Chapter 12: The complications of sinusitis

B. H. Pickard

In most cases sinusitis is uncomplicated and the effects are contained within the sinus cavity. It is the purpose of this chapter to draw attention to the effects of the spread of infection beyond the sinus wall and thus to influence the clinician first, by guiding his treatment in order to prevent the subsequent spread of disease, and second, by making him aware of the sinus origin of these complications when he sees them.

First are the systemic effects of sinusitis: pain, malaise, anxiety and pyrexia. Second are the effects on the nose of an infected discharge from an open sinusitis. Third, in a closed sinusitis, the disease may extend beyond the normal confines of the sinus, forward into the face, laterally into the orbit, upward and backward into the cranial cavity.

The type and activity of the infection will dictate whether an acute spreading infection such as orbital cellulitis or meningitis and encephalitis occurs or whether an abscess forms within the orbit or cranium, extradurally, subdurally or within the brain. Finally, infection may spread within the skull bones to produce an osteomyelitis.

Anatomy

The paranasal air sinuses consist of an ordered group of cavities within the bones of the skull. They are approximately symmetrical although the frontal sinuses in most skulls differ on the two sides and the sphenoid is seldom symmetrical. These discrete sinuses, in many places separated from each other by a thin sheet of bone, form a continuous system from the frontal sinus in the forehead through the ethmoid to the sphenoid below the sella turcica. The lower margin of the ethmoid labyrinth abuts on the maxillary sinus below.

The maxillary sinus (antrum of Highmore) is the largest and contains up to 15 mL of air in the adult. Mostly in the maxilla, it extends laterally into the body of the zygoma. It is shaped like a triangular pyramid with the base upward to form the orbital floor which is incomplete at its central thin part where it is traversed by the groove and canal of the infraorbital nerve. The medial wall is shared with the nasal cavity and is penetrated by one or two openings joining the sinus to the hiatus semilunaris in the middle meatus of the nose.

The anterior wall underlies the cheek and is thinnest at the canine fossa above which is the foramen through which the infraorbital nerve emerges. The posterolateral wall is attached to the pterygoid process laterally, forms the anterior wall of the infratemporal fossa and is closely related to the maxillary artery in its third part before it gives rise to the sphenopalatine and greater palatine branches which supply the posterior part of the nasal cavity.

The ethmoid sinuses, varying in number from three to 20 on each side, are closely packed together into the space between the medial wall of the orbit and the upper part of the nasal cavity. Above, they reach higher than the cribriform plate extending into the frontal bone each side of the ethmoid notch of the frontal bone. Below and laterally the lower cells are in contact with the upper medial recess of the maxillary sinus. Below and medially the
labyrinth is related to the middle meatus and middle turbinate which may contain a separate sinus.

The anterior and middle groups drain into the middle meatus and the posterior group into the superior meatus. It is not easy to define and distinguish these groups.

The most posterior sinus is the sphenoid which lies behind the most posterior ethmoid, completing the sequence posteriorly. If small, the sinus is situated in front of the sella in contact with that of the opposite side. If large on one or both sides, the cavity is in close proximity to the whole outer surface of the sella turcica which appears as a hemispherical prominence protruding into the cavity. The structures closely related to the sinus are the hypophysis (pituitary), the optic nerves and chiasma, the internal carotid arteries and the cavernous sinuses. Each sinus has a single opening into the sphenoid recess.

A fully developed frontal sinus is L-shaped in sagittal section and shows a vertical part extending into the forehead with a scalloped upper and lateral margin. The horizontal part spreads into the anterior and medial part of the roof of the orbit.

In some skulls the horizontal part is absent or replaced by an anterior ethmoid sinus. Throughout, the frontal sinus is closely related to the anterior cranial fossa being separated by the inner table, or dural plate, of frontal bone. Each sinus communicates with the anterior end of the hiatus semilunaris by the frontonasal duct. The frontal sinus is not present at birth but can be recognized from the age of 5 years. Commonly asymmetrical the sinus is sometimes absent on one or both sides.

**General effects of sinusitis**

**Pain**

In acute closed sinusitis the pain may be severe and the nasal effects minimal. The pain is felt at the sinus or referred to other areas supplied by the trigeminal nerve. Frontal sinus pain may be felt in the forehead, the orbit or as headache.

Maxillary sinus pain is felt in the situation of the sinus, in the upper teeth or above and lateral to the sinus. Although facial swelling may occur with maxillary sinusitis, it is uncommon.

Facial pain is more widespread in acute pansinusitis. In chronic closed sinusitis the pain is much less and extension of disease may present signs before the sinusitis is suspected.

**Systemic effects**

The acute inflammation of 200 cm\(^2\) of vascular mucous membrane by active organisms will allow sufficient toxic absorption to give general effects of prostration, malaise, pyrexia and tachycardia.
Nasal effects of sinusitis

Although the nose has been infected at the start of an acute sinusitis, in a closed sinusitis the nasal mucous membrane may return to normal giving neither signs nor symptoms of sinusitis. On the other hand, in an open sinusitis the escape of discharge into the nose will perpetuate a rhinitis. This rhinitis may be simple, hypertrophic or at worst atrophic.

The atrophic rhinitis complicating chronic sinusitis may present a difficult clinical problem if surgery is required to control the sinusitis since any surgery is likely to aggravate the atrophic changes and increase the crusting.

Mucocoele

In the course of an acute infection, chronic infection or as the result of injury, the opening of one sinus may be permanently stenosed. As a result, even after subsidence of the infection the pressure in the sinus cavity will increase as a result of continued secretion. A gradual expansion will result.

The stenosis of the ostium is most likely to occur in the frontal sinus where the narrow duct, approximately 2 mm wide, passes for a distance of 5-10 mm through the ethmoid bone in close relationship to the anterior ethmoid sinuses.

As the sinus expands with pressure, erosion of the bony walls occurs and the thinnest section - the orbital wall of the horizontal part - will most often (90%) give way first and the mucocoele will continue to expand into the orbit. If the cavity remains uninfected it may enlarge slowly without pain and considerable displacement of the eye may occur before the condition is recognized.

The differential diagnosis lies between a sinus enlargement and other causes of ocular displacement such as dyshormonal exophthalmos, orbital tumours and pseudotumours. Treatment is by immediate surgical exploration and the restoration of a permanent passage into the middle meatus of the nose.

When the displaced bone has been removed it is usual for the orbital contents and displaced periosteum to fall back into their correct position, but if displacement has been prolonged and extreme, the restoration may be incomplete.

In one in 10 of the frontal sinus mucocoeles the anterior wall will erode first and the swelling appear on the forehead. In a very small number expansion will occur through the posterior wall or dural plate, and subsequent expansion will invade the anterior cranial fossa. The picture may elude detection if the only signs are those of frontal lobe compression.

In children, a mucocoele from an ethmoid sinus is more common and will expand into the orbit as the thin lateral wall of the sinus (lamina papyracea) is expanded. The picture is very similar to that of frontal sinus expansion but with less downward displacement of the eye. In a young person the return of the displaced orbital soft tissue is more rapid.
If the orbital contents do not return sufficiently closely to their correct position, not only is the result unsightly but diplopia may persist. It may be necessary to correct the non-alignment by surgery to re-site the anterior attachment of the extraocular muscles.

**Expansion of the maxillary sinus**

The anatomy is such that sufficient obstruction of the ostia to permit expansion of the maxillary sinus by retained secretions is rare, but it is sometimes found in caseating sinusitis, cholesteatoma or as a result of facial fractures.

The expansion will occur by erosion or displacement of the two thin areas of the sinus wall, namely the canine fossa and the floor of the orbit through or close to the canal and groove of the infraorbital nerve. If the displacement is in the canine fossa, there is a gradual filling of the lower hollow part of the cheek with little or no pain. The swelling may develop over a period of months or years and be unnoticed by the patient. An upward expansion will present as a protrusion of the orbital contents, swelling of the lower eyelid and an upward and forward displacement of the eye.

Occasionally, simple drainage of the mucocoele by intranasal antrostomy may be sufficient. If there has been much displacement of bone a Caldwell-Luc operation will allow access to this displaced bone in order to restore the bony contours of the sinus to their normal position. If the upward bony displacement is too great to be replaced from below, a skin incision must be made along the inferior margin of the orbit. From this exposure the orbital periosteum is elevated. If possible all the bone is pressed down into its normal position but some may have to be removed. Care must be taken to identify and preserve the infraorbital nerve.

If the sinus has been expanded by cholesteatoma or caseating sinusitis the removal of all the lining is necessary to reduce the risk of recurrence.

**Spread of infection**

**Pharyngeal and laryngeal complications of sinusitis**

In open or discharging sinusitis the discharge is carried backward in the nasal cavity and descends through the nasopharynx into the pharynx. The mucous membrane will become infected and show a simple pharyngitis which is unresponsive to treatment. Spread of infection through the lining to invade the subepithelial lymphoid tissue will produce a granular pharyngitis with visible nodules as the lymphoid masses enlarge. Alternatively a dry atrophic pharyngitis may result.

In younger persons a chronic or recurring tonsillitis may be the first evidence of sinusitis. Further downward spread will give laryngitis or tracheitis and bronchitis but the relationship of sinusitis to bronchiectasis is not cause and effect but related underlying pathology.
Dental complications

The roots of the upper teeth, particularly the second premolar and first molar may lie in close proximity to a well-formed maxillary sinus. The tooth roots which project into the antrum are then covered by a thin layer of bone resembling the fingers of a glove. Extraction of one such tooth, even with the greatest care and after recognition of the special anatomical problems may result in an oroantral fistula, which can be recognized by the passage of air if the patient attempts a Valsalva manoeuvre which, on this occasion, means an attempt to exhale against the pinched nostrils with the mouth open.

The tooth socket should immediately be cleared of any tooth or bone fragments and a dental plate provided which will protect against the access of food. If the maxillary sinus is infected, either before the extraction or as a result of access of food and organisms via the fistula there is a risk of persistence of the fistula.

After 4-6 weeks of failure to heal, a surgical repair should be attempted. The sinus mucosa, which by now will have prolapsed into the fistula to form a polyp, should be excised along with the lining of the opening. A flap of buccal mucosa with the underlying periosteum can be raised, and with both ends attached, the centre is advanced medially and sutured across the hole. The only unfortunate result is a local loss of buccal sulcus which may make denture fitting difficult.

The alternative is a pedicle flap of palatal mucosa and periosteum, attached posteriorly to include the greater palatine artery. The bony edge of the fistula is reduced in order that the flap may lie without kinking. The free anterior end of the flap is turned laterally across the hole and sutured in place.

After repair the site should again be immediately protected by a dental plate.

Local spread of infection

Swelling of the face

Cellulitis may arise from frontal, ethmoid or maxillary sinusitis as the infection spreads in the subcutaneous tissues. There is mild pyrexia and some pain but the swelling may be localized or widespread over one half of the face, reaching from the mandible to the hairline and back to the ear.

Although the diagnosis of cellulitis may be clear, it is often difficult to establish the site of origin of the infection as a similar picture is given by spread from the teeth, skin pustule, lymph nodes, salivary glands or the outer ear.

The diagnosis of sinusitis as the cause is obscured by the overlying soft tissue swelling which gives an appearance of loss of transradiance on the usual X-ray views of the sinuses. Further examination of the films will show that the opacity extends beyond the limits of the sinus.
Abscess as an extension of chronic sinusitis is sometimes visible in the face. Direct forward extension through the thick anterior wall of the frontal sinus is rarer, but an abscess beside the bridge of the nose above the medial canthus is more common.

Ethmoidal sinusitis may give rise to an abscess below the medial canthus resembling an abscess of the lacrimal sac. An abscess of the cheek is rare in simple maxillary sinusitis but more likely in destructive or caseating sinusitis.

Surgical treatment of these abscesses is necessary once suppuration has occurred. The sinus itself must be explored and free drainage established for the abscess, either through the sinus cavity or by a separate drain. In attempting the latter it must be remembered that there is an area of osteitis between the sinus cavity and the abscess which, if left, may perpetuate the condition.

**Orbital extension**

The maxillary, ethmoid and frontal sinuses have extensive bony walls in common with the orbit.

**Extraperiosteal abscess**

In a chronic empyema of the sinus pus may seep through a natural opening in the bone, such as the canals for the anterior ethmoid or infraorbital vessels, or through eroded bone to form an extraperiosteal abscess within the orbital cavity.

If this abscess forms on the medial wall of the orbit the eye will be displaced forward, laterally and downward, whereas an abscess on the floor will displace the eye forward and upward. If the subperiosteal abscess is anterior, arising from the frontal or an anterior ethmoid sinus, a soft tissue swelling can be felt behind or above the medial canthus.

Antibiotic treatment combined with drainage of the abscess and the causal sinus is imperative to prevent damage to the orbital contents by further extension.

**Orbital cellulitis**

An acute infection can spread through the orbital periosteum to enter the orbital fat, wherein it can extend between the orbital muscles, nerves and blood vessels.

If an orbital cellulitis has developed the eyelids will be swollen but not red. On forcing open the eyelids the eye will be seen to be proptosed, the conjunctiva swollen and engorged and the eye movements restricted. The most worrying indication of the extent of the infection is a decrease in vision. This may be partial or complete and is sometimes permanent.

It is usually possible to arrest the damage to the orbital contents by high doses of antibiotics. An abscess may form and its position should be established by orbital scanning before a decision is made jointly with the ophthalmologist as to the method of drainage.
Cellulitis of the eyelids

An acute ethmoid sinusitis, usually in a young person, can spread forwards and laterally into the eyelids. There is soft tissue swelling with redness of the skin as the cellulitis develops in front of the orbital septum which is a fibrous layer running from the orbital margin to the tarsal plates.

The condition is dramatic, frightening and painful but much less dangerous than orbital cellulitis. When the eyelids are pulled apart the eye is seen to be in the normal position, the conjunctiva is normal, eye movements and vision are unaffected.

Cellulitis will usually resolve on medical treatment but occasionally an abscess will remain. In an older patient this complication is an indication for subsequent surgical treatment of the sinus as erosion of the bony wall is the common route of infection. In a child the underlying sinus disease will usually resolve completely without surgical intervention.

Intracranial complications of sinusitis

Despite the progress in medical treatment of sinus and ear disease, spread of infection from sinusitis and otitis media is the commonest cause of intracranial sepsis. The cavities of the frontal, ethmoid and sphenoid sinuses are closely related to and separated by a thin wall of bone from the anterior cranial fossa. The roofs of the ethmoid cells extend upward into the frontal bone each side of the ethmoid notch containing the cribriform plate and crista galli. Infection may spread toward the meninges by erosion of bone, by pressure within a sinus, by osteitis of the wall of a sinus or through the veins in the bone.

Meningitis and encephalitis

An acute infection entering the anterior cranial fossa will produce a localized or general meningitis. Further invasion will cause an encephalitis.

The clinical picture will change. The patient will become ill, the pyrexia will increase and the pain which was at first localized to the sinus will spread to a more generalized headache with vomiting, pains in the back and stiffness of the neck. Consciousness will be affected as the condition advances with clouding and later unconsciousness.

The cervical rigidity, head retraction and positive Kernig's sign will indicate the diagnosis, although ocular signs, papilloedema and decreased pupil reaction may not occur in the first few days. The bacterium responsible can only be established by lumbar puncture.

Treatment is energetic with heavy doses of a suitable antibiotic. When the intracranial infection has been controlled, the sinus responsible should be explored and permanent drainage established. In rare cases where the response to treatment is slow or if the condition, having improved, relapses, the sinus should be drained before the intracranial infection has been arrested.
Extradural abscess

Gradual erosion of bone by a chronic sinusitis, pyocele or infected mucocoele, may allow pus to collect between the dura mater and the bony skull wall.

The clinical picture may change little and gradually, the emphasis moving from sinus symptoms to a more general headache. An extradural abscess should be suspected if the symptomatic response to proper drainage of an infected sinus is not immediate and complete.

Treatment is by aspiration with instilling of an appropriate antibiotic. Rarely drainage or excision are needed if response is complete. The sinus responsible must be explored and drained.

Subdural abscess

Further inward extension of suppuration will produce an abscess between the dura and the brain. The clinical manifestations are more dramatic, there are pyrexia, fits and localizing neurological signs. Immediate treatment is by aspiration of the abscess and antibiotics are necessary to prevent permanent damage to the underlying brain.

Intracerebral abscess

As the frontal lobe of the brain is invaded the clinical picture will change. The patient may not appear severely ill at first and, if an abscess forms gradually in the brain tissue, the early signs may be drowsiness and apathy. Localizing signs do not appear early in a frontal lobe abscess but fits and papilloedema will appear as the abscess develops. Treatment is by a combination of antibiotics and aspiration of the abscess in the first instance with drainage of the sinus at a later stage unless there is rapid refilling of the abscess.

Cavernous sinus thrombosis

The venous cavernous sinuses lie on each side of the body of the sphenoid bone within which are the two sphenoid sinuses. The internal carotid artery, third and fifth nerves (especially the trochlear, ophthalmic and maxillary divisions) lie in the walls of the venous sinus. Tributaries of the cavernous sinus are the ophthalmic vein, various cerebral veins, sphenoparietal and central retinal veins.

Cavernous sinus thrombosis can result from infection in the orbit, on the face or in the paranasal sinuses. The illness appears suddenly with a sharp increase in temperature, pain in the eyes, proptosis and swelling of the conjunctiva and eyelids. The signs are usually bilateral as the thrombosis spreads to the second venous sinus.

Treatment is by antibiotics to control the local infection and pyaemia, and by anticoagulants to arrest the spread of thrombosis, but it still remains a dangerous condition.
Osteomyelitis

The cancellous portion of the vertical part of the frontal bone contains a large volume of bone marrow in the adult skull. In the infant, the body of maxilla contains bone marrow as well as the developing maxillary sinus. Both these sites can harbour an osteomyelitis secondary to sinusitis, the maxilla in the first year of life and the frontal bone in an adolescent or adult after full development of the frontal sinus.

Osteomyelitis of the maxilla in a child will present as a painful gradual swelling of the cheek and lower eyelid, with pyrexia and malaise. The infection usually subsides on medical treatment without pointing or discharge and surgical drainage is rarely necessary.

Osteomyelitis of the frontal bone is more extensive and dangerous. The area of potentially infected bone is greater and the proximity to the anterior cranial fossa allows intracranial spread.

As infection spreads from the frontal sinus into the frontal bone, pain does not increase immediately, but as the typical puffy tumour (Potts) appears there is severe pain. Treatment is energetic and medical, but surgical drainage and the removal of sequestra may be needed later. The final result may be a visible deformity of the forehead.

Barotrauma

This subject is covered in Volume 1, Chapter 7 but the specific aspects relating to the sinuses merit repetition.

Symptoms

In a healthy person the pressure changes in commercial flying are of little consequence. However, if there is any obstruction of the ostia, problems may occur. At first there is a mild discomfort with or without a sense of heaviness over the affected sinus and, whereas a Valsalva manoeuvre will usually relieve the ear symptoms at this stage, it is valueless in sinus barotrauma.

This discomfort will develop into pain which reaches its maximum when the aircraft lands. The pain will gradually subside over a period of hours or days as the low pressure is relieved by the development of an effusion in the sinus.

The acute condition can be relieved by a further ascent and sometimes will not recur if descent is more gradual.

In the rapid descent of unpressurized fighter aircraft the pain was sometimes sufficiently severe as to make it impossible for the pilot to maintain control.

Treatment

The frontal sinus is most often involved as a consequence of the anatomy of the frontonasal duct. Treatment is medical including analgesics for the pain and medication for
any underlying infection or allergic condition which may have predisposed to the obstruction. If the maxillary sinus is involved the acute pain may be relieved by antrum puncture.

**Prevention**

The main problem lies in the treatment of aircrew or passengers who repeatedly suffer sinus barotrauma after flight. The first step is to identify any anatomical or pathological disorder in the nose which would obstruct air entry into the affected sinus or sinuses. If such a disorder is treated the future attacks may be averted.

In rare cases, an antrostomy may be needed to bypass the natural ostium of a maxillary sinus which is inadequate. It is never justified to explore and drain the frontal sinus to prevent barotrauma. A prolonged abstinence from flying would be preferable.