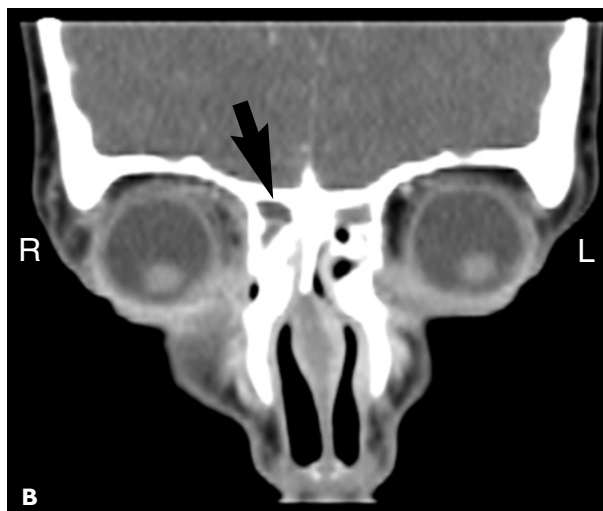
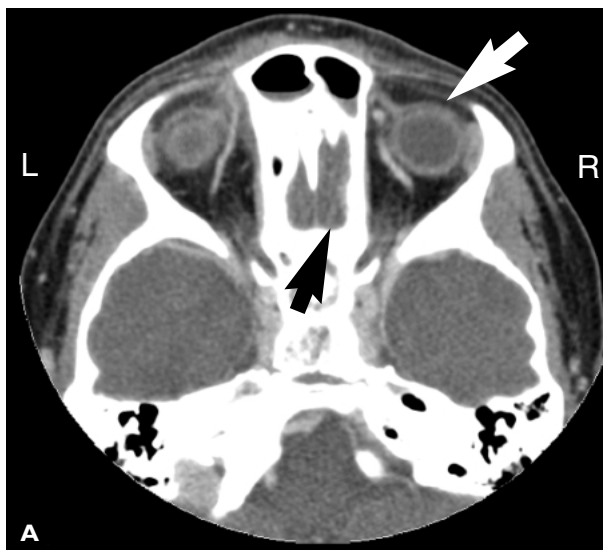
Preseptal cellulitis is present when the eyelid becomes swollen without evidence of intraorbital infection. Most patients with orbital or postseptal cellulitis have periorbital swelling and edema, proptosis, and orbital pain.

#### Subsequent Presentation to the Emergency Department

The patient returned to the emergency department 11 days later (day 16 of antibiotic therapy) with a new chief complaint of facial swelling for several hours. There was no known trauma to the face. He was afebrile, appeared well, and had normal vital signs. His only other complaint was of a mild headache. His physical examination was significant for a minimally tender 3 × 3-cm area of doughy, puffy edema over the glabella. No periorbital edema or erythema was noted. The pupils were equal, round, and reactive, and the conjunctivae were not injected. The extraocular movements were normal, and there was no pain with movement of the eye. Cranial nerves II through XII were intact; the remainder of the neurologic and mental status examinations were normal. Frontal sinus radiographs were obtained and showed partially opacified but patent frontal sinuses without air/fluid levels (**Figure 2**). No periosteal reaction over the frontal bone was observed by conventional radiography. The patient was discharged with instructions to complete the planned course of antibiotics. Arrangements were

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**Figure 1.** Computed tomographic scans of orbits of the case patient obtained at initial presentation, (A) axial and (B) coronal views. Extensive sinusitis is apparent (black arrows) with right periorbital cellulitis (white arrow). Note asymmetry of orbital contents. Right superior oblique myositis was also noted (not visible in these images).

made to obtain a CT scan of the head on an outpatient basis, and follow-up evaluation was suggested. A clinic appointment was scheduled with the infectious diseases clinic service later during the week.

#### Key Point

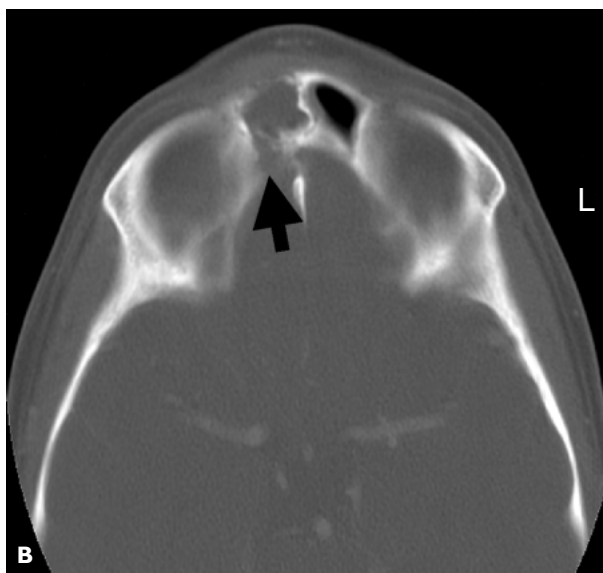
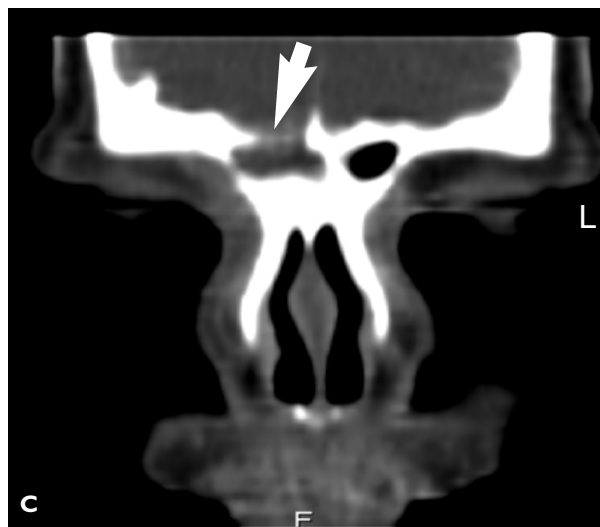
Conventional roentgenography has limited value in the diagnosis of sinusitis and its complications, particularly for the frontal sinuses.



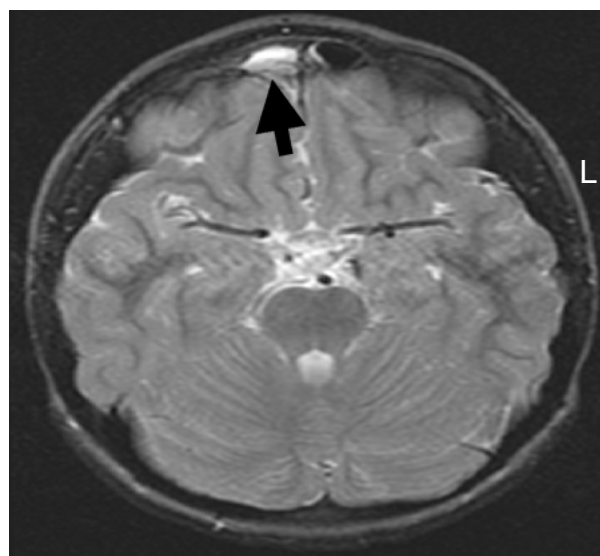
**Figure 2.** Anteroposterior and lateral skull plain films of the case patient obtained when he presented with sudden onset of glabellar swelling. The films fail to show evidence of a periosteal reaction over the frontal bone.

#### Subsequent Presentation to the Infectious Diseases Clinic

The patient presented to the hospital infectious diseases clinic several days after the second emergency department visit. He underwent an outpatient CT scan earlier that morning. The patient continued to be well-appearing on examination, afebrile, and without complaint. His physical examination was notable for the finding of edema over the glabella and superior aspect of the right orbit. Extraocular movements and cranial



**Figure 3.** Computed tomographic scans of case patient on the day of admission. Axial views show (A) edema overlying the right frontal sinus with (B) bony erosion anteriorly and posteriorly. (C) Bony erosion is also evident on coronal reconstruction. Arrows indicate site of bony defect.



**Figure 4.** Axial T2-weighted magnetic resonance image of the case patient obtained preoperatively reveals abnormal intracranial dural enhancement in the region posterior to the right frontal sinus without extra-axial fluid collection (arrow).

nerves II through XII were intact. The CT scan obtained that morning showed progression of disease in the right frontal sinus, with bony erosion anteriorly and posteriorly into the anterior cranial fossa (Figure 3). Based on the results of the CT scan and his history and physical examination findings, the patient was admitted to the hospital for initiation of intravenous antibiotic therapy and trephination of the right frontal sinus.

The complete blood count obtained at the time of admission to the hospital showed all values to be within normal limits. A magnetic resonance image (MRI) obtained preoperatively showed abnormal intracranial dural enhancement in the region posterior to the right frontal sinus without extra-axial fluid collection (Figure 4).

**Table.** Classification of Orbital Complications of Frontal Sinusitis

Stage	Diagnosis	Clinical Signs
Stage I	Periorbital (preseptal) cellulitis	Upper eyelid swelling without extraocular or visual changes
Stage II	Orbital (postseptal) cellulitis	Eyelid swelling, periorbital swelling, proptosis, chemosis, limited or no impairment of extraocular movement
Stage III	Subperiosteal abscess	Displacement of the globe downward and laterally, impairment of extraocular movement, impairment of visual acuity (later finding)
Stage IV	Orbital abscess	Severe proptosis, complete ophthalmoplegia, impairment of visual acuity that can progress to irreversible blindness
Stage V	Cavernous sinus thrombosis	Orbital pain, chemosis, proptosis, sepsis, ophthalmoplegia. Can progress to the other eye.

Adapted from Chandler JR, Langenbrunner DJ, Stevens ER. The pathogenesis of orbital complications in acute sinusitis. *Laryngoscope* 1970;80:1414–28.

Trephination of the right frontal sinus yielded soft, eroded bone and mucopurulent fluid. One culture yielded *Staphylococcus saccharolyticus* from the broth, but this was thought likely to be a contaminant. All other aerobic, anaerobic, fungal, and acid-fast bacilli cultures were negative.

#### Key Point

CT scanning is the single most important study for evaluation of complicated paranasal sinus disease and is the examination most likely to lead to the appropriate diagnosis of intracranial complications of sinusitis. Patients with extracranial complications of sinusitis should also undergo CT scan because of the high incidence of concomitant intracranial disease processes.

- **What are the complications associated with frontal sinusitis?**
- **How should a patient suspected of having suppurative complications of frontal sinusitis be evaluated?**

#### COMPLICATIONS OF FRONTAL SINUSITIS

When treating a patient with a history of acute frontal sinusitis who presents with the complaint of facial swelling and an acute change in symptoms, it is important to consider the complications known to involve intracranial and extracranial structures, including the orbit and adjacent bony and soft tissues. Frontal sinusitis alone rarely causes an orbital complication; however, acute pansinusitis is associated with a risk of up to 60% to 80% for subsequent orbital complications. These complications primarily affect children, with a peak incidence between the ages of 5 and 10 years. Periorbital or preseptal cellulitis is the most common and least severe complication of frontal sinusitis and is responsible for the majority of clinically important orbital complications of sinusitis.

The orbital septum and tarsal plate are a barrier

between the preseptal eyelid and the orbit. The orbital septum is contiguous with the periosteum of the inferior and superior margins of the orbit. There is no lymphatic or venous connection between the pre- and postseptal compartments. Therefore, the orbital septum normally acts as a barrier to the spread of infection from the face to the deep orbital structures.

Symptoms and the results of the physical examination are the most important factors in developing a differential diagnosis. Although CT is the “gold standard” for diagnosing severe complications such as orbital abscess, it is important to keep in perspective that radiographic studies are only an adjunct to the medical history and clinical findings.

Extracranial complications of frontal sinusitis include mucocele formation, infection of an existent mucocele (termed a “mucopycocele”), osteomyelitis of the frontal bone, and Pott’s puffy tumor, which is a subperiosteal abscess of the frontal bone associated with underlying frontal osteomyelitis. Orbital complications include periorbital (preseptal) cellulitis, orbital (postseptal) cellulitis, subperiosteal abscess, orbital abscess, and cavernous sinus thrombosis.

The most recent system of classification for orbital complications was introduced in 1970 by Chandler et al.<sup>1</sup> This system organizes the typical patterns of secondary orbital involvement into a logical progression and remains widely used today (Table).

Intracranial complications of frontal sinusitis include meningitis, dural sinus thrombosis, epidural abscess, subdural abscess, and brain abscess. Worrisome symptoms suggesting an intracranial complication of frontal sinusitis include headache, vomiting, neck stiffness, altered mental status, seizures, papilledema, unilateral weakness, and cranial nerve signs. In particular, an altered level of consciousness has been shown to be a poor prognostic factor in patients with intracranial complications of

sinusitis. Seizures, hemiparesis, and other focal neurologic signs have also been shown to be associated with significant morbidity.

It should be noted that despite the possibility of the dramatic symptoms listed, headache and fever are the most common presenting signs and symptoms of intracranial complication in patients with frontal sinusitis. A small percentage of patients can present silently with no signs or symptoms whatsoever. Although the case patient did not exhibit symptoms indicative of intracranial complications, it is particularly important to maintain a high index of suspicion in patients with a history of sinusitis and new symptoms.

If there is suspicion of loculated intracranial infection, prompt neurosurgical intervention is the treatment of choice. Neither antibiotic therapy nor sinus trephination alone is adequate. Patients may deteriorate quickly, due either to the rapid expansion of intracranial fluid collections or to venous thrombosis.

#### Key Point

Presence of periorbital swelling can indicate inferior spread of frontal sinus disease. These symptoms should prompt a search for intracranial disease, even in the absence of neurologic symptoms.

#### CLINICAL COURSE AND FOLLOW-UP OF CASE PATIENT

Given the history of frontal sinusitis complicated by orbital (postseptal) cellulitis and acute onset of forehead swelling, the patient was diagnosed with Pott's puffy tumor and started on vancomycin, ceftriaxone, and metronidazole, along with intranasal mupirocin, fluticasone, and oxymetazoline. He was discharged in good condition 1 week after admission with a plan to continue IV antibiotics for 8 weeks. At the time of discharge, he had a normal neurologic examination and no new symptoms. The Pott's puffy tumor had been replaced by the anticipated postoperative swelling and ecchymoses. Two weeks after discharge, he underwent outpatient nasal endoscopy and debridement of the frontal sinus. Two months after discharge, having completed antibiotic therapy, the patient underwent a revision right frontal endoscopic sinus surgery with ethmoidectomy, maxillary antrostomy, and frontal sinusotomy for retained opacification of the right frontal sinus. Twelve days after this procedure, the patient experienced a right-sided complex partial seizure. MRI imaging of the brain was normal and CT evaluation of the sinuses revealed no significant changes. A limited immunologic evaluation, including a pneumococcal antibody panel, immunoglobulin subclass analysis, serum immunoglobulin E levels, a

tetanus titer, and a *Bartonella henselae* titer were normal. Imaging studies obtained several months after completion of antibiotic therapy showed sclerosis of the right frontal sinus with continued opacification. The posterior wall defect of the sinus had resolved, and the patient was doing well.

#### POTT'S PUFFY TUMOR

Inflammation of the dura mater, and the formation of matter between it and the skull, in consequence of contusion, is generally indicated and preceded by one [sign] I have hardly ever known to fail; I mean puffy, circumscribed, indolent tumor of the scalp . . .

—Percivall Pott

*Injuries of the Head from External Violence*, 1760.

The patient described in this case report had two important complications of paranasal sinus disease: the relatively common complication of postseptal cellulitis, and the less common complication of Pott's puffy tumor. Originally described by Sir Percivall Pott as a complication of trauma, but more commonly observed as a complication of frontal sinusitis, Pott's puffy tumor is a rare entity, with only 20 to 25 cases reported in the literature of the postantibiotic era.<sup>2-5</sup>

An understanding of the developmental anatomy of the frontal sinuses provides insight into the pathogenesis and potential complications associated with Pott's puffy tumor. The frontal sinuses develop from the ethmoid air cells, with pneumatization between the inner and outer tables of the frontal bone starting during the first few years of life. By age 12 to 13 years, the frontal sinuses are close to adult size. Accordingly, Pott's puffy tumor tends to be a complication of older children, with a predilection for being observed in preteen and teenage boys.<sup>6-9</sup>

#### Key Point

Complications of frontal sinusitis can occur in the early stages of sinus pneumatization.

Pott's puffy tumor can occur as a result of the spread of sinusitis to the frontal bone, with the development of osteomyelitis in the frontal bone and extension of purulent material anteriorly or posteriorly. Interestingly, it is also reported following trauma to the prefrontal region of the skull and surrounding soft tissues.<sup>10</sup> Pott's puffy tumor can be associated with subdural empyema, brain abscess, cortical vein thrombosis, and epidural abscess.<sup>11,12</sup> Because the mucosal venous drainage of the frontal sinus occurs through diploic veins of Breschet,

which communicate with the dural venous plexus, septic thrombi can potentially evolve from foci within the frontal sinus and propagate through this venous system. Intracranial involvement thus is possible with or without direct erosion of the frontal bone. In previously reported cases, cultured organisms consisted mostly of microaerophilic streptococci, including  $\alpha$ -hemolytic streptococci, *Peptostreptococcus* species, *Bacteroides* species, and other anaerobes such as *Fusobacterium* species. These organisms may be more common in the setting of Pott's puffy tumor compared with other otorhinologic infections because of the relatively lower oxygen concentration in the frontal sinus caused by compromised ostial patency.

Although a significant decrease in the incidence of disease of the frontal sinuses has occurred since the advent of antibiotics, serious complications of sinusitis continue to occur. Clinical presentation of patients with Pott's puffy tumor includes a range of findings, from mild illness (consisting of rhinorrhea, headache, and fever) to severe toxicity, including alterations in the level of consciousness and focal neurologic findings. Although the case patient's signs and symptoms referable to his orbital cellulitis improved, the development of swelling overlying the frontal sinus was an important clue suggesting an underlying osteomyelitis.

This case illustrates that suppurative complications of frontal sinusitis may initially be subtle and difficult to diagnose.<sup>13</sup> Inflammation and tenderness over the frontal sinus is often lacking, and intracranial extension, even to the point of frank frontal lobe abscess, may have minimal neurologic consequences beyond apathy or personality disturbances. For diagnosis, a high index of suspicion based on the history and clinical examination is essential. Forehead swelling, especially in a patient with a history of sinusitis and/or trauma, should not be regarded as a simple case of soft-tissue pathology. Radiologic evaluation, either by CT scanning or MRI, is an essential aspect of the evaluation of such patients.

#### Key Point

Suppurative complications of frontal sinusitis may initially be subtle and difficult to diagnose. A high index of suspicion based on the history and clinical examination is essential.

Treatment of Pott's puffy tumor typically requires consultation with an otolaryngologist for surgical removal of osteomyelitic bone, abscess drainage, and removal of granulation tissue. Neurosurgical evaluation may be necessary for management of intracranial complications. Appropriate antibiotic therapy should be given for at least 6 to 8 weeks. Furthermore, endo-

scopic sinus surgery may be necessary, as it was in this case, to re-establish patency of the frontonasal passage and allow for adequate drainage and ventilation of frontal sinuses.

#### Key Point

Treatment of Pott's puffy tumor requires a multidisciplinary approach including surgical drainage and prolonged antimicrobial therapy. Neurosurgical evaluation and sinus surgery may be necessary depending on the extent of the disease and the degree of antecedent sinus disease.

#### CONCLUSION

The case patient's clinical presentation clearly signaled the presence of sinusitis that was antecedent to his postseptal cellulitis and persisted throughout the course of his disease. Although the postseptal cellulitis responded to intravenous antibiotics, additional symptoms and signs necessitated re-evaluation in the emergency department. Sinus radiographs were insufficiently sensitive to rule out Pott's puffy tumor as a complication of his sinusitis, a diagnosis that should have been suspected on clinical grounds. As the morbidity associated with this case demonstrates, early diagnosis, aided by the use of appropriate imaging studies, is of the utmost importance in the management of Pott's puffy tumor.

Although recent studies suggest that conservative management of complications of paranasal sinus disease in children (consisting of antibiotics alone) results in outcomes as good as those traditionally achieved by antibiotics and sinus drainage,<sup>14</sup> in the present case, it is tempting to speculate that earlier, more aggressive surgical drainage of the patient's sinusitis may have prevented the later complication of Pott's puffy tumor. The finding of glabellar edema following an episode of documented sinusitis should suggest this rare but classic syndrome, first described with uncanny precision by an astute clinician in an era when neuroradiologic imaging was unavailable.<sup>15,16</sup>

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