Chapter 13: Acute suppurative otitis media and acute mastoiditis

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Acute suppurative otitis media is one of the most common diseases in childhood: this is because the middle ear cleft is readily infected from the nose and nasopharynx by way of the eustachian tube, and the incidence of such infections peaks in early childhood before maturation of the immune system. It does however occur at any age.

Definition

Acute suppurative otitis media

Acute suppurative otitis media is inflammation of the mucous membrane lining of the middle ear cleft (consisting of the eustachian tube, tympanic cavity, mastoid antrum and mastoid air cells) produced by pus-forming organism.

Acute mastoiditis

Acute mastoiditis, formerly a common complication of acute suppurative otitis media, is now rare in countries with well-developed primary medical care. While some degree of mastoiditis inevitably occurs early in the course of acute suppurative otitis media, since the middle ear and mastoid mucosa are in continuity, the clinical entity of acute mastoiditis consists of persistence of pain in and behind the ear despite adequate antibiotic therapy or time for natural resolution, together usually with persistence of otorrhoea, fever, and tenderness over the mastoid antrum.

Anatomy of the middle ear cleft

This is described in detail in Volume 1, Chapter 1. Here the reader's attention is drawn to the important ways in which the child's anatomy differs from that of the adult.

The eustachian tube

The eustachian tube is relatively shorter, wider and straighter in the infant and young child than in the adult. Hence infected material from the nose, adenoids and sinuses more readily passes along the eustachian tube to the tympanic cavity, particularly during feeding (especially in the supine position), coughing, sneezing and vomiting. Furthermore, the period when the tube is wider and straighter coincides with the period when children are particularly prone to upper respiratory infections and when they are also more likely to have a large mass of adenoid tissue. In older children and adults, forcible nose-blowing may propel infected mucus into the tympanic cavity.

The mastoid process

The mastoid process has not developed at birth and thus the stylomastoid foramen with the emerging facial nerve is relatively superficial in infancy and, therefore, the nerve is more easily cut by a postauricular incision. The mastoid process begins to develop during the
second year of life, by a downward growth of bone. When complete, at puberty, the stylomastoid foramen and facial nerve are then much more deeply placed on the inferior aspect of the skull deep to, and just anterior to, the mastoid process.

**The mastoid antrum**

The mastoid antrum is fully formed at birth but, as the mastoid process has not developed, it is very superficial, about 2 mm deep to the bony surface. It reaches the adult depth of about 15 mm at puberty. Thus, between infancy and puberty the antrum acquires an increased bony covering at the rate of approximately 1 mm per annum.

**The mastoid air cells**

Pneumatization of the mastoid bone occurs at the same time as the development of the mastoid process. Resorption of haemopoietic marrow occurs and, at the same time, mucous membrane from the antrum grows into the bony spaces so formed to line them, forming a complex system of interlinked air cells. Persistent infection of the bony framework of these air spaces constitutes the clinical entity of acute mastoiditis. In a small percentage of individuals, pneumatization does not take place, so although the mastoid antrum is always present, the mastoid bone is acellular and of 'ivory' type, and these patients do not develop acute mastoiditis. Intermediate types also occur, either as normal variants, or due to arrest of pneumatization by childhood ear infections.

**The tympanic membrane**

The tympanic membrane is fully formed at birth but is more horizontally placed, making access for myringotomy difficult. Along with the developments outlined above, it gradually assumes a more vertical plane.

**Acute suppurative otitis media**

**Aetiology**

**Route of infection**

*By way of the eustachian tube*

The relative incompetence of the eustachian tube in younger children is referred to above. The vast majority of infecting organisms reach the middle ear by way of the eustachian tube in both children and adults, most commonly from an ordinary head cold. Even after the eustachian tube reaches its adult, more protective, form, infection still reaches the middle ear by direct spread along the mucosa, or infected mucus can be propelled into the middle ear by forcible nose-blowing, sneezing, pressure changes as in flying, and forcing water up the nose as in jumping into swimming pools.
By way of the tympanic membrane

The route can be by way of the tympanic membrane, either due to a pre-existing perforation, when infected material may enter the middle ear during hair-washing, face-washing and swimming; due to a traumatic perforation by an unsterile object; or due to operative trauma, for example, myringotomy, tympanotomy, or through a ventilation tube.

Blood-borne infection

It is thought that some viral infections of the middle ear, including the acute specific fevers and influenza, may be blood-borne. While this chapter is concerned with acute suppurative otitis media and hence with pyogenic infection, pyococci frequently follow and invade tissues already affected by viruses.

Age

Acute suppurative otitis media is a common disease of childhood, with about five children in every 100 having at least one attack in their first 10 years (Lewis et al, 1967). The peak incidence is sometimes stated to be from 5 to 7 years, after which it declines rapidly. However, several studies have shown that the incidence is highest among preschool children, especially before the second birthday. In one such study of a population of 146822 of all ages living in various parts of Finland, about 50% of all cases of acute suppurative otitis media were found in infants under 2 years old (Pukander et al, 1982). The annual incidence in this study was 4.4%.

Sex

According to Bordley, Brookhouser and Tucker (1986) 60-65% of otitis media cases in children are males. The Finnish study referred to above showed that the annual attack rater was 4.84% in males and 4.07% in females. No rationale for this apparent inequality has been identified.

Socio-economic factors

The incidence is highest in low hygiene populations, and under conditions of overcrowding and malnutrition.

Climate

A higher incidence of acute suppurative otitis media is seen in cold climates, especially in winter. The incidence is also higher in urban areas than in the country.

Racial factors

Studies in the USA (Brodley, Brookhouser and Tucker, 1986) have shown a higher incidence of acute suppurative otitis media in white children compared with black; a particularly high incidence is seen in Eskimos and American Indians.
Nasopharyngeal tissue masses

Adenoids

Adenoids tend to block the eustachian tubes and also to act as a focus on infection from which organisms pass up the tube. However, controversy continues as to the exact role of the adenoids in acute suppurative otitis media as well as in non-suppurative middle ear effusions. Maw (1985) has shown that adenoidectomy is beneficial in resolving middle ear effusions, although the age of the child might be more significant, as children over 6 years showed better clearance than children under 6. It can be argued that the presence of adenoids, in impending eustachian tube function, would play a similar role in acute suppurative otitis media. McKee, as long ago as 1963 in two careful studies showed evidence of the effectiveness of adenoidectomy in significantly reducing the incidence of acute suppurative otitis media. Interestingly, he also showed that adenoidectomy alone was as effective in reducing acute suppurative otitis media as adenoidotonsillectomy, suggesting that tonsils rarely play any part in the aetiology. McKee also commented on the importance of age, the worst results having been achieved in children over 8, in whom the number of attacks would be declining anyway. However, it is well known that both children and adults with no adenoids can suffer frequent otitis media due to the many other factors involved. Careful assessment of the possible role of adenoids, as compared with other aetiological factors, in each individual case, is therefore mandatory.

Other nasopharyngeal masses

These act in a similar way to adenoids and include polyps, teratoma, angiofibroma, lymphoma and, in adults, carcinoma (see Volume 4, Chapter 19).

Respiratory disease

Chronic rhinitis and sinusitis produce a constant flow of infected mucus which may enter the eustachian tubes, while the infected sputum of bronchitis, bronchiectasis and pneumonia may also be coughed into the nasopharynx and enter the tubes.

Allergy

The importance of allergy as an aetiological factor in acute suppurative otitis media is still debatable. While allergic oedema of the eustachian tube undoubtedly occurs and might provide a rationale for recurrent acute suppurative otitis media in some cases, many atopic subjects have no ear problems.

Pre-existing middle ear effusion

A pre-existing middle ear effusion may act as a ready culture medium for invading pyococci.
Immunodeficiency syndromes

Immunodeficiency syndromes, including hypogammaglobulinaemias, are rare but important causes of recurrent upper respiratory infections including acute suppurative otitis media, and should always be excluded when recurrences are very frequent.

Chronic systemic disorders

Chronic systemic disorders undoubtedly predispose to acute suppurative otitis media as they do to other infective disease. Examples occurring in both children and adults are diabetes, leukaemias, anaemias, cystic fibrosis and nephritis.

Cleft palate

Children with cleft palate have a high incidence of middle ear disease, either acute suppurative otitis media or otitis media with effusion, due to eustachian tube dysfunction secondary to the tensor palati anomaly.

Primary ciliary dyskinesia

Primary ciliary dyskinesia, although excessively rare and more usually associated with otitis media with effusion, can also contribute to recurrent acute suppurative otitis media.

Pathology

Microbiology

While acute suppurative otitis media is appropriately considered as a bacterial disease, viruses undoubtedly play a role in many cases, paving the way for pyococcal invasion. Attempting to culture viruses from the middle ear in acute suppurative otitis media has a low yield of about 5% - possibly they are inactivated or absent by the time the full clinical picture has developed. At the present time, the most commonly isolated pathogens are Streptococcus pneumoniae and Haemophilus influenzae; the next most common are group A beta-haemolytic streptococcus, Staphylococcus aureus, and Neisseria catarrhalis. Gram-negative bacilli such as Pseudomonas aeruginosa, various Proteus species and Klebsiella pneumoniae have also been reported.

Middle ear inflammatory process

This can proceed quite rapidly, and consists of a stage of mucosal oedema with increased secretion, followed by hyperaemia, white cell infiltration and pus formation. This process clearly cannot be limited to the tympanum since the air spaces and mucosa of the entire middle ear cleft are in continuity; hence, tubal occlusion occurs due to mucosal swelling, preventing drainage, and involvement of the mastoid air cells also occur. If pus accumulates under pressure and there is tubal occlusion, the tympanic membrane may rupture. Destruction of cilia, normally present in the anterior part of the tympanum and in the tube, contributes to the poor drainage of thick secretions through the tube.
Spread of infection

Spread of infection can occur due to retrograde thrombophlebitis, bone necrosis, congenital dehiscences and fracture lines, as follows:

1. intracranially, giving rise to extradural abscess, subdural abscess, meningitis, brain abscess, lateral sinus thrombosis, and otitic hydrocephalus;
2. to the labyrinth causing suppurative labyrinthitis;
3. to the facial nerve canal, causing facial paralysis;
4. to the neck, by breaking through the mastoid tip, producing Bezold's or Citelli's abscess;
5. to the petrous apex.

Details of (1) and (2) can be found in Volume 3, Chapter 12.

Symptoms

The variation in the clinical picture in any infection is due to the varying virulence of the invading microorganism, varying host defence, and effectiveness of and compliance in treatment.

Acute suppurative otitis media can vary from a relatively minor attack of earache with tympanic membrane hyperaemia lasting a few hours, to a fulminating febrile illness perhaps with complications requiring surgery.

By far the most common presenting symptom of acute suppurative otitis media is pain in the affected ear or ears which is accurately described and well located by older children and adults, who point to the ear canal and say the pain is 'deep inside', and frequently severe and throbbing. Children too young to describe their pain tend to pull at the ear lobe, or repeatedly push the ear into their pillow. The child may already be irritable, restless, off his food and seem feverish, or these symptoms may develop some hours after the onset of pain. Usually the attack will have been preceded by an upper respiratory infection, and symptoms and signs of this may be present. Deafness in the affected ear or ears will soon be noticed by older children and adults; the disease is often bilateral in children and the parents of young children would notice deafness in these cases, but in unilateral cases it may not be apparent.

At this stage the disease may not progress and will gradually resolve, with the pain subsiding and the hearing gradually recovering.

In many cases, however, it proceeds to a stage of intense pain, followed by rupture of the tympanic membrane and a complaint of aural discharge. A small percentage of both children and adults also complain of giddiness.
There may be a history of one or more of the predisposing factors described under aetiology.

**Signs**

Before describing these it is important to consider the method of examining young children. It is of the utmost importance to gain their confidence as there may be only one chance to examine them - an abortive or clumsy attempt at otoscopy may result in a distraught and terrified child who will not submit to examination a second time. Children can be thought of as miniature adults with their own name and distinctive personality, and their own (sometimes inappropriate) views as to how the consultation should be conducted. They fear pain and the unknown, and should therefore be examined with the utmost gentleness, speaking to the child by name and reassuring him that by keeping still the examination will not be painful. The best position for examination is on the mother's lap: she holds the child's head against her chest with one hand on his forehead, and with her other hand restrains his arms. If possible the child's legs should be held firmly by the mother between her thighs.

**Ears**

In the early stages of acute suppurative otitis media the tympanic membrane will be injected along the handle of the malleus, around the periphery, and sometimes over the pars flaccida. Later the whole tympanic membrane becomes hyperaemic and opaque. If infection continues and pus begins to accumulate under pressure, the pars tensa starts to bulge, mainly posteriorly, and acquires yellowish colour. Finally the tympanic membrane ruptures and discharge will be seen in the external canal, which may be serous, serosanguineous, mucopurulent or frankly purulent. It is important to note whether the discharge has the shiny, glossy appearance of mucus - if the discharge contains mucus it can only come from the middle ear. The presence or absence of an offensive odour from the discharge should also be noted - if present it suggest underlying chronic otitis media. (See also Differential diagnosis below.) At this time the pain usually subsides. After mopping or aspirating discharge it is usually possible to see a small central perforation, commonly in the posterior segment of the pars tensa. Sometimes, however, the perforation may be difficult to see as the oedematous edges of the middle ear mucosa tend to obscure it. It may be located by applying a negative pressure with a Siegle's speculum, or aspirating under the operating microscope, when a blood or discharge may be seen emerging from the perforation. The perforation may also be anterior, but is only marginal or in the pars flaccida in acute-on-chronic middle ear disease. If the infection has followed trauma to the tympanic membrane a jagged perforation may be seen. If a ventilation tube is *in situ*, pus may be seen pulsating through the lumen.

Mastoid tenderness, elicited by pressure over McEwen's triangle, may be present early in the course of acute suppurative otitis media. It assumes significance as a sign of mastoiditis if it persists or increases despite adequate treatment.

During resolution the hyperaemia fades and the perforation heals, often leaving no trace but sometimes leaving a scar.

In older children and adults the Rinne and Weber tests will indicate conductive deafness. In younger children the hearing for a whispered voice will be impaired.
Nose and throat

As stated, the commonest cause of acute suppurative otitis media is the common cold, and examination of the nose and throat may show inflammation of the mucosa and nasal mucoid discharge. If there is bacterial rhinitis and/or sinusitis, mucopurulent or purulent nasal and postnasal discharge may be seen. Sometimes there is also acute adenoiditis with yellow patches of purulent exudate similar to tonsillitis.

General signs

Children are frequently febrile, but adults rarely so. A temperature of 40°C is not unusual in children. The disease may present in neonates as a pyrexia of 'unknown' origin, occasionally even with meningitis. Other general signs would be those of any underlying general or predisposing condition.

Signs of complications

Acute suppurative otitis media may be a serious illness. Complications may develop rapidly and it is necessary to be alert to the signs of these.

Tenderness and oedema over the mastoid process with protuberance of the pinna indicate mastoiditis, as do sagging of the posterosuperior canal wall, and granulation tissue pouting through the perforation, with discharge persisting for 3-4 weeks from the onset. (See also below, Differential diagnosis and Acute mastoiditis.)

Sick children should always be tested for neck stiffness, and in severe cases a thorough examination of the central nervous system should be carried out to exclude intracranial complications. Nystagmus must be looked for in patients complaining of vertigo, and the fistula test carried out.

Investigations

Microbiology

In all cases when otorrhea is present, an ear swab should be taken for culture and sensitivity of organisms. It is not necessary routinely to culture for viruses, since these are seldom found and there is no specific treatment anyway. If the ear is not discharging it is often useful to take nose and throat swabs, since the ear will usually contain the same organisms.

Blood studies

A full blood count including differential white cell count is helpful in patients with acute suppurative otitis media. In very ill patients, or those in whom complications, particularly intracranial ones, are suspected, a rising leucocyte count may be the only indication that pus is accumulating somewhere as other symptoms and signs may be
diminished by antibiotic treatment. The full blood count will also exclude or identify leukaemias, anaemias and neutropenia.

Quantitative immunoglobulin electrophoresis to detect varying degrees and types of hypogammaglobulinaemia should also be carried out in patients with frequent attacks of acute suppurative otitis media.

Audiometry

Pure tone audiometry needs to be performed fairly early in the course of acute suppurative otitis media, but need not be done when the patient is in severe pain and febrile. It will obviously show conductive deafness, but its value lies in establishing a baseline and monitoring the resolution of the disease.

Tympanometry should not be carried out in the acute stage as it is painful and adds no useful information, but again when improvement begins it can be undertaken to establish a baseline as, not infrequently, acute suppurative otitis media leaves an unresolved middle ear effusion.

Mastoid X-rays

X-rays are only required if mastoiditis is diagnosed. Clouding of the mastoid air cells is always present in acute suppurative otitis media, but when there is doubt as to whether mastoid surgery is needed, X-rays are useful as evidence of breaking down of air cells (coalescent mastoiditis) will strengthen the indications (see Volume 1, chapter 17.)

Urine examination

Urine examination is carried out in recurrent cases to exclude diabetes.

Diagnosis

This is usually straightforward and is based on the history of earache, deafness, and perhaps otorrhoea, probably preceded by a respiratory infection, together with the inflammatory changes found on examination which have been described above. However, there are some pitfalls and these are discussed later.

Differential diagnosis

This is considered later under Acute mastoiditis.

Prognosis

In this antibiotic era complete resolution of acute otitis media is the rule, with absence of complications, healing of the tympanic membrane, and restoration of normal hearing. In a few, a sterile middle ear effusion or a perforation persists. Only a very small percentage proceed to acute mastoiditis. The life-threatening intracranial complications are very rare, and are more often associated with a pre-existing chronic otitis media.
Complications

Mastoiditis

Mastoiditis may also lead to postauricular abscess or Bezold's and Citelli's abscess.

Facial paralysis

This subject is discussed in Volume 3, Chapter 24. Here it can be stated that facial paralysis occurring in the course of acute suppurative otitis media or acute mastoiditis almost invariably recovers completely with medical or surgical treatment of the primary condition; surgery of the nerve trunk is not required.

Intracranial complications

Extradural abscess, subdural abscess, meningitis, brain abscess, lateral sinus thrombosis and otitic hydrocephalus may occur.

Labyrinthitis

Labyrinthitis can also occur.

Petrositis

Petrositis and Gradenigo's syndrome are both complications.

Mastoiditis and petrositis are described below. Intracranial complications and labyrinthitis are rare nowadays but when they do occur it is more commonly in association with chronic otitis media. These conditions are described in Volume 3, Chapter 12.

Sequelae

(1) Persistence of a sterile middle ear effusion after resolution of the acute inflammatory stage, causing persistence of hearing impairment.

(2) High-tone sensorineural deafness, usually mild, presumably due to the inflammatory process involving the deep surface of the round window membrane.

(3) Persistent perforation of the tympanic membrane can occur, more particularly in debilitated patients who have suffered a fulminating attack of acute suppurative otitis media leading to more widespread necrosis of the tympanic membrane; discharge may also persist, and the disease may evolve into chronic suppurative otitis media.

(4) Extensive scarring of the tympanic membrane, middle ear adhesions and resorption of ossicles may occur in recurrent cases (adhesive otitis). Hyalinized collagen deposits in the middle ear and tympanic membrane (tymanosclerosis) may also occur.
Treatment of acute suppurative otitis media

Treatment of acute suppurative otitis media is considered under the following headings:

(1) curative
   medical
      general
      analgesics
      topical
      antibiotics
      [decongestants]
      surgical - myringotomy

(2) [prophylactic]

(3) treatment of associated conditions

(4) treatment of complications.

The square brackets indicate treatment modes not generally considered to be appropriate.

Curative

Medical treatment

General

Both children and adults are best managed in bed in the acute phase, in a warm room, of adequate humidity to maintain ciliary function. Febrile and toxic children will need no persuasion to stay in bed; afebrile children can be allowed up but kept indoors. As in any infective illness, nourishment and fluid intake must be adequate, and supplementary vitamins, especially C, can be added if the patient's normal diet is thought to be inadequate. Some patients, both children and adults, are better managed in hospital, depending on the severity, length of history, response to previous treatment, and other factors such as association with diabetes or other illness. Hospitalization provides the opportunity for frequent observation of the general and local condition, and for investigations, if complications are suspected or surgery is considered.

Analgesics

These must be given in adequate dosage and with sufficient frequency to control pain.

Topical

When otorrhoea is present the discharge should be gently mopped with dry sterile cotton wool or sucked from the canal, as often as it recurs. A piece of cotton wool can be placed at the orifice of the ear canal to prevent the discharge running down and excoriating the skin of the ear lobe.
**Antibiotics**

Most otologists and primary care physicians in the UK would favour early administration of antibiotics in all but the most minor cases, despite the fact that some cases may be viral, and notwithstanding the need to avoid overprescribing. Van Buchem, Peeters and Van't Hof (1985) disagree with this and advocate withholding antibiotics for 3-4 days, asserting that the vast majority of cases recover with symptomatic treatment only. However, the widely observed and rapid decline, since the advent of antibiotics, of acute mastoiditis, formerly an extremely common complication of acute suppurative otitis media, supports the concept that antibiotics limit the disease and minimize its consequences. Minor cases in which the pain lasts for only a few hours do not require treatment, nor those in whom pain is very slight. In practice a 'trial' of no treatment is usually inevitable as it may be 12-24 hours before the patient can obtain medical care.

*Route of administration.* Oral administration is the route of choice except in very severe cases. In these one or more antibiotics may be given intravenously.

*Duration.* Antibiotics should usually be given for 5-10 days, depending on the severity of the case. If a patient is treated at home the importance of treatment compliance should be emphasized.

*Choice of antibiotic.* Administration should not be begun before an ear swab is taken (or nose and throat swabs if the ear is not discharging), but after this there is no need to wait for the result. Amoxycillin is a useful first-line treatment as it is well tolerated and the common bacteria of acute suppurative otitis media are usually sensitive to it. Other useful antibiotics are erythromycin, trimethoprim, trimethoprim with sulphamethoxazole (co-trimoxazole), and cefaclor. Severe and fulminating cases can be given a combination of ampicillin, flucloxacillin and metronidazole intravenously.

The response to the chosen regimen should be monitored carefully and, if ineffective, it should be altered according to the results of the swab cultures and organism sensitivities.

**Decongestants**

Both systemic and topical decongestants are often prescribed in the hope that they will improve the patency of the eustachian tube and thus improve middle ear drainage. The use of systemic decongestants has a logical basis as pseudoephedrine and phenylephrine have been shown to increase tubal patency in dogs (Jackson, 1971); unfortunately, however, many trials have now shown that systemic decongestants are no better than a placebo in the management of middle ear disease. Admittedly, some trials were more concerned with secretory otitis media but Olson et al (1978) studied 169 children with acute suppurative otitis media and treated all with antibiotics plus either pseudoephedrine or placebo; the outcome was the same in both groups. Possibly the doses commonly used do not produce effective vasoconstriction, or vasoconstriction may occur, only to be followed by the rebound phenomenon observed in the nose after the use of some nasal sprays. Since systemic administration of pseudoephedrine and similar compounds may sometimes cause sleep disturbance, irritability and, occasionally,
psychotic symptoms, especially in children, the conclusion is inescapable that their use is unwise.

Topical decongestants are also widely prescribed but the passage of drops or nebulized particles through the nose and nasopharynx seems hardly likely to produce a useful effect on the eustachian tube. Lilholdt et al (1982) did not find any improvement in eustachian tube function in children with proved severe tubal dysfunction after their noses were sprayed with either oxymetazoline hydrochloride or placebo. The use of topical decongestants in acute suppurative otitis media is not recommended as they are unlikely to produce a useful effect on the eustachian tube.

**Surgical treatment**

While the vast majority of ears with acute suppurative otitis media will respond to the above regimen of appropriate antibiotics, bed-rest and analgesia, and while some tympanic membranes will rupture spontaneously with or without treatment, in a very small minority there is persistence of pain and temperature with a red bulging tympanic membrane despite adequate medical management. Myringotomy should then be undertaken with a view to releasing pus accumulating under pressure.

The operation is carried out under general anaesthesia using an operating microscope, and with full aseptic procedures. The patient is placed supine on the operating table with the head turned to one side. Using an aural speculum and angled myringotome, a radial incision is made in the posteroinferior segment; the maximum bulging is posterior in acute suppurative otitis media, and the inferior incision avoids the risk of damaging the ossicular chain, chorda tympani and facial nerve. Pus then gushes out under pressure, and a swab is taken and sent for culture and sensitivities. Residual pus is gently sucked out. The incision should be about 3-4 mm in length; tiny incisions tend to heal too quickly and allow put to reaccumulate in the middle ear cleft. Ventilation tubes should not be inserted in acute suppurative otitis media.

Postoperatively, on recovering from anaesthesia the patient will usually say that the earache has disappeared, and generally the temperature quickly returns to normal. Antibiotic treatment is continued until resolution is virtually complete, but the regimen is changed if necessary as soon as the results of the swab taken at operation are known.

**Prophylactic treatment**

Long-term daily treatment with antibiotics or sulphamethoxazole has been shown to be effective in reducing the number of episodes in patients prone to acute suppurative otitis media. However, all antibiotics are potentially toxic and long-term prophylaxis with oral antibiotics is not generally recommended as the risks may be greater than the risk of another attack of acute suppurative otitis media. (Note that this statement applies only to recurrent acute suppurative otitis media and it is recognized that there may be a place for such prophylaxis in other conditions.) Occasionally acute suppurative otitis media occurs so frequently and with such severity that a trial of continuous antibiotic treatment, especially in the winter, is justified.
Treatment of associated conditions

The treatment of acute suppurative otitis media, especially when recurrent, should include a search for and management of treatable associated disease. The role of the adenoids has been considered under Aetiology above, and many otologists would consider it necessary to remove the adenoids in some cases of recurrent acute suppurative otitis media. Adenoidectomy should be carefully and thoroughly performed with special attention to removal of adenoid tissue from the fossae of Rosenmüller. Rhinitis and sinusitis should also be looked for and treated vigorously. The presence of lower respiratory infection requires treatment with the help of a paediatrician or respiratory physician. Other conditions referred to under Aetiology must receive the appropriate management, for example early repair of cleft palate.

Treatment of complications and sequelae

Persistence of middle ear effusion

This is a common sequel to an attack of acute suppurative otitis media and therefore there must be careful follow-up of each case, with otoscopy supplemented by tympanometry and pure tone audiometry as necessary, until complete resolution occurs or persistence of fluid is found. The management is described in Chapter 12.

Persistent perforation of the tympanic membrane

See Volume 3, Chapter 10.

Labyrinthitis and intracranial complications

These are described in Volume 3, Chapter 12.

Facial paralysis

Facial paralysis occurring in the course of middle ear cleft infection is usually due to a dehiscent facial nerve canal - when the infection is controlled in most cases the facial nerve recovers.

Mastoiditis and petrositis

Mastoiditis and petrositis are described below.

Acute mastoiditis

Aetiology and pathology

In developed countries with effective primary and secondary health care, acute mastoiditis is nowadays rare, largely due to the widespread use of antibiotics for acute suppurative otitis media. However, if the preceding attack is untreated, or fails to respond, the inflammatory process will persist and increase in the mastoid air cells. The accumulation of
pus in the air cells leads to necrosis of the bony walls of the cells producing the so-called 'coalescent mastoiditis'. For a time the disease may remain walled off within the mastoid bone, but eventually it will spread:

1) laterally through the lateral outer table of the mastoid bone to give a subperiosteal abscess and, if pus ruptures through the periosteum, a subcutaneous abscess.

2) superiorly and posteriorly, giving rise to:

   (i) extradural abscess
   (ii) subdural abscess
   (iii) meningitis
   (iv) brain abscess of (a) the temporal lobe or (b) the cerebellum
   (v) lateral sinus thrombosis
   (vi) otitic hydrocephalus

3) medially causing labyrinthitis or petrositis and Gradenigo's syndrome

4) inferiorly through the mastoid process tip or medial wall causing Bezold's abscess, caused by pus tracking along the sternomastoid muscle or Citelli's abscess caused by pus tracking along the posterior belly of the digastric muscle

5) anteriorly to the facial nerve canal causing facial paralysis, and also to the postero-superior external auditory canal wall, causing the appearance of sagging of the meatal skin in that area.

**Predisposing factors**

These are the same as described above for acute suppurative otitis media. The disease can occur at any age, but is far more common in children.

**History**

The patient will have had an attack of acute suppurative otitis media, with the characteristic symptoms and signs described above, anything from a few days up to 3 or 4 weeks previously. The attack of acute suppurative otitis media will probably have been preceded by a head cold or other upper respiratory infection or, in children, by an acute specific fever, such as measles or scarlet fever.

**Symptoms**

**General**

Mastoiditis is frequently a serious illness with pyrexia and general malaise. Fever, restlessness and refusal of food may be the only symptoms in very young children.
Local

Commonly there is persistence of earache, otorrhoea and increasing hearing impairment, from the time of onset of the preceding acute suppurative otitis media. Sometimes the original symptoms abate, especially if antibiotic treatment has been given, only to recur, together with fever, some 2-4 weeks later. Occasionally the only symptom is persistent profuse otorrhoea. The patient may complain of nasal obstruction or nasal discharge. The presence of unilateral headache is a danger sign suggesting the onset of intracranial complications. Similarly a complaint of giddiness is a warning that labyrinthitis is imminent, or developing.

Signs

General

The patient will frequently appear pale, ill and restless. There may be pyrexia of 40°C or more in children, though in adults pyrexia may be low or absent.

Local

External auditory canal

On examination of the external auditory canal, there may be discharge, either mucopurulent or purulent, but seldom offensive, unless acute disease has occurred on previously chronic otitis media; the discharge may be seen to pulsate through a perforation. Sagging of the postero-superior canal wall may be present.

Tympanic membrane

Perforation of the tympanic membrane is almost invariably present, and is nearly always postero-central - occasionally, however, mastoiditis can develop behind an intact tympanic membrane, which will appear red and full or bulging.

Granulations or a polyp, bright red in colour, may be seen pouting through the perforation when disease has been present for weeks rather than days.

Signs of complications such as severe headache, drowsiness, vomiting, and neck stiffness are serious indications of intracranial complications and must prompt an immediate and thorough examination of the central nervous system. Vertigo with nystagmus suggests labyrinthitis.

Postauricular area

Mastoid tenderness elicited by pressure over McEwen's triangle, will invariably be present. It will probably have persisted from the onset of the preceding acute suppurative otitis media attack, and may increase.
Swelling over the mastoid bone may be present, and if so either the postauricular groove is accentuated indicating that the pus is still subperiosteal, or the postauricular groove is absent, because either the periosteum has given way and the pus is subcutaneous, or there is simple inflammatory oedema over the mastoid.

The presence of fluctuation will distinguish the later abscess formation from the earlier simple inflammatory oedema.

Protuberance of the pinna can occur either due to simple inflammatory oedema over the mastoid, or to subcutaneous abscess; subperiosteal abscess with retention of the postauricular groove does not push the pinna forwards unless the abscess is very large.

Investigations

These are the same as for acute suppurative otitis media but the points below should be remembered.

Microbiology

It is particularly important to obtain an ear swab and an early report on the culture and sensitivities in case the organisms are not sensitive to the first treatment. Patients, particularly children, may have a serious illness which in turn may lead to further complications such as meningitis, and valuable time will be lost in treating this potentially lethal condition if culture is not performed. In more severe cases initial blood cultures are also indicated.

Blood studies

A full blood count should be carried out promptly, and repeated during the course of the disease. A rising leucocyte count invariably indicates pus accumulating and unless there is an obvious cause such as a fluctuant postauricular abscess, signs of intracranial spread must be looked for.

Audiometry

A pure tone audiogram may show as much as 40-50 dB of conductive hearing loss; comparison with an audiogram performed during the preceding acute suppurative otitis media attack may show that the hearing loss has increased. If the patient is ill, or the mastoid is very tender, only Rinne and Weber tests are called for.

Mastoid X-rays

While seldom required in simple acute suppurative otitis media, X-rays will show not only clouding of cells, which is always present in acute suppurative otitis media but also breaking down of bony air cell walls, indicating progressive disease, or coalescent mastoiditis. The films are also a useful guide, if surgery is required, as to the extent of pneumatization, which varies greatly (see Chapter 2).
Diagnosis

Diagnosis is made on the history, symptoms and signs, supported by X-rays, as already described. The principal features can be summarized as follows: an attack of acute suppurative otitis media fails to resolve and is followed by persistent or recurrent earache, pyrexia and otorrhoea, increasing deafness, together with mastoid tenderness and sometimes a protuberant pinna.

Differential diagnosis of acute suppurative otitis media and acute mastoiditis from other conditions

Acute suppurative otitis media

Acute suppurative otitis media may sometimes have to be distinguished from the following conditions.

Otitis externa

Otitis externa may also give earache and otorrhoea, and the tympanic membrane may appear red as the outer layer is in continuity with the canal epithelium and is frequently involved in the inflammatory process. The discharge is frequently watery, but if purulent it never has the shiny, glossy appearance of middle ear discharge due to the presence of mucus. The hearing in otitis externa is normal or only slightly impaired (except when the canal is blocked by discharge), whereas in acute suppurative otitis media the hearing loss is usually more marked. Itching is a very common feature of otitis externa, but does not occur in acute suppurative otitis media. Very severe otitis externa may mimic acute mastoiditis (see below).

Tympanic membrane hyperaemia

The whole tympanic membrane can become quite diffusely red in a child who is crying. Since he may be crying because he has earache, time must be allowed for him to settle down and then the examination is repeated. The insertion of an aural speculum may cause slight flushing down the handle of the malleus and round the periphery of the pars tensa, so examination should be very gentle to avoid confusion with this early sign of developing acute suppurative otitis media.

Otitis media with effusion

The tympanic membrane may sometimes look pinkish and opaque, but is never as intensely red as in acute suppurative otitis media.

Myringitis haemorrhagica bullosa

This condition frequently occurs during epidemics or respiratory viruses such as influenza, and is characterized by excruciating earache followed by a small quantity of serosanguineous discharge. Inspection of the tympanic membrane shows either the presence of haemorrhagic blebs, or the outlines of ruptured blebs. When uncomplicated the hearing is
usually normal. Secondary bacterial invasion of the middle ear may occur, so the two conditions may coexist.

**Other causes of otalgia**

There are many causes of otalgia remote from the ear itself, and these are discussed in Volume 3, Chapter 13. The diagnostic point here is that the patient with pain referred to the ear from some other structure will have a perfectly normal tympanic membrane and hearing.

**Acute mastoiditis**

This may have to be distinguished from the following conditions.

**Acute severe otitis externa**

Acute severe otitis externa is usually localized in the form of a furuncle. This may lead to really marked postauricular oedema and protuberance of the pinna and this, together with severe earache and some purulent otorrhoea, produces the resemblance to acute mastoiditis. However, in furunculosis there is severe pain on pushing the tragus gently in and on pulling gently on the pinna; this does not occur in acute mastoiditis. There will be no history of a preceding attack of acute suppurative otitis media. The hearing is usually normal or only slightly impaired (unlike mastoiditis) unless the canal is completely occluded by swelling or discharge. If the postauricular groove is accentuated, this is a sign of subperiosteal pus which has spread from the mastoid. X-rays of the mastoids will show apparent cloudiness of the air cells in either condition (due in external otitis to the overlying oedema), but if breaking down of the bony mastoid air cell walls is shown, this indicates that mastoiditis is present.

**Postauricular lymphadenitis**

Very rarely, suppuration in a postauricular lymph node, due to infection in the skin or scalp, may cause confusion. However the tympanic membrane, external auditory canal and hearing will all be found to be normal.

**Erysipelas**

Erysipelas may occasionally affect the skin of the postauricular area, and resemble mastoiditis because of pain, fever and red oedematous skin. However, careful examination will reveal a raised, red spreading edge of the lesion, contrasting sharply with the normal pale adjacent skin. The external canal skin, tympanic membrane, and the hearing will all be normal.

**Complications of acute mastoiditis**

These have been referred to under Pathology and will not be described here, except petrositis. The reader is reminded that labyrinthitis and the intracranial complications are discussed in the chapter on complications of otitis media (Volume 3, Chapter 12).
**Acute petrositis**

The degree of pneumatization of the temporal bone is extremely variable, but may extend right through the petrous bone to its apex. If so, when there is mastoiditis, there is nothing except host defence and timely treatment to prevent infection spreading right to the petrous apex. However, acute petrositis is now excessively rare, and even in the preantibiotic era it was not common.

**Clinical picture**

The clinical picture is that of the preceding acute suppurative otitis media and acute mastoiditis which fails to respond to treatment, sometimes even if this included cortical mastoidectomy. There is persistence of earache and temperature, then pain is felt in the distribution of the ipsilateral trigeminal (fifth cranial) nerve. Finally, involvement of the ipsilateral abducent (sixth cranial) nerve gives rise to diplopia, and examination of the eye movements will show paralysis of the external rectus muscle of the eyeball on the affected side (sixth nerve paralysis).

**Gradenigo’s syndrome**

The features of this are acute infection of the middle ear cleft, associated with discharge of pus from the ear, pain in the distribution of the trigeminal nerve and sixth nerve paralysis. The syndrome is due to the close anatomical relationship of the fifth and sixth nerves with the petrous apex. But, besides acute petrositis, it may also be due to an extradural abscess or a patch of meningitis overlying the petrous apex.

**diagnosis**

Diagnosis depends on the foregoing clinical picture, assisted by polytomography and/or computerized tomographic scanning of the temporal bone.

**Treatment**

Intensive antibiotic treatment is begun immediately and, in a previously untreated case with a short history, this may well be all that is required. However if the patient fails to respond in 24-48 hours, or if cortical mastoidectomy has already been performed but the disease nevertheless progresses to petrositis, further surgical exploration will be required. This is considered below following surgical treatment of acute mastoiditis.

**Treatment of acute mastoiditis**

**Medical**

Even when a child or adult presents with an advanced case of acute mastoiditis with postauricular oedema and protuberant pinna, the treatment is initially medical in hospital, and the majority of these cases will resolve completely. Exceptions are cases with postauricular fluctuation, previous adequate medical management, or suspected intracranial complications.
The patient should be admitted to hospital so that he can be monitored carefully to ensure resolution or to detect lack of progress or early signs of complications. The treatment regimen is as described for acute suppurative otitis media, with a preference for intravenous antibiotic therapy in advanced cases.

**Surgical**

*Cortical mastoidectomy*

Cortical mastoidectomy is indicated:

1. if subperiosteal fluctuation, suspected intracranial complications, or a neck abscess are present when the case presents

2. if there is persistence of pain, temperature, and otorrhoea, or even profuse otorrhoea on its own, after 2-4 weeks of adequate medical management including use of the correct antibiotic based on culture results, and known compliance in the antibiotic regimen.

The aim of the operation is to exenterate the mastoid air-cell system as completely as possible; the ossicular chain is not disturbed.

**Preoperative investigation**

Besides those previously mentioned, the patient's fitness for general anaesthesia should be assessed, when possible an immediate preoperative audiogram should be performed, and the central nervous system examined to exclude or assess intracranial complications (with particular reference to facial movements to exclude a preoperative facial paralysis or nystagmus). Mastoid X-rays not only help to confirm the indications for surgery, but also give guidance to the surgeon on the extent of pneumatization and the positions of the dura of the middle and posterior cranial fossae.

**Preparation**

A postauricular incision is used and as it is fairly close to the hair-line, the hair should be taped out of the way with Sellotape or other adhesive tape. It is not usually necessary to shave the hair.

**Anaesthesia**

Premedication will always be required as for any other operation requiring general anaesthesia. A general anaesthetic with endotracheal intubation is given.

**The operation**

This is performed under general anaesthesia. A curved incision is made through the skin of the postauricular region a few millimetres behind and parallel to the postauricular groove.
Care must be taken in the lower half of the incision in infants, in whom the mastoid process is undeveloped, and the facial nerve, as it leaves the stylomastoid foramen is therefore superficial; in the upper half of the incision the lower border of the temporalis muscle should be identified and retracted superiorly. If it is necessary to incise it to obtain adequate exposure, the vessels running at its lower border are first ligated or diathermized.

In older children and adults, the tendon of the sternomastoid muscle has a wide attachment to the superficial aspect of the mastoid process; the fibres are scraped off with a periosteal elevator. Between the temporalis muscle and the sternomastoid the soft tissues, including the postauricular muscles and periosteum, are incised down to the bone.

The periosteum is elevated forwards as far as the lateral end of the posterior bony meatal wall, backwards for a few millimetres, and upwards to the level of the upper attachment of the pinna. All bleeding points are secured and a self-retaining retractor is inserted.

In exenterating part of the mastoid bone to uncover the antrum it must be remembered that the antrum is at a depth of 15 mm in the adult, but only a few millimetres in the infant; the surface marking of the antrum is McEwen's triangle; and the position of the middle and posterior fossa dura can be judged by examining the lateral oblique X-ray of the mastoid.

Bearing in mind these landmarks, bone is gradually removed with the drill until the antrum is exposed.

If pus is encountered a further swab is taken and sent for culture. To confirm that the antrum - rather than merely a large cell - has been entered, a small Dundas-Grant probe is passed into the aditus. This should be performed gently to avoid dislodging the short process of the incus. At the same time the size of the aditus can be judged; if it is very small it may be enlarged slightly with a fine bone curette to ensure adequate drainage of the middle ear. (Note that the bony posterior meatal wall must be preserved, and the skin is not dissected from it.)

The air cells are now followed and removed in every direction. It is particularly important to clear all the cells from the sinodural angle. The smooth bone covering the middle fossa dura above and the lateral sinus posteriorly is usually recognized.

There is frequently a group of cells in relation to the vertical part of the facial nerve which are best removed under the operating microscope. In a well-pneumatized skull, cells may extend anteriorly into the root of the zygoma and posteriorly into the occipital bone; these too must be followed as far as is practicable.

It is not necessary to remove the whole top of the mastoid process unless it is necrotic, but the lateral wall and all cells up to the tip should be removed.

The bony cavity thus created has the antrum as its deepest point, and is bounded above by the dural plate, posteriorly by the sinus plate and anteriorly by the bony meatal wall and aditus. In patients with intracranial complications, a small area of both middle fossa dura and
lateral sinus should be exposed; if this reveals granulations or an extradural abscess, exposure of dura is continued until healthy dura is found.

A small drain is inserted into the antrum and led out near the mastoid tip. The skin is closed with interrupted sutures, and a dressing pad and bandage should be applied firmly to prevent a subcutaneous haematoma.

**Postoperative care**

As soon as the patient is conscious, the facial movements are examined to exclude operative damage to the facial nerve. Antibiotic therapy is continued.

The patient's temperature should be taken every 4 hours. It usually falls dramatically within the first 24 hours, when the patient can be allowed to get out of bed.

The drain should be removed when there is no further discharge either through the wound or through the external meatus. In practice this is usually after 2-3 days, but the drain should be left longer if necessary.

The sutures can be removed on the fifth to seventh day.

A postoperative audiogram is obtained as soon as the ear is dry. At this stage there should be some improvement, although normal hearing may not be regained until 2-3 weeks after the operation.

**Complications**

Complications of the operation are few and due mainly to errors of technique.

*Persistent deafness.* This may be due to incus dislocation or removal. This should be suspected when the ear becomes dry and the tympanic membrane heals but conductive deafness persists. Impedance audiometry will confirm disruption of the ossicular chain. Tympanotomy and reconstruction of the ossicular chain may then be indicated.

Persistent infection due to residual disease may cause a conductive deafness. This should resolve with proper medical treatment and good drainage. However, if it persists, reopening of the mastoid and exenteration of the remaining cells is required.

*Complete facial nerve paralysis.* If present immediately postoperatively, but not preoperatively, the facial nerve has been damaged at operation, and the mastoid must be reopened and the facial nerve explored.

*Meatal stenosis.* This may occur if the bony meatal wall is taken down and the skin dissected off the bony wall. It requires excision of the stenosed area and firm packing of the canal until re-epithelialization occurs.
Simple incision and drainage of a postauricular abscess

This condition occurs when pus spreads beyond the confines of the middle ear cleft and ruptures through the lateral surface of the mastoid process into the subperiosteal space. (This then would normally be an indication for cortical mastoidectomy since incision and drainage alone may not be sufficient to enable the mastoiditis to resolve.) However in two circumstances simple incision of the abscess is indicated:

1) In infant, who may occasionally develop a postauricular abscess from a middle ear infection, but in whom the mastoid is not pneumatized nor the mastoid process developed. Particular care must be taken with the incision because of the superficial placing of the facial nerve (see Anatomy at the beginning of this chapter).

2) In any patient, of any age, judged too ill to sustain even the not very long procedure of cortical mastoidectomy, in whom time is of the essence and rapid evacuation of at least some pus is thought to be adequate for the time being. For such cases an even simpler alternative is needle aspiration.

The procedure consists of a simple postauricular incision over the point of maximum fluctuation. When the pus is found a swab is taken, then as much pus as possible is sucked out. A small drainage tube is stitched in and the incision closed.

Myringotomy

Myringotomy alone is obviously not a sufficient form of surgery for acute mastoiditis, but in those few patients who require surgery, but in whom there has been no spontaneous perforation of the tympanic membrane, a myringotomy should be performed as well as other appropriate procedures.

Surgical treatment of acute petrositis

The indication is the presence of acute petrositis, perhaps with Gradenigo's syndrome, and failure to respond rapidly to medical treatment.

The following account of the various approaches to the petrous cells used in the past, has been given by Mawson (1979). It is emphasized that such surgery would be exceptionally rare nowadays; it is difficult and hazardous, and should only be performed by those with very considerable familiarity with the field.

Extrapetrosal drainage

A cortical mastoidectomy operation is performed or reopened. Any fistulous tracks found must be followed. If necessary surgery must proceed to radical mastoidectomy. Tracks may then be found which lead towards the apex from the hypotympanum or attic.

There are various routes for a deep exploration.
**Eagleton's operation**

A wide exposure of the dura of the middle fossa is made by removal of the tegmen, the base of the zygoma and part of the squamous temporal bone. The dura of the middle fossa is gently elevated towards the petrous apex.

**Almoor's operation**

The petrous apex is approached through a triangle bounded by the tegmen tympani above, the carotid artery anteriorly and the cochlea posteriorly.

**Ramadier's operation**

Here the petrous apex is approached more widely. The tympanic plate of the external auditory canal, posterior to the base of the glenoid fossa suture line, is removed. The carotid artery is lifted forward by a gauze sling. The petrous apex may then be explored through the posterior wall of the bony carotid canal.

**Frenckner's operation**

Sometimes a group of cells runs under the arch of the superior semicircular canal. This is a good approach to the petrous apex, but it would have to be combined with an approach to the hypotympanum.