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CT Evaluation of Neoplasms in the Temporal Region

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Abstract

Background: Temporal bone imaging has always been a challenge. Though infections and trauma are the most common pathologies encountered; a wide range of neoplasms affect this region which can become a serious threat if overlooked. Computed Tomography (CT) plays a crucial role in diagnosis and characterization of these neoplasms. It is very helpful to evaluate the extent of the lesion and involvement of adjacent structures, helping to decide appropriate management. **Aims and Objectives:** The purpose of our study was primarily to evaluate various neoplasms in the temporal region based on CT findings in patients presenting to the radiology department in a tertiary care centre. **Materials and Methods**: The prospective study done over a period of 2 years in the Department of Radio-diagnosis at Dr. Vasantrao Pawar Medical College, Hospital and Research Centre, Nashik included 26 patients with neoplasms involving the temporal region. CT scan of all these patients was performed on Siemens Somatom Perspective (128 slice). The imaging findings were correlated with histopathological and surgical findings wherever available. **Results**: The study comprised of 26 patients in which bulk of the patient's i.e. 42% had features of vestibular schwannoma on imaging. Glomus tumour and cerebellopontine angle epidermoid cyst found in 15% and 11% of patients, respectively were the other common lesions. Neoplasms were most common in the age group of 41 to 50 years. There was female preponderance (62%) amongst patients. Headache and hearing loss were the most common complaint. **Conclusion**: We can ascertain from this study that neoplasms in the temporal region show characteristic findings on CT imaging. These imaging characteristics coupled with other imaging and clinical findings help us to achieve an accurate diagnosis. Imaging techniques enables a reliable non-invasive assessment of these neoplasms.

Keywords: Computed Tomography, Glomus Tumour, Temporal Bone, Vestibular Schwannoma

1. Introduction

Neoplasms in the temporal region have highly variable clinical presentation. The symptoms vary between patients in character and intensity. Some of these neoplasms can become serious medical problems if not identified and treated, with involvement of the adjacent inner ear and extension into the extra temporal region[1]. The evaluation and diagnosis of neoplastic lesions in the temporal region is a challenging task for both the radiologist and otolaryngologist. Careful and thorough analysis is required for the early diagnosis and treatment.

Computed Tomography (CT) scanning excels in the evaluation of lesions in this region. They are more

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accurate in identifying many soft tissue abnormalities and are much less prone to artefacts than conventional radiography. CT is becoming the investigation of choice for definitive preoperative temporal bone imaging as new advances are being developed.

High-resolution Computed Tomography (HRCT), a modification of routine CT involves the usage of thin sections and special algorithms offering excellent spatial and density resolution in addition to providing useful data not only regarding bony outlines but also soft tissue changes further narrowing down the differential diagnosis. Because HRCT can assess this area with unprecedented accuracy, it has allowed better understanding of the lesions which has considerably reduced the morbidity and mortality pertaining to lesions of this region.

Magnetic Resonance Imaging (MRI) studies can be extremely useful in the evaluation of vascular disorders of the temporal bone. In certain cases, routine and contrast-enhanced MRI scores over HRCT; however, in most instances, it acts as a next step for confirmation and further characterization[2].

Contrast administration is used to assess the enhancing characteristics and vascularity of the neoplasms, thus giving clues to the histopathology[3].

CT has now become the most widely used imaging modality for assessment of neoplastic lesions in the temporal region. The extent, nature of the lesion and involvement of adjacent structures can be clearly demonstrated on CT scan. The extent of the neoplasm will often determine the aggressiveness of the surgical approach[1,4].

2. Aims and Objectives

To aim is to study the characteristic features and associated findings of neoplasms in the temporal region on CT imaging.

3. Materials and Methods

This prospective study was carried out over 24 months (October 2016 to October 2018), with due permission from the ethics committee. CT scan of 26 patients was performed who were referred to the Department of Radio-diagnosis at Dr. Vasantrao Pawar Medical College, Hospital and Research Centre, Nashik with clinically suspected temporal bone or ear pathologies. The clinical and demographic data were recorded after due consent to correlate the findings. The patients who were not willing to give consent, who were previously operated and those with known or detected neoplasm related to temporal region were excluded.

All the CT scans were done on Machine: Siemens Somatom Perspective (128 slice). CT scan of temporal bone with axial and coronal reconstruction was performed which is a pre-requisite for detailed evaluation.

Scout films were taken in all patients before beginning the scan. Intravenous contrast was administered to study the lesions wherever required. CT images were analysed for specific features relevant to the neoplastic lesion in temporal region. The findings of CT scan were correlated with histopathologic diagnosis.

4. Observations and Results

A total of 26 patients of neoplastic lesions in the temporal region were evaluated by CT and their imaging features were studied with the aim of describing neoplasms in the temporal region. The results obtained were as follows:

Majority of the patients in this study i.e. 50% were in the age group of 31 to 50 years. The peak incidence was observed in the age group of 41–50 years (n = 7) (Chart 1).

The study comprised of 10 males and 16 females (Table 1), between the age groups of 0 - 70 years.

The most common neoplasms were vestibular schwannoma (n = 11) followed by glomus tumour (n = 4). Three patients had Cerebellopontine Angle (CPA) epidermoid cyst. 2 patients had osteoma while 2 patients had fibrous dysplasia. One patient had External Auditory Canal (EAC) exostosis. One patient had carcinoma of EAC, one patient was a rare case of Langerhans cell histiocytosis while 1 patient had metastasis involving the temporal bone (Table 2).

Vestibular schwannoma was the commonest neoplasm in this study. Highest incidence was found in the 5th decade with majority of the patients belonging to the age group of 41-70 years, which comprised of 7 out of 11 patients of vestibular schwannoma (Chart 2), (Figure 1 to 3).

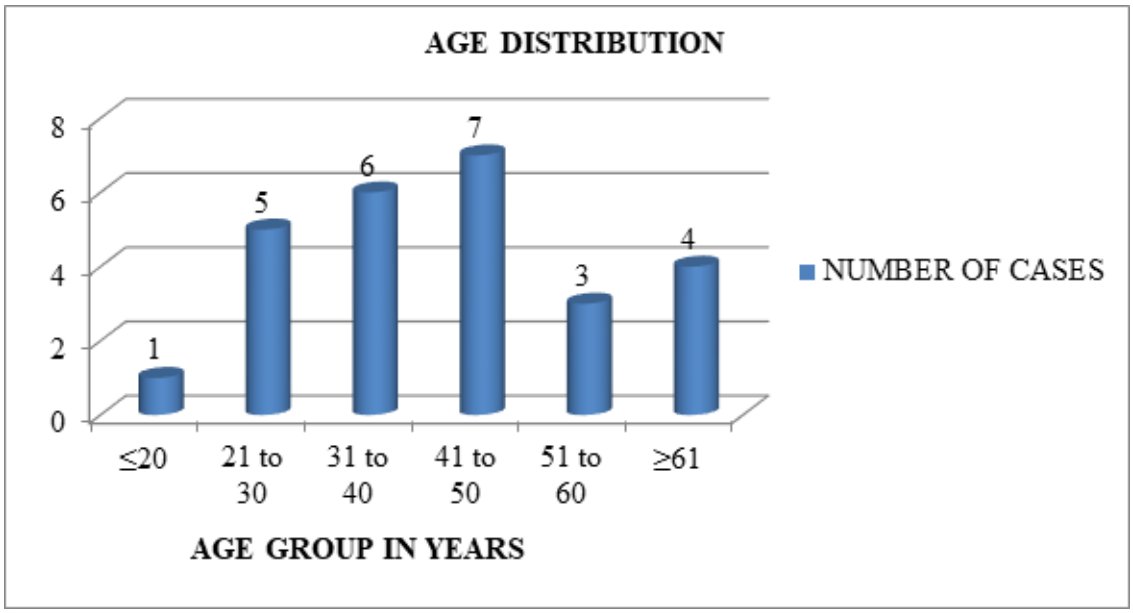

Chart 1. Age distribution of neoplasms in the temporal region

Table 1. Sex distribution of neoplastic lesions

SEX DISTRIBUTION OF NEOPLASTIC LESIONS	NUMBER OF CASES	PERCENTAGE
Male	10	38
Female	16	62
Total	26	100

Table 2. Distribution of neoplastic lesions

DISTRIBUTION OF NEOPLASTIC LESIONS	NUMBER OF CASES	PERCENTAGE
Vestibular Schwannoma	11	42
CPA epidermoid CYST	3	11
Glomus Tumour	4	15

Table 2 Continued

Exostosis	1	4
Osteoma	2	8
Fibrous Dysplasia	2	8
Carcinoma of EAC	1	4
Langerhans Cell Histiocytosis	1	4
Metastasis	1	4
Total	26	100

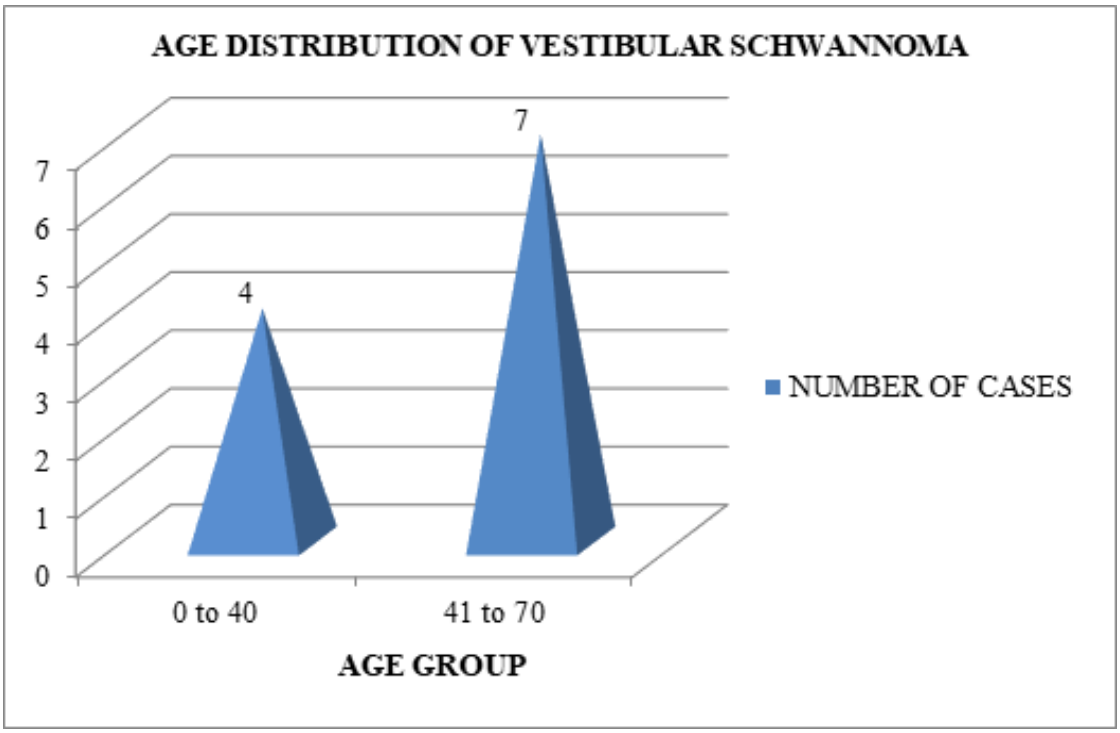

Chart 2 . Age distribution of vestibular schwannoma

The most common presenting symptoms were headache (81%) followed by hearing loss (54%). Other presenting complaints were tinnitus (38%), vomiting (23%), otalgia (15%), otorrhea (12%), and vertigo (8%) (Table 3).

Table 3. Clinical features associated with neoplasms

Clinical Features	Number of Cases
Headache	21
Hearing loss	14
Tinnitus	10
Vomiting	6
Ear pain	4
Ear discharge	3
Vertigo	2

5. Discussion

The temporal bone region is subjected to a large variety of lesions. CT is acquiring an increasingly important role in the radiographic assessment of temporal bone. Clinical examination lacks precision in the evaluation of temporal bone neoplasms while conventional radiography is unreliable, which renders CT as the modality of choice for their assessment.

This study is undertaken to develop a systematic approach for evaluation of neoplastic lesions in the temporal bone region.

Localization of lesion in the region of temporal bone to one of the following is imperative to evaluate the neoplasm:

- Internal Auditory Canal (IAC)/CPA
- Middle ear
- EAC and mastoid
- Petrous apex
- Facial nerve

The commonly seen tumors are:

- Vestibular schwannoma
- Meningioma
- Glomus

Other rare tumors are:

- Metastases
- Rhabdomyosarcoma
- Langerhans Cell Histiocytosis
- Carcinoma
- Primary bone tumors – aneurysmal bone cysts, giant cell tumors, exostoses etc.

5.1 IAC/CPA Tumors

5.1.1 Vestibular Schwannoma

It comprises of 60%–90% of all neoplasms in the IAC/CPA making it the most common tumour in this region[5]. The majority of patients lie in the 40-70 year age group[6]. However, in cases of neurofibromatosis type II, they present much earlier, commonly in the first 2 decades. In addition to bilateral vestibular schwannomas, neurofibromatosis type II is often associated with other neoplasms in the brain and spine like meningiomas, ependymomas and schwannomas of other cranial nerve origin. Common symptoms are hearing loss of sensorineural type, tinnitus, disequilibrium and secondary pressure effects of the tumour.

CT Findings

Identification of vestibular schwannomas on CT has often been difficult without contrast study as most of them are isoattenuating to cerebellum[5]. However, in cases when it leads to asymmetrical widening and expansion of the porus acousticus on the affected side, it may easily

Case 1: Vestibular Schwannoma

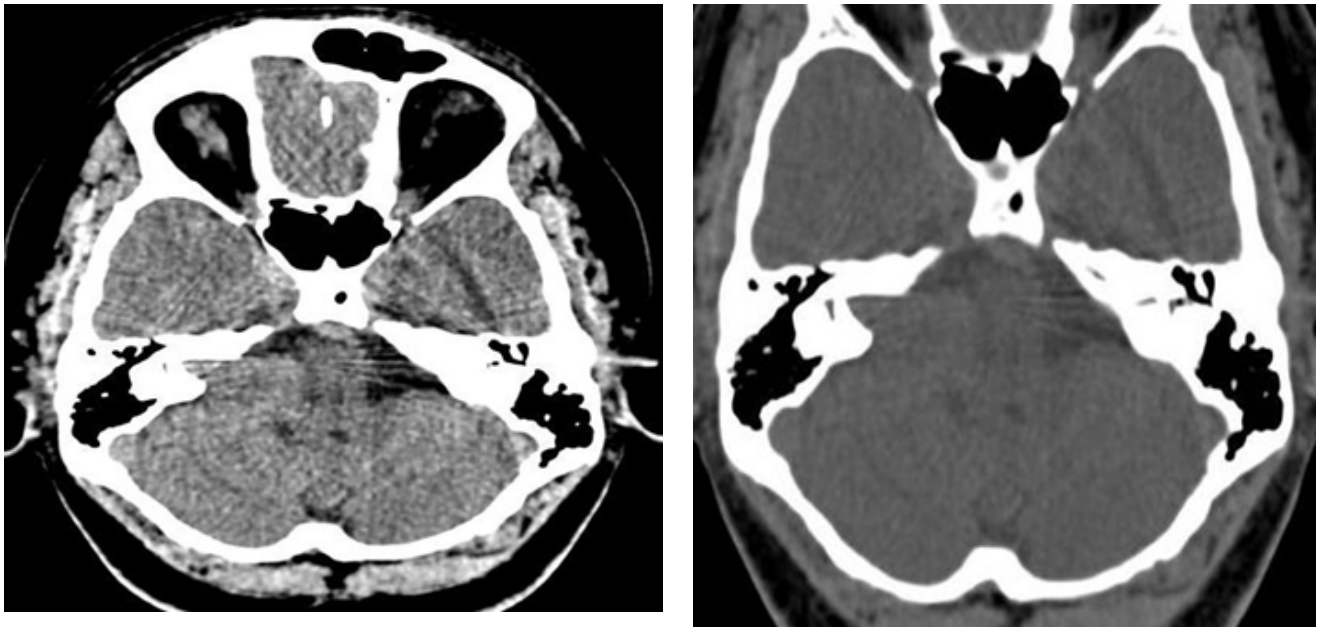

Figure 1 and 2. Vestibular schwannoma. Plain CT brain axial image (above) shows a heterogeneous extra-axial mass lesion at the right CP angle with few hypodense cystic areas within (arrow). Bone window image (below) reveals widening of the porus acousticus on right side (arrow). These findings were suggestive of vestibular schwannoma.

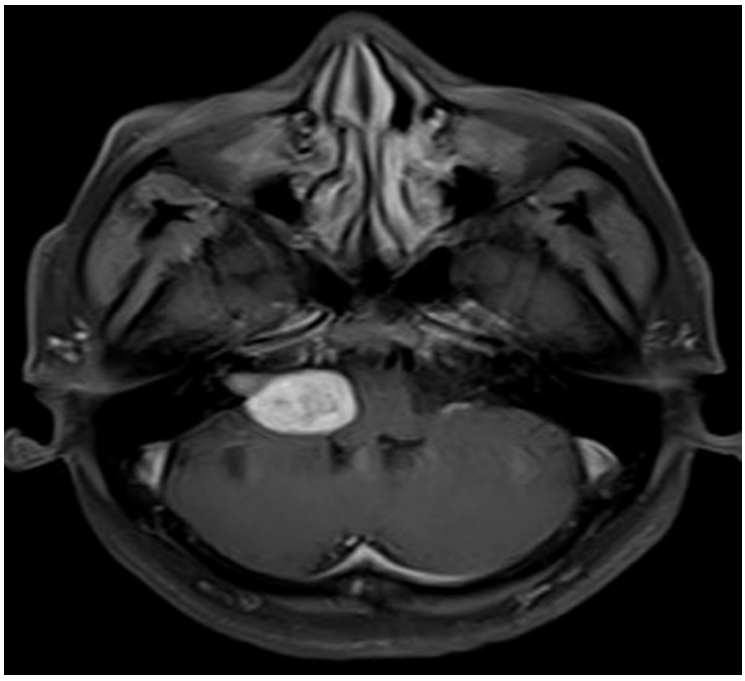

Figure 3. Vestibular schwannoma. Complementary contrast enhanced MRI image in the same patient shows a heterogeneous avidly enhancing extra-axial lesion at the right CP angle with few cystic components within (thin arrow). Intra-canalicular segment and trumpeted IAC is well seen (block arrow). These findings were suggestive of vestibular schwannoma.

delineated on CT bone window images. Rare features include haemorrhage and calcification, which are usually seen after treatment. The tumour enhances avidly and inhomogeneously[7], but small tumors are still challenging to detect on CT images (Figures 1, 2 and 3).

Secondary changes such as widening of ipsilateral CPA and quadrigeminal cistern, narrowing of contralateral cistern and displacement and compression of 4th ventricle are noted. In addition bony changes such as difference in canal height of more than 2 mm, shortening of posterior wall of canal by more than 3 mm and presence of focal erosion are usually present.

Vestibular schwannoma was found to be most common CPA tumour in our study accounting for 11 out of 14 cases (79%) of CPA tumors. It was the most common IAC and/or CPA lesion in a study by Mikhael et al. (1987)[8].

Highest incidence of vestibular schwannoma in this study was seen in the 5th through 7th decades (7 out of 11 cases, 64%), as shown in their study by Propp et al., (2006).[6]

5.1.2 Meningioma

Meningiomas are common intracranial tumors. 5-10% of them are located at cerebellopontine angles. Enlargement of porus acousticus is more commonly seen in vestibular schwannoma but may also be seen with meningiomas. The patients with CPA meningioma usually present with sensorineural hearing loss or facial nerve symptoms. Their removal surgically is done mainly to restore hearing.

Meningiomas are centred at the CPA, often located eccentric to the porus acousticus unlike vestibular schwannomas. They seldom expand the porus or the IAC when they extend into the IAC. In the cerebellopontine angle it is a distant second to vestibular schwannoma in incidence. They arise from meningoepithelial arachnoid cells. Its peak incidence is 40 to 60 years, Female: Male - 2:1 to 4:1

CT Findings

They are sharply circumscribed mass that abuts the dural surface and forms an obtuse angle. Majority of them are

Case 2: Epidermoid Cyst

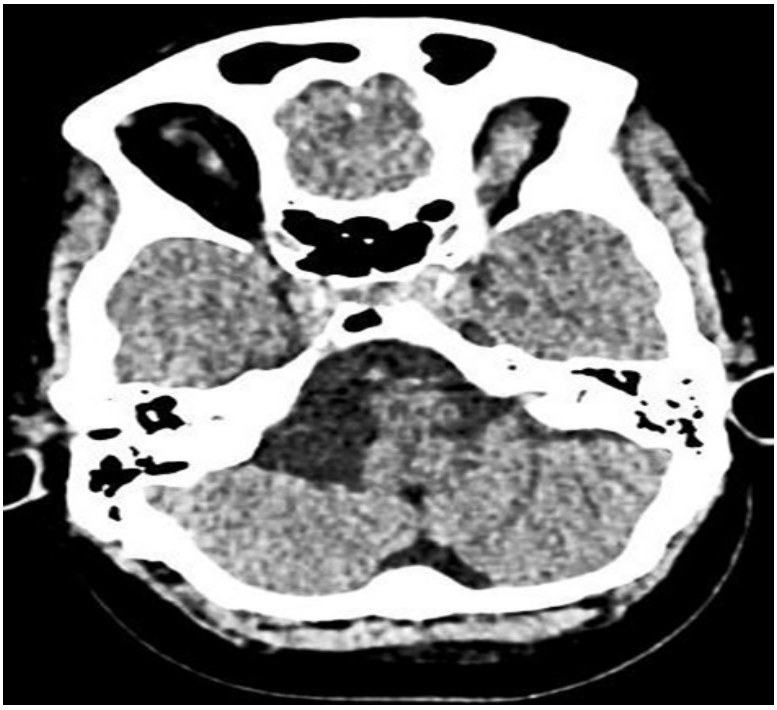

Figure 4. CPA Epidermoid cyst. Plain CT brain axial image shows a lobulated lesion at the right CP angle with attenuation similar to CSF (arrow), suggestive of epidermoid cyst.

hyperdense to brain parenchyma and show strong and uniform enhancement and calcification is seen in 20 to 25% cases with few tumors showing cystic areas[9].

5.1.3 Epidermoid Cyst

Epidermoid cysts are the most common CPA mass after vestibular schwannoma and meningioma[5]. They are not true neoplasms. Age and gender: 20 to 60 years, Male = Female

CT Findings

They are lobulated, similar in attenuation to Cerebrospinal Fluid (CSF). Large, long-standing cysts may cause smooth remodelling of the adjacent petrous bone secondary to pressure effect. Calcification is uncommon. Occasionally may appear hyperdense due to hemorrhage, high protein content or iron containing pigment (Figures 4 and 5).

5.1.4 Endolymphatic Sac Tumor

Endolymphatic sac tumour is a locally invasive tumour[10]. Most cases are sporadic. Von Hippel Lindau syndrome is associated with minority of cases. This tumor causes bony destruction in the retrolabyrinthine petrous bone around the vestibular aqueduct.

CT Findings

Bone invasion is well appreciated on CT which reveals a lytic tumor giving a moth-eaten appearance associated within tratumoral bone spicules[10].

Middle Ear Tumors

Whenever soft tissue density is noted in the middle ear, it should be differentiated from a vascular structure.

Paraganglioma are the most common middle ear tumor. Other neoplasms include facial nerve schwannomas, meningiomas, hemangiomas, choristomas; perineural

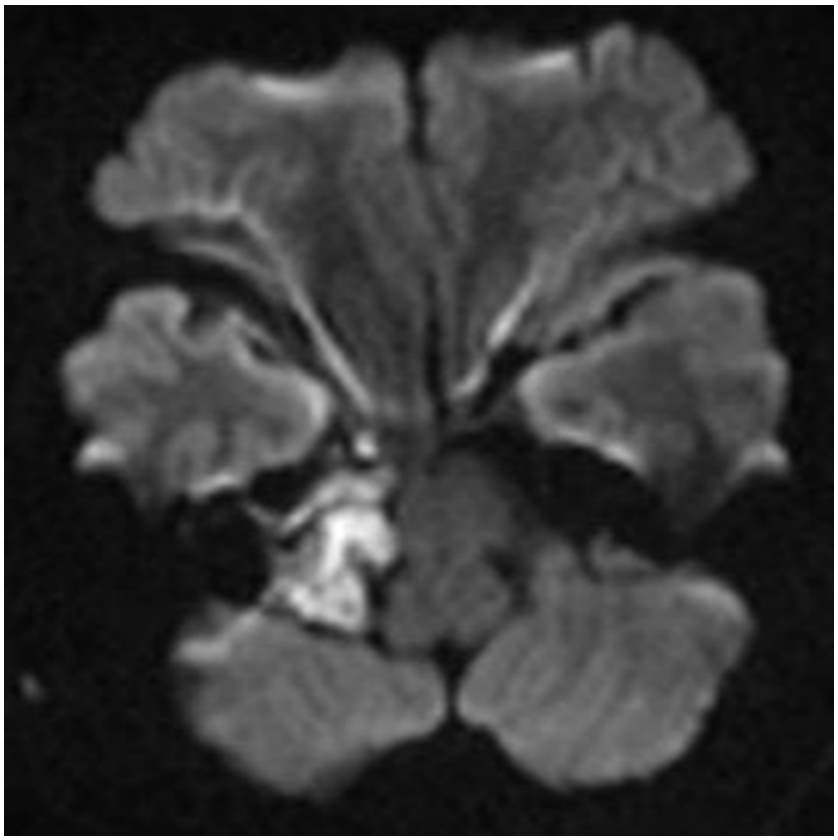

Figure 5. CPA Epidermoid cyst. Complementary plain MRI axial diffusion weighted image in the same patient shows a lobulated lesion at the right CP angle showing diffusion restriction (arrow), suggestive of epidermoid cyst. The lesion was similar to CSF intensity on MRI.

spread of tumor and mixed pattern type of adenomatous tumor. Malignant neoplasms like carcinomas and rarely metastases can also be found in this region.

Choristomas in this region is often related to abnormal facial nerve manifestations or associated incudo-stapedial abnormalities[11].

5.1.5 Glomus Tumors[12,1]

They are termed based on their location:

- Glomus tympanicum - glomus formations on cochlear promontory.
- Glomus jugular tympanicum - involving jugular foramen and middle ear.
- Glomus vagale - involving nasopharyngeal carotid space

These tumors have a female predilection. They were commonly seen in female patients in our study, in line with literature[14-15].

Case 3: Glomus Tumour

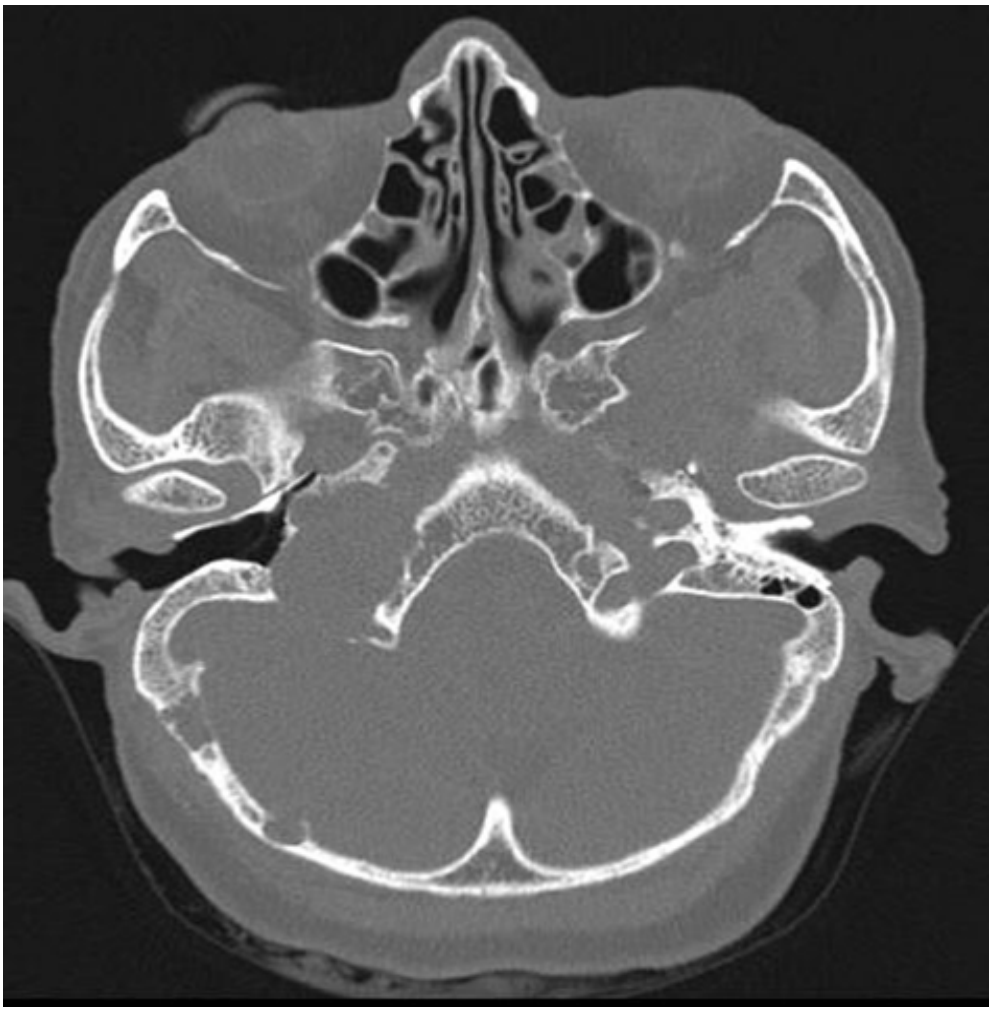

Figure 6. Glomus tumour. HRCT axial image shows an irregular lytic lesion causing widening and destruction of the right jugular fossa extending to the carotid canal and inner ear (block arrow). Bony erosions of the basi-occiput and lateral aspect of foramen magnum on the right side was also seen (thin arrow). These findings were suggestive of glomus tumour.

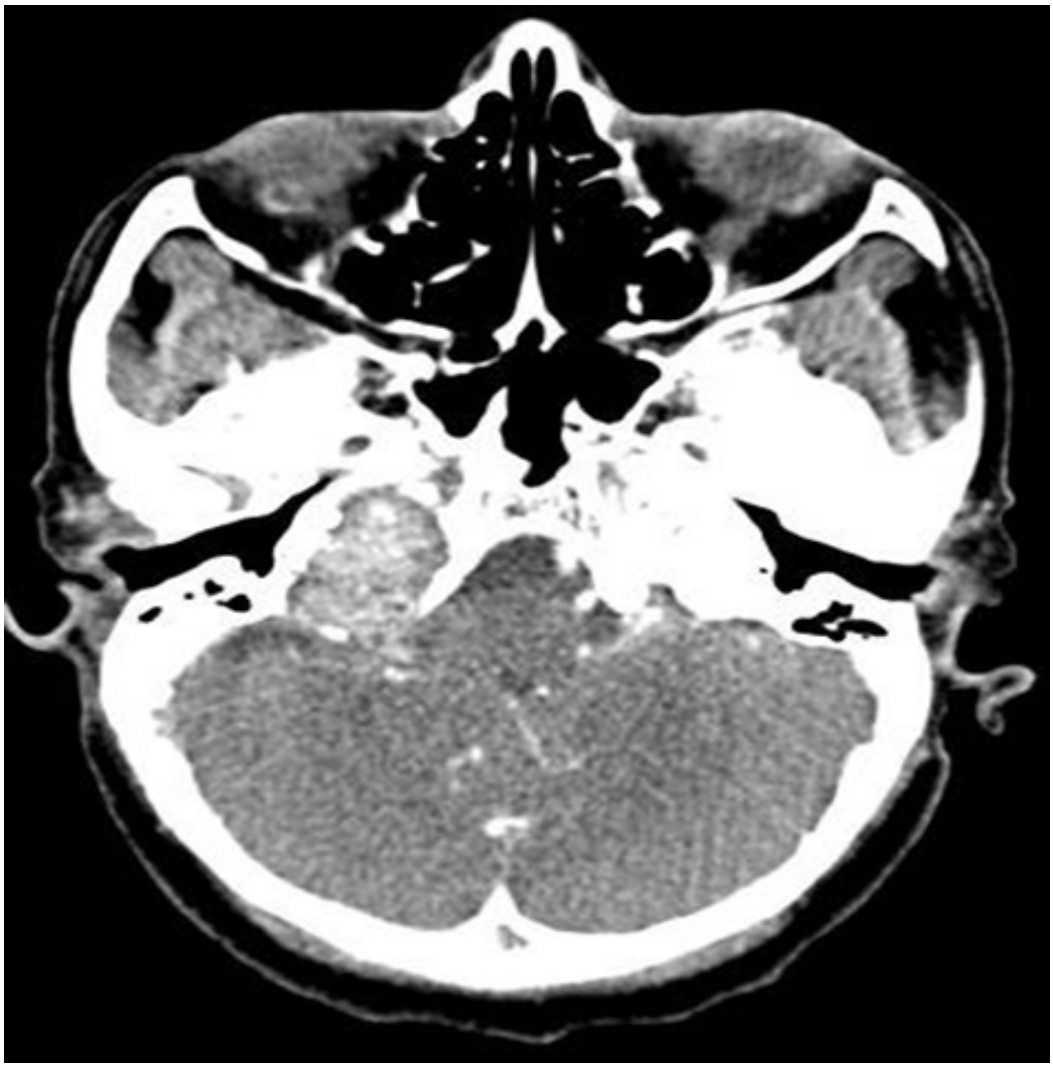

Figure 7. Glomus tumour. CECT axial image in the same patient shows an intensely enhancing lesion involving the right jugular fossa extending anteriorly to the carotid canal with involvement of the inner ear (arrow). These findings were suggestive of glomus tumour.

They cause local infiltration, grow slowly, following the path of least resistance along existing pathways in the temporal bone and seldom metastasize.[13] Common complaints include hearing loss, tinnitus and bloody ear discharge. These tumors are highly vascular and therefore they show avid enhancement on post contrast study (Figures 6 and 7).

CT Findings

Characteristic feature includes a localized lytic lesion causing permeative bone destruction. Hence, it becomes important to inspect the margins of the jugular foramen to exclude a glomus jugulo tympanicum. CT is employed to diagnose and stage the tumour. Angiography may reveal enlarged feeding arteries and rapidly draining veins.

5.1.6 Middle Ear Adenoma

They are rare benign tumour of the middle ear with a mixed adenomatous pattern[16]. Local bony erosion or invasion is not seen with these neoplasms.

CT Findings

Opacity involving the middle ear cavity. It might be cumbersome to differentiate it from otitis media, which has similar imaging characteristics on CT[16].

5.2 EAC And Mastoid Tumors

Most of the neoplasms in this region are malignant. Squamous cell carcinoma is the most common malignancy involving this region. Less common malignancies include basal cell carcinoma, lymphoma, melanoma; metastases, Langerhans cell histiocytosis, chondrosarcoma and osteosarcoma.

A prolonged history of chronic ear infection sis seen in patients with EAC squamous cell carcinoma. Marked

Case 4: Squamous cell carcinoma of EAC

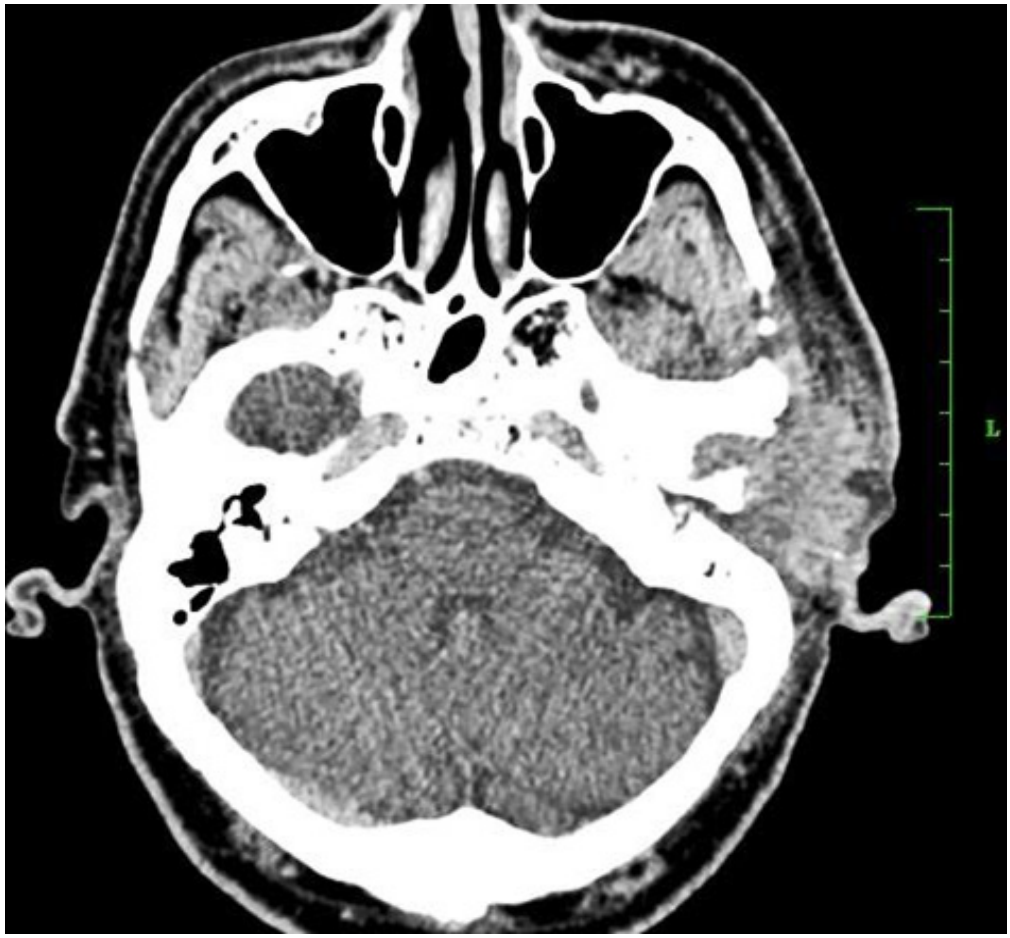

Figure 8. Squamous cell carcinoma of EAC. CECT axial image shows an ill-defined enhancing soft tissue density lesion in the regionof left EAC, completely filling it (arrow). The lesion was seen extending anteriorly in left temporal fossa, along left temporo-mandibular joint and inferior pole of left parotid gland. Histo-pathologically proven case of squamous cell carcinoma of EAC.

bony destruction and surrounding soft tissue invasion characterize these tumors (Figure 8)[17].

5.2.1 Exostosis of the EAC[18]

It is also referred to as Surfer's ear as it is predominantly seen in individuals who are cold water surfers. It is a benign bony overgrowth of the EAC brought about by chronic exposure (>10 years) to cold wind and water that acts as local irritant and results in new bone formation.

Exostosis are often multiple and bilaterally symmetrical, broad based elevated lesions which most commonly occur near the anterosuperior portion of the external auditory canal (Figure 9). They are usually asymptomatic but may infrequently cause severe stenosis of the external auditory canal with conductive hearing loss, impaction of cerumen and subsequent recurrent infections, where surgical removal and canalplasty is required[18]. The main differential is osteoma which is comparatively less common, usually unilateral,

Case 5: Exostoses of the EAC

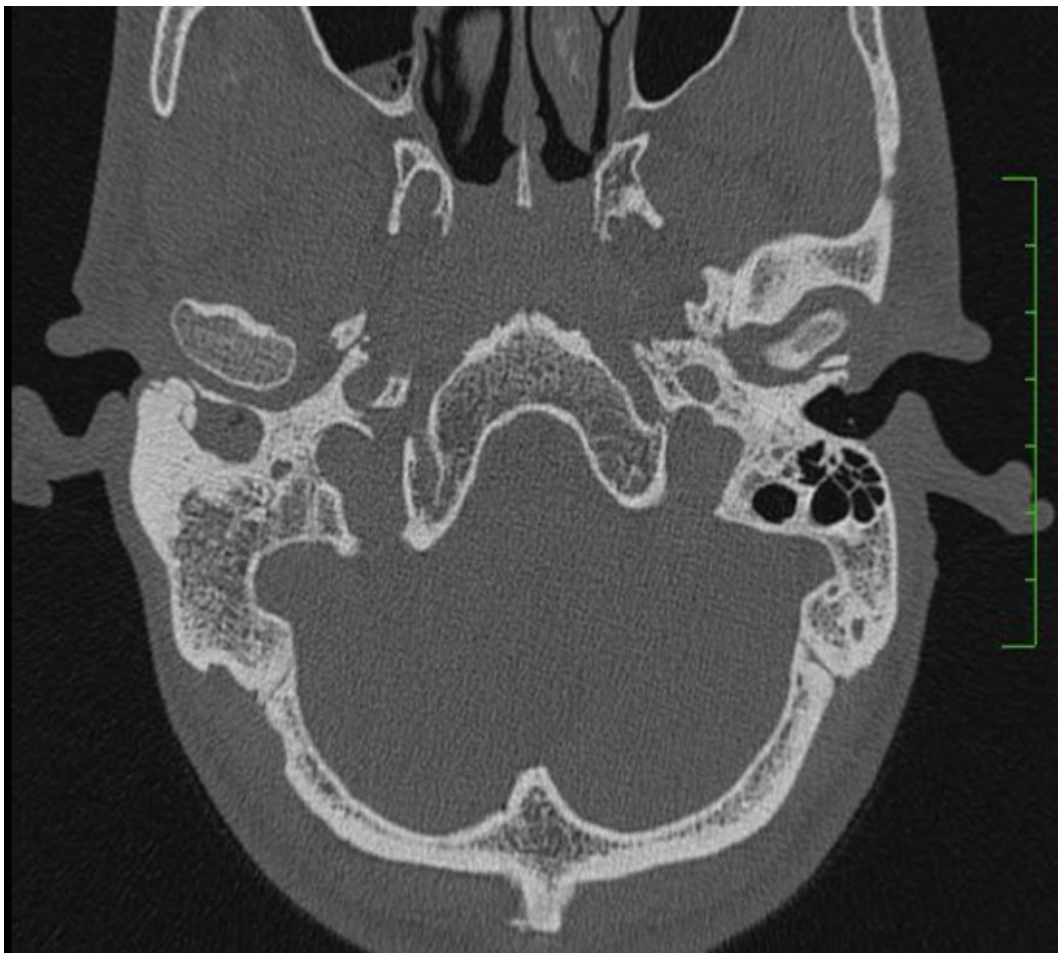

Figure 9. Exostoses of the EAC.HRCT axial image shows a broad based exostosis (thin arrow) causing obliteration of the right EAC with retained secretions in the external auditory canal (block arrow). Few other smaller bony exostoses are also seen further compromising the right EAC (curved down arrow). Sclerosis of the right mastoid is also seen.

Case 6: EAC osteoma

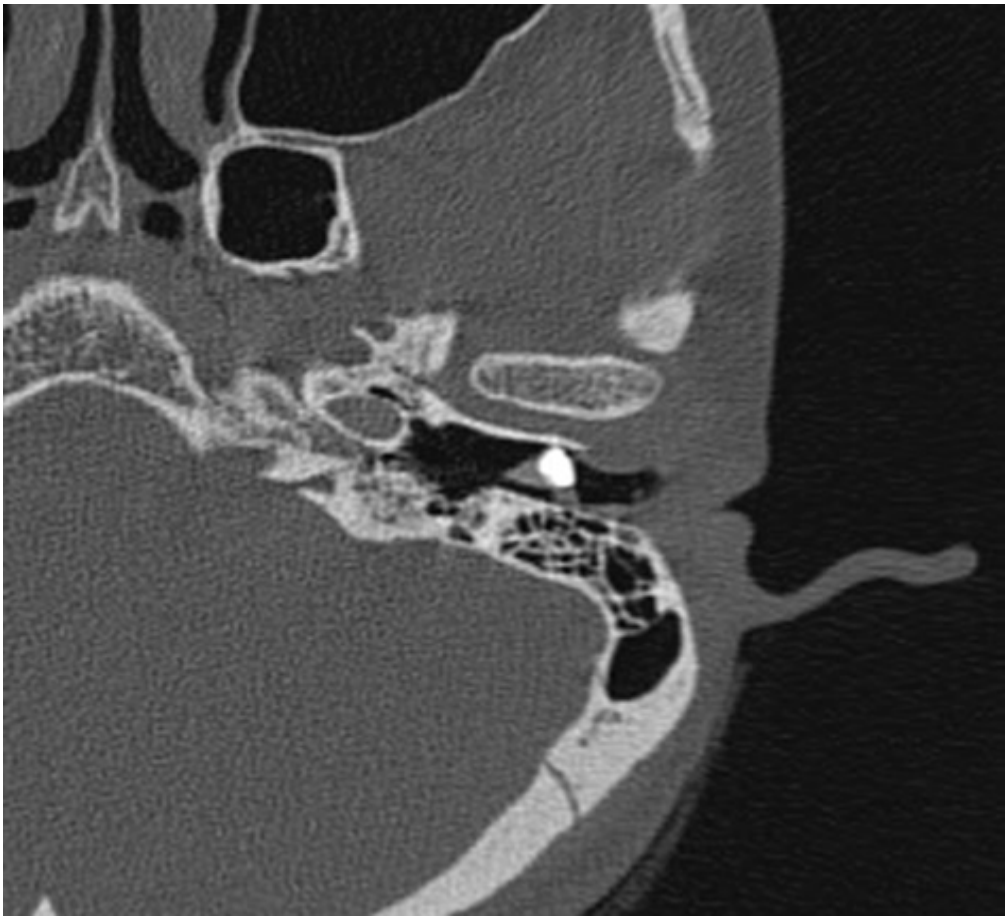

Figure 10. EAC Osteoma.HRCT axial image shows a pedunculated bone density lesion attached to the anterior wall of the left EAC through a stalk and almost obliterating the canal, suggestive of EAC Osteoma.

solitary and pedunculated bony growth attached to tympanosquamous or tympanomastoid suture (Figure 10).

5.2.2 Fibrous Dysplasia

It is a developmental dysplasia in which there is a defect in the normal osteoblastic differentiation and maturation which results in abnormal proliferation of fibrous tissue. Subsequently, normal bone progressively gets replaced by this fibrous tissue and islands of immature woven bone. It results in expansion of bone and narrowing of vessels, neural foramina. It is of two types viz. monoostotic and polyostotic.

CT Findings

Loss of pneumatisation with bone expansion and ground glass opacity (Figure 11) are characteristic features of fibrous dysplasia[19].

Case 7: Fibrous Dysplasia

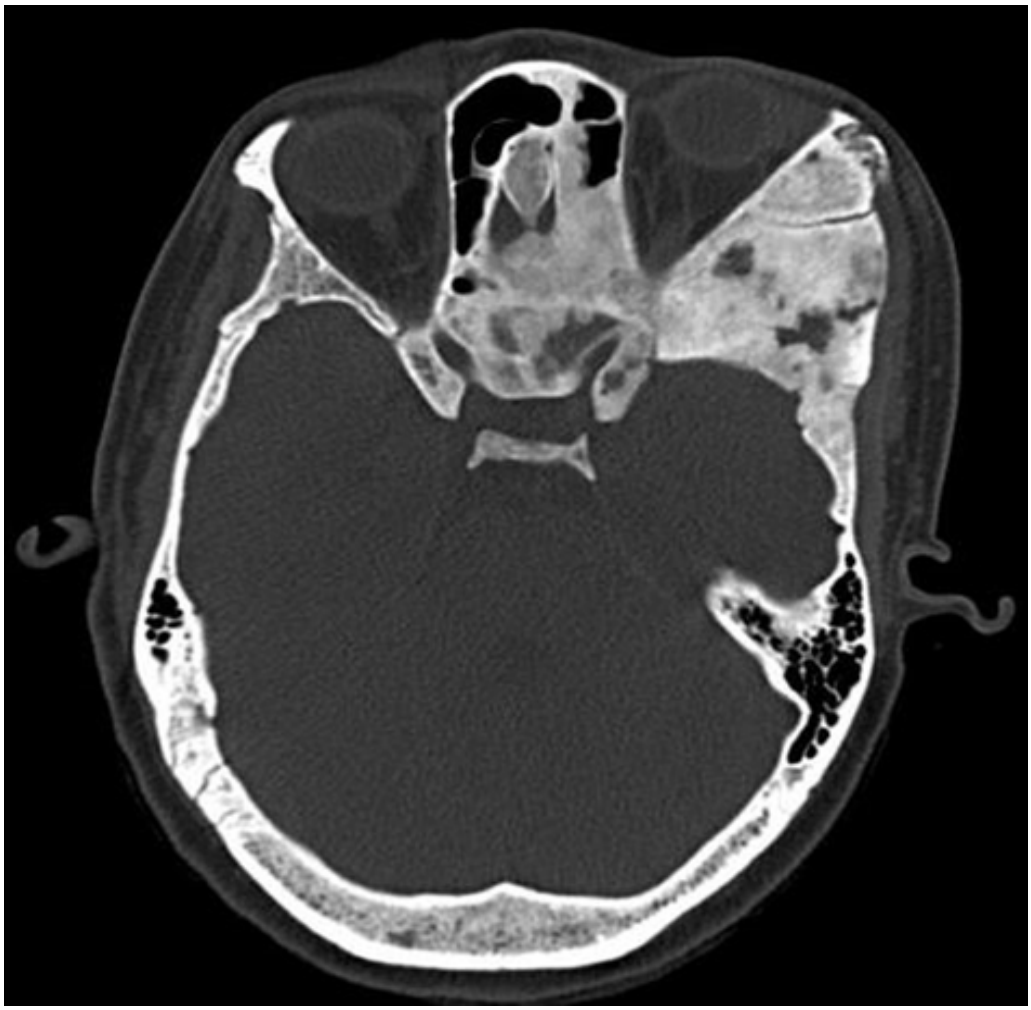

Figure 11. Fibrous dysplasia. HRCT axial image shows expansile ground glass opacification involving squamous part of left temporal bone (arrow). Similar involvement of the frontal bone, greater and lesser wing of sphenoid, walls of maxillary sinus, zygoma, roof of orbit and nasal turbinates on the left side was seen. These findings were suggestive of fibrous dysplasia.

5.2.3 Langerhans Cell Histiocytosis

Idiopathic Langerhans cells proliferation leads to this neoplastic process. Temporal bone involvement varies from 15%–61% of cases, which is also the most common site of skull base involvement. The mastoid is the most frequently affected part of temporal bone. Less frequently involved are the squamous bone, petrous apex and middle ear. Clinical presentations include mastoid swelling or mass, otalgia, and otorrhea[20].

CT Findings

Solitary or multiple soft tissue density lytic lesions with sharp edges and non-sclerotic margins. Occasionally, there may be involvement of the ossicular chain and

Case 8: Langerhans cell histiocytosis

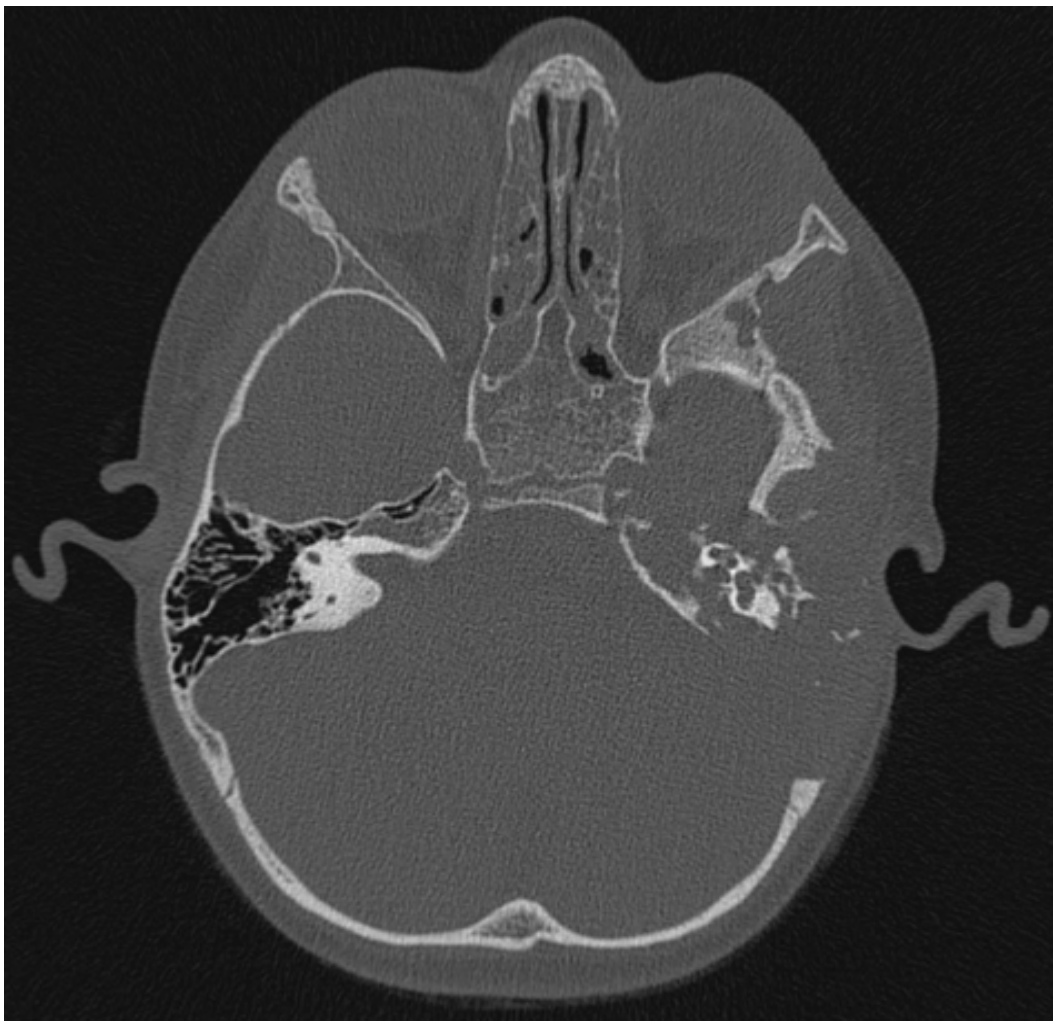

Figure 12. Langerhans cell histiocytosis of temporal bone. HRCT axial image shows extensive bony destruction/osteolysis of left temporal bone (arrows). There was associated bony destruction/osteolysis of zygomatic bone, greater wing of sphenoid, lateral wall of orbit and frontal bone on the left side in the same patient

the bony labyrinth leading to their erosion. Marked enhancement is seen on post-contrast studies (Figures 12 and 13).

Langerhans cell histiocytosis is relatively rare, occurs primarily in children and has a predilection for males[21]. MRI and CT are complimentary modalities for evaluating pediatric temporal bone region masses[22]. The lesions can mimic malignant neoplasms, such as lymphoma, rhabdomyosarcoma, and neuroblastoma metastases. In our study, we found 1 case of Langerhans cell histiocytosis in a male child which presented as a soft tissue lesion associated with destruction of the temporal bone on HRCT.

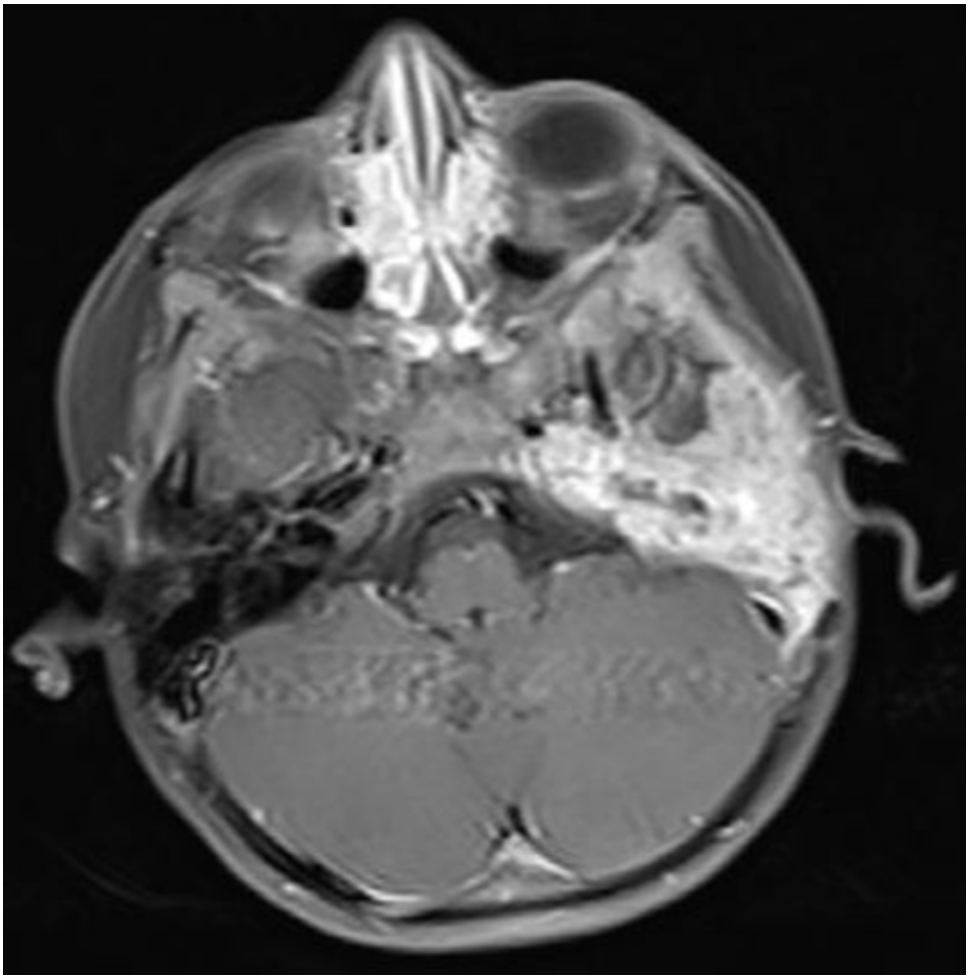

Figure 13. Langerhans cell histiocytosis of temporal bone.Complementary contrast enhanced MRI axial image in the same patient shows an ill-defined heterogeneously enhancing lesion involving the left temporal region (arrows).

5.3 Petrous Apex Tumors

Chondrosarcoma, chordoma, osteosarcoma and meningioma are the most common neoplasms in the region of the petrous apex. Other less common tumors include lymphoma and metastases. Chondrosarcoma is the most common primary malignant neoplasm in this region. Common benign lesions include cholesterol granuloma and epidermoid. The secondary involvement of this region can occur by invasion from tumors such as nasopharyngeal carcinoma, trigeminal schwannoma and jugular paraganglioma.

5.3.1 Chondrosarcoma

Chondrosarcoma is the most common primary malignancy to involve the petrous apex. These tumors tend to occur along the petrosphenoidal and petrooccipital synchondroses, off midline. Occasionally, however, chordomas, which arise from notochordal remnants and are typically seen in the midline, may be found off midline as well and may mimic a chondrosarcoma radiologically.

CT Findings

Soft tissue density lesion showing mild to moderate heterogeneous post-contrast enhancement. Calcifications

may be seen within the lesion. Other imaging features include lytic bony destruction, endosteal scalloping and soft-tissue extension[19].

5.4 Facial Nerve Tumors

5.4.1 Facial Nerve Schwannoma[19]

Facial nerve schwannomas have a tendency to involve multiple segments; it can involve any segment of the facial nerve. There is a predilection for the region of the geniculate ganglion from where the middle cranial fossa extension of the tumour may occur. Clinical presentation depends upon the segment involved.

CT Findings

The tumour may be seen as an enhancing hyperdense lesion along the course of the facial nerve canal. The best clue for identification of this tumour on CT is bony expansion, scalloping or remodelling extending along the facial nerve canal[19].

5.4.2 Hemangioma

Hemangiomas can be found along the track of the facial nerve as it courses through the temporal bone. They have a predilection for the region around the geniculate ganglion. Other less common sites include the region of IAC and at the posterior genu. A variant of these tumors is ossifying hemangioma, which has a distinctive appearance owing to its bone forming as seen in the CT scan.[23]

CT Findings

Osteolytic expansile lesion centered in the facial nerve canal with irregular margins. The presence of internal ossific matrix giving a honeycomb appearance is pathognomic. Meningiomas involving the bone may be challenging to differentiate from these tumors[23].

5.4.3 Perineural Spread of Tumour

This malignant process is characterized by segmental facial nerve enhancement and thickening. Parotid gland neoplasms, like adenoid cystic carcinoma or mucoepidermoid carcinoma or a nearby skin malignancy that metastasizes to the parotid gland or secondarily invades it, are the common sources[24].

5.5 Metastasis

Metastasis to the temporal bone can occur by direct extension or haematogenous extension. Haematogenous extension can be from breast, kidney or lung. Direct spread occurs commonly from salivary gland, nasopharyngeal or sellar masses. 1 case of metastatic deposit into the temporal bone was found in our study, seen in a patient with carcinoma of lung.

6. Conclusion

- A wide range of specific neoplasms affect the relatively small and complex region of temporal bone. Systematic approach and careful interpretation of the CT images is necessary to diagnose these neoplasms.
- From this study we can indicate that neoplasms in the temporal region show characteristic findings on CT imaging.
- Combination of HRCT, contrast enhanced CT, MRI and clinical findings add much more information in differentiation of these neoplasms non-invasively.
- Also, CT provides essential information for planning the surgical approach by laying down an anatomical roadmap for the surgeon preoperatively.

7. Declarations

Funding: None
Conflict of interest: None declared

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