Sudan University of Science and Technology

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Study of Temporal Bone Diseases Using High Resolution Computed Tomography (HRCT)

دراسة امراض العظم الصدغي باستخدام الاشعة المقطعية عالية التمييز

A thesis Submitted for Partial Fulfillment the Requirements of M.Sc. Degree in Diagnostic Radiologic Technology

By

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Dedication

Tomyparents

To mybrothers

Tomysisters

Tomyteachers,friendsandcolleagues

Acknowledgments

Praise and thanks are due to **Allah,the lord and creator.**

Special thanks to my supervisor,Dr. Muna Ahmed ,for her valuable and continuous help and guidance.

My thanks are extended to the staff of the CT department in Alzaytouna specialist hospital & Antalya medical center which helped me in collecting the information.

Abstract

This study was aimed to study the temporal bone diseases using HRCT. Data was obtained retrospectively from 52 patients of different ages and gender who are selected from ENT hospital and clinically suspected of having symptoms related to the temporal bone such as ear discharge, conductive hearing loss, vertigo and facial palsy. traumatic patients wereexcluded.

The study was done at Alzaytouna specialist hospital& Antalya medical center during 2016 year. HRCT images were obtained by taking 2mm sections using ultra high algorithm in both coronal and axial planes. contrast media was used as and when required. The results were then analyzedstatistically.

In this study temporal bone diseases were more common in female 60% than male population 40%. Majority of patient are in the age group of 21-40 years . Infection was the most common pathology 82 %, followed by neoplasm (benign and malignant) 10 %, congenital malformation 2% and other pathological lesions 6%.The incidence of unilateral involvement 66% ismore than bilateral involvement 34%.

HRCT has major role in the demonstration of detailed anatomy and identifying various findings related to the location ,extent and complication of thedisease.

HRCT can able to evaluate air space and bony structure and it can detect the presence of opacification and soft tissue density but cannot able to distinguish the type of tissues , the clinical correlation and biopsy was advised in thiscases.

HRCT has a great importance in guiding the surgical approach that can prevent further serious complications.

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List of abbreviations

AN	Acosticneuroma
CPA	Cerepro pontineangle
CSF	Cerepro spinalfluid
CSOM	Chronic suppurative otitis media
CT	Computedtomography
EAC	External auditorycanal
EBCT	Electron beam computed tomography
ELSTs	Endolymphatic sactumors
EMI	Electric and Musical Industries
H	Hour
HRCT	High resolution computed tomography
IAC	Intrnal auditorycanal
KO	Keratosisobturanse
KV	Kilovoltage
KW	Kilowaats
MA	MiliAmpair
ME	Middleear
MPR	Miltiplaner reconstrction
OE	Otitisexterna
OM	Otitismedia
SNHL	Sensorial hearingloss
TM	Tympanicmembrane

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Chapter One

Introduction

Chapter one

1.1 Introduction

Many imaging modalities are available for the evaluation of the temporal bone including plain radiography, angiography, cerebrospinal fluid analysis, air and non-ionic cisternography, computed tomography (CT) and magnetic resonance imaging (MRI). CT and MRI are currently the most widely used techniques and have largely replaced the other modalities. CT has the advantage of producing images with higher contrast and a better spatial resolution. High resolution CT (HRCT) images are obtained with thin sections (1-2 mm) and special bony algorithm for high details. (Chakeres, 200

HRCT, a modification of routine CT, provides a direct visual window into the temporal bone providing hitherto unavailable minute structural details. HRCT scanning excels in the evaluation of bone and air space anatomy and disorders of temporal bone. (Chandra,1999)

Computed tomography is the method of choice for imaging of temporal bone fractures, middle ear disease, and conductive hearing loss, although magnetic imaging can add important information. (Casselman, 1996).

Indications for computed tomography (CT) of the temporal bone have been significantly expanded with the inclusion of soft-tissue abnormalities of the external ear and the auditory canal. (Chakers ,1985)

Newer high resolution multidetector spiral imaging system can generate nearly isotropic voxels for multiplanar reconstruction, making need for multiple series with direct imaging in several planes unnecessary . (Chakeres, 2003)

Awide array of pathology may affect the relatively small anatomical regionofthetemporalbone.oftenthereisoverlapofclinicalsymptomin pathological entities arising from temporal bone. Thus,the combination of agood clinical history in conjunction with dedicated temporal bone CT facilitates evaluation for subtle or not-so subtle disease.There are four general categories of pathology affecting the temporal bone:congenital malformations, inflammatory conditions,trauma and tumor and tumor-like conditions. (Phillips , 2012)

The most important advantage of spiral CT in temporal bone imaging is it is perfect visualization of the contrast between bony structure and the air in the middle ear.In addition to detailed evaluation of the bony structure and also permits assessment of soft tissue component as well(Maffee,1983)

Computed tomography(CT) has revolutionized imaging of the temporal bone . Recent advances in 32,64 and now 128-slice CT scanners allow the acquisition,volumetric data that allows image reconstruction in any plane. (Phillips , 2012)

1.2 The problem ofstudy

Temporal bone is complex structure with tiny bony which are less than 1mm in diameter, these are close to the limits of resolution by imaging.

1.3 Objectives of thestudy

1.3.1 Generalobjective

To evaluate the temporal bone pathologies using (High Resolution Computed Tomography)

1.3.2 Specificobjectives

- To determine the most common disease affecting the temporalbone.
- To find the outcome of HRCT scans in diagnosing of temporal bone disease.
- To evaluate the bony structure and assess the soft tissue component.
- To assess temporal bonepneumatization.

4.1 Significances of study

This study will enhance evaluation of temporal bone disease by HRCT. Although there is other modalities like MRI and X-ray but cannot give high resolution and clear detail of temporal bone.

5.1 Overview of the study:

This study fall into five chapters: chapter one is an introduction what is CT temporal as well as statement of the problem, objectives and overview of the study. Chapter two theoretical backgrounds and literature review of the study. chapter three which deal with material and method ,chapter four which presented the results of the study, chapter five which involves discussion, conclusion and recommendations, and the study end with the references and appendixes.

Chapter two

Theoretical background

Chapter two

2.1Theoretical background.

2.1 .1Anatomy of the temporalbone:

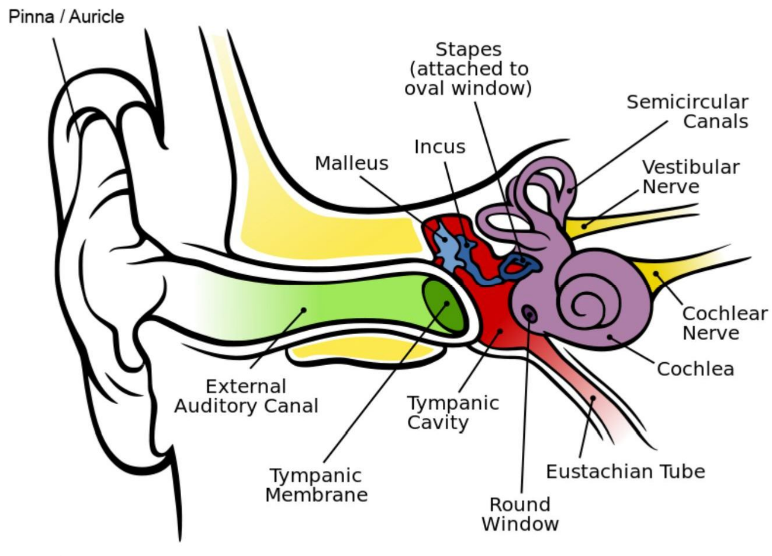
The two temporal bones contain many complex and important structures. They form part of the sides and base of the cranium and together with the sphenoid bone create the middle cranial fossa.The temporal bone can be divided into four portions: squamous, tympanic, mastoid, and petrous .(Lorrie, 2007)

The thin squamous portion ptojects upward to form part of the side walls of the cranium . Exetnding from the squamous portion is the zygomatic process,which project anteriorly to the zygoma of the face to form the zygomatic arch.At the base of the zygomatic process is abony eminence termed the aritcular tubercle that forms the anterior boundary of the mandibular fossa.The mandibular fossa is the depression that articulates with condyloid process of the mandible ,creating the tempromandibular joint.(Lorrie ,2007)

The tympanic portion lies below the squama and forms the majority of the external auditory meatus. Just posterior to the tympanic portion is the mastoid portion, which has aprominent conical region termed the mastoid process. The mastoid process encloses the mastoid air cells and mastoid antrum. (Lorrie , 2007)

The mastoid antrum is located on the antrosuperior portion of the mastoid process.It is an air-filled cavity that communicate with the middle ear (tympanic cavity) .(Lorrie ,2007)

The petrous portion of the temporal bone ispyramidal in shape and situated at an angle between the surface of the petrous pyramid forms the anterior bony limit of the posterior fossa.Near the center of this surface is the opening to the internal auditory canal, which transimits the seventh andeighth cranial nerves.Other openings associated with the posterior surface of the petrous pyramid are the jugular foramen and the carotid canal ,which provide passage for the internal jugular vein and the internal carotid artery.An enlargement of the jugular foramen is the jugular fossa.The carotid canal courses superiorly at its lower segement then changes direction and isseen coursing posterior to anterior.superior to the carotid canal is an indentation on the petrous portion called Meckel cave , Also known as the *trigeminal cave,*which located between two layers of dura and encloses the trigeminal ganglion. Between the apex of the petrous pyramid , The body of the sphenoid bone and the basilar portion of the occipital bone is jagged slit termed the foramen lacerum ,which contains cartilage and allows the internal carotid artery to enter the cranium,providing small arteries that supply the inner surface of the cranium .the inferior surface of the petrous pyramid gives rise to the long slender styloid process that is attached to several muscles of the tongue and ligament of the hyoid bone. The stylomastoid foramen issituated between the mastoid process and styloid process.this foramen constitutes the end of the facial nerve canal. The interior of the petrous pyramid houses the delicate middle and inner ear structure figure(2.1). (Lorrie ,2007)



Figure(2. 1): Overview diagram of the ear**.** This illustration represents the outer ear (pinna, external auditory canal, and outer portion of the tympanic cavity known as the ear drum), the middle ear (malleus, incus, stapes, and Eustachian tube) and the inner ear (cochlea, semicircular canals, and the vestibule). (Chittka and Brockmann,2005).

2.1 .1 Structure of the External,Middle,and Inner Ear:

The structure of the ear can be divided into three main portions: external,middle,and inner.

2.1.1.1 The external ear consist of the auricle and the external auditory meatus. The external auditory meatus terminates at the tympanic membrane of the middle ear (TM).The air-containing middle ear,or tympanic cavity, communicates with both the mastoid antrum and the nasopharynx. Air is conveyed from nasopharynx to the tympanic cavity through the auditory tube (Eustachian tube).The external auditory canal(EAC) is an s-shaped tube terminated medially (centerally) by the TM.ThewallsoftheEACarelinedwithskinandthemostexternalpartofthe canal is covered with small dust –filtering hairs and mucous glands producing cerumen (ear wax).The lateral (outer) one-third of the canal is surrounded by cartilage and the medial (inner) two-thirds of the canal pass through the temporal bone.The average length of the adult EAC is 25mm (1 inch) (Wever & Lawrence ,1954 ; Yost & Nielsen,1977).

2.1.1.2 The middle ear consist of the tympanic membrane and three auditory ossicles(malleus , incus, and stapes)as well as their supporting muscles (stapedius and tensor tympani)and ligament .The lining of the middle ear cavity coverstheaircellsofthemastoidbonefigure(2.2&2.3). (Lorrie ,2007)

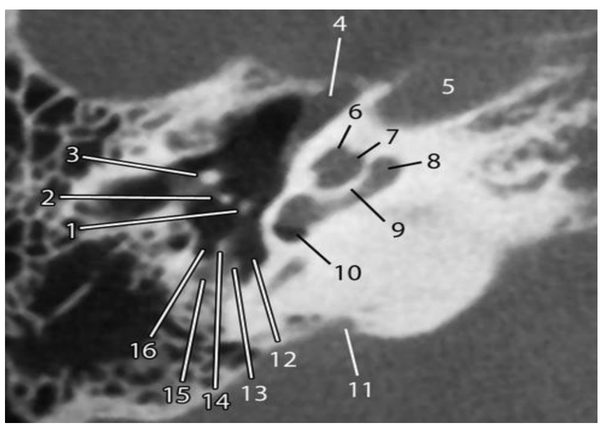
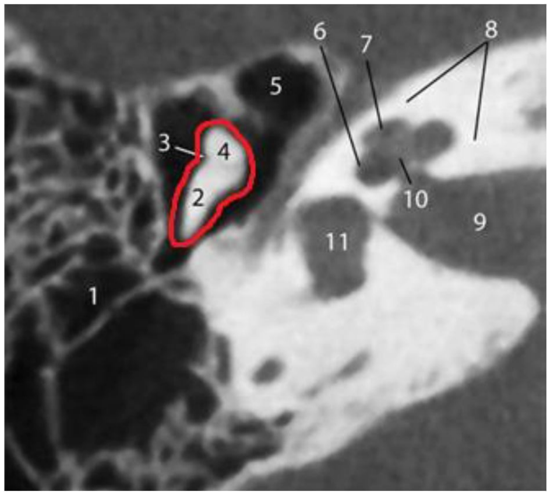


Figure (2.2): Axial CT scan of the middle ear. This axial CT scan illustrates the features of the middle and inner ear as well as surrounding structures. 1, stapes; 2, incus; 3, malleus; 4, tensor tympani; 5, carotid canal; 6, apical turn of the cochlea; 7, middle turn of the cochlea; 9, interscalar septum; 10, round window niche; 11, vestibular aqueduct; 12, sinus tympani; 13, stapedius; 14, pyramidal eminence;15,mastoidportionofthefacialnerve;16,facialrecess.(Juliano ,2013)



Figure(2.3): Axial CT of ossicular chain and surrounding structures. This figure shows an axial CT image of the middle ear and clearly demonstrates the ice-cream cone appearance of the ossicular chain (circled). 1, mastoid air cells; 2, incus; 3, incudomalleal joint; 4, malleus; 5, epitympanum; 6, basal turn of the cochlea; 7, middle turn f the cochlea; 8, otic capscule; 9, IAC; 10, modiolus; 11, vestibule. (Juliano ,2013)

2.1.1.3 The inner ear or bony labyrinth,contains the vestibule , semicircular canals, and the cochlea. The vestibule is small compartment located between the semicircular canals and the cochlea.Two openings of the vestibule are the oval window for the foot plate of the stapes and the vestibular aqueduct, which contains the endolymphatic duct .The semicircular canals are continuous with the vestibule and are easily identified because of their three separate passages (superior[anterior],posteriorandlateral)thatareatrightanglestoeachother .The cochlear is aconical srtructure with a base that lies on the internal auditory canal.located within the basilar turn of the cochlea is the round window.Within the bony labyrinth is acomplicated system of ducts called the membranous labyrinth.The membranous labyrinth is filled with endolymph, a fluid that helps with the propagation of sound waves. Extending from the vestibule is a slender endolymphatic duct that terminates as the endolymphatic sac, which is located between two dural layers on the posterior wall of the petrous pyramid figure(2.4). (Lorrie,2007)

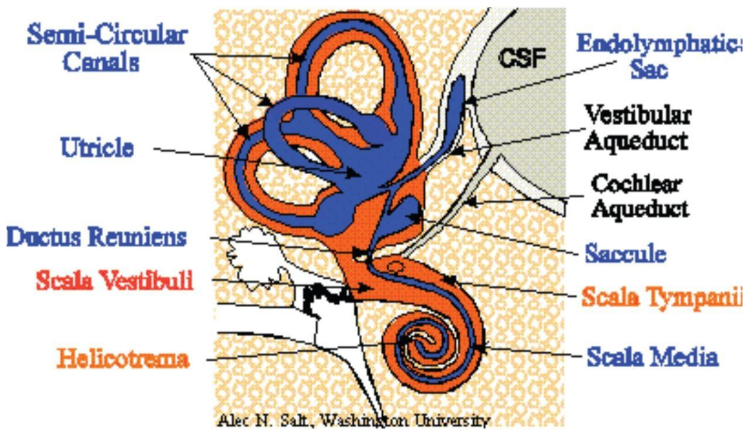


Figure (2.4) : The structures of the inner ear. (The darker [endolymph] and lighter [perilymph] spaces are filled with the inner ear fluids. The dashed line in the picture separates graphically the vestibular system [above] from the cochlea [below]. (Henry,2007)Temporal bone pneumatization is divided into five compartments: middle ear, squamo – mastoid (mastoid), perilabyrinthine, petrous apexand accessory. Accessory regions are; squamous, zygomatic,occipital and styloid cells .The squamomastoid region is subdivided into three compartments: mastoid antrum,central mastoid tract and the peripheral mastoid area .(Alberti ,1995)

The pneumatized cells are believed to appear on the 22-24thweeks of fetal life. The pneumatization of the mastoid cells begins at the 33rdweeks and continues up to 8-9 years of age. The antrum reaches to adult size on the 35th week.(Ahmet , 2004)

2.1.2. physiology:

2.1.2.1 The functions of temporal bone air cellsare:

Reception of sound, Resonances, Insulation, Air reservoir action, Acostic dissipation and Protection from external violence and lightening of the weight of the skull .(Virapongse , 1985)

2.1.2.2 The function of Auditorysystem:

The act of hearing is called audition.The sensory and perceptual system that facilitates hearing is called the hearing mechanism or the auditory system which consist of right and left ear connected through a network of ascending and descending neural fibers connected to the brain .The ear is organ for hearing and balance and it has three major parts:the outer ear(external ear),middle ear, and the inner ear. **(**Alberti,1995)

2.2.2.1outerear:

The outer ear is anatomical structure directing the sound waves to the middle ear and acting as a sound collector and acostic amplifier .It includes the pinna (auricle),which isthe visible earflap,and the external auditory canal terminated by the tympanic membrane (TM) .The TM separates the outer ear from middle ear.The acostic function of the outer ear is to collect and selectively amplify incoming acostic stimuli and to direct them toward the TM and associated structure of the middle ear.Additionally ,both the pinna and the external auditory canal (EAC) protect the TM against injury, foreign bodies,and outside changes in temperature and humidity. (Alberti,1995)

2.1.1.1 Middleear:

The stapedius and the tensor tympani muscles provide mechanical support for the ossicles but also contract when the ear is exposed to an intense sound .The contraction of stapedius muscls pulls the stapes and tilt its base in the ovale window ,there by reducing the range of movement of the stapes.The tensor tympani muscle contraction pulls the handle of the malleus medially, tensing the TM,and reducing the amplitude of its oscillations.This contraction in response to a loud sound is known as the *acostic reflex* or (middle ear reflex) which is most effective at reducing the transmission of low frequency sound.(pickles,1988)

2.1.1.2 Innerear:

The vestibular system is organ of balance containing receptors sensitive to gravity,linear movement,and angular acceleration of the head. **(**Alberti ,1995).

The cochlea contains the cochlear aqueduct that houses the neural receptors sensitive to vibrations and serves as the organ of hearing. **(**Alberti ,1995)

The vibration of the stapes in the oval window sets into motion the cochlear fluid (perilymph) in scala vestibuli.When the stapes is pushed medially, some of the incompressible fluid in the inner ear is pushed through the helicotrema to scala tympani,which causes an outward bulging of the round window.When the stapes pulled away, the round window membrane of scala tympani is displaced inward toward the cochlea.The presence of the round window eliminates potential reflections so that there are no interference effect inside the cochlear fluid during oval window motion. (Henry , 2007)

The motion of the oval and round window membranes are delayed against each other because of the time needed to move fluid through the helicotrema.These create pressure differentials between both channels which set into motion of basilar membrane.This movement set into motion of the organ of corti that resultsin creating a biochemical reaction in the nerve cells of the organ.The organ of corti is structure containing the vibration receptors of the inner ear that convert mechanical energy into electrical energy.this energy results in neural impulses that are transmitted to the brain. **(**Alberti,1995)

2.2.3 Function of mastoid part:

Mastoid air cell system is an air reservoir and also an active cavity having gas exchange capability independent of Eustachian tube .Mastoid cavity buffers the effects of pressure change in the middle ear by supplying air to the middle ear.(Virapongse ,1985)

2.3 Pathology :

2.3.1 Normalvariant:

2.3.1.1 variant which simulatedisease:

There are several normal variants which may simulate disease and itshould be reported because they can be endanger during surgical approach. (Vercruysse ,2006)

2.3.1.1.1 Cochlearcleft:

Acochlear cleft is a narrow curved lucency extending from the cochlea towards the promentry. It is often visible in infants and children but can also be seen in adults.It can be mistaken for fracture line or an otosclerotic focus. (Vercruysse ,2006)

2.3.1.1.2 petromastoidcanal:

The petromastoid canal or subarcuate canal connect the mastoid antrum with the cranial cavity and houses the subarcuate artery and vein .It diameter is around 0.5mm.It can be confused with a fracture line. (Vercruysse,2006)

2.3.1.1.3 cochlearaqueduct:

The cochlear aqueduct is a narrow canal which runs toward the cochlea in almost the same direction as the as the direction as the inner auditory canal ,but situated more caudally .It connects the perilymph with the subarachoid space and it point where infected cerebrospinal fluid. (Vercruysse,2006)

2.3.1.2 variant which may pose a danger during surgery:

2.3.1.2.1 Jugular bulb or jugular bulb diverticulum:

The jugular bulb often asymmetric, with the right jugular bulb usually being larger than the left .If it reaches above the posterior semicircular canal it is called a high jugular bulb.If bony separation between the jugular bulb and tympanic cavity is absent it termed a dehiscent jugular bulb. Rarely an out pouching is seen-this is known as jugular bulb diverticulm. (Vercruysse,2006)

2.3.1.1.2 Bulging sigmoid sinus:

The sigmoid sinus can protrude into the posterior mastoid .it can be accidentally lacerated during a mastoidectomy and therefore should be mentioned in the radiological report when present .It can be mistaken for a fracture line. (Vercruysse,2006)

2.3.2 External Auditory Canal:

2.3.2.1 BenignNeoplasms:

The most common benign lesions of the external auditory canal include exostosis and osteomas. Exostoses are more common than osteomas. They tend to ariseinthe medial portion of the canal along the tympanomastoid and tympanosquamous suture lines. Exostoses are frequently bilateral. Where exostosis are often multiple with broad bases, osteomas are singlewith pedunculated shapes. They may also occur in the mastoid or IAC, but the EAC is by far more common .(Alan ,2004)

2.3.2.2 Malignant Neoplasms:

Malignant neoplasms of the EAC are uncommon. Most involve the canal by local extension. Skin neoplasms such as squamous or basal cell more commonly occur on the auricle and then extend into the canal. Salivary gland neoplasms such as mucoepidermoid carcinoma or adenoid cystic carcinoma may also invade the EAC from the parotid. Squamous cell carcinoma of the EAC may mimic necrotizing external otitis due to the findings of pain, otorrhea, and bone destruction on CT. (Alan,2004)

2.3.2.3 Malignant OtitisExterna:

The term malignant, when referring to OE, does not imply tumor, but rather the aggressive nature of the disease. Other terms for the disease include necrotizing external otitis and skull base osteomyelitis. (Alan ,2004)

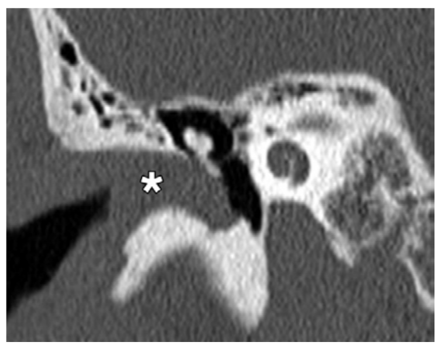
As the infection progresses, it may extend through the fissures of Santorini and access the deep neck spaces and infratemporal fossa resulting inlife-threatening infections and cranial nerve deficits. Radiologic workup most commonly consists of CT scan to delineate bony destruction. If intracranial complications or extension is suspected, then MRI is preferred. (Alan,2004)

2.3.2.4 Cholesteatoma:

While very common in the middle ear and mastoid, cholesteatoma occurs only about 0.1 – 0.5% of otologic patients. These lesions tend to occur in the posterior aspect of the EAC, directly lateral to the annulus. Due to this position, CT is often recommended to evaluate for involvement of the facial nerve. These lesions are commonly focal, do not extend around the circumference of theEAC, and often present with persistent otorrhea and pain. On CT the lesions usually appear focal and show erosion of local bony cortex. (Alan ,2004)

2.3.2.5 KeratosisObturans:

This condition usually occurs in patients with a history of sinusitis or bronchiectasis and and not have persistent drainage. It occurs throughout the EAC, often causing total obstruction of the canal. Rather than destroying the bone, KO progressively widens the EAC in a broad, usually circumferential manner. The bony cortex should appear intact on CT figure(2.5) .(Alan,2004)



Figure(2.5): Coronal CT image of keratosis obturans demonstrates a soft-tissue plug in the external canal(*), with mild expansion of the canal but no bone erosion .(Juliano , 2013)

2.3.3 Middle Ear andMastoid:

2.3.3.1 OtitisMedia:

Clinically, OM is less aggressive than mastoiditis. It may cause local pain and drainage, but pain over the mastoid cortex and swelling over the mastoid cortex would be unusual for the diagnosis of OM.

Radiographically, fluid may partially or totally fill the middle ear space and mastoid cavity, which is the source of confusion in the differential. OM may have complete opacification of the mastoid and ME space, but will have no destruction of bony septae or mastoid cortex .(Alan, 2004)

2.3.3.2 Mastoiditis:

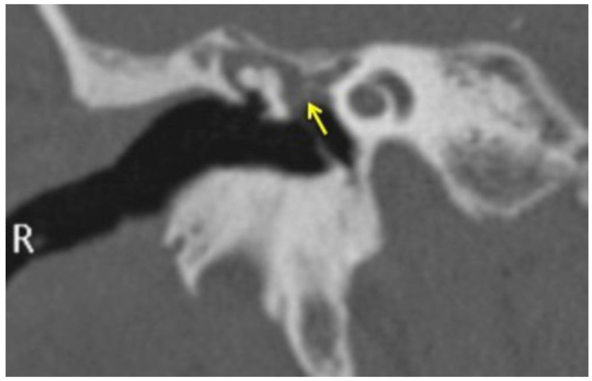
Where OM will have partial to complete ME and mastoid opacification, mastoiditis commonly will have complete mastoid opacification. The presence of bony septae destruction may allow for the application of the term “coalescent” mastoiditis which indicates the destructive nature of the disease. Lateral cortex disruption may result in a sub-periosteal abscess. Inferior cortical disruption (mastoid tip) may result in a Bezold’s abscess. Superior disruption of the tegmen may result in meningitis, venous sinus thrombosis, or several types of intracranial abscesses figure (2.6). (Alan,2004)

Figure (2. 6): Axial CT image of Chronic mastoiditis. shows cloudy mastoid cells with fewer than normal, thickened trabeculae (Juliano , 2013)

2.3.3.3 Cholesteatoma:

Cholesteatoma may present as a primary or acquired lesion. Congenital lesions are by far less common, accounting for only 2% of cholesteatomas. They may occur anywhere within the temporal bone, and radiologic differentiation may not be possible. Acquired cholesteatomas are thought to arise from aberrant rests of epithelial cells which may be present due to trauma, prior surgery, or more commonly, eustacian tube dysfunction or recurrent otitis media. Both eustacian tube dysfunction and recurrent OM are though to produce a prolonged negative pressure within the middle ear space. This allows for a slow retractive process to occur along the weak area of the TM at the pars flacida. The result is a pocket of epithelial cells which produce keratin but cannot clear this debris. The result is a cholesteatoma. As a result, most acquired cholesteatomas will present within Prussak's space which is just deep to the pars flacida. Early cholesteatomas of this region may begin to erode the scutum (superior EAC wall) or theossicles.

As the mass grows, openings in Prussak's space allow the tumor to spread posteriorly where it then has access to the remainder of the middle ear space and mastoid. When it expands, it causes remodeling or erosion of surrounding bone, which may show as scutum, ossicle, or septae erosion. Large lesions may erode into vital structures, and care should be taken to evaluate the tegmen for possible dura exposure, fallopian canal for dehissences of the facial nerve, and the bony labyrinth for canal fistulas figure(2.7). (Alan ,2004)



Figure(2. 7): Axial CT of cholesteatoma shows a soft-tissue mass in Prussak space and extend medial to the ossicles. (Juliano et al 2013).

2.3.3.4 Paragangliomas,also known as **glomus tumors** or**choddectomas:**

Are the secod most common tumor to involve the temporal bone and the most common tumor of the middle ear.

These tumors originate from paraganglia along the tympanic branch of the glossopharyngeal nerve and the auricular branch of the vagus nerve and within the interavagal paraganglia inferior to the foramen .Paragangliomas are highly vascularandcanresultinbonedestructionasthetumorgrowsfigure(2.8).(Alan ,2004)

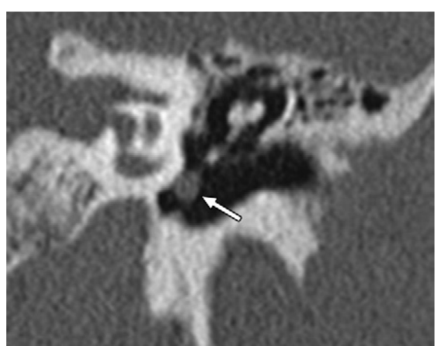


Figure (2.8): Coronal CT image of glomus tympanicum demonstrates a small, rounded nodule in the middle ear abutting the cochlear promontory (arrow). (Juliano ,2013).

2.3.3.5 Chronic suppurative otitismedia:

Chronic suppurative otitis media (CSOM) is chronic inflammation of the middle ear and mastoid cavity, which presents with recurrent ear discharges or otorrhoea through a tympanic perforation. (Acuin,2004)

Safe CSOM is CSOM without cholestetoma .It can be sub divided into active or inactive depending on whether or not infection is present .Unsafe CSOM involves cholestetoma. Cholestetoma is a non malignant but distructive lesion of the skull base .The underlying pathology of CSOM is an ongoing cycle of inflammation ,ulceration ,infection and granulation. Acute infection of tne middle ear causes irritation and inflammation of mucosa of the middle ear with oedema .Inflammation produces mucosal ulceration and break down of epithelial lining .Granuloma formation can develop into polyps in the middleear .this process may continue ,destroying surrounding structures and leading to various complications of CSOM. (Acuin,2004)

2.3.4 Labyrinth:

2.3.4.1 Labyrinthitis:

This disease has multiple causes; bacterial, viral, autoimmune, or traumatic. Viral is the most common, and symptoms include vertigo, sensory hearing loss, tinnitus, and possibly nausea/vomiting. While radiographic confirmation of this disease is not necessary for diagnosis inmost cases, common features may be noted on imaging. MRI is the study of choice. This usually demonstrates enhancement of the membranous labyrinth on T1 after contrast administration. Pre-contrast images should not enhance, and if present may represent labyrinthine hemorrhage due to trauma. (Alan,2004)

2.3.4.2 LabyrinthitisOssificans:

This disease is the result of labyrinthine inflammation. CT may show a non-descript fibrous or bony opacification of the normally fluid filled membranous labyrinth. MRI may show a signal void on T2 images which would normally be bright due to the presence of perilymph .(Alan ,2004)

2.3.4.3 Otosclerosis:

This disease is due to resorption of the endochondral layer of the otic capsule with deposition of new spongy bone.. CT scans are usually not necessary for diagnosis, but when performed may show a small focus of soft tissue density at the anterior aspect of the oval window. This may be small, or may obscure the oval window entirely. Care should be taken to evaluate the position of the facial nerve, since a facial nerve overlying the oval window may preclude surgical intervention. When the sclerosis is present beyond the area of the oval window, it may be referred to as retro-fenestral or cochlear otosclerosis figure (2.9) .(Alan, 2004)

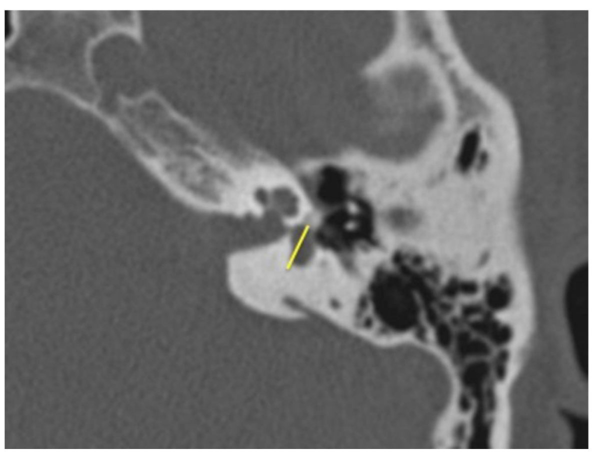


Figure (2. 9): Axial CT image of Fenestral otosclerosis .shows otosclerosis of Fissula ante fenestram and oval window . (Juliano , 2013)

2.3.5 Internal Auditory Canal and CerebellopontineAngle:

2.3.5.1 AcousticNeuroma:

Acoustic neuroma or vestibular schwannoma is the most common mass ofthe cerebellopontine angle. They are benign masses. These lesions mayalsoremain stable for multiple years with no signs of growth on long-term follow-up.CT scans of acoustic schwannomas tend to show the features of a porus-centered mass, acute angles, IAC involvement. They also demonstrate thehomogeneous nature of the mass. Calcifications and central necrosis are rare,however, central clearing has been noted in some larger lesions. The density ofAN on CT issimilar to that of nearby brainstem, and more dense thansurrounding CSF. Ifgiven IV contrast, the tumor will most likely showhomogeneous uptake and turn very bright. A non-homogeneous uptake may beseen with previously treated lesions and large tumors. MRI is the study of choiceif the diagnosis of AN is in question. On standard T1 images, the tumor shouldbe relatively isointense topons but more intense than CSF. On T2 images, thelesion should be mildly brighter than pons, but darker thanCSF. AfterGadolinium, the T1 sequenceshould show a very intense lesion, brighter than all other surrounding structures. (Alan, 2004)

2.3.5.2 Meningioma:

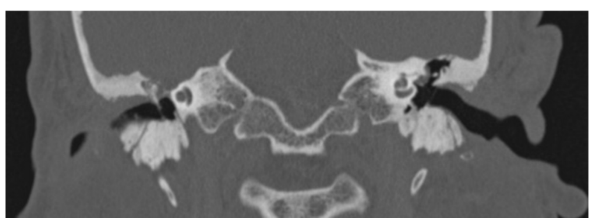
Meningioma is the second most common diagnosis of a primary CPA lesion. The meningioma is a vascular tumor, not homogeneous masses, and may show central clearing. Calcifications can be present in up to 25% and the significant finding is a “dural tail”.

On CT scan, meningiomas may appear isodense to surrounding structures and it may also show calcifications within the tumor, which are highly suggestive of the diagnosis. MRI is the study of choice. T1 images will show a lesion near the intensity of pons, however, it is may not be homogeneous, and may have a central hypointensity in larger lesions. On T2 images the lesion is between pons and CSF in intensity. After administration of gadolinium, the T1 image should show an intense lesion. (Alan,2004)

2.3.6 PetrousApex:

2.3.6.1 CholesterolGranuloma:

This is the most common primary lesion of the petrous apex. Inflammation in the apical air cells leads to deposition of cholesterol debris which leads to a foreign body reaction. This reaction leads to friable vessels
and repeat hemorrhage and cholesterol deposition, thus restarting the cycle. These lesions have a characteristic appearance on MRI, with intense signals on both T1 and T2 differentiating it from other lesions figure (2.10). (Alan,2004)



Figure(2. 10): Coronal CT image of wright cholesterol granuloma with ossicular destruction . (Juliano , 2013)

2.3.6.2 Endolymphatic sac tumors (ELSTs):

occur along the posterior petrous apex and typically involve the vestibular aqueduct. These tumors are locally invasive papillary cystadenomatous tumors arising from the endolymphatic sac.It cause local bone destruction as they grow and have central calcification and posterior rim calcification figure (2.11). (Alan ,2004)

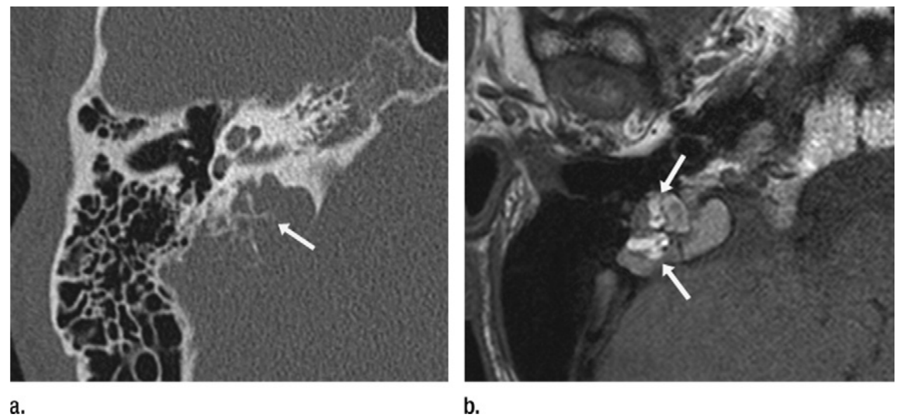


Figure (2.11): Axial Images of endolymphatic sac tumor (a) Axial CT image demonstrates an expansile lesion causing lytic bone destruction, centered around thevestibularaqueduct. Intratumoral spicules can be seen (arrow) (b) On nonenhanced T1-weighted MR image, areas of intrinsic T1 shortening are quit characteristic of this tumor (arrows). The tumor was resecte by means of a translabyrinthine approach. (Juliano,2013)

2.3.6.3 Cholesteatoma:

Cholesteatoma of the petrous apex may be congenital (also known as epidermoid), or may result from extension of mastoid disease. The presentation may be similar to a middle ear cholesteatoma, with recurrent otorrhea. Radiographic findings are similar with soft tissue densities, erosion of surrounding bone (Alan ,2004)

2.3.6.4 Petrositis:

Acute petrositis is an infection of the air cells of the petrous apex. This typically occurs from extension of a middle ear or mastoid infection through the peri-labrynthine air cells.

CT findings resemble those of mastoiditis, including opacification of the petrous air cells with destruction of bony septae. Acute petrositis is severe diagnosis, and complications include brain and epidural abscesses, meningitis, and venous sinus thrombosis. (Alan,2004)

2.3.7 Metastasis:

Metastasis to the temporal bone has been found with almost any type of tumor. The most frequent lesions include breast, lung, prostate, and melanoma being the most common. These lesions may arise at almost any location within the temporal bone .(Alan,2004)

2.3.8 Trauma:

On the basis of the fracture plane ,temporal bone fracture classified into two main categories longitudinal and transverse.Aditional classification described fractures with respect to involvement of the otic capsule or petrous apex .(Phillips,2012)

Thelongitudinalfracturerunparalleltothelongaxisofthepetrousbone ,it is typically traverse the middle ear cavity with frequent disruption of the ossicles and resultant conductive hearing loss .The transverse fracture runs perpendicular to the long axis of the petrous bone.The fracture plane typically extends from the jugular foramen magnum to the middle cranial fossa,commonly passing through or near the vestibular aqueduct with variable involvement of the otic capsule .There are two subtypes of the transverse fractures:medial and lateralrelativetothearcuateeminence.BothsubtybesfrequentlyresultinSNHL .(Phillips2012)

Of the ossicles,the incus is the most vulnerable to injury ,owing to the anatomy and the supportive ligamentous structure stabilizing the malleus and stapes. As a result ,most common injuries are incudostapedial joint subluxation

,malleoincudal subluxation,incus dislocation,and dislocation of the malleoincudal complex.Less common ossicular injuries include stapedial and mallear fractures .(Phillips2012)

2.1.4 Physics and Equipmeny

2.4 CTmachine:

Since its introduction by Godfrey Hounsfield and Allan Cormack, CT has continued to evolve. New techniques cover a wide variety of applications. However, with such technologic innovation comes complexity .(Lois ,2001)

The main advantages of CT over conventional radiography are in the elimination of superimposed structures, the ability to differentiate small differences in density of anatomic structures and abnormalities, and the superior quality of the images .(Lois , 2001)

2.4.1 Step-and-Shoot scanning:

The scanning systems of the 1980s operated exclusively in a “step-and-shoot” mode. In this method the x-ray tube rotated 360° around the patient to acquire data for a single slice, the motion of the x-ray tube was halted while the patient was advanced on the CT table to the location appropriate to collect data for the next slice, and steps one and two were repeated until the desired area was covered .(Lois,2001)

2.4.2 Helical (Spiral)scanning:

Many technical developments of the 1990s allowed for the development of a continuous acquisition scanning mode most often called spiral or helical scanning. Key among the advances wasthe development of a system that eliminated the cables and thereby enabled continuous rotation of the gantry. This, in combination with other improvements, allowed for uninterrupted data acquisition that traces a helical path around the patient. (Lois,2001)

2.4.3 Multidetector row CTscanning:

The first helical scanners emitted x-rays that were detected by a single row of detectors, yielding one slice per gantry rotation. This technology was expanded on in 1992 when scanners were introduced that contained two rows of detectors, capturing data for two slices per gantry rotation. Further improvements equipped scanners with multiple rows of detectors, allowing data for many slices to be acquired with each gantry rotation (Lois,2001)

2.4.4 CTscanner:

CT scanners are complex, with many different components involved in the process of creating an image. Adding to the complexity, different CT manufacturers often modify the design of various components.From a broad perspective, all makes and models of CT scanners are similar in that they consist of a scanning gantry, x-ray generator, computer system, operator's console, and physician's viewing console. Although hard-copy filming has largely been replaced by workstation viewing and electronic archiving, most CT systems still include alaser printer for transferring CT images to film. (Lois , 2011)

Data are acquired when x-rays pass through a patient to strike a detector and are recorded. The major components that are involved in this phase of image creation are the gantry and the patient table .(Lois ,2011)

2.4.4.1 Gantry:

The gantry is the ring-shaped part of the CT scanner. It houses many of the components necessary to produce and detect x-rays. Gantries vary in total size as well as in the diameter of the opening, or aperture. The range of aperture size is typically 70 to 90 cm. The CT gantry can be tilted either forward or backward as needed to accommodate a variety of patients and examination protocols.Thedegreeoftiltvariesamongsystems,but±15°to±30°isusual.

The gantry also includes a laser light that is used to position the patient within the scanner. Control panels located on either side of the gantry opening allow the technologist to control the alignment lights, gantry tilt, and table movement. In most scanners, these functions may also be controlled via the operator’s console. A microphone is embedded in the gantry to allow communication between the patient and the technologist throughout the scan procedure figure(2.12) .(Lois , 2011)

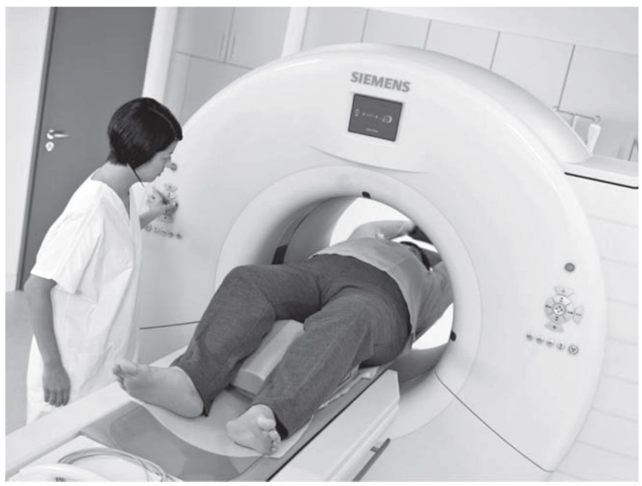


Figure (2.12): CT scanner **.**The gantry and patient table are Major components of a CT image system. . (Lois ,2011)

2.4.4.2 Slipring:

Early CT scanners used recoiling system cables to rotate the gantry frame. This design limited the scan method to the step-and-shoot mode and considerably limited the gantry rotation times. Current systems use electromechanical devices called slip rings. Slip rings use a brushlike apparatus to provide continuous electrical power and electronic communication across a rotating surface. They permit the gantry frame to rotate continuously, eliminating the need to straighten twisted system cables (Lois ,2011)

2.4.4.3 Generator:

High-frequency generators are currently used in CT. They are small enough so that they can be located within the gantry. Highly stable three-phase generators have also been used, but because these are stand-alone units located near the gantry and require cables, they have becomeobsolete.

Generators produce high voltage and transmit it to the x-ray tube. The power capacity of the generator is listed in kilowatts (kW). The power capacity of the generator determines the range of exposure techniques (i.e., kV and mA settings) available on a particular system. CT generators produce high kV (generally 120–140 kV) to increase the intensity of the beam, which will increase the penetrating ability of the x-ray beam and thereby reduce patient dose. In addition, a higher kV setting will help to reduce the heat load on the x-ray tube by allowing a lower mA setting. Reducing the heat load on the x-ray tube will extend the life of the tube .(Lois,2011)

2.4.4.4 Collingsystem:

Cooling mechanisms are included in the gantry. They can take different forms, such as blowers, filters, or devices that perform oil-to-air heat exchange. Cooling mechanisms are important because many imaging components can be affected by temperature fluctuation (Lois , 2011)

2.4.4.5 X-raysource:

X-ray tubes produce the x-ray photons that create the CT image. Their design is a modification of a standard rotating anode tube, such as the type used in angiography.Tungsten, with an atomic number of 74, is often used for the anode target material because it produces a higher-intensity x-ray beam. This is because the Compensating filters are used to shape the x-ray beam (Lois ,2011).

CT tubes often contain more than one size of focal spot; 0.5 and 1.0 mm are common sizes. Just as in standard x-ray tubes, because of reduced penumbra small focal spots in CT tubes produce sharper images (i.e., better spatial resolution), but because they concentrate heat onto a smaller portion of the anod they cannot tolerate as much heat. (Lois ,2011)

2.4.4.6 Filtration:

They reduce the radiation dose to the patient and help to minimize image artifact.As radiation emitted by CT x-ray tubes is polychromatic, Filtering the x-ray beam helps to reduce the range of x-ray energies that reach the patient by removing the long-wave length (or “soft”) x-rays. These long-wave length x-rays are readily absorbed by the patient, therefore they do not contribute to the CT image but do contribute to the radiation dose to the patient. In addition,creating a more uniform beam intensity improves the CT image by reducing artifacts that result from beam hardening. (Lois,2011)

2.4.4.7 Collimation:

Collimators restrict the x-ray beam to a specific area, thereby reducing scatter radiation. Scatter radiation reduces image quality and increases the radiation dose to the patient. Reducing the scatter improves contrast resolution and decreases patient dose. Collimators control the slice thickness by narrowing or widening the x-ray beam .(Lois , 2011)

The source collimator is located near the x-ray source and limits the amount of x-ray emerging to thin ribbons. It is referred to as prepatient collimation. The source collimator affects patient dose and determines how the dose is distributed across the slice thickness . The source collimator resembles small shutters withan opening that adjusts, dependent on the operator’s selection of slice thickness. In MDCT systems, slice thickness is also influenced by the detectorelement configuration . Some CT systems also use predetector collimation. This is located below the patient and above the detector array. Because this collimator shapes the beam after it has passed through the patient it is sometimes referred to as postpatient collimation. The primary functions of predetector collimators are to ensure the beam is the proper width as it enters the detector and to prevent scatter radiation from reaching the detector (Lois E2011).

2.4.4.8 Detector:

The term detector refers to a single element or a single type of detector used in a CT system. The term detector array is used to describe the entire collection of detectors included in a CT system. Specifically, the detector array comprises detector elements situated in an arc or a ring, each of which measures the intensity of transmitted x-ray radiation along a beam projected from the x-ray source to that particular detector element. Also included in the array are elements referred to as reference detectors that help to calibrate data and reduce artifacts. (Lois ,2011)

The optimal characteristics of a detector are as follows: high detector efficiency, defined as the ability of the detector to capture transmitted photons and change them to electronic signals; low, or no, afterglow, defined as a brief, persistent flash of scintillation that must be taken into account and subtracted before image reconstruction; high scatter suppression; and high stability, which allowsasystemtobeusedwithouttheinterruptionoffrequentcalibration.(Lois , 2011)

The patient lies on the table (or couch)andis moved within the gantry for scanning. The process of moving the table by a specified measure ismost commonly called incrementation, but is also referred to as feed, step, or index. Helical CT table incrementation is quantified in millimeters per second because the table continues to move throughout the scan. The degree to which a table can move horizontally is called the scannable range, and will determine the extent a patient can be scanned without repositioning. (Lois , 2011)

2.4.5 Scanner Generation:

The configuration of the x-ray tube to the detectors determines scanner generation. As new developments in scanning occurred, each new tube-detector design was referred to by a consecutive generation number.

The first system produced by the now defunct EMI medical division had a design that is referred to as first generation. A thin x-ray beam passed linearly over the patient, and a single detector followed on the opposite side of the patient. The tube and detector were then rotated slightly, and the process was repeated until a 180° arc was covered. Scan times were very long. This design is no longer in use .The second-generation design is one in which the x-ray beam also passed linearly across the patient before rotating. However, a fan-shaped x-ray beam was used, rather than the thin beam used with first-generation designs. Only part of the field of view could be covered with this fan beam. A detector array was also incorporated in the second-generation design. Although scan times were shorter than that of the original design, they were still very long. This type of design is also no longer used .The next advance in CT technology brought the third generation design. This design consists of a detector array and an x-ray tube that produces a fan-shaped beam that covered the entire field of view and a detector array Reference detectors are typically located at either end of the detector array to measure the unattenuated x-ray beam .(Lois ,2011)

Fourth-generation scanners use a detector array that is fixed in a 360° circle within the gantry. The tube rotates within the fixed detector array and produces a fan-shaped beam . Although many more detector elements are included in this design,thenumberofdetectorsinuseatanyonetimeiscontrolledbythewidth of the beam. Fourth-generation scanners may also be called rotate-only systems .(Lois , 2011)

Many variations of these basic designs have been introduced and then abandoned. The only other design currently in use iscalled electron beam imaging, also referred to as EBCT or ultrafast CT. It differs from conventional CT ina number of ways. This system, which was originally produced by Imatron, uses a large electron gun as its x-ray beam source. A massive anode target is placed in a semicircular ring around the patient. Neither the x-ray beam source nor the detectors move, and the scan can be acquired in a short time . Invented in the 1980s, its superior speed compared with traditional CT scanners of the time made it particularly suited to cardiac imaging.However, shortfalls in spatial resolution kept EBCT from use in routine imaging, dramatically limiting the technology's clinical versatility. Additional drawbacks were high cost and difficulties obtaining insurance reimbursement.The future of EBCT is uncertain as the newer multidetector row technology applied to third-generation scanners has increased scanning speed so that they compare favorably with EBCT. (Lois , 2011)

2.5 Previous studies:

Jyothi AC et al (2016) studied the role of high resolution computed tomography in the evaluation of temporal bonelesions.

This prospective study done at department of otolaryngology at Navodaya Medical College,raichur during the period of 1stJune2012 to 31stMay 2014.fifty patient who presented to our out patient department for clinical features suggesting temporal bone pathologies were subjected to HRCT of the temporal bone .The patients included were those having ear discharge, head trauma, facial palsy or those complaining of vertigo, tinnitus and hearing loss. Patients with history of previous surgery and those with electric devices at the skull base, such as cochlear implant were excluded from the study.

The study comprised of 27 males and 23 females. The age group of subjects ranged from 7 years to 60 years. Of the 50 temporal bone HRCT studies 41 scan were having infections of the temporal bone (82%), 5 were having tumors (10%) and 4 were having traumatic injuries to the temporal bone(8%).Of 41 scans havinginfectioninthetemporalbone,2scanrevealedmalignantotitisexterna,

29 scans showed varying degrees of mastoiditis and 10 scans showed cholesteatoma which ranged from limited form to extensive tybe.The HRCT findings like extension of cholesteatoma, opicification of mastoid air cells, ossicular erosion and intracranial extension were compared with the intraoprative findings and in all the cases, both were similar In all the cases, nature of surgery was dependent on the nature and extent of the disease.He conclude that the middle ear disease is a common clinical entity; imaging, especially HRCT, play a crucial role in diagnosis and assessing the disease extent , helping to decide appropriate management .Temporal bone imaging is challenging and involves thorough understanding of the anatomy, especially in the relation to HRCT imaging. Most of the middle ear pathologies appear as “soft tissue” on imaging. careful analysis of the soft tissue on the HRCT is crucial in achieving the right diagnosis; HRCT is ideal for the evaluation of temporal bonelesion.

Kumar R. et al , (2016) Studied Role of High Resolution Computed Tomography in Evaluation of Pathologies of the TemporalBone.

A total of 50 patients were studied. Age group varied from 3 to 70 years. Data for the study were collected from patients attended/referred to the Department of Radio-Diagnosis, PBM Hospital, Bikaner (RAJ.) Patients were selected on the basis of their symptoms and clinical findings suggestive of a lesion involving the temporal bone such as otalgia, otorrhoea andsensorineuronal deafness, pulsatile structures of Temporal bone thereby making HRCT a valuable tool in diagnosis and treatment.

Sunita M et al 2015 studied the importance of pre-operative HRCT temporal bone in chronic suppurative otitismedia.

Study done on 50 patients of chronic suppurative otitis media with pre-operative HRCT temporal bone and the results analyzed.

In this study 31 patients(62%) were in the age group 20-30years and the mean age group was 27 years. The youngest was 11 years and the oldest was 59 years. On HRCT temporal bone, pneumatisation was seen in 38%, diploeic in 4%, sclerosed in 50% and cavity in 8% of the cases. Soft tissue density was seen in 6 cases in actively discharging tubotympanic type of CSOM and in all the 19 cases of atticoantral type of CSOM. The extent of involvement of the disease in this tubotympanic type of CSOM was more in the antrum followed by epitympanum, aditus, mastoid air cells and middle ear. The ossicular destruction was more common with incus, followed by stapes in actively discharging tubotympanic type of CSOM. In atticoantral type of CSOM, incus was most commonly eroded, followed by stapes and malleus. Scutum, tegmen, lateral semicircular canal, mastoid cortex and sinus plate erosion was seen in atticoantral type of CSOM, but not in tubotympanic type of CSOM. Facial canal dehiscence was seen in 1 case in Jan- June tubotympanic type and in 4 cases in atticoantral type of CSOM. They concloued that HRCT temporal bone could detect bony erosion accurately and also the extent of soft tissue involvement with ossciular chain status. This was very much useful in planning the surgical approach not only in atticoantral but also in tubotympanic type of CSOM. We emphasize the need for HRCT temporal bone study pre-operatively not only in atticoantral but also in tubotympanic of CSOM with actively dischargingears.

Bagul(2016) study the HRCT study of temporal bone pathologies.

It was conducted at RKDF Medical College, Bhopal, Madhya Pradesh from December 2014 to March 2016. HRCT scan was performed in 120 patients who presented with history, symptoms, and signs of the temporal bone pathologies.

The most common age group involved was11-20 years (38%) and least commonage group was 61 and above comprising (3%) of total cases The etiologic distribution of the lesions was inflammatory (50%) followed by traumatic (11.6%), benign (10%), congenital (6.6%), and malignant (5%) . Thus, the inflammatory disease wasfound to be the most frequently occurring pathology affecting the temporal bone. Inflammatory pathologies were common in younger age group (<30 years) and neoplastic pathologies were common in older age group (>50 years). Traumatic conditions equally distributed in all age group. Congenital disease frequently diagnosed in <10 years of agegroup.

Congenital malformation of the external and middle ear is more common than inner ear anomalies. Atresia or hypoplasia of the external auditory canal (EAC) is most common anomaly detected in our study. The degree of distortion range from web to small band of soft tissue covering EAC to completeabsence.

He conclude that HRCT scan of temporal bone depicts complex bony details and associated soft tissue pathologies accurately. Due to various limitations of clinical examination and radiography, it is not possible to differentiate various pathologies affecting the temporal bone and study their extent. HRCT temporal bone overcome with all these limitations and its single most important imaging tool to evaluate various congenital, inflammatory, traumatic, and neoplastic pathologies of the temporal bone. Now HRCT temporal bone is standard imaging modality for pre-operative evaluation and management of various pathologies of the temporalbone.

Raga .M (2013) studied the charectrization of mastoid air cells pathologies using spiral CT.

The study was conducted in Alfaisal Specialized Hospital and Ibn Elhaitham Diagnosting center in the period from September 2012 to January 2013.100 patients of different ages and different genders whom suspected of having mastoid air cells pathologies wereincluded.

The gender distribution as follow (58% female&42% male) . 28% of them diagnose on CT of having chronic mastoiditis& CSOM,8% as having CSOM,2% as having cholesteatoma&CSOM.

The side of lesions in 49% of patients on bilareal side ,26% at the right side and 25% at the left side.

The pathological changes on the mastoid bone explain as the 13% with mastoid bone sclerosis ,6% with mastoid bone erosion and 81% with normal mastoid bones.

The middle ear cavity opacifcation noted in 78% of patients,67%of them were diagnosed by CT as having chronic mastoiditis &CSOM while 11% of them diagnosed as having cholesteatoma.

Ossicular change were detected in 29% of patients,14% of them with partial erosion ,while 15% of them with total erosion .

She conclude that spiral CT is an effective imaging modality in study of mastoid air cells diseases and their complications .

The diseases of mastoiditis with CSOM had higher frequency and also their complications(ossicular erosion, scutum erosion, and loss of hearing).

There wascorrelation between mastoid air cells diseases and middle ear diseases,and with the help of spiral CT it is possible to acquire multiple slices and understand the complex relationships of anatomicstructures.

Using 3D, multi-planar reformation techniques would be benefited to detect and diagnosed the complications of mastoid air cells diseases.

The advent of HRCT scanning has revolutionized diagnostic imaging of the temporal bone .spiral CT offers the greatest structural definition of any currently available imaging modality.

Chapter Three

Materials and Methods.

3.1 Materials

3.1.1 Machine used

GE 4 slice in Antalya medical center, Toshipa 64 slice in Alzaytouna specialist hospital.

CENTET	MACHINE	NAME OF MACHINE	INSTALLATION	NO.OF SLICE
Antalya	G.E	Optima	2011	8
Alzytona	Toshiba	Aquillion	2012	64

3.1.2 Patients

52 patient (31 female, 21 male) their age (4 - 85) years old, Whom suspected of temporal bone diseases were referred to CT departmentcenter.

3.2 Methods

3.2.1 Technique

The patient should wear comfortable ,loose-fitting clothing during the procedure,metal object including jewelry, eye glasses ,hairpins should be removed piror the exam.If contrast agent is request the patient must be fasted 4-6 h befor the exam . CT scans were performed including protocol of axial images from the area of temporal bone with patient in supine position ,head first .The images were made at 100 -120 kv and 80-225 mAs, with thin slice 1-2mm slice thickness and special bony algorithm.Topogram were taken routinely inall patients before starting the scan. Scanning commenced from the lower margin of the external auditory meatus including the inferior mastoid and extend upward to the arcuate eminence of the superior semicircular canal as seen on lateral topogram .Slight extention of the head was given to avoid gantry tilt and thereby protect the lense from radiation.

Helical acquisition in the axial plane was performed .Reformatted coronal images were obtained perpendicular to the axial plane from the cochlea to the posterior semicircular canal.

The contra lateral temporal bone was included for comparison .Intravenous contrast was used as and when required.

3.2.2 Image interpretation

All axial and coronal views were evaluated by technologist and diagnosed by radiologist.

3.2.3 Data analysis

The data were collected by using data sheet from medical reports and were analyzed by using excel program and SPSS programmes.

Chapter four

The Results

Chapter four

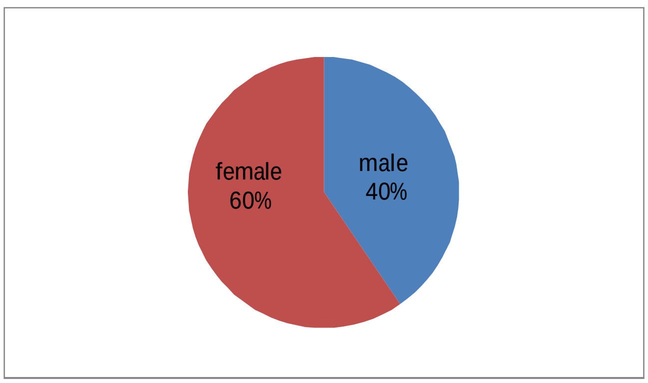
The Results

The Results:

The study carried in 52 patients, age between (4-85) years old when under went CT scan, the data collected by the following tables and graphs.

Table (4-1) Demonstrates the study group gender:

Gender	Frequency	Percentage of temporal bone
Male	21	40%
Female	31	60%



Figure(4-1-1) shows the study group

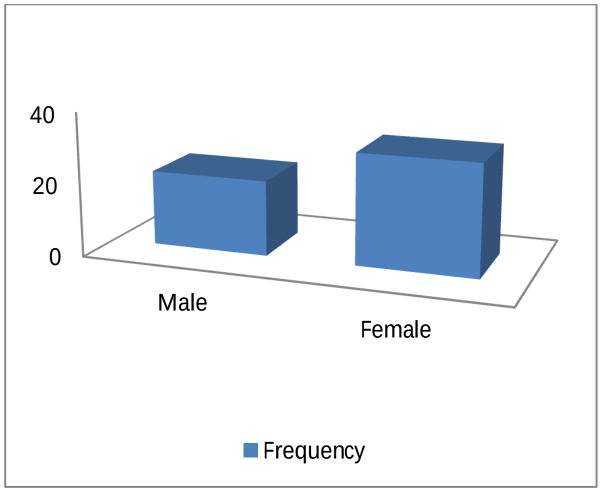


Figure (4-1-2) shows the study group

Table(4-2) Demonstrates age distribution of study group:

Age	Frequency	Percentage
01-20	8	15%
21-40	25	48%
41-60	15	29%
61-80	3	6%
81-100	1	2%

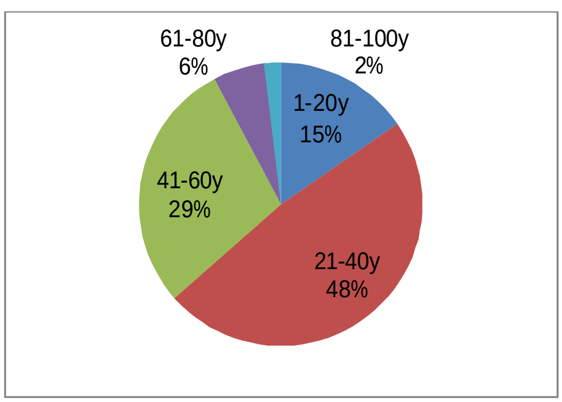


Figure (4-2-1) shows age distribution of study group

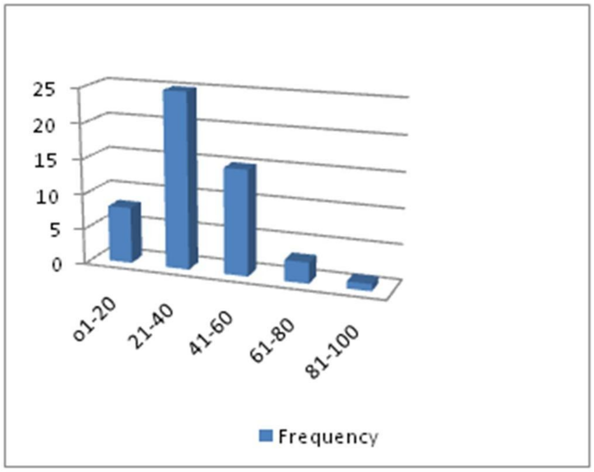
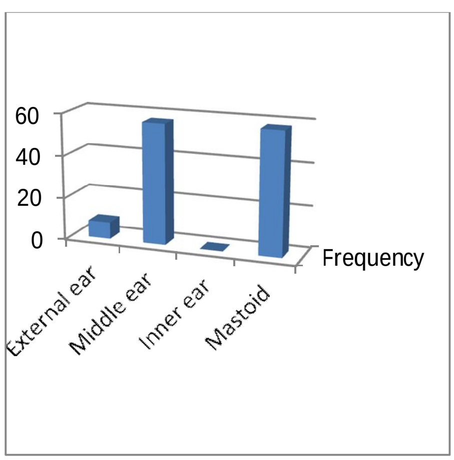


Figure (4-2-2) shows age distribution of study group

Table (4-3) Demonstrates the site of pathological lesion:

Site of lesion	Frequency	Percentage
External ear	8	7%
Middle ear	57	55%
Inner ear	0	0%
Mastoid	58	56%



figure(4-3) shows the site of pathological lesion

Table (4-7) Demonstrates CT findings of infection:

CT findings	Frequency	Percentage
Opacified mastoid	46	53%
Opacified middle ear	43	50%
Sclerosis of mastoid	18	21%
Bony septa destruction	6	7%
Mucosal change	3	4%
Erosion of ossicles	9	11%
Erosion of scutum	4	5%
Cholesteatoma	5	6%
Intracranial complication	1	2%
Soft tissue density	5	6%

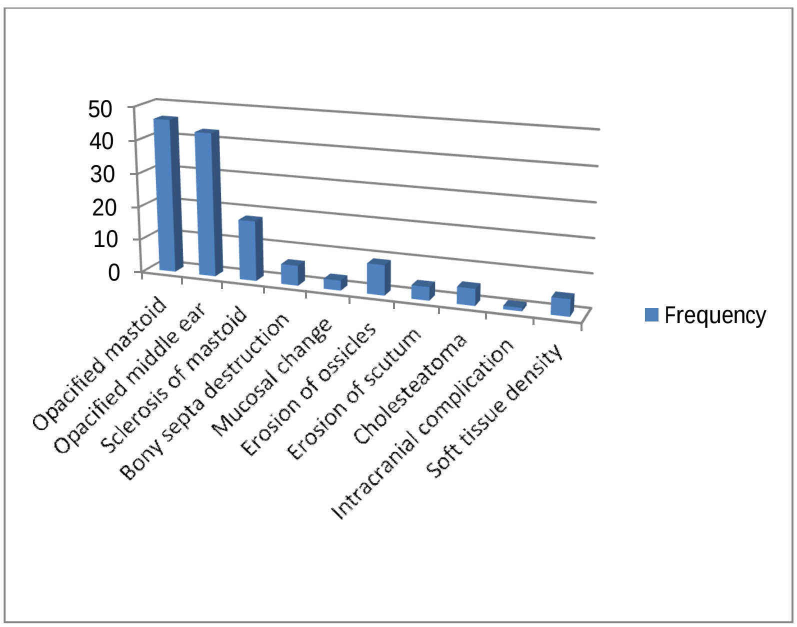


Table (4-9) Demonstrates degree of ossiclular erosion:

CT findings	Frequency	Percentage
Partial erosion	2	3%
Complete erosion	4	5%
Ill defined	1	1%
Destruction	2	3%

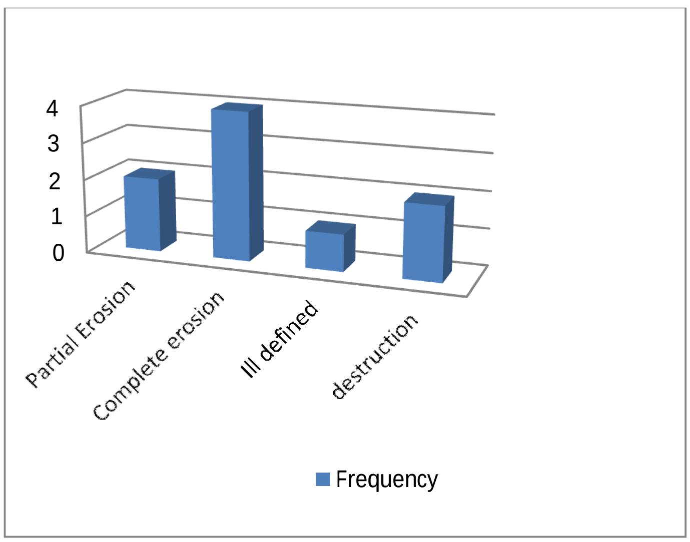
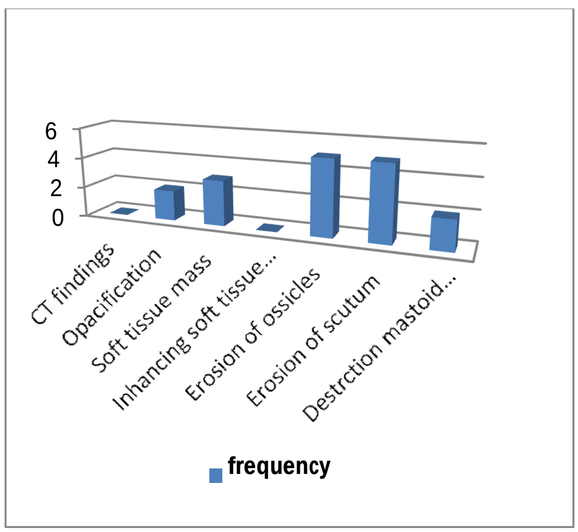


Figure (4.9) shows degree of ossiclular erosion

Table(4-10) Demonstrates CT findings of cholesteatoma:

CT findings	Frequency	Percentage
Opacification	2	40%
Soft tissue mass	3	60%
Inhancing soft tissue mass	0	0%
Erosion of ossicles	5	100%
Erosion of scutum	5	100%
Destruction mastoid septa	2	40%



Figure(4-10) shows CT findings of cholesteatoma

Table (4-11) Demonstrates CT findings of neoplasm:

CT finding	Frequency	Percentage
Soft tissue density	2	40%
Enhancing soft tissue density	2	40%
Cystic density	1	20%
Bony destruction	2	40%
Intracranial complication	2	40%
Facial canal involvement	1	20%

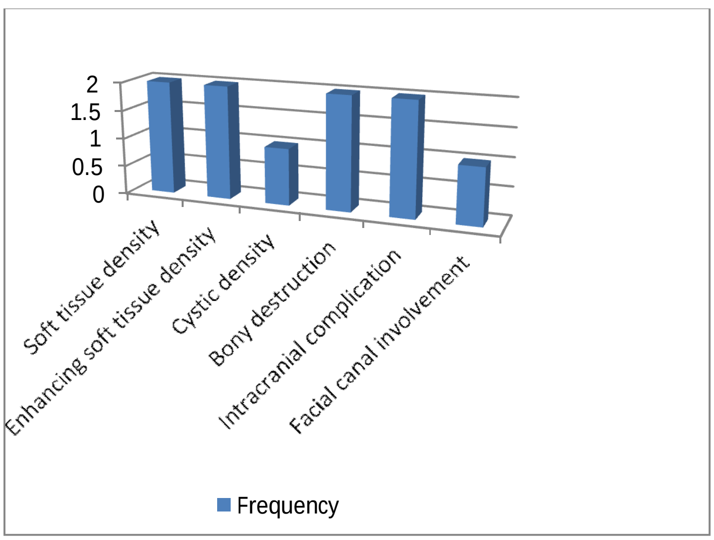


Figure (4-11) Shows CT findings of neoplasm

Chapter five

Discussion, Conclusion& Recommendation

Chapter five

Discussion, Conclusion and Recommendation

5.1 Discussion:

In this study 52 patients were evaluated for their various symptoms of temporal bone diseases.

The gender distribution show the female (60%) is more than male (40%) (table 4-1). this result is reversed to study of (Kumarn R et al 2016) and (Jyothi AC et al 2016) ,and similar to(Vivek et al 2014) , (Arzu et al 2011) and(Raga M 2013).

The age distribution on table (4-2) show the commonest age group of (21-40) which it similar result of (Vivek et al 2014) .

Inflammatory disease was the most common pathology seen(82%), which is similar result to (Kumar R et al 2016) and(Bagul 2016) , followed by neoplastic pathologies (10%) also is the similar to(Jyothi AC et al 2016) , The congenital malformations of temporal bone fall in to rare disease categories (2%), and we have one case of EAC atresia .In (Bugal 2016) study the congenital malformations representing (6.6%) of cases with EAC atresia most common anomaly detected. Other lesion include one case of osteopetrosis, forigen body and EACs obstruction .bilateral involvement (34%) is less common than unilateral pathological lesion (66%), table (4-5).In this study Mastoid and middle ear were affected more than the inner and external ear strctures,(table 4-3) this result is agrrement with (Raga M 2013) . According to location (table 3-4)and degree of involvement table(4-8) &(4-9), HRCT can able to classify various type of infections with the CSOM most common ,table(4-6), Also, CT can able to demonstrate any anatomical abnormality and assessing complications of infection table(4-4) ,it shows non specificdeprise (opacification) (89%) this means it cannot able to detect the type of deprise. this is agreement with the result study of (Arzu et al 2011),also show mucosal change (3%). Sclerosis (18%) and erosion of surrounding bony tissue (such as the ossicle (11%), scutum (5%), mastoid septation (7%)), can be demonstrated in CT imaging as well table (4-7) . CT appearance of cholesteatoma is a non-inhancment, homogenous, soft tissue mass associated with erosion of ossicles and scutum which is similar to result of (Jyothi AC et al 2016) and (Arzu T et al 2011).two cases of cholesteatoma cannot differentiated from surrounding opacification but the presence of bone erosion aid in the diagnosis table(4-10). Neoplasm present in HRCT as lesions iso to slightly hypodense to adjacent brain(soft tissue density 40%) ,some tumor enhancing when contrast media is used (40%).HRCT is used to evaluate the bony invasion by the tumor.The aspect of bone invasion can provide information about the type and the exact extension of the tumor and the invasion of vascular structure, nerve cannels and intracranial extention table(4-11).In this study one case of benign lesion, CT cannot able to differentiate the type of soft tissue and clinical correlation is advised,(Appendixes),(Arzu T et al 2015) has the sameresult.

In osteopetrosis HRCT show most of the bony tissue was expanded by dense lamellar bone and replacement of mastoid and pertrous air cells. The ossicles were normal.

In EAC obstruction HRCT cannot able to differentiating the type of soft tissue and biopsy is advised.

Foreign body appear as partial opacification and clinical correlation is needed.

5.2 Conclusion

HRCT scan was helpful in determining the anatomy of the temporal bone and accurately classified and predicted the extent of the disease process,especiallyin patients who have or suspected of having complications. Also it lay down anatomical roadmap for the surgeon preoperatively, and it can able to evaluate both bony and air space structure accurately and detect the presence and extension of soft tissue ,but could not be relied on to differentiate the type oftissue.

5.3 Recommendations

The study recommended that the study should be done on large number of patients as well as at multiple centers.

Obtaining of direct coronal scan may aid in differentiating of some pathologies and increase the diagnostic value.

Using of virtual endoscopy reconstruction soft ware,which it is non invasive Imaging method and permit the investigator to navigate through the anatomy nondestructively.

MRI is essential for soft tissue and inner ear evaluation.

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Appendixes

Appendixes

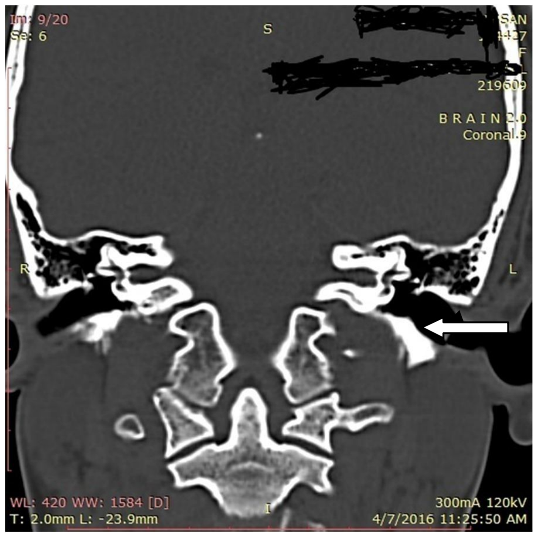
Appendix (A)

Data sheet

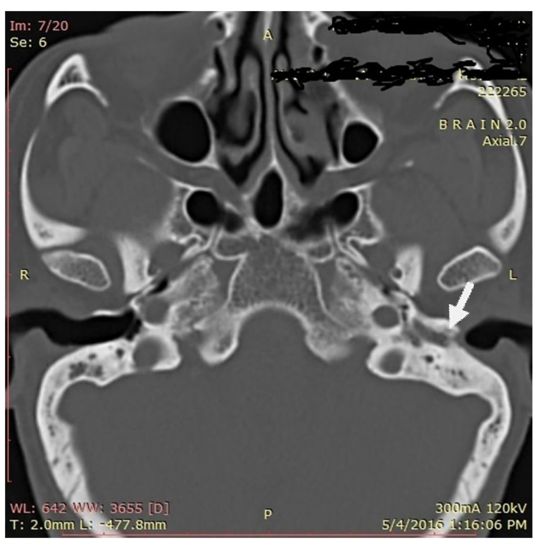
No	age	Gender	masoid		Middle ear		Inner ear		Ossicles		Scutum		IAC		EAC		Intra cranial extention	Diagnosis
			R	L	R	L	R	L	R	L	R	L	R	L	R	L		

Appendix (B)

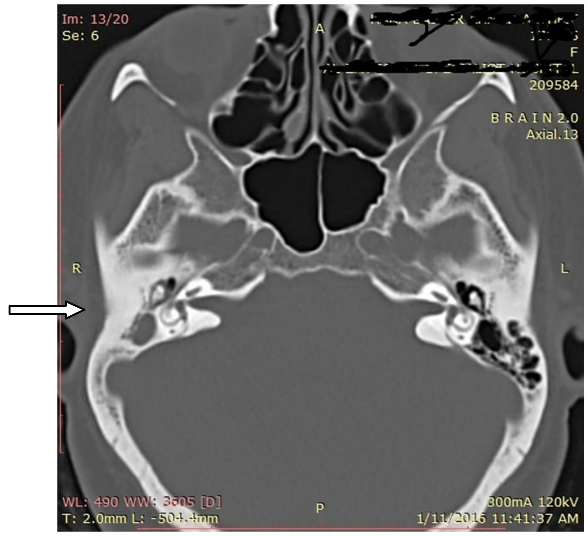
Image of the study



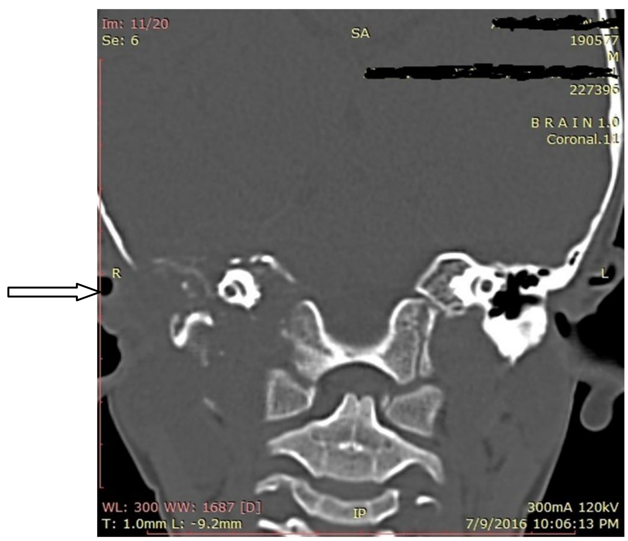
Afemale patient 14 years old with soft tissue density Seen in the left external auditory canal……?wax……? polyp,for clinical Correlation.



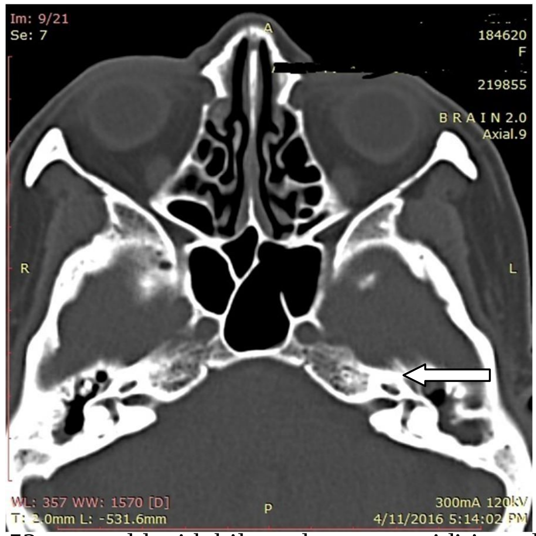
A female 22years old with left metal atresia.



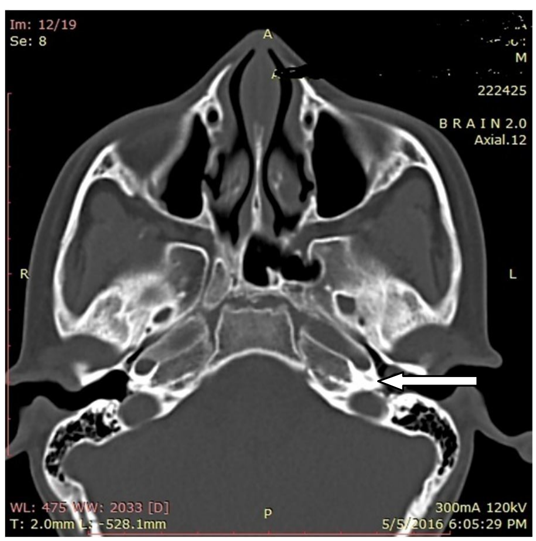
Afemale 26 years old with right oto-mastoiditis



A male patient 4 years old with right bening tumor(eosoniphilic granuloma).



Afemale 52 years old with bilateral oto-mastoiditis and left Cholesteatoma.



Amale patient 10 years old with foreign body in the distal part of the left external auditory Canal and adjacent part of middle ear.