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Original Article

Radiological Imaging Analysis of Intracranial and Extracranial Complications of Acute and Chronic Mastoiditis

[1]Hamza Hussain Bangash, [2]Saniya Siddique, [3]Waqar Ahmed, [4]Misha Anam, [5]Maroof Ahmed khan, [6]Mahnoor Amir, [7]Muhammad Hamza, [8]Eze franklin Chidera, [9]Sehrish Khan, [10]Anju Benny

[1]Queen Elizabeth The Queen Mother Hospital, Margate (United Kingdom)
[2]Binzhou Medical University, Yantai, Shandong, PR (China)
[3]Pakistan Institute of Medical Sciences, Islamabad (Pakistan)
[4]Children Hospital & The Institute of Child Health, Lahore (Pakistan)
[5]Shadan Institute of Medical Sciences ,Hyderabad, (India)
[6]Army Medical College (National University of Medical Sciences), Pakistan
[7]Poonch Medical College, Rawalakot, Azad kashmir (Pakistan)
8Beachland Sspecialist Hospital, Arepo Ogun State (Nigeria)
[9]Abbasi Shaheed Hospital, Karachi (Pakistan)
[10]ACS Medical College and Hospital (India)

Corresponding Author: Misha Anam, Children Hospital & The Institute of Child Health, Lahore (Pakistan)

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ABSTRACT

Background: Mastoiditis is a common complication of Otitis Media. If left untreated, it can further complicate with its intracranial and extracranial extensions. To avoid such perplexities, early diagnostic imaging should be performed, and surgical intervention should be planned accordingly.

Objective: The aim of the study is to highlight the significance of diagnostic radiological imaging in the early diagnosis of complications associated with acute and chronic mastoiditis as well as the role of aggressive surgical intervention as a life saving measure in complicated cases, which are either refractory to intravenous medication or have intracranial extensions.

Study Design: Retrospective Cohort Study consisting of 56 successfully treated patients for intracranial and extracranial complications of acute or chronic mastoiditis in past one year, at Children Hospital & Institute of Child Health Lahore, May 2021- June 2022.

Results: Out of 56 patients, 32 patients were diagnosed with acute mastoiditis and 24 with chronic mastoiditis. Male predominance was noted with male to female ratio 1.9:1. The incidences peaked at the age of 2-5 years and 10-14 years. The most common associated complications were Conductive hearing loss 82.1%, Ossicular erosions 75%, Meningitis 67.8%, and Subperiosteal abscess 60%. All the patients underwent mastoidectomy with different approaches, relevant to their pathology.

Conclusion: The medical treatment is often inadequate or inappropriate for the complete eradication of mastoid pathology. Additionally, the ongoing antibiotic therapy frequently masks the signs and symptoms of life-threatening complications of mastoiditis. In cases like these, radiological investigations play a pivotal role in the early diagnosis and planning of prompt surgical intervention to significantly reduce morbidity and mortality.

Keywords: mastoiditis, abscess, complications, radiology, pediatrics, surgery.

INTRODUCTION

Mastoiditis is the inflammation of mucoperiosteum and bony septa of mastoid air cavity mainly due to complicated otitis media [1]. With the advent of antibiotics, the incidence of mastoiditis has declined all over the world [2]. But still, in the developing countries such as Pakistan, otitis media and its complications are quite prevalent [1,2]. The incidence of surgical mastoiditis in United States is only 0.004%. Mastoiditis can occur at any age but children younger than 2 years are more susceptible (median age=12 months) [3]. Over 5 years of age, the average incidence of mastoiditis in developing countries is 4 cases per 100,000 [4]. The exact prevalence of mastoiditis in pediatric population of

Pakistan is still unknown. Mastoiditis is one of the most common complications of Acute and Chronic Otitis Media due to the free communication between the middle ear cavity and mastoid air cells [1-5].

Acute mastoiditis associated with acute otitis media often does not require any radiological investigations or extensive workup. Simple antibiotic treatment is usually enough to completely resolve the condition [5]. The findings of CT imaging performed at the early stage may include non-specific increased attenuation of middle ear cavity and mastoid sinus with or without fluid opacification in it. Moreover, the preservation of bony structures might also be observed, including ossicular bones, trabeculae, and mastoid cortical boundaries [6].

Nevertheless, the long-standing collection of serous/mucous/purulent secretions in the middle ear cavity and mastoid sinus results in localized signs of inflammation at first. In acute mastoiditis, the edema and swollen mucosa of mastoid cavity and middle ear result in trapping of secretions in antrum and air cells causing gradual erosion of the surrounding trabeculae and ossicles. The damaged mastoid trabeculae result in post-auricular swelling, erythema, and abscess. From mastoid air cavity, infection can easily travel to middle and posterior cranial fossa through bone resorption and to the sigmoid sinus via thromboembolic phenomenon [6, 7].

Hematological investigations including CBC with differential count, ESR and CRP are important. Most commonly, the patients have remarkably raised white blood cells count with a shift to the left and raised inflammatory markers such as ESR and CRP levels. However, in immunocompromised or malnourished/low BMI patients, these levels may not correlate with the severity of the infections because of weaker immune system and nutritional deficiencies [8].

Radiological investigations are significant in providing precise information regarding the spread of the disease. CT imaging can reveal the bony structure integrity of mastoid and middle ear. The suggestive findings on CT scan could be:

- Fluid in the middle ear cavity and mastoid cavity resulting in obliteration of air space and hypopneumatization.
- Mucosal thickening in mastoid causing mastoid condensation.
- Ill-defined bony margins of inner ear and mastoid bony framework, with external communications or fistula formation.
- Periosteal thickening, periosteal disruption, and subperiosteal abscess.

Whereas MRI imaging can detect:

- Partial to complete opacification of mastoid air cavity and/or middle ear cleft.
- Mastoid mucosal contrast enhancement/diffusion restriction accounting for mucosal edema and fluid collection in the cavity. However, it always needs clinical correlation before labeling the patient with mastoiditis.
- Brain parenchymal and peripheral soft tissue changes because of complicated mastoiditis.
- Lymphadenopathy and extent of lymph nodes involvement [6-8].

Depending on the pathology, mastoiditis could be of two types: Coalescent and non-coalescent/incipient mastoiditis. The incipient or non-coalescent mastoiditis is a clinical condition in which the otitis media with mastoiditis can be confirmed on CT, with or without the presence of fluid in the cavities and increased attenuation of mastoid, but with no radiological evidence of bony disruption/resorption or periostitis. The incipient mastoiditis is completely treatable with intravenous antibiotic therapy and seldom results in complications [9].

On the contrary, when the mastoid infection stays for long, it results in the spread of infection to the surroundings. The suppurative fluids in mastoid under pressure cause pressure effects, local acidotic environment, ischemia, and bony resorption of the pneumatic walls. The fluid filled mastoid air cells start to coalesce into larger cavities under inflammatory reactions, purulent exudates, and granulation tissue. The resultant mastoid empyema on CT scan often indicates the development of coalescent mastoiditis. If left untreated, the non-coalescent or incipient mastoiditis can also progress to coalescent mastoiditis. The CT scan is used to confirm the erosion of mastoid walls [9-10].

In coalescent mastoiditis, infection can spread to the surrounding structures by four routes. 1. Direct extension via pre-formed, anatomical pathway, 2. Bony erosions, 3. Thrombophlebitis or Thromboembolic phenomenon, and 4. Hematogenous pathway. The osteoclastic bony resorption progresses in all directions resulting in intracranial and extracranial extensions [11].

- Anteriorly, the mastoid abscess can communicate with middle ear cavity via mastoid antrum and can result in spontaneous resolution with prompt medical and/or surgical treatment.
- Laterally, the mastoid wall destruction can lead to sub-periosteal abscess.

- Medially, the abscess can travel to petrous air cells causing petrositis.
- Posteriorly, the infection can spread to middle and posterior cranial fossa.
- Inferiorly, the abscess can travel along the fascia and result in cervical abscesses.

There is another type of mastoiditis called Latent or masked mastoiditis, with the consequences like that of coalescent mastoiditis but the progression is sub-clinical. Patient presents with mild symptoms of otitis media with the prolonged history of broad-spectrum antibiotic intake. On otoscopic examination, the tympanic membrane id usually found intact with no significant finding. At that time, if the CT Temporal Bone is advised to the patient, it can reveal the silent progression of disease with its extensions. Such patients present to the hospital in emergency department with acute onset of intracranial complications i.e., meningitis, subdural abscess, Dural venous thrombosis, etc. [11, 12]

Based on the anatomical location, the superadded infection by opportunistic bacteria is very common in mastoiditis [13]. The devastating complications of mastoiditis can be classified into two categories, intracranial and extracranial extensions. The patients with intracranial extensions often present to emergency with poor GCS, altered sensorium, high grade fever, seizures, nuchal rigidity, severe headaches, etc. [14] The possible intracranial extensions of mastoiditis could be Temporal lobe abscess, Cerebellar abscess, Brain abscess, Epidural or Subdural abscess, Venous Sinus Thrombosis, etc. Among extracranial extensions Subperiosteal abscess, Facial nerve palsy, Labyrinthitis, Petrous apicitis, and Bezold's abscess are included [13, 14].

MATERIALS AND METHODS

A retrospective review of radiological findings and surgical interventions of 56 selected patients of pediatric age group (one month to 14 years) with complicated acute/chronic mastoiditis was performed. Within 24 to 48 hours of hospital admission, Cranial and Temporal Bone Computed Tomography (CT) of all the patients was performed. Sedation was usually not necessary while performing CT, but some children were irritable and required mild to moderate sedation. Those with the suspicion of intracranial and extracranial extensions or inconclusive CT reporting were advised further diagnostic radiological imaging. Although, the differentiation between the coalescent and incipient mastoiditis can be made on CT imaging alone. Still, all the radiological investigations were performed and reported under consultant's supervision and surgeries were planned according to the provisional diagnosis.

Consents for the radiological examination and surgical procedures were taken from the parents/guardians of the patients. All the patients underwent the baseline investigations for pre-anesthetic evaluation for General Anesthesia. Per-operatively, the radiological findings were verified, and surgical samples were taken for histopathology, culture, and sensitivity tests. Eye protection was ensured while performing CT scan by taking the sections slightly below the orbitomeatal line, keeping the low milliampere-seconds value (30-50mAs), and using the high-resolution bone algorithm.

INCLUSION CRITERIA

- Patients who had been given Intravenous Antibiotic Therapy before, but they failed to respond.
- Patients who underwent surgical intervention for the management of complications of acute/chronic mastoiditis and were successfully treated.
- Patients who were still attending regular follow-up checkups.

EXCLUSION CRITERIA

- The patients with incomplete medical/surgical record, unclear diagnosis or treatment plan were not included in the study.
- Patients whose surgical treatment was refused by their parents or guardians.
- The cases in which per-operative findings confirmed the conditions that were pre-operatively confused with CSOM such as Rhabdomyosarcoma of middle ear n=1, or the patients in which the pre-operative radiological findings couldn't be confirmed n=4. Radiology department was reported, and the relevant scans were discussed with them again for re-evaluation and improvement of the results in the future.

The data is described in tabulated form in terms of Frequencies (n) and Percentages (%).

RESULTS

In this study, 56 patients were recruited according to the above mentioned including and excluding criteria. All the recruited patients were successfully treated during their hospital stay and were on regular follow-up. According to the collected data, there is an evident male predominance. Males (n=37, 66%) were about twice in number as compared to females (n=19, 34%) with Male: Female ratio of 1.9:1. Patients were divided into 4 groups based on their age, 1 month to 2 years (n=11, 20%), 2 to 5 years (n=23, 41%), 5 to 10 years (n=4, 7%), and 10 to 14 years (n=18, 32%).Out of 56 patients, 48 (86%) patients presented to the medical outdoor

department and 8 (14%) patients were admitted to the hospital in pediatric ENT department who were referred by pediatric medical or surgical department. After clinical and radiological examination, 32 (57%) patients were diagnosed with acute mastoiditis and 24 (43%) patients with chronic mastoiditis. Majority of the patients (n=26, 46%) were having left sided mastoiditis while n=21, 38%% patients had right side involved and a few had bilateral mastoiditis (n=9, 16%).

Mode of Admission	**Frequency (n)**	**Percentage (%)**
OPD	48	86%
Emergency	8	14%
Gender	**Frequency (n)**	**Percentage (%)**
Male	37	66%
Female	19	34%
Age Group		
1 month- 2 years	11	20%
2-5 years	23	41%
5-10 years	4	7%
10-14 years	18	32%
Pathology	**Frequency (n)**	**Percentage (%)**
Acute Mastoiditis	32	57%
Chronic Mastoiditis	24	43%
Site of Infection		
Left	26	46%
Right	21	38%
Bilateral	9	16%
Recurrence of Mastoiditis	**Frequency (n)**	**Percentage (%)**
Yes	2	4%
No	54	96%

Table 1. Demographic features and clinical presentation at the time of hospital admission. Most of the outdoor patients with relatively common or vague symptoms such as fever n=22, cough n=5 (9%), vomiting n=12 (21%), earache n=56 (100%), irritability n=36 (64%) etc. which could be easily overlooked on general examination or could be assessed for sore throat or upper respiratory tract infection. But careful examination of these patients raised suspicion of mastoiditis and relevant radiological examination confirmed the diagnosis later. The most found specific clinical findings were otitis media (confirmed on otoscopy), Retro auricular swelling with fluctuation n=54 (96%), tenderness n=56 (100%), and erythema n=56 (100%). The critical patients of mastoiditis with complications, were received and admitted via emergency (n=8, %) with signs and symptoms of Septicemia n=8 (14%), Head/Neck abscess with discharging sinus n=4 (7%), Stroke n=3 (5%), and Coma (GCS<8) n=2 (4%).For the patients with clinical symptoms of Facial Nerve Palsy n= 3, Electromyography test was performed for the confirmation of the Facial Nerve Involvement. Such patients were evaluated by neurologists and physiotherapists during their hospital stay and discharged on their follow-up.

Symptoms	**Frequency (n)**	**Percentage (%)**
Fever	22	39%
Earache	56	100%
Irritability	36	64%
Anorexia	43	77%
Vertigo	28	50%
Vomiting	12	21%
Sleep disturbance	14	25%
Cough	5	9%
Rhinitis	18	32%
Signs	**Frequency (n)**	**Percentage (%)**
Purulent Rhinorrhea	34	61%
Otorrhea	29	52%
Acute Otitis Media (AOM)	26	46%
Otitis Media with Effusion (OME)	52	93%
Retro auricular swelling (fluctuation +)	54	96%
Retro auricular Erythema/Pruritis	54	96%
Retro auricular tenderness	56	100%
Head/Neck Abscess with discharging sinus	4	7%
Comatose	2	4%
Facial Nerve Palsy	3	5%
Septicemia	8	14%
Stroke	3	5%

Table. 2. Frequency and Percentage of Signs and Symptoms of the patients at the time of presentation.

Hearing Assessment of all the patients was performed by professional audiologists, including Pure Tone Audiometry (PTA), Tympanometry, and Brain Evoked Response Audiometry (BERA). The age limit to perform BERA is one to three years so; it could be performed on 15 (26.7%) patients only. The results are elaborated in detail in the table given below.

Hearing Assessment		
Pure Tone Audiometry	**Frequency (n)**	**Percentage (%)**
Conductive Hearing loss	46	82%
Unilateral	41	73%
Bilateral	5	9%
Sensorineural Hearing loss	18	32%
Unilateral	16	29%
Bilateral	2	4%
Tympanometry	**Frequency (n)**	**Percentage (%)**
Flat Tympanic Membrane	56	100%
Unilateral	53	95%
Bilateral	3	5%

Table. 3. Results of Hearing Assessment Test.

With multidisciplinary approach, the patients were analyzed carefully, and their surgeries were planned accordingly. For majority of the patients, simple mastoidectomy was adequate (n=19, 34%). However, n=15 (27%) underwent Radical Mastoidectomy, n=13 (23%) Modified Radical Mastoidectomy, and n=9 (16%) Atticotomy with Simple Mastoidectomy.

Sr. No.	Surgical Interventions	Frequency (n)	Percentage (%)
1	Simple Mastoidectomy	19	34%
2	Radical Mastoidectomy	15	27%
3	Modified Radical Mastoidectomy	13	23%
4	Atticotomy with Simple Mastoidectomy	9	16%
5	Burr-hole Craniotomy	19	34%
6	Incision and Drainage of Cervical Abscess	5	9%
	Total	56	100%

Table. 4. Surgical Interventions performed in these selected patients of mastoiditis.

The surgical management of mastoiditis with complications needed multi-disciplinary approach including pediatric neurosurgery, ENT surgery, and General surgery departments. Medical consultation was also taken from expert pediatric physicians. After successful medical and surgical treatment, patients were discharged. On follow-up visits in last one year, 2 patients complained about the recurrence of the symptoms of acute mastoiditis. On examination, mastoiditis was confirmed in those patients in its early stages. Those patients were readmitted to the hospital for appropriate, adequate, and aggressive intravenous antibiotic treatment. Patients fully recovered within 2 weeks (mean= 10 days).

DISCUSSION

Otitis Media is common in childhood. But it is most common in first 5 years of the age due to direct invasion of viruses and bacteria of throat infections via relatively horizontally located eustachian tubes and/or co-existence of hypertrophied nasopharyngeal adenoid tissue [15]. Otitis Media with Effusion (OME) is a clinical condition in which the middle ear infection results in the formation of serous or mucoid secretion in the middle ear which can later become infected and purulent [16]. Multiple studies suggest that the fluid from middle ear cavity can freely move to the mastoid air cells and is occasionally present, even in uncomplicated otitis media [14-16]. So, in majority of the patients, the radiological examination may suggest the effusion in both, middle ear as well as mastoid air cells, termed as 'Otomastoiditis'. Otomastoiditis is a radiological term which can only be confirmed on CT Temporal Bone but always needs clinical correlation. Mastoiditis is not merely the presence in the mastoid air cavity, but it is a constellation of specific signs and symptoms which can only be assessed and confirmed on clinical examination [7-8]. Although mastoiditis is a clinical diagnosis, the supporting investigations are essential for the confirmation of the diagnosis in the suspected cases, to back up the clinical assessment, and to plan the surgery

by identifying the clear margins and extent of infection [6-9].

In our study, significant male predominance was observed; however, there is no evidence in literature to prove any anatomical or physiological variations based on gender difference [17].The management of coalescent mastoiditis varies from patient to patient. The possible treatment options are conservative/IV antibiotic therapy, IV antibiotic with myringotomy and tympanotomy tube insertion, and mastoidectomy. If the patient's condition allows, an intravenous antibiotic trial for 24-48 hours should be done before stepping onto next step.If the condition does not improve after 48 hours, surgery should be planned immediately. In some cases, myringotomy with tympanostomy tube insertion is enough to cure complicated/chronic mastoiditis. In some cases, mastoidectomy needs to be done [17, 18].

Mastoidectomy is a surgical procedure involving the removal of infected mastoid air cells. It is indicated in the acute or chronic mastoiditis, Chronic Suppurative Otitis Media (CSOM), and congenital or acquired cholesteatoma. There are 3 different approaches tomastoidectomy.

1. **Simple Mastoidectomy**

It includes mastoid exploration without removing or damaging the healthy mastoid air cells, middle ear structures, or ear canal. The purpose of this procedure is to simply open the mastoid sinus space and remove the debris, necrotic tissue, the infective secretions, and the damaged mastoid air cells. According to our collected data, most of the patients were successfully treated with simple mastoidectomy.

2. **Radical Mastoidectomy**

It is a canal wall down mastoidectomy, reserved for the recurrent mastoiditis/acquired cholesteatoma formation. It involves widening of the ear canal to facilitate the drainage of infective fluid from the mastoid cavity resulting in the exteriorization of the mastoid cavity, without the reconstruction of already damaged ear ossicles and tympanic membrane.

3. **Modified Radical Mastoidectomy**

The technique is like radical mastoidectomy, except it provides better visualization, better results, low recurrence of disease, and recovery of hearing loss by repairing the middle ear ossicles and tympanic membrane. It also involves exteriorization of the mastoid cavity [19].

The selection of the surgical procedure greatly depends on the general/clinical condition of the patient, pre-operative anesthetic evaluation, and radiological findings. The pictorial display of the CT and MRI scans is shown and explained below, highlighting the mastoiditis and its associated complications.

1. **Incipient Mastoiditis**

As described earlier in the article, incipient/non-coalescent mastoiditis involves infection of mastoid air cells without resulting in bony disruptions or central/peripheral extensions [8]. It mostly resolves with conservative treatment or in the case of coexistent CSOM, simple mastoidectomy may be needed.

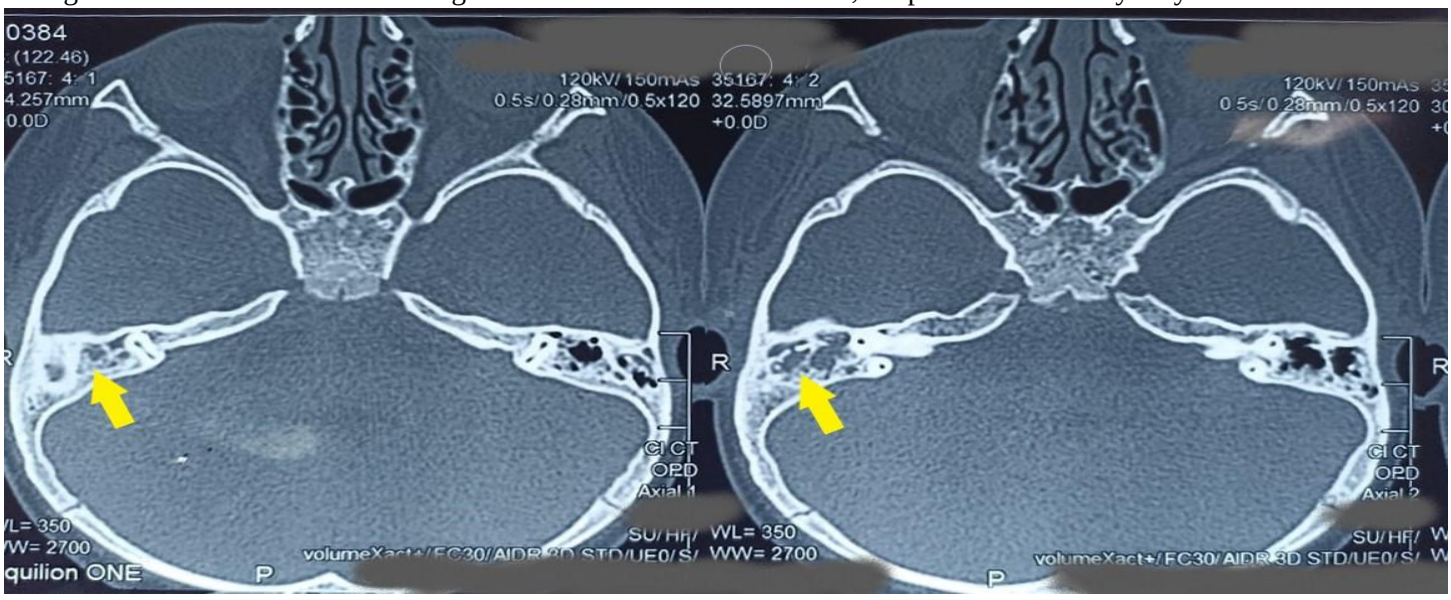

Figure 1. Incipient Mastoiditis: Acute otitis media with acute mastoiditis as CT Temporal bone axial view shows opacification of right middle ear cavity with loss of pneumatization of mastoid air cells on the right sides. However, the fluid is contained within the cavities. Ossicles and osseous walls of mastoid and middle ear cavity are intact. Per-operative findings include glue ear and serous fluid with negative pressure entrapped in the mastoid cavity

2. **Sub-periosteal Abscess:** Sub-periosteal abscess is the collection of pus due to the migration of exudate from mastoid sinus to the sub-periosteum of periauricular area (most commonly post auricular area) leading to tender swelling and erythema on the affected side [12]. It requires incision and drainage of the abscess with good IV antibiotic cover, with or without mastoidectomy.

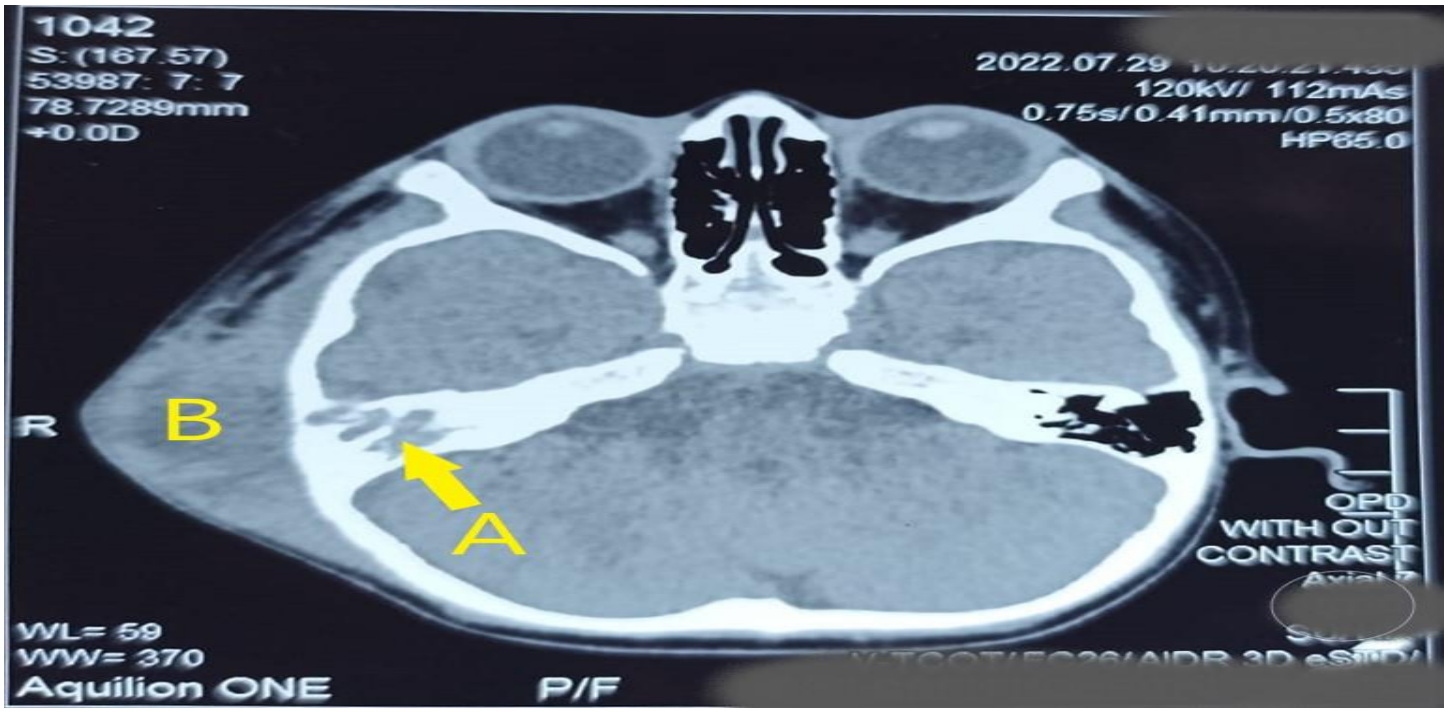

Figure 2. Subperiosteal Abscess: HRCT Temporal Bone revealing Right Otitis Media and Right Mastoiditis with osseous destruction of right mastoid temporal bone (A) and lateral extension to the postauricular soft tissue to form 4.0 x 3.3 x 2.3 cm fluid pocket/abscess (B). Left middle ear and mastoid air cavity seems normal.

3. **Coalescent Mastoiditis:** The type of mastoiditis involving osseous destruction and rapid spread of infection intra and extra-cranially. Early detection and prompt treatment with appropriate and adequate IV antibiotics can save the patient from complications. However, most the of patients have already developed the complications at the time of presentation. Surgery is planned after clinical and radiological assessment [7, 8].

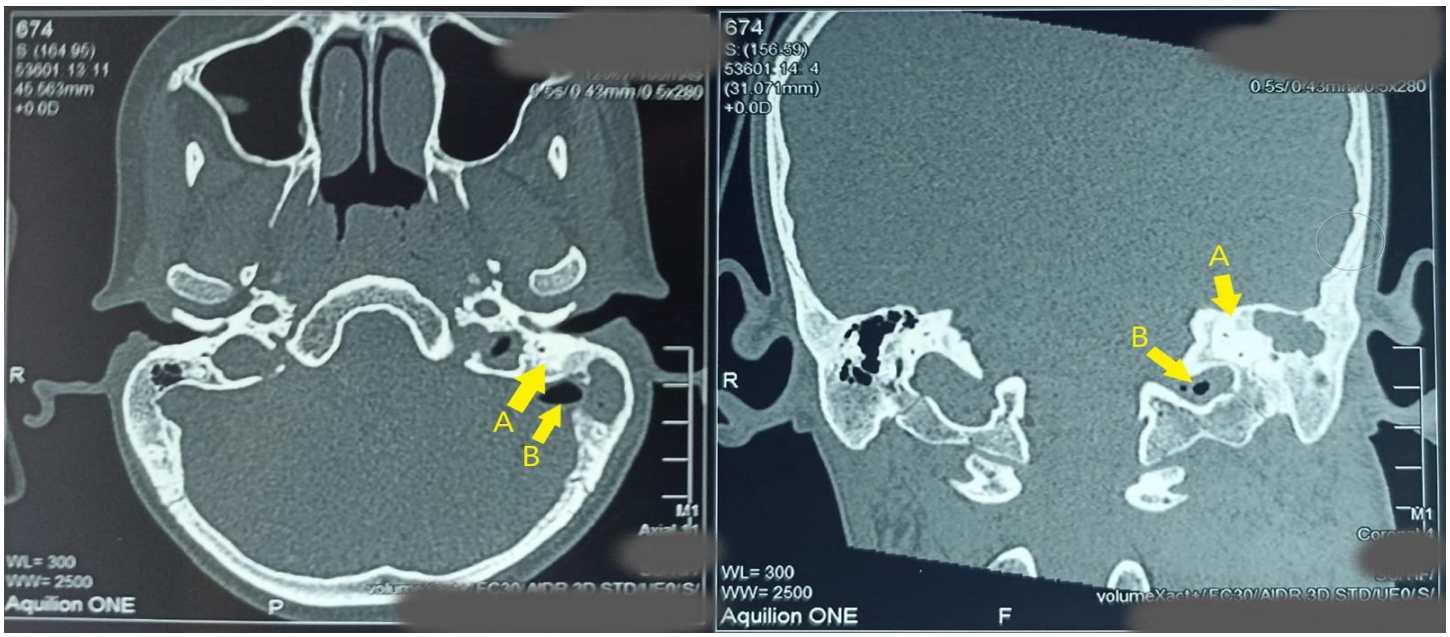

Figure 3. Coalescent Mastoiditis: Acute otitis media and acute mastoiditis associated with trabeculae and posterior bony wall destruction, leading to the hypopneumatization of the left mastoid cavity (A), abscess on the left side, surrounded by air bubbles in focally inflamed brain parenchyma (B).

4. **Perisinus Abscess:** Migration of the pus from mastoid cavity in between the split layers of dura matter around the sigmoid sinus, in the posterior cranial fossa is called perisinus abscess. It is also associated with sigmoid sinus thrombophlebitis [10]. Mastoidectomy drains the perisinus abscess, so no special procedure is required.

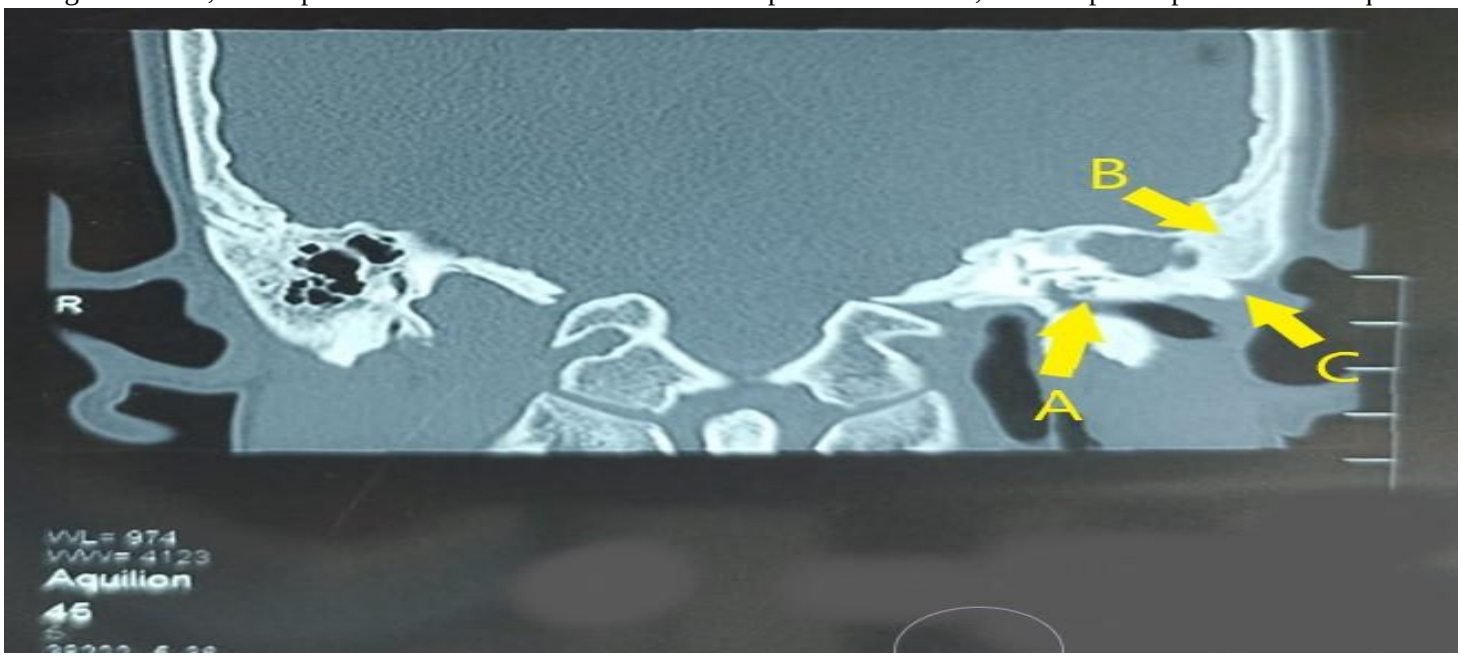

Figure 4. Perisinus Abscess. Left sided mastoiditis with lateral osseous disruption of mastoid cortex (A)and superior sigmoid plate (B) leading to the formation of small subdural abscess (C) and seepage of exudate around the lateral wall of the mastoid and sigmoid sinus on the left side.

5. **Epidural Abscess:** When the mastoid abscess is in free communication with the meninges after bony resorption of the surrounding osseous boundaries, the migration of abscess to the epidural space causes epidural abscess. The picture shown below shows Left CSOM with mastoiditis associated with epidural abscess and sigmoid sinus involvement [18].

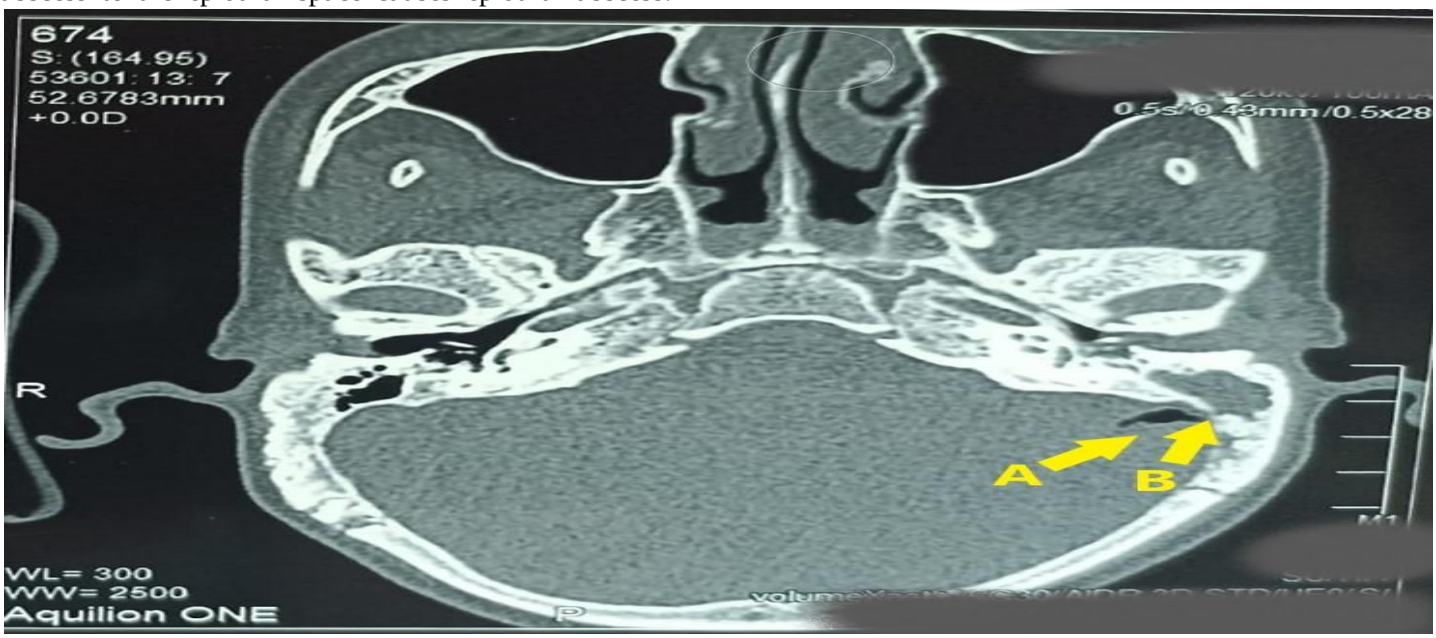

Figure 5. Epidural abscess (A) with thrombophlebitis of sigmoid sinus in a critically ill patient with Left chronic mastoiditis. CT Temporal bone axial view shows increased attenuation of left middle ear and left mastoid air

antrum with massive osseous disruption on its posterior wall (B), along the sigmoid sinus plate. Patient fully recovered after Mastoidectomy with epidural abscess drainage along with IV antibiotic regimen during the hospital stay.

6. **Petrous Apicitis:**Petrous bone is non-aerated in most of the people, but radiological investigations can pick the findings of recent congestion of previously aerated petrous bone. Petrous apicitis is purely a radiological diagnosis and cannot be confirmed clinically [19].

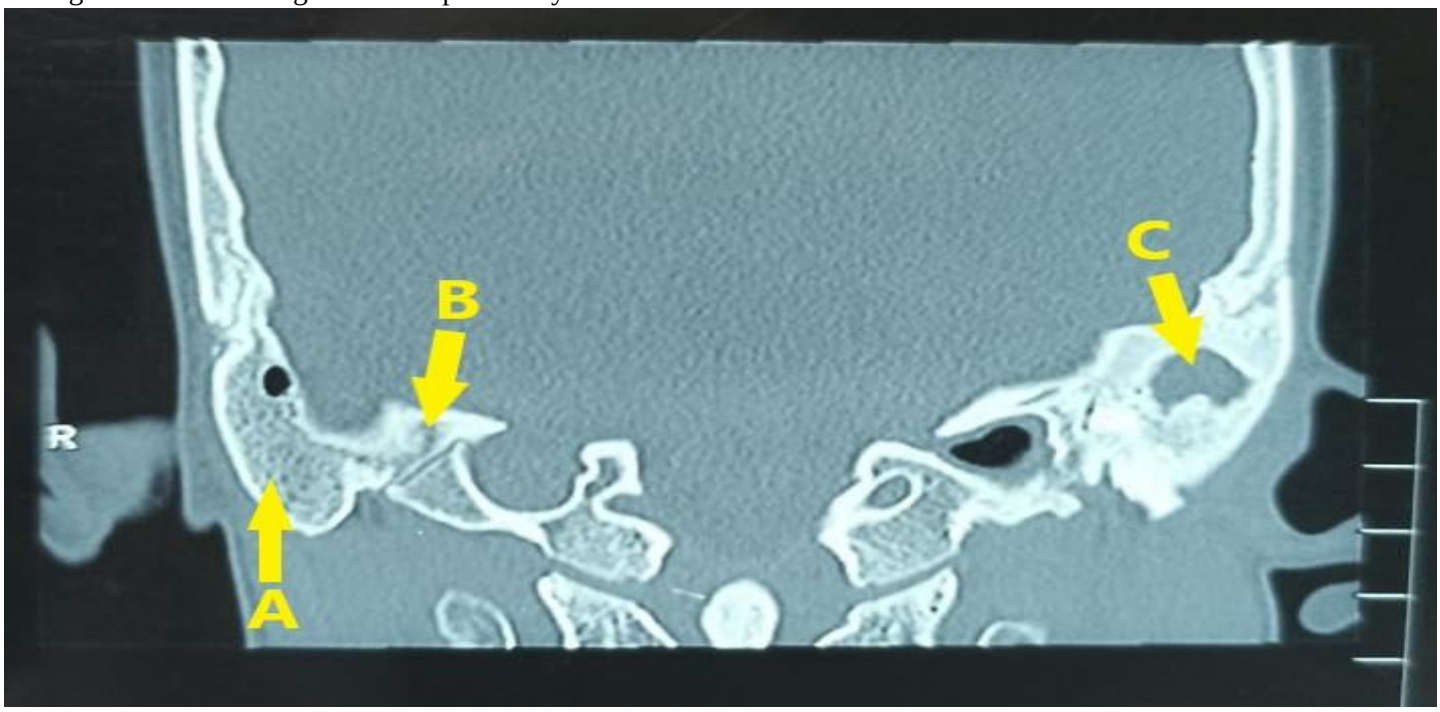

Figure 6. Petrous Apicitis: CT showing excessive enhancement and erosive changes bilaterally over the mastoid air cavity and the apex of petrous sinus. There is hypopneumatization of right mastoid cavity (A)with evident osseous disruption of right petrous bone (B); while the left mastoid is fully congested (C) Air pocket with focal meningeal edema.

7. **Gradenigo Syndrome:** It is a constellation of otitis media, Bell's Palsy, and Abducent nerve palsy. Most commonly, it results from the unresolved petrous apicitis, leading to the involvement of facial and abducent nerve due to their proximity [18, 19]. The patient presents with chronic or recurrent otitis media, facial pain along the distribution of trigeminal nerve, diplopia, and bell's palsy.

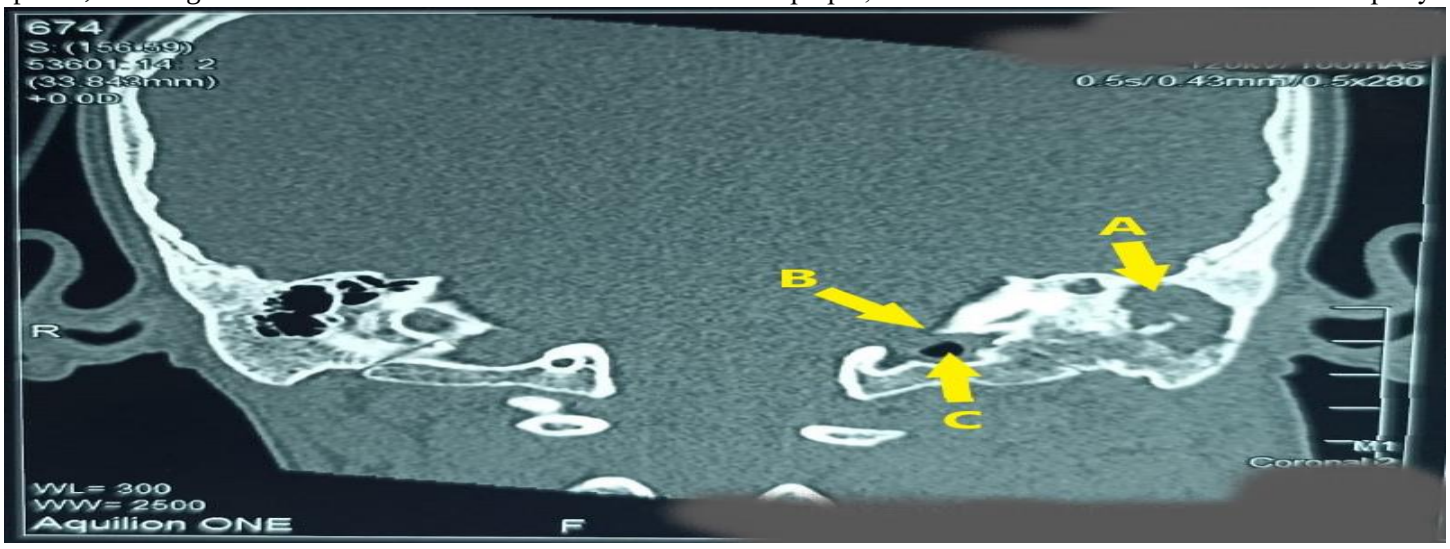

Fig.7. Gradenigo Syndrome: CT scan showing the attenuation of left middle ear cavity, left mastoid air sinus (A), and left petrous apex (B) with the osseous disruption and bone resorption, resulting in the focal meningeal inflammation (C). The clinical examination confirms involvement of the facial nerve and abducent nerve.

8. **Subdural Abscess:** Migration of mastoid abscess to the subdural space after the bony resorption of the walls of mastoid leads to subdural abscess. Depending on the clinical assessment and size of the abscess, the decision of surgery is taken [13]. However, draining of abscess simultaneously with the elective mastoidectomy is preferred.

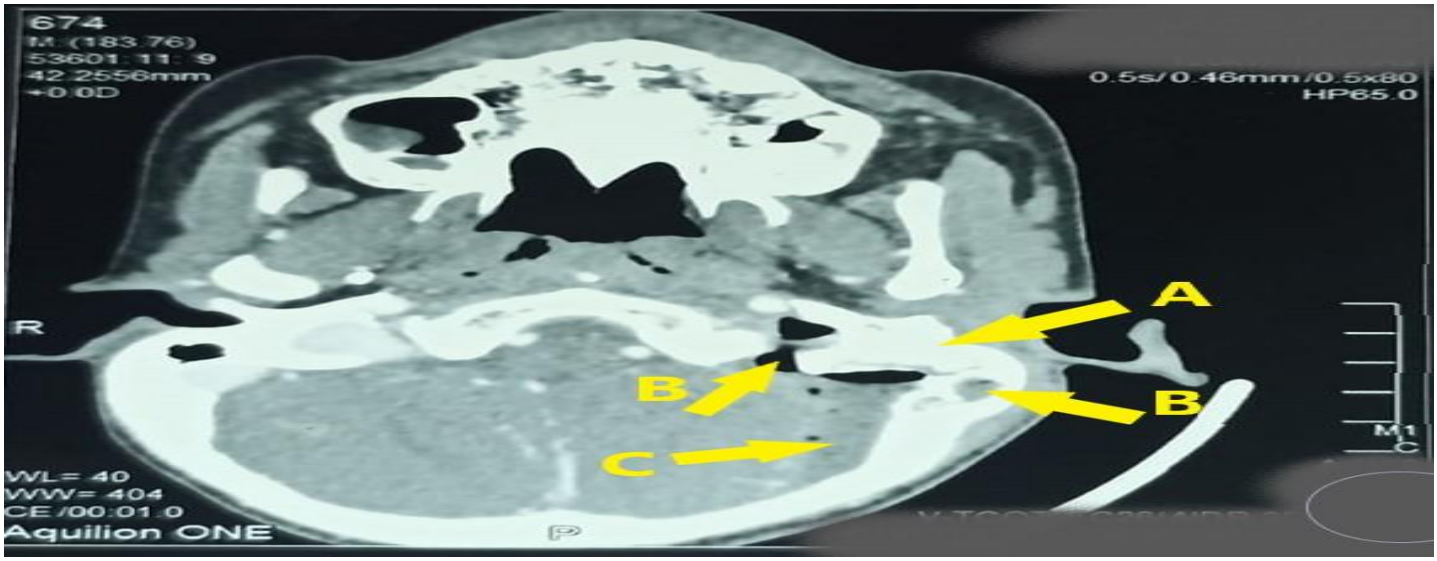

Figure 8. Subdural Abscess: Axial Contrast enhanced CT scan showing increased attenuation of left middle ear and mastoid cavity (A), with large osseous disruption with air trappings along the posterior aspect of mastoid antrum and along the boundary of sigmoid sinus (B) resulting in seepage of exudate in between the meninges, causing a large subdural abscess (C).

9. **Bezold's Abscess:** The downward extracranial extension of mastoid abscess leads to Bezold's abscess, extending from the periauricular region to the posterior triangle of neck. Its consequences are as devastating as that of intracranial extensions because the local inflammatory effect of the abscess surrounds the Carotid Artery and Internal Jugular Vein of the affected side and causes thrombophlebilitis, thrombus followed by embolus formation, stroke/sudden death. [17]

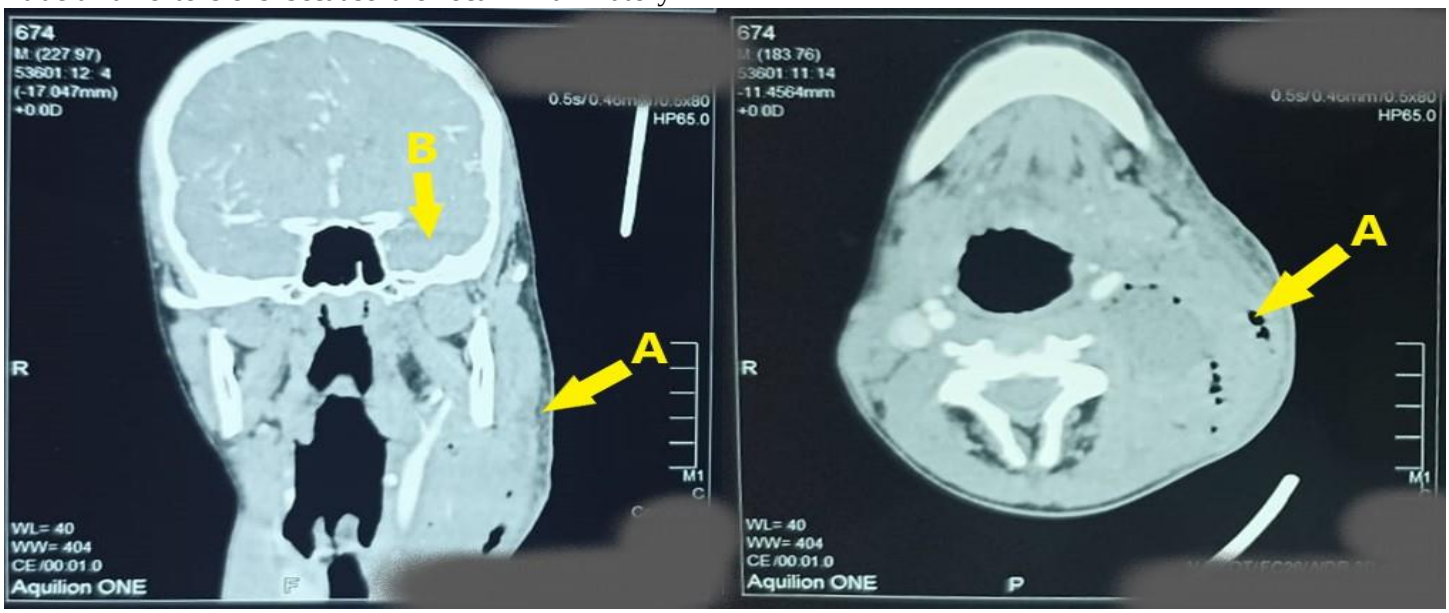

Figure 9. Bezold's Abscess. MRI neck with IV contrast coronal (Left) and Axial (Right) view, showing 66 x 11 x 35 mm (AP x CC x TR) multiloculated, multiseptate peripherally enhanced collections involving soft tissue and

muscles of the left side of the neck (A) with intracranial extra axial extension into posterior fossa (B). The neck abscess also caused cervical lymphadenopathy, thrombophlebitis, and thrombus formation in left Internal Jugular Vein, confirmed on Doppler Ultrasound of the neck.

10. **Brain Abscess:** The free communication of the mastoid cavity with the middle and posterior cranial fossa in coalescent mastoiditis can cause localized/diffused seepage of pus in the brain parenchyma after diffusing through or disrupting the meninges [18]. The patient may present with meningitis, stroke, and/or coma.

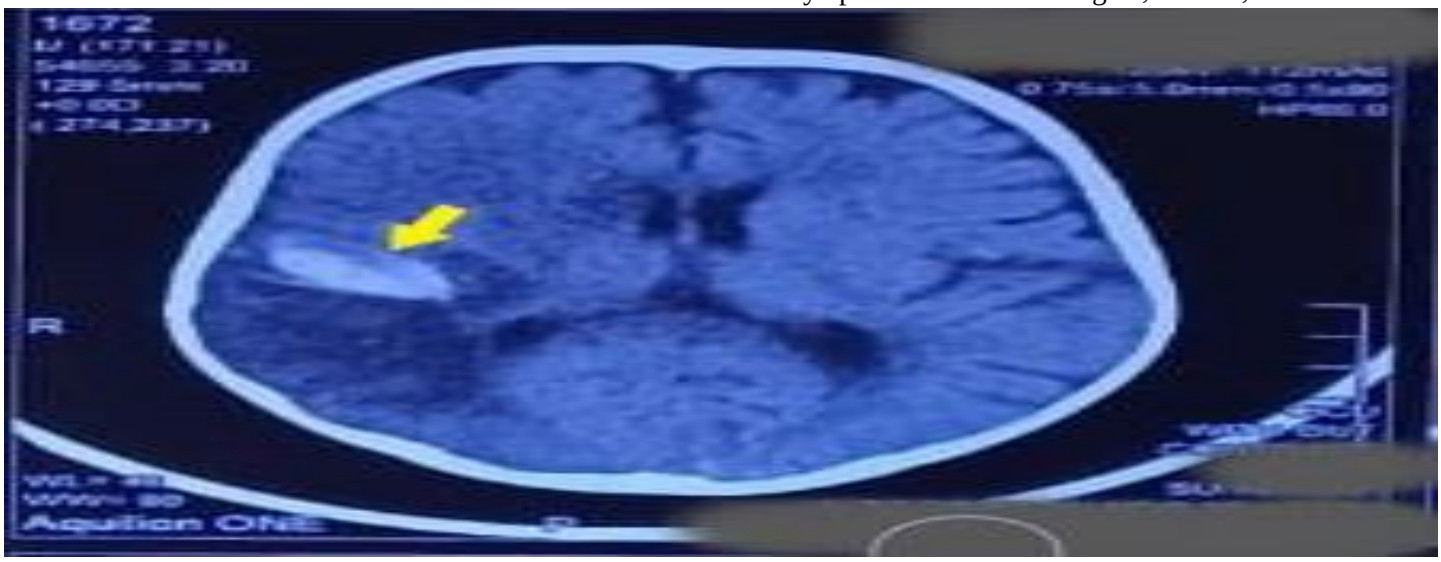

Figure 10. Brain Abscess., MRI brain with IV contrast showing acute large opacity over right temporal lobe with surrounded hypodense area. Patient presented with left sided body weakness (couldn't be fully assessed due to poor GCS), signs and symptoms of meningitis such as high-grade fever, nuchal rigidity, impaired vision, altered sensorium, etc.

11. **Labyrinthitis:** It is the inflammation of membranous labyrinth and vestibulocochlear nerve because of the ongoing inflammation in coalescent mastoiditis. The patient with labyrinthitis was presented to us with vertigo, nausea, and hearing loss [19]. The condition usually resolves with the surgical/medical treatment of mastoiditis, without any permanent affects. Fig. 11.

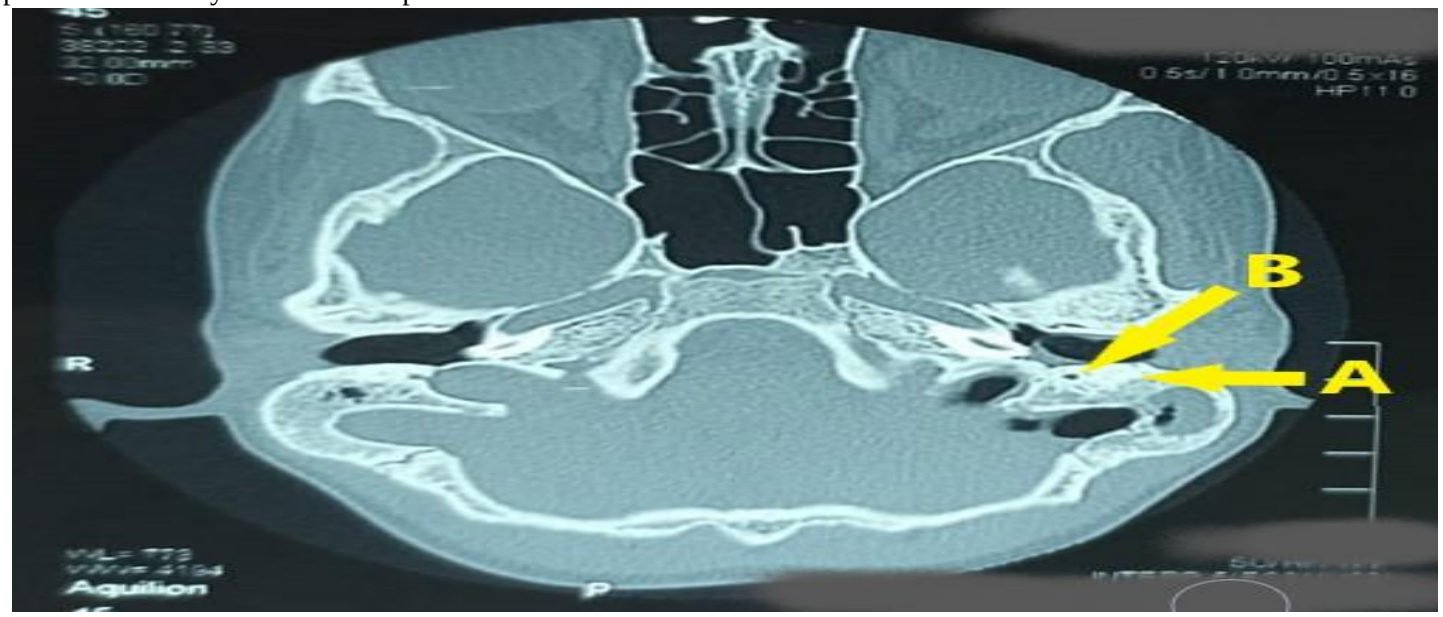

Figure 11. Labrynthitis:The CT Temporal bone axial view suggests Left CSOM, Left mastoiditis (A) with initial stages of ossification of membranous labyrinth (B). The MRI scan of the similar patient shows loss of normal fluid content of the inner ear and enhancement of the membranous labyrinth.

12. **Cerebellar Abscess:** When the mastoid abscess makes its way to the parenchyma of cerebellum, it results in the cerebellar abscess on ipsilateral side. The fistulous tract formation between the mastoid cavity and posterior cranial fossa leads to serious neurological complications with rapid progression. The patient may present with meningitis, stroke, septic shock, and poor sensorium [18, 19].

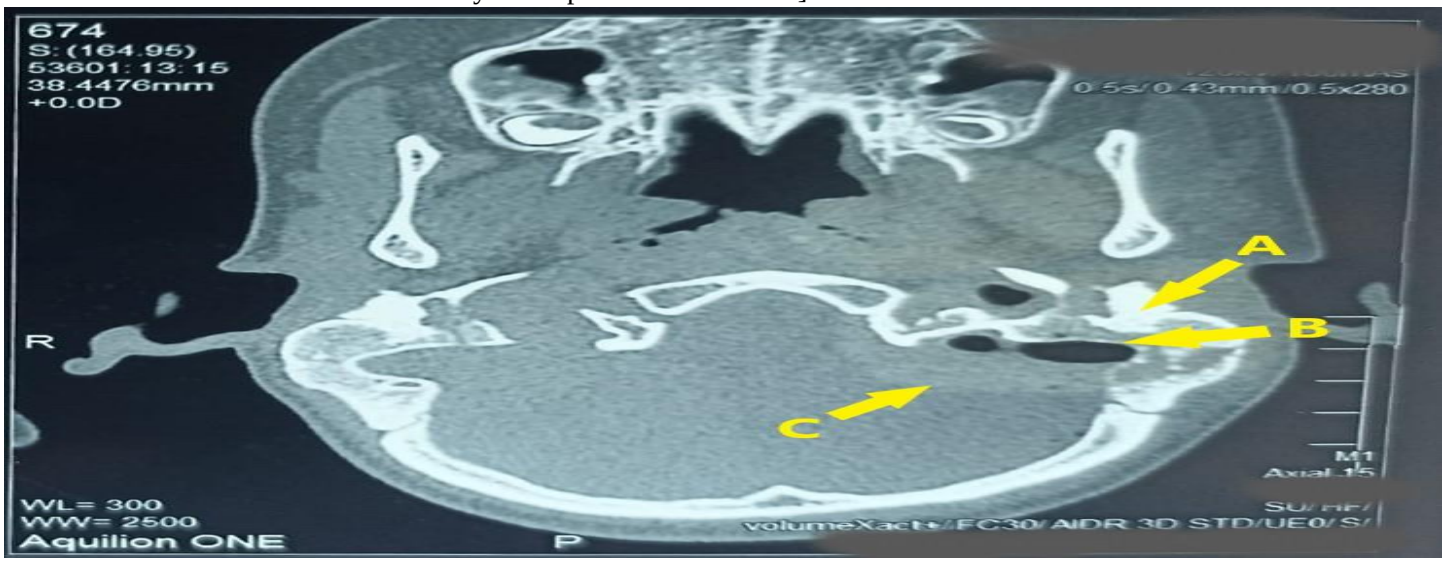

Figure 12. Cerebellar Abscess: CT Temporal Bone with IV Contrast Axial view. Hypo pneumatization, massive osseous erosion, and sclerosis of left middle ear cavity and left mastoid cavity (A), resulting in the fistulous tract formation between the middle ear cavity and posterior cranial fossa (B) resulting in left cerebellar abscess (C). MRI Brain of the patient was also performed, showed peripheral ring enhancing lesion in the left cerebellar hemisphere with necrotic center, mild ventriculitis, and less well-defined rim.

In the presence of clinical signs of otitis media and mastoiditis (either acute or chronic) e.g., protrusion of the ear pinna and post auricular tenderness/erythema/abscess, the suggested treatment option is myringotomy with tympanocentesis and grommet insertion, per-operative ear swab sample collection for culture and sensitivity test followed by intravenous antibiotic regimen according to antibiotic susceptibility. If the patient does not improve with this treatment, radiological investigations should be repeated to check for the signs of mastoiditis. Presence of radiological signs of mastoiditis and periosteal abscess calls for mastoidectomy [19, 20].

CONCLUSION

The global prevalence of mastoiditis and its associated complications have remarkably reduced with the advent of antibiotics. However, the early diagnosis of this serious clinical problem is still challenging. Use of antibiotics masks most of the early signs and symptoms of the severe complications. Nevertheless, advanced diagnostic imaging plays a vital role in the early detection and administration of prompt and adequate intravenous antibiotic therapy to help the pediatric physicians prevent the life-threatening consequences. Computed Tomography (CT) Temporal bone with IV contrast should be performed as soon as possible in all the suspected patients of acute or chronic mastoiditis. If the CT suggests or suspects intracranial extensions, then the Magnetic Resonance Imaging (MRI) brain with IV contrast should be advised. Magnetic Resonance Arteriogram/Venogram and Doppler Ultrasound is recommended for thromboembolic phenomenon in intracranial and extracranial blood vessels, respectively. These imaging techniques significantly help the physicians and surgeons to plan the effective modality of treatment in respective patients.

CONFLICT OF INTEREST: None

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