Surgical Anatomy of the Ear Lecture No. 1

The ear is divided to External,Middle and Inner ear.

The external ear:

It composed of auricle (pinna) and the external auditory meatus.

It’s function is to collect and transmit sound to the tympanic membrane

The auricle is composed of cartilage covered with perichondrium to which the skin are very closely adherent

The lateral surface has characteristic prominences and depressions which are different in every individuals even identical twins,the curved rim is helix,anterior and parallel to it is another prominence,antihelix.Superiorly this divided into two crura,between which is is the triangular fossa,above the two crura is the scaphoid fossa. In front of antihelix,and partly encircled by it,is the concha Below the crus of the hlix and overlapping the external auditory meatus is the tragus.Opposite to it at the inferior limit of antihelix is the antitragus,below the antitragus is soft area composed oaf fibrous and adipose tissue called lobule.

The external auditory meatus:  
The outer third is cartilaginous, t he inner two are bony , the outer cartilagenous portion is  
covered with skin that contain hair follicles,sebaceous glands and

cerminous glands which secrete wax While these structures are lost in the inner bony meatus where the

skin is thin and hair-free

Owing to the tight union of cartilage and skin any inflammatory process will be extremely painful

The EU canal extends from the concha of the auricle to the TM is approximately 2.4 cm ,the diameter of the canal varies greatly between individuals and between different races

In adult the cartilagenous portion runs inward and slightly downwards and forward Therefor the canal is straightened by gently moving the auricle upwards and backwards to counteract the direction of the cartilagenous portion.

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In the neonate,there is vitually no bony external meatus as the tympanic bone is not not yet developed

So that the auricle must be gently drawn downwards and backwards for the best view of the tympanic membrane

Tympanic membrane:

The tympanic membrane or ear drum is oval in shape and measures about 1cm indiameter and supported around its periphery by a fibrous thickening (the annulus).This fibrous annulus fits in turn into a slot in the tympanic bone.

Ther is small deficiency superiorly,called the notch of Rivinus.

Tne ear drum consists of three layers

The outer layer is epithelial layer continous with the skin.   
The middle layer which is fibrous layer  
The inner layer which is mucous layer continous with the lining with tympanic cavity  
The tympanic membrane is divided into two parts:  
Pars tensa and pars flaccida  
Pars flaccida is the most superior part occupying the notch of Rivinus and its medial layer is comprised of irregular elastic fibers,hence the flaccidity,,it issmall sometime difficult to see,it *called some time (attic),perforation in this area are potentially unsafe.*

*The middle ear  
The* middle ear is an air-containing cavity in petrous part of the temporal bone lined with mucous membrane ,it contain the auditory ossicles,it is narrow,oblique,slit like cavity whose long axis lies approximately parallel to the plane of tympanic membrane.   
It divided into:  
●Epitympanum→ upper most portion or attic above the level of the mallear fold  
●Mesotympanum→ middle portion  
*●Hypotympanum→ lower portion*

The middle ear cleft or tympanic cavity is an air filled space situated within temporal bone ,it made up of:

1 mastoid air cell

2 middle ear cleft

3 tympanic membrane

4 Eustachian tube

Function of the middle ear

Transmit sounds,which reach the TM in the form of air pressure waves,to the inner ear where a liquid wave is set up.

The sound energy is transmitted across the middle ear by a chain of three bones malleus,incus and stapes called ossicles the ossicular chain together with the ear drum amplifies the sound energy

The middle ear has six portions:  
Roof(superior),floor(inferior),anterior wal,posterior wall,medial wall,lateral wall  
Floor

The Ossicles  
The auditory ossicles are:  
Malleus  
Incus  
Stapes

The malleus is largest ossicle,had a head,a neck,a handle or long process,an anterior process,and alateral process  
The head is rounded and articulate posteriorly with the incus.The neck is cnstricted part below the head.  
The handle pesses downward and backward and firmily attach to the medial structure of the tympanic membrane,it can be seen through the tympanic membrsne on otoscopic eqxamination.  
The anterior process is a specula of bone connected to the anterior wall of the tympanic cavity by a ligament.  
The lateral process project laterally and attached to the anterior and posterior malleolar fold

The incus posses a large body and two processes  
The body is rounded and articulates anteriorly with the head of malleus  
The long process descends behind and parallel to the handle of malleus.Its lower end bends medially and articulates with head of stapes.Its shadow on T.M can sometime be seen on otoscopic examination.  
The short process projects backward and is attached to the posterior wall of tympanic membrane by a ligament

The stapes has a head,a neck,two limbs(crura) and a base(foot plat   
   
The head is small and articulates with the long process of incus.  
The neck is narrow and receives the insertion of stapedius muscle  
The two limbs diverge from the neck and attached to the oval base or foot plate  
The foot plate is 3mm x1.4mm and it lies in the oval window

The Eustachian tube   
The auditory tube extends from the anterior wall of tumpanic cavity downwards,forwards,and medially to the nasopharynx.  
Its posterior third is bony,its anterior two-third is cartilaginous.  
It serves to equalize pressure of air in tympanic cavity and nasopharynx..

The inner ear:

Called also the labyrinth,it consists of bony capsule that is almost embedded in the petrous part of temporal bone ,it consists of:

Bony labyrinth,comprising a series of cavities within the bone

Membranous labyrinth,comprising of series of membranous sacs and ducts contained within the bony labriynth

Bony labryrinth

It consists of three parts :

1-The vestibule

2-The semicircular canals

3-The cochlea

They are lined by endosteum and contain a clear fluid called the perilymph

The vestibule is the central part of the bony labyrinth .In its lateral wall is the fenestra vestibule (oval window) which is closed by the base of stapes,and the fenestra cochleae (round window) which is closed by secondary tympanic membrane.

Logged within the vestibule are the saccule and utricle of the membranous labyrinth

There are three semicircular canals,superior,posterior and lateral---- -open in posterior part of the vestibule by five orifices

The superior and posterior are vertical while the lateral semicircular canal is set in horizontal position

The cochlea resembles a snail shell,it opens in the anterior part of the vestibule.It consists of a centeral pillar(the modiolus) around which a tube makes two and one half spiral turn.The cochlea is divided by a membrane into scala vestibule above and scala tympani below

Membranous labyrinth

It is logged within the bony labyrinth and filled with endolymph and surrounded by perilymph and consists of utricle and saccule which are logged in the bony vestibule,also contain three semicircular ducts which lie within the bony semicircular canals,also contain the duct of cochlea which lie within the bony cochlea

Physiology of hearing

Airborne sound consists of vibration of the atmosphere and the purpose of auditory apparatus is toconvert this vibrations in air to vibrations in the inner ear fluid,and then to nerve impulses to be transmitted along the auditory nerve to the higher centrese of hearing.

The auricle collect sound waves to some extent,then pass along the external auditory meatus to the tympanic membrane,the vibration of tympanic membrane are transmitted to the malleus,incus and stapes.

Then the sound transmitted to the oval window,causing the vibration to be set up in the endolymphatic and prilymphatic compartments of the inner ear,so the middle ear structure convert the sound from air to fluid

The stapes moves in a rocking rather than a piston motion and as the fluids cannot be compressed,these vibrations are transmitted to the round window membrane. This reciprocal action of the oval and round windows is essential.

In the normal ear the presence of tympanic membrane and air containing middle ear prevents the sound pressure waves from reaching the round window and opposing the out ward movement of the round window membrane,this protection of the round window is lost when there is large perforation of the tympanic membrane,and this is one factor which may produce deafness.

The tympanic membrane is at its most efficient when the air pressure in the external auditory meatus and the middle ear is equal,and this equalization is achieved by the Eustachian tube.

Then the vibration transmitted to the inner ear produce displacement of the basilar membrane and shearing movement between the hair cell and tectorial membrane of the organ of Corti which intiates nerve impulse in the fibers of auditory nerve

Physiology of balance

The balance of the body is maintained by coordination of information from three systems;

1.proprioception. i.e sensation from muscle,joints,tendons and ligament

2.the eye

3.the vestibular system

The vestibular system cosists of the semicircular canals,the utricle and the saccule.

The semicircular canals respond to angular (rotatory) acceleration while the utricle and saccule respond to linear acceleration.

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Diseases of external ear

Congenital abnormalities: The auricle develops from series of six tubercles,anomalies of development may be associated with others in the middle or inner ear or congenital malformation of the face or lower jaw.

Accessory auricles

They are usually found in the preauricular region ,but may occur anywhere along a line extending down to the sternoclavicular joint.They may appear to be simple skin tags but frequently contain cartilage.

Bat ear:

This is the most common congenital deformity of the ear,the condition is usually bilateral ,and the child may be teased at school.

Lop ear

Less common,the superior part of the pinna appears appear to be falling forwards;just very low set skin tag

Anotia

Total absence of the auricle,no obvious external ear

Microtia

The pinna is rudimentary and malformed usually placed lower and more anteriorly than normal

These anomalies usually associated with meatal atrasia and other abnormalities of middle ear.

1/3 of patient presented with other genetic abnormalities like:

Defined syndrome 9%

Facial cleft and cardiac defect 30%

Injuries to the pinna

Trauma to the pinna may result in a simple laceration or partial or complete avultion.The only obvious abnormality sometimes is a swelling resulting from haematoma formation,which is an extravasation of blood between the cartilage and overlying perichondrium Haematoma auris is a collection of blood between the auricular cartilage and

Perichondrium

The haematoma is painless and inflammation is minimal.

If left untreated, the natural outcome is thought to be deformity of the pinna and

the classic ‘cauliflower’ or ‘wrestler's’ ear. How much deformity is caused by a

single incident and how much is cumulative is not documented.

More rarely, supervening infection can lead to perichondritis and cartilage

necrosis – particularly if the cause or the subsequent treatment breach the skin

barrier.

The pinna appears swollen and blue and the ear may be tender with a feeling of heat and discomfort, if untreated the pinna may become distorted and thickened ,as the haematoma resolved ,a "cauliflower ear" may result.

Tteatment of haematoma

Aspiration or drainage should be done,if the swelling is liquefied this is done by syringe and large bore needle and if a solid or organised clot is present ,it should be opened and evacuated under strict aseptic condition .

Whatever the method used a firm pressure dressing is applied in an attempt to discourage more blood from clotting.

After partial or complete avultion the pinna can be reattached ,otherwise a bone anchored prosthesis can be fitted.

Infection of the pinna

Perichondritis

It is inflammation of the covering of the cartilage.It is either due to infection of haematoma or other injury,or may complicate severe otitis externa,or it may happen as a complication of mastoid surgery when the cartilage is cut in the presence of gross infection or the infection may be introduced by aspiration or incision, a frost bite or burn also play a role.insertion of ear ring..

Signs and symptoms

The pinna is uniformly enlarge

The pinna become thickend

The surface of pinna is red,and shiny

Pain,sever pain

Constitutional symptoms may present

Treatment

A broad spectrum antibiotic "antipseudomonal"

A swab may be needed for culture and sensitivity

If subperichondrial abscess form,it should be incised and drain,but incision should be delayed until definitive fluctuation can be elicited as a premature incision may result in further spread of infection

Skin infection of the pinna

Impetigo

It is an infection of skin by staphylococci and most commonly occur in young children,it involve the auricle and sometime the head and neck and face but it dose not into the external auditory meatus.

Vesicle filled with serum arise on a reddish-purple base.

It may be secondary to the otorrhea of middle ear infection

Treatment

Removal of crust,which may be formed when the vesicle to exudates serum which dries to form amber crusts,the removal done with warm,sterile saline

Topical antibiotic daily for several days

Treatment of otitis media or externa

Herpes zoster

May appear around the ear as a part of Ramsay Hunt Syndrome "Facial palsy due to the neuritis of the facial nerve caused by herpes zoster virus ,it accompanied by otalgia,hearing loss,vertigo"

The vesicle may heal spontaneously but painful neuralgia may precede or follow their eruption

Tumours of the pinna

May be benign like papilloma,fibroma and chondroma

May be malignant like:

Sq.cell carcinoma present as an indurated ulcer with everted margens,the regional lymph nodes may be involved

Basal cell carcinoma "Rodent ulcer"

Result from proliferation of basal cell of the epithelium,it is found less commonly in the auricle than on the skin of face and forehead.

It occur more likely over 50 year old usually asymptomatic,but it can be invasive desrtroying the cartilage and bone it began as flat,slightly raised lesion developed to rolled edge with a penetrating ulce which bleeds readily.

Conditions of EUM

Furanculosis

It is a localized form of OE resulting from infection of a single hair follicle,which is present in lateral cartilaginous portion of EUM ,so it confined to the lateral canal

Bacterial invasion of a single hair follicle will result in deep skin infection,may progress to postule which may progress to local abscess formation,often with considerable associated odema and cellulitis.

Symptoms do not usually discriminate furunculosis from severe otitis externa,the pinna and tragus are tender on palpation ,otoscopic examination is difficult but it can establish the diagnosis,samples for bacteriological culture may guide therapy but do not contribute to the diagnosis of the disease

Staphylococcus aureus is the most common organism causing furunculosis,uncontrolled cases suggest that pathogenic straine of staph.aurius are of different phage types Staph.aurius causing other skin infection like impetigo (furunculosis of all body site not ontological only)

Sporadic cases happen when pathological organism are introduced into the canal in the context of other risk factors like: heat,humidity,trauma and maceration.

If untreated the infection usually progress to a localized abscess which then discharge in to external ear canal ,the infection can also spread towards the deeper tissues where it may cause a diffuse soft tissue infection spreding to the pinna,postauricular skin and parotid gland.

Repeated infection can causa permanent scarring and fibrosis of EUM which lead to subsequent meatal stenosis,this will predispose to chronic diffuse otitis externa.

Management options

Oral antibiotic treatment is recommended in the early stages(pencillinase resistant penicillin,macrolide,cephalosporine,clindamycin and quinolone.

Macrolid…..Erythromycin

Cephalosporin is one of B-lactam group

Quinololone…fluoroquinolone ….Ciprofluxacine,Norfluxacine,Levofluxacine

If there is sever spreading to soft tissue intravenous antibiotic therapy

Foreign body in the ear

More commonly are cotton wool,insect,beads,paper,small toy,small battery and eraser.

Most commonly seen in children inserted them into their own ear present with pain,or discharge, caused by otitis externa or may be asymptomatic . Live insects in the ear are annoying due to discomfort created by noise and movement.Removal may be very simple or challenging and frustrating this depend in

1 nature of the FB

Living insect first killed by oil

Irregular\soft graspable non living object by pair of crocodile forceps

Organic objects should not be syringed

Button battery should not be syringed may leak on exposure to water

Inorganic round\smooth non graspable difficult to grasp syringing is safe ,blunt ear hook may need microscope

2 the precise lacation of the FB

The easier access,widen diameter,elastic nature,lesser sensitivity of canal make the removal easier

Complications

By the action of introduction of FB or FB itself or attempts of removal,laceration of canal skin,otitis externa.damage and perforation of TM ,multiple attemps and use of multiple instrument are associated with complication

Wax production

Wax is produced by the hair-bearing skin of EUM ,wax is a combination of desequated skin and cerumen formed by glands in the base of the hair follicles.Hairs are present in the outer third of the EUM .Most external canals are self-cleaning with desequamated skin migrating up to the hair follicles where it separated from the dermis and mixes with the cerumen to form wax.the wax migrates down the hair and falls out of the ear canal.

The most common is partial obstruction of the canal,this is amenable to removal by either syringing ,probe removal,or removal under microscopic control,syringing is popular with GPs and nurses.

Occlusive wax,especially if adherent to canal wall may need to be softened prior to removal ,it can reduce the need to syringe,to soften the wax the patient is asked to turn their head on the side to allow the external canal to be filled with ear softener . The tragus is then pushed in and out to aid pentration into the wax ,the patient should continue this for about 20 minutes prior to syringing ,if the wax remains adherent and resistance to syringing ,the patient should be sent home with instruction to repeat manoeuvre regularly for the rest of the day and the next morning before syringing is attempted again

Ear toilet and Syringing

Is indicated where wax obstruct the view of the TM

Mopping the ear canal

A mop can be to used ►dry the ear canal after syringing

►►remove discharge

►►►remove debris

This allows visualization of TM and make treatment as ear drops to become into contact with EUC

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Otitis externa

Is a generalized condition of the skin of EUC is characterized by general oedema and erythema associated with ichy discomfort and usually an ear discharge Acute otitis externa affects approximately 4 of every 1000 children and

adults per year Approximately 80% of cases occur in the summer

Predisposing factors

❶ Anatomical

like Narrow EUM (heridatory,iatrogenic,exostosis,etc.)

Obstruction of the normal meatus(keratosis obturance, FB,hearing aid,hirsute canal,etc.)

❷ Dermatological like eczema,sebhorrhic dermatitis

❸ Allergic like exposure to topical medication

❹ Physiological like humid environment or immunocompromization

❺ Traumatic skin maceration (bathing), ear probing,laceration,radiotherapy

❻ Microbiological like in active CSOM,exposure

Pathology

The clinical course of OE has been divided to following stages

1 preinfalmmatory

The protective lipid/acid balance (normal pH 4-5) is lost and stratum corneum become oedematus ,blocking off the sebaceous and apocrine glands producing aural fullness ,itching.With increase oedema and scratching there is disruption of epithelial layer and invation of resident or introduced organisms

and will result in stage 2

2 Acute inflammatory stage (Mild,Moderate or Severe)

More oedema,obliteration of the lumen Mild,Moderate or Severe with thickening exudates. In severe cases increasing pain ,auricular changes and cervical lymphadeopathy,after six months or some consider chronicity after inflammation lasting longer than three weeks as entering the chronic phase,there is some evidence that individuals whose skin has a tendency to remain at low pH are more prone to develop a chronic problem

3 Chronic stage

Is characterized by thickening of external canal skin and fibrous canal stenosis .

Microbiology

*Pseudomonas aeruginosa* was the most common bacteria responsible for infections.

*Staphylococcus* sp were the next most common pathogens.

Fungi were responsible for only 2% of cases, but may be more prominent in casesof persistent or chronic infection

Investigations

Investigations are rarely required for cases of otitis externa. Cultures for

bacteria and fungus are indicated in cases of persistent or refractory

infection, particularly to identify fungal infection

Clinical Manifestations

Pain is a common symptom associated with bacterial infection. The

pain may be severe and is exacerbated by manipulation of the

auricle or the tragus. Itching may be experienced in early bacterial

infections, and in fungal infections and in all forms of chronic otitis

externa. Aural fullness and decreased hearing may be experienced

in any case of otitis externa resulting in accumulation of debris in

the ear canal. Otorrhea is more common in bacterial infections.

Examination of the canal may reveal the following findings:

1. An erythematous canal with scant discharge in cases of early

bacterial otitis externa

2. An edematous canal filled with purulent-squamous debris in

cases of well-established bacterial otitis externa

3. An accumulation of white debris sprouting hyphae best seen with

the otologic microscope, typical of candidal otitis externa

4. An accumulation of a moist white plug dotted with black debris

(“wet newspaper”) typical of *Aspergillus niger*

5. A maculopapular eruption on the conchal bowl and in the ear

canal consistent with an allergic reaction to a topical agent (e.g.,

neomycin)

6. A thickened, erythematous canal associated with an allergic or

contact dermatitis

7. Granulation tissue in the canal and on the tympanic membrane

caused by chronic infection

Treatment

Careful débridement of the ear canal in any case of otitis externa is

crucial to facilitate clearance of the infectious organism and to

allow topical medications to reach the target tissue.

If the ear canal is so edematous that topical medication would not

reach its medial extent, an ear wick may be inserted.

Classically, the physician made these fromstrands of cotton.

Currently available Merocel wicks (Medtronic, Inc.), offer better absorption of the drug, however, and

expand when wet to decrease canal edema substantially

Antibiotic drops remain the mainstay of treatment for otitisexterna.

For many years mainstay of treatment was a combination solution of polymyxin, neomycin, and hydrocortisone (PNH)

Quinolone antibiotics are available in otic and ophthalmic solutions.

Ciprofloxacin is available as an otic preparation combined with hydrocortisone and as a newer

Fungal otitis externa can be treated with meticulous débridement

of the ear Clotrimazole

1% solution (Lotrimin) is available over the counter and provides

broad-spectrum antifungal activity

ketoconazole ointment are effective as well.

Complications

If untreated,mild attachs of otitis externa can spontaneously resolve as the epithelial barrier becomes re-established ,the piloapocrine unit produce normal secreations and the pH of the canal returns to normal.

If the inflammation progress faster than repair pain will increase ,otorrhea,and oedema of the canal occur,lymphadenopathy due to rich lymphatic drainage.

This can lead to perichondritis,chondritis,cellulits,parotitis and\or erysipelas,in immunocompromised patient malignant otitis externa can develop

Malignant otitis externa

Is an aggressive and potentially life threatening infection of the soft tissue of the external ear and surrounding structures. quickly spreading to involve the periostium and bone of the skull base.it is not a neoplastic process so it is a misnomer.

Sometime called necrotizing OE, or skull base osteomyelitis.

Staging

Stage 1 malignant OE with infection of soft tissue beyond the EUM,but negative bone scan

Stage 2 soft tissue infection with positive bone scan

Stage 3 as above with cranial nerve paralysis

Stage 4 meningitis,empyema,sinus thrombosis or brain abscess

Lecture 4 Acute Otitis Externa