

TITLE: Complications of Acute Otitis Media

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History

Hippocrates noted in 160 BC that "acute pain in the ear with continued high fever is to be dreaded for the patient may become delirious and die." Prior to the antibiotic era, ¼ to ½ of the patients with acute otitis media presented with mastoiditis, subperiosteal abscess, and sigmoid sinus thrombophlebitis. 2-6% of all patients developed an intracranial suppurative complication, with a fatal outcome in ¾ of them. (3) Intracranial and extracranial extension of middle ear infection continues to be a serious medical problem especially in children. The incidence of mastoiditis and intracranial suppurative intracranial complications in the pediatric age group has consistently increased over the past 2 decades. Abuse or inadequacy of antibiotic treatment have been attributed a role in selecting resistant bacterial strains. (3) Another explanation is that antibiotic therapy masks the signs and symptoms of mastoiditis, providing time for the process to extend to the mucoperiosteum and erode the bony septae. (5)

Pathophysiology

The tendency of middle ear infections to spread beyond the confines of the middle ear and its adjacent spaces is influenced by a number of factors, including the virulence of the infecting organism and its sensitivity to antibiotics, host resistance, the adequacy of antibiotic therapy, the anatomic pathways and barriers to spread, and the drainage of the pneumatic spaces, both natural and surgical. One should also consider the immune status of the host: Immunocompromised individuals are at increased risk of developing not only otitis media but also complications of otitis media. Moreover, the organisms causing the infection are more likely to be atypical pathogens. One should consider infants to be in this group of patients, since their immune systems are not fully mature.

Diagnosis

Initial diagnostic workup of complicated acute otitis media is usually triggered by a history and physical that is incongruent with with a standard middle ear infection. A complete head and neck exam should be performed with attention to the otoscopic exam and the cranial nerve exam. For patients with high suspicion of meningitis, a Kernig's and Brudzinski's sign should be checked. A fundoscopic exam may reveal signs of intracranial pressure. The workup usually includes a CT of the temporal bones with contrast. In patients that are suspected of having a sinus thrombosis, magnetic resonance venography may be performed. A complete blood count with differential and an erythrocyte sedimentation rate are often performed. Audiogram should be performed when feasible to evaluate for sensorineural hearing loss associated with labyrinthitis.

Intratemporal complications

Mastoiditis

Mastoiditis is the most common intratemporal complication of acute otitis media. Work from Norway reports the incidence of acute mastoiditis in children under age 2 at around 15 per 100,000. For children above age 2, the incidence is slightly less at 5 per 100,000. The Cochrane review found that routine antibiotic treatment of AOM in a population reduces the risk of mastoiditis. (4) Mastoiditis occurs when the aditus ad antrum becomes obstructed by inflammation. The pressure thus generated by the purulent secretions within the mastoid, or the antrum in young infants, is relieved by egress through the cribiform area or the tympanomastoid fissure. This initially results in inflammation and tenderness in the postauricular sulcus. Suspicion of mastoiditis should be raised when certain findings are present, In a review of 124 patients, pain was the most common presenting symptom. Physical signs included an abnormal-appearing tympanic membrane (88%), fever (83%), a narrowed external auditory canal (80%), and postauricular edema with proptosis. (76%). (2) Even without clear evidence of mastoiditis, a "masked" mastoiditis should be suspected if there is persistent pain or otorrhea despite 2 weeks of antibiotic treatment. Acute mastoiditis is defined not by fluid in the mastoid air cells, but by bony destruction with coalescence of the mastoid cavity. This can be seen on a CT scan of the temporal bones, which is usually ordered when there is high clinical suspicion for mastoiditis. An important caveat when treating these patients is that when there is one complication of acute otitis media, look for another. This is reinforced by reviews that show the incidence of second complications, when mastoiditis is present, at up to 38%. (4) A retrospective review of 101 cases of mastoiditis revealed that increased white blood cell count was predictive of a second complication. (1)

Mastoiditis should be initially treated at least with IV antibiotics. Culture and gram-stain directed therapy is optimal. The most common pathogen recovered from culture is *Streptococcus pneumoniae*. *Streptococcus pyogenes*, *Staphylococcus aureus*, and coagulase-negative *Staphylococcus* species are also common. There is also a higher incidence of *Pseudomonas aeruginosa* as compared to cases of uncomplicated acute otitis media. The AAOHNS guide to antimicrobial therapy recommends vancomycin plus ceftriaxone as empiric therapy.

The use of interventions beyond antibiotic therapy have been debated in the literature. The dilemmas that the otologist faces when dealing with mastoiditis are: the indications for a surgical treatment, the timing of surgery (immediate versus delayed), and the choice of surgical procedure. Whether a myringotomy, a myringotomy with PE tube, or a mastoidectomy is performed, the goals of surgery are to drain the infection and to obtain pus for culture.

A review of 45 patients showed that in 32 cases of uncomplicated mastoiditis, there were no treatment failures among 20 patients treated with IV antibiotics alone. However when these patients were compared to the 12 patients that had PE tubes with or without mastoidectomy, they had slightly longer hospital stays with a longer time to symptomatic resolution. (3) It should be noted that the patients selected for medical therapy may have had less severe disease at presentation. Another review of 44 patients showed that among the 38 patients with uncomplicated mastoiditis, only 1 did not improve with myringotomy, tube, and IV antibiotics. This patient underwent mastoidectomy after he did not clinically improve within 96 hours of initial surgery. (5) Still another retrospective review of 58 cases examined conservative versus aggressive therapy. 17 patients received IV antibiotics alone with a 100% cure rate. A second group of 28 patients, presumably with more severe disease underwent myringotomy and/ or tubes in addition to antibiotics. There were 4 treatment failures in this group. Of these, 3 had a subperiosteal abscess and 1 had a cholesteatoma. (9) None of these treatment failures had preoperative CT scan. It is possible that imaging would have detected these additional complications and triggered more aggressive therapy, preventing treatment failure.

Facial Nerve Paralysis

Facial nerve paralysis associated with acute otitis media is a rare, but disturbing complication. The incidence is estimated at 0.005%. Despite the striking presentation of this complication, the prognosis is excellent. A recent review of 11 patients over 26 years reported a full recovery to House-Brackman I or II. All of these patients received a myringotomy with tube placement, along with IV antibiotics; Only 1 patient underwent mastoidectomy. Interestingly, 5 of 7 positive cultures grew *Staphylococcus aureus*, suggesting that the bacteriology of otitis media with associated facial paralysis may be different. (14) Another study reviewed 10 children who presented with facial paralysis after the onset of acute otitis media. 8 patients with incomplete paralysis had full return of function after myringotomy and intravenous antibiotics. The 2 patients with complete paralysis required mastoidectomy to control otorrhea and fever after initial myringotomy and antibiotics. Both patients had a prolonged recovery, but eventually recovered to House-Brackman I or II. (13) A larger study of 22 patients showed complete resolution of paralysis in 21. (15) These studies support the conservative management of this complication. Corticosteroids should be considered, though there is no good evidence for their effectiveness. Mastoidectomy should be performed only when it is necessary to treat otitis media. Surgical facial nerve decompression is not indicated in these cases.

Labyrinthitis

Bacterial labyrinthitis may occur by either direct bacterial invasion (suppurative labyrinthitis) or through the passage of bacterial toxins and other inflammatory mediators into the inner ear (serous labyrinthitis). Meningitis typically affects both ears, whereas otogenic infections typically cause unilateral symptoms. Profound hearing loss, severe vertigo, ataxia, and

nausea and vomiting are common symptoms of bacterial labyrinthitis. Bacterial infections of the middle ear or mastoid most commonly spread to the labyrinth through a dehiscence of the horizontal semicircular canal. Usually, the dehiscence is the result of erosion by a cholesteatoma. This complication is potentially life-threatening; infection in the inner ear can spread to the subarachnoid space causing meningitis. Early mastoidectomy is indicated in these cases to fully decompress and drain the purulent infection. As with other complications of otitis media, culture-directed antibiotics are an integral part of the treatment regimen. The sensorineural hearing loss is usually irreversible. Labyrinthitis ossificans often follows suppurative labyrinthitis; therefore, decisions regarding cochlear implantation must be made early. Serial MRIs have been advocated to monitor for this complication, since CT may not be sensitive enough for early detection. Serous labyrinthitis occurs when bacterial toxins and host inflammatory mediators, such as cytokines, enzymes, and complement, cross the round window membrane, causing inflammation of the labyrinth in the absence of direct bacterial contamination. Penetration of the inflammatory agents into the endolymph at the basilar turn of the cochlea results in a mild-to-moderate high-frequency SNHL. Audiologic testing reveals a mixed hearing loss when a middle ear effusion is present. Vestibular symptoms may occur but are less common. Treatment is aimed at eliminating the underlying infection and clearing the middle ear space of effusion. A small series of patients was examined as part of a larger study. 3 of 3 pediatric patients with isolated serous labyrinthitis had resolution of hearing loss with myringotomy, PE tube, and IV antibiotics. (15)

Gradenigo's syndrome:

In 1907, Gradenigo described his classic triad of abducens nerve paralysis, severe pain in the distribution of the trigeminal nerve, and acute suppurative otitis media. The symptoms were attributed to suppurative disease of the petrous apex. The petrous apicitis is detectable on CT scan of the temporal bones. This complication is often found with synchronous intracranial complications. Small series of patients show complete resolution of the petrous apicitis with complete mastoidectomy, PE tube, and IV antibiotics. (15)

Subperiosteal abscess.

Drainage of subperiosteal abscess. They found a 93% success rate in the 43 patients reported. (10) It should be noted that close follow up is needed for patients if this treatment regimen is used. Recurrences do occur even in cases that undergo aggressive therapy with mastoidectomy. (11) A low threshold for repeat imaging should be kept, especially for infants and other immunosuppressed patients. However, this regimen avoids the morbidity and potential complications of mastoidectomy in young patients. (7)

Bezold abscess

In 1881, Bezold described a complication of mastoiditis presenting as a laterocervical abscess. Bezold's abscess is caused when a suppurative process erodes the mastoid cortex along the digastric ridge and spreads between the digastric and sternocleidomastoid muscles. This is a serious complication because of its ability to spread downwards along great vessels and reach the mediastinum. This complication is exceedingly rare in children, probably because of the absence of extensive pneumatization of the mastoid in younger patients. These abscesses may be difficult

to detect clinically. Diagnosis can be hindered by infrequency of presentation and inconsistency of signs and symptoms. The common clinical signs and symptoms are pyrexia (74%), otalgia (52%), neck swelling (48%), otorrhea (41%), restriction of neck motion (41%), neck pain (41%), and facial nerve paralysis (15%).(12) There is a paucity of published data on the management of Bezold's abscess. At minimum, these patients should undergo initial myringotomy with tube placement, and culture directed antibiotics. Early aggressive surgical management in the form of mastoidectomy and incision and drainage of the neck abscess should be considered because of the potential of this infection to spread throughout the neck.

Intracranial Complications

Meningitis is the most common intracranial complication of otitis media. The earliest symptoms are headache, fever, vomiting, photophobia, irritability, and restlessness. Infants may have seizures. As the infection progresses, the headache increases, and vomiting becomes more pronounced. Neck stiffness, with resistance to flexing the neck so that the chin does not touch the chest, may start with minimal discomfort and progress. Brudzinski's sign, the inability to flex the leg without moving the opposite leg (or flexion of the neck resulting in flexion of the hip and knee), is a sign of meningitis. Similarly, Kernig's sign, an inability to extend the leg when lying supine with the thigh flexed toward the abdomen, is suggestive of meningitis. When meningitis is suspected, a lumbar puncture is performed to obtain CSF for bacteriologic analysis. In meningitis, the CSF is cloudy or yellow (xanthochromic); also, an elevated white blood cell count, low glucose, and high protein are expected. Treatment for meningitis resulting from acute otitis media should be directed at *H. influenzae* type B with second- or third-generation cephalosporins. One should be aware that rapid bacteriolysis releases large amounts of inflammatory fragments that can have severe neurologic and auditory sequelae (sensorineural hearing loss). Glucocorticoids, such as dexamethasone, have been shown to decrease these sequelae. Serial audiograms are recommended as hearing loss can occur as a late complication. In addition, the aforementioned labyrinthitis ossificans can occur with meningitis, preventing future cochlear implantation. Consequently, serial MRIs should be performed in children with profound hearing loss as a sequela of meningitis to detect this development early.

Brain abscess

Brain abscess is a particularly morbid complication of otitis media. The mortality associated with brain abscess of otogenic origin in the antibiotic era is about 25%. Multiple organisms are usually present in brain abscesses. Polymicrobial cultures with a high incidence of anaerobes are reported in various studies. Streptococcus and staphylococcus are common gram positive organisms that are isolated from brain abscesses. *Escherichia coli* and *Proteus*, *Klebsiella*, and *Pseudomonas* species are typical gram-negative isolates. It is interesting to note that *H. influenzae* is rarely found in otogenic brain abscesses. Otogenic brain abscesses are often the result of venous thrombophlebitis rather than direct dural extension. Brain abscess formation is indicated by high fever, headache, and neurologic deficit. Currently, the management of brain abscesses is a controversial. The patient must be hospitalized and treated with appropriate, high-dose antibiotics immediately. The management of the brain abscess takes precedence over that of the primary infective source because the patient is seriously ill and the neurosurgical procedure may be the life-saving procedure. The patient should be first stabilized neurologically; only then should the ear causing the infection be operated on.

Extradural abscess

Infection can also accumulate in the epidural (extradural) space, a potential space between the dura mater and the bone of the intracranial cavity. Large accumulations of pus are rare. Granulation along the dura mater is seen more commonly than an actual epidural abscess. Epidural collections that are accessible from the mastoid cavity should be drained at the time of surgery.

Sigmoid sinus thrombophlebitis

Sigmoid sinus and lateral sinus thrombosis is a rare, but feared complication of otitis media. The thrombosis typically begins in the sigmoid sinus and propagates to the lateral sinus and occasionally to the internal jugular vein. In rare cases, emboli may shower to distant locations and cause significant morbidity and mortality. Patients present with the typical symptoms of mastoiditis, along with worsening headache. Picket fence fevers and signs of sepsis are occasionally present. More than half of patients may present with associated cranial nerve findings. These cranial nerve findings are often seen with accompanying elevated intracranial pressure on lumbar puncture. (16) Imaging should be performed in patients suspected of having this condition. Though CT will delineate bony abnormalities and provide a road map for surgery, MRI/ MRV is slightly more sensitive at detecting thromboses. The two imaging modalities should both be performed to maximize diagnostic accuracy. On contrasted CT scan, a filling defect may be seen in the affected sinus. In 1/3 of these, contrast may accumulate in the collateral veins surrounding the non-enhancing thrombus to yield a pathognomonic “empty delta sign.” The proper treatment of this condition has only been studied in small case series. Accepted standard practices include myringotomy with tube, IV antibiotics, and mastoidectomy. The plate overlying the sigmoid sinus is opened and the sinus aspirated. If there is return of blood, the sinus is not opened. If there is no blood return, the sinus is opened, and the clot removed. Postoperative anticoagulation remains controversial. Some authors cite the low incidence of septic emboli as a reason to withhold anticoagulation. (17) Others believe anticoagulation should be used for patients who already have had evidence of embolic events or for those who have thrombus extension past the sigmoid sinus.

Otitic hydrocephalus

Otitic hydrocephalus involves increased intracranial pressure without effect or signs of hydrocephalus. Furthermore, there is no evidence of ventricular dilatation and focal neurologic signs are absent. Headache, drowsiness, vomiting, blurring of vision, and diplopia are typical symptoms. Papilledema and sixth cranial nerve palsy are usually evident. Optic atrophy can eventually develop. A normal CSF cytology and biochemistry along with an opening pressure greater than 24 mm H₂O are necessary to make the diagnosis, and to exclude meningitis. Otitic hydrocephalus is very commonly associated with sigmoid sinus thrombophlebitis; however, not all patients with sigmoid sinus thrombophlebitis develop otitic hydrocephalus. Treatment should include proper therapy for associated sinus thromboses. Medical therapy includes corticosteroids, mannitol, diuretics, and acetazolamide.

Conclusion

Based on the information gathered in this text, one can construct a practical algorithm to treat complicated otitis media. If a patient has simple coalescent mastoiditis or meningitis, a myringotomy with tube and culture-directed antibiotics should be attempted first. If there is no improvement after 72 hours, mastoidectomy should be performed. This approach can also be used when children have a subperiosteal abscess, except transcutaneous incision and drainage should be added to the initial treatment. If a patient has intracranial complications, mastoidectomy should be performed initially. Aspiration and possible removal of sinus thrombosis should be performed at this surgery. Drainage of epidural abscesses should also be performed. If a patient has a brain abscess, neurosurgical procedures should precede otologic procedures. This algorithm should optimally prevent the spread of infection while sparing children the morbidity of extensive surgery.

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