CT and MRI imaging of chronic otitis media complications.

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Aims and objectives

Acute otitis media, is in most cases a purulent inflammation of the mucus membrane of the middle ear. It is caused by viruses (80% of cases) and/or bacteria from the nasopharynx reaching the middle ear cleft via the Eustachian tube. The disease mostly affects young children. More than 60% of all children under the age of 6 years experience one or more episodes. Acute otitis media, should be managed with care to prevent subsequent complications such as mastoiditis (inflammation of the mastoid cell system), acute labyrinthitis (dizziness, vertigo, deafness), facial palsy, thrombosis of the sigmoid sinus, meningitis and subdural-epidural abscess. Correct high dosage antibiotic therapy, combined with antiphlogistic therapy of the blocked Eustachian tube, will heal the disease in most cases [1].

Chronic inflammation of the middle ear mucosa is characterized by a long standing central perforation of the tympanic membrane with permanent or intermittent drainage (active and inactive stages). Perforations resulting from acute otitis media generally heal in a few days. The most frequent pathogenic organisms cultured from chronically draining ears are Pseudomonas aeruginosa (60-80%). The episodes of reactivation (active stages) are initiated by upper respiratory infections or by penetration of water in ear [2].

Cholesteatoma of the middle ear is relative frequent and may arise all through life. In the great majority of cases, it is secondary to an inflammation and/or infection of the middle ear (acquired cholesteatoma). Cholesteatoma implies the presence of keratinizing stratified squamous epithelium within the middle ear cleft. The simplest definition will be that of "skin in the wrong place". It is considered as the "unsafe" chronic otitis media, owing to the high risk of complications.

Intratumoral and intracranial complications of otitis media suggest infection spreading to adjacent structures outside the defense barriers (mucoperiosteum and intact bony walls) of the middle ear and mastoid. Complications occur in association with cholesteatoma and less frequently in association with chronic otitis media without cholesteatoma and acute otitis media [3].

Complications without bone erosion initiate through progressive thrombophlebitis of small venules, as in acute otitis media or in acute exacerbation of chronic otitis media. As already mentioned bone erosion results from cholesteatoma (due to bone erosion by pressure or enzymatic actions) or coalescent mastoiditis. Other possible pathways for the infection to spread are: oval and round window, internal auditory canal, endolymphatic duct and sac, developmental dehiscences of the tegment or the hypotympanum, over the jugular bulb, skull fractures or previous aural surgery (Fig 1).

Complications are distinguished as intratumoral, intracranial and extracranial, with diffuse meningitis and brain abscess, being the most important.
Intratemporal or cranial: Labyrinthitis, serous or purulent, labyrinthine fistula, petrositis and facial paralysis.

Intracranial: extradural or epidural abscess, perisinus abscess (pachymeningitis), the most frequent complication, localized or diffused meningitis, lateral sinus thrombosis (rarely seen today), temporal lobe or cerebellar abscess.

Extracranial complications include external otitis, jugular vein thrombophlebitis, Bezold’s and retropharyngeal abscess [3,4,5,6,7].

Chronic suppurative otitis media, remains a serious concern, particularly in developing countries, and socioeconomically poor regions. There continues to be reports of chronic suppurative otitis media complications as life threatening.

When complications are suspected patients should undergo a CT and/or MRI scan of the temporal bone. CT scan is superior for evaluating the bony details of the middle ear and mastoid space. High resolution CT defines the size and location of a cholesteatoma and provides important information on the integrity of the ossicular chain lateral semicircular canal, cochlea, tegmen, otic capsule, cortical bone of middle and posterior fossa, and facial canal. It will show soft tissue causing coalescence of mastoid air cells in mastoiditis, and may show destruction of the overlying cortex with overlying postauricular abscess formation. A frank subperiosteal abscess is found in only 48-49% of acute mastoiditis cases. On a coronal CT scan blunting of the scutum is often observed. A contrasted CT scan will detect abscess formation or sigmoid sinus thrombosis.

On the other hand, in cases of suspicion of intrapetrous extension or intracranial complications an MRI is more sensitive for diagnosing them. Then again a contrasted magnetic resonance imaging (MRI) study of the head should be performed if intracranial abscess formation or sigmoid sinus thrombophlebitis is suspected. Enhanced MRI is sensitive for sigmoid sinus thrombosis. Additional imaging with MR venography demonstrates the degree of patenty of the related venous sinuses. MRI is superior to CT in the identification of intracranial suppurative lesions, meningeal inflammation, and extradural granulation tissue notably on (FLAIR fluid-attenuated inversion recovery)-weighted images. It also helps to visualize meningeal enhancement more clearly. T2-weighted images can identify intraparenchymal edema and thus be used to make an earlier diagnosis of impending intracranial complications than can be made with CT scanning Magnetic Resonance angiography (MRA) shows blood flow, sinus obstruction and the subsequent reversal of flow [8,9,10,11].
Fig. 1: Schematic drawing of the pathways of intratemporal and intracranial complications of otitis media.

Methods and materials

We retrospectively reviewed and evaluated CT and/or MRI images of 16 patients (11 men and 5 women) with initial diagnosis of chronic otitis media (with or without cholesteatoma) or acute otitis media. These patients underwent brain and temporal bone CT and/or MRI scan after clinical suspicion of existing complications. The study included patients with an acute infection beyond 2 weeks or the recurrence of symptoms within a 2 to 3-week period, as well as those with fever, purulent otorrhea, headache, nuchal rigidity, facial palsy, hearing loss, seizures and vertigo.

A PHILIPS 16 and 64 and a SIEMENS 16, MDCT scanner were used. The imaging parameters were arranged for the examination of the temporal bones taking 1- or 1.5-mm axial and coronal images with 1- or 1.5-mm intersection gaps. IV contrast medium administrated only in cases of suspected complications. In nine patients MRI scan was also conducted with a PHILIPS 1,5 Tesla, scanner taking T1 and T2 images in axial, coronal and sagittal planes, with a cut width of 1-1.5 mm with a 1 mm interspace, and T1 images after intravenous administration of gadolinium.
Results

Twelve of sixteen patients (75%), found with cholesteatoma (Fig. 2,3) and nine of them (25%) had multiple, either extracranial or intracranial, complications, at the time of imaging. Simultaneous occurrence of extracranial and intracranial complications, although rare in clinical practice, were present in one case brain CT scan revealed a subperioseal abscess of the mastoid process, thrombosis of the right sigmoid sinus, epidural abscess in the right temporal and occipital lobe, and an abscess in the right temporal lobe (Fig. 4,5). The sigmoid sinus found thrombosed in 6 cases. (Fig. 6,13). In one patient there was extracranial extension of the thrombosis to the internal jugular vein (Fig 7). In 4 patients retrograde thrombophlebitis extended intracerebrally, resulting in one/or several brain abscesses, (Fig. 8,9,10,11,12) including subdural ones. Pachymeningitis, was present in two cases (Fig. 10,12).
**Fig. 2:** HRCT scan of the temporal bone, axial image, in a patient with persistent purulent otorrhea. There is a mass of soft tissue density (cholosteatoma) occupying the right middle ear cavity with destruction of the ossicular chain. Notice frontal aberrant position of the ipsilateral sigmoid sinus.

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Fig. 3: HRCT scan of the temporal bone, axial and coronal images, in a woman with headache and vertigo. Soft tissue material (cholosteatoma) depicted in the left attic causing erosion of the tegment and aditus ad antrum of the mastoid. Also observe ossicular chain obliteration (black arrow head) and partial erosion of the lateral semicircular canal (black arrow).

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Fig. 4: Brain CT scan, axial image, after intravenous contrast administration in a 17 years old patient with acute suppurative otitis media was admitted to the emergency department due to high fever and severe confusion. Clinical examination revealed suppurative otitis media of the right ear. There was direct extension of the infection from the middle ear to the epidural space as a result of erosion of the tegment tympani due to the presence of cholesteatoma (not shown). Epidural abscess is the most common intracranial complication arising from middle ear infection. It results from spread by contiguity following bone destruction in coalescent mastoiditis.

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Fig. 5: CT scan-axial image, after intravenous contrast administration. Abscess of the right temporal lobe (same patient as figure 4)

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**Fig. 6:** MRI angiography coronal image. Left sigmoid sinus thrombosis as a complication of chronic otitis media in a patient presented with occipital headache, vomiting and confusion.

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Fig. 7: CT scan of the neck-axial image: Thrombophlebitis of the right internal jugular vein as a complication of suppurative otitis media and sigmoid sinus thrombosis (not shown here).

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Fig. 8: Brain CT scan after iv contrast material administration-axial image. Abscess in the left cerebellar lobe as a result of retrograde thrombophlebitis due to left sided chronic suppurative otitis media.

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Fig. 9: Brain MRI scan- T2 axial image: Hyperintense focus in the right temporal lobe presenting the early phase of an abscess.

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Fig. 10: MRI axial T1 image after iv gadolinium administration -bilateral frontal lobe abscess due to meningoencephalitis complicating chronic suppurative otitis media of the right ear. There is also thickening and enhancement of the wall of the right cavernous sinus (black arrow), along with (white arrow) X, XI, XII nerve sheath enhancement and pachymeningitis (red arrow).

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**Fig. 11:** MRI coronal T1 image after iv gadolinium administration. Subdural abscesses due to retrograde thrombophlebitis complicating chronic otitis media of the right ear, in the same as in image 10, patient. Subdural empyema secondary to otitis media usually develops in the interhemispheric fissure and along the tentorium cerebelli and appears at imaging as widening of the extracerebral space with compression of the adjacent sulci.

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**Fig. 12:** Same patient as figure 9, one week later. Brain MRI scan-axial T1 image after intravenous gadolinium administration. Thickening of the meninges in the right occipital region, abscess in the right temporal lobe

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**Fig. 13:** Same patient as in figure 11. MR venography revealing almost complete absence of flow in the left sigmoid sinus.
Conclusion

In spite of significant decrease after antibiotic advent, intracranial complications of otitis media still represent a jeopardizing situation associated with high mortality. A high index of suspicion and early diagnosis are essential for better outcome in these patients. Extension of the infectious process beyond the mastoid system can lead to a variety of intracranial and extracranial complications. It is more than obvious the contribution of CT and MRI imaging in the diagnosis of the different life threatening consequences of chronic otitis media. Cholesteatoma was found to be the main contributing factor.