GUSTATORY FUNCTION IN CHRONIC OTITIS MEDIA (MUCOSAL TYPE) BEFORE AND AFTER TYMPANOPLASTY

By

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In partial fulfillment of the requirements for the degree of

MASTER OF SURGERY IN OTORHINOLARYNGOLOGY

Under the guidance of

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DEPARTMENT OF OTORHINOLARYNGOLOGY

SRI DEVARAJ URS MEDICAL COLLEGE

TAMAKA, KOLAR

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LIST OF ABBREVIATIONS

COM	⇨	Chronic Otitis Media
NST	⇨	Nucleus of the Solitary tract
PBN	⇨	Parabrachial nuclei
CPA	⇨	Cerebellopontine angle
IAC	⇨	Internal auditory canal
GSPN	⇨	Greater superficial petrosal nerve
CTN	⇨	Chorda tympani nerve
AICA	⇨	Antero inferior cerebellar artery
TM	⇨	Tympanic Membrane
EAC	⇨	External Auditory Canal
EGM	⇨	Electrogustometer

ABSTRACT

Background:

Taste plays an important part in relishing what we eat. The taste from the anterior two thirds of the tongue is mediated by the chorda tympani nerve which travels unprotected through the middle ear cavity. Many studies have been done to investigate the consequences of middle ear surgery on gustatory function, but there is a lacuna in our knowledge on the effects of chronic inflammation on taste function. In this study an attempt is made to evaluate the impact of middle ear disease on gustatory function.

Objective:

To compare the pre-operative and post-operative gustatory function in patients with Chronic Otitis Media (mucosal).

Methods:

Patients who presented to the department of ENT with chronic otitis media (mucous type), undergoing Tympanoplasty were included in the study. The selected patients were subjected to evaluation of gustatory function using different concentrations of taste solutions one day prior to surgery. Taste scores were documented pre-operatively, at 6^{th} week and 3^{rd} month post-operatively. The taste scores thus obtained were recorded and analysed for any difference in the taste threshold pre and post operatively using Paired T test.

Results:

A total of 107 patients were included in the study, age of the patients ranged from 16 years to 76 years with a mean age of 33.2 years.

There is a significant improvement in taste threshold post-operatively both at 6^{th} week and 3rd month in comparison to the pre-operative taste scores, which is statistically significant (p=0.001). Age of the patient and duration of illness has a significant impact on the recovery of taste function. Analysis with correlation coefficient suggests that there is an improvement in taste function with time.

Conclusion:

Taste impairment in patients with COM, improves significantly after disease removal by Tympanoplasty.

KEYWORDS:

Taste, chronic otits media, tympanoplasty, chorda tympani nerve

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PHOTOGRAPHS

Introduction

INTRODUCTION

Taste plays the most important role in appreciating or relishing what we eat. An impaired taste sensation may lead to changes in dietary habits and affect the quality of life. Taste sensation gives valuable information about environmental dangers. For certain occupations like gourmet chefs, wine tasters the sense of taste is critical.

In the past emphasis has been given to the hearing disability caused by Chronic Otitis media and its improvement is considered an important factor for assessing success of surgery. Taste disturbance has rarely been investigated upon in the past. Though patients suffering from COM seldom complain of taste disturbance, testing of gustatory function by quantitative methods in various studies have revealed an elevation of taste threshold in these patients.[1]

The taste from the anterior two thirds of the tongue is mediated by the chorda tympani nerve which travels unprotected through the middle ear cavity.[2] Chronic inflammation in the middle ear may result in functional impairment of the chorda tympani nerve.[1, 3]

Many studies have been done to investigate the consequences of middle ear surgery on gustatory function, but there is a lacuna in our knowledge on the effects of chronic inflammation on taste function. This study is aimed to evaluate the impact of middle ear disease on gustatory function and whether there is an alteration in gustatory function after clearance of the disease by middle ear surgery.

RESEARCH HYPOTHESIS

Chronic Otitis Media (mucosal) adversely affects taste sensation due to involvement of Chorda tympani nerve.

RESEARCH QUESTION

Does Chronic Otitis Media (mucosal) adversely affect taste sensation?

Objective

OBJECTIVE OF THE STUDY

To compare the pre-operative and post-operative gustatory function in patients with Chronic Otitis Media (mucosal).

Review of Literature

REVIEW OF LITERATURE

ANATOMY OF TASTE BUDS

Taste sensation is initiated when a chemical stimulus is given to gustatory receptor cells. Taste bud, which is the basic anatomic unit of taste, contains these receptors. Taste buds are mainly found on the tongue, but are also located on the surface of pharynx, larynx and soft palate. Taste buds on the tongue are enclosed within structures called papillae, in contrast to extra lingual taste buds which are located on the surface of the epithelium.[4]

The taste bud is made up of spindle-shaped clusters of cells. Taste buds consist of basal cells, taste receptor cells, and edge cells; edge cells form the lateral boundary of the taste bud. The three types of receptor cells in a taste bud are: dark cells, light cells, and intermediate cells. Dense granules are present in the apical portion of dark cells, which are absent in light and basal cells. Basal cells are proliferative cells and they constantly replace the population of taste receptor cells as they turnover.[4]

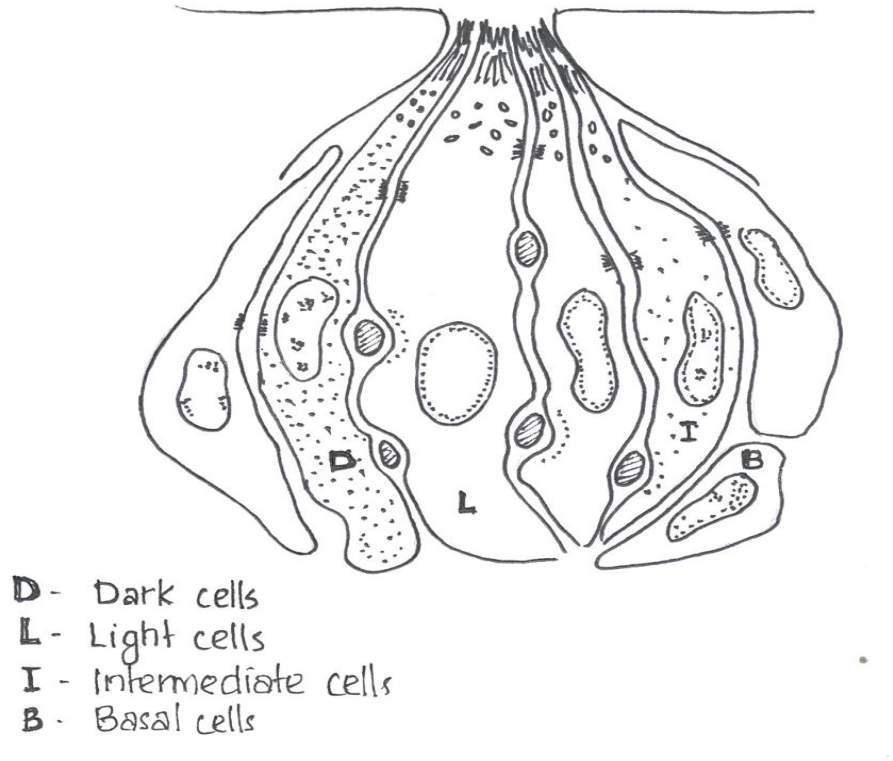


Figure .1: Anatomy of a taste bud

In a taste bud (Figure 1) the cells are concentrically arranged around a central pore that opens into the oral cavity through the epithelium. Membrane receptors are present in the apical microvilli which project towards the central pore where gustatory stimuli can interact with the receptors. Basal surface of the taste bud is penetrated by the afferent nerve which synapse with the receptor cells.[5] One nerve fibre may synapse with multiple receptor cells and conversely, each receptor cell can be innervated by multiple afferent fibres. Taste receptor cells in vertebrates are modified epithelial cells, but they possess many characteristics of neurons.[4]

Taste buds on the tongue (Figure 2) are present in three different types of papillae.

1. Fungiform papillae
2. Circumvallate papillae
3. Foliate papillae

The fungiform papillae are club like raised structures present on the anterior two thirds of the tongue. On the posterior one-thirds of tongue, taste buds are mainly within the circumvallate and foliate papillae. In man, there are approximately 200 to 300 fungiform papillae, which contain around 1600 taste buds. This number varies between individuals. On the lateral surface of the tongue foliate papillae, contain approximately 1000 taste buds. There are 8 to 12 circumvallate papillae, and they form an inverted V called as Sulcus Terminalis on the dorsal surface of the tongue which separates the anterior two thirds from the posterior one third. They contain approximately 250 taste buds each.[4]

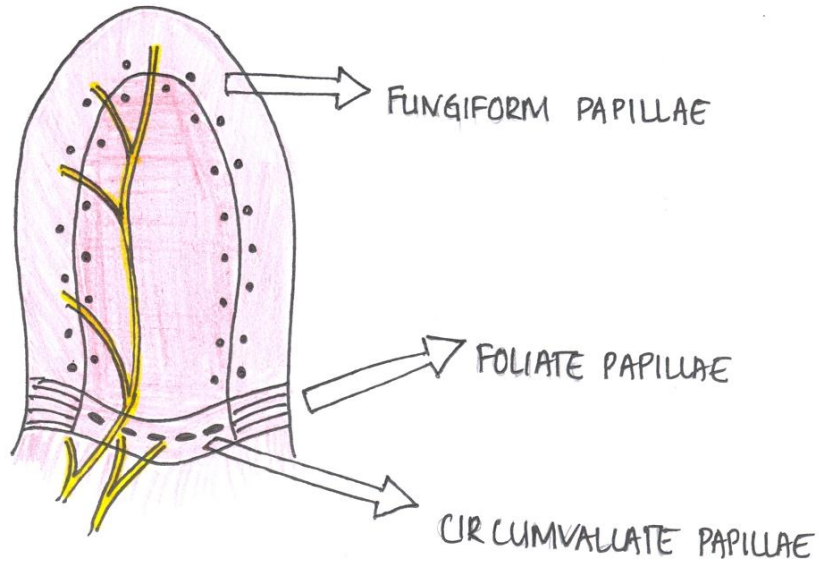


Figure 2: Arrangement of taste buds on the tongue.

A fourth type of papillae, is the filiform papillae, it is not involved in gustatory function as it does not contain taste buds.

Saliva plays a very important role in the initial events of taste transduction. It transports taste molecules which are dissolved in it to the surface of the taste receptor cells and removes these molecules once stimulation of the taste receptor has occurred. Fungiform papillae are bathed in saliva from the major salivary glands. The circumvallate and foliate papillae have deep, narrow clefts that separate them from saliva of the major salivary glands. Von Ebner's glands secrete saliva through ducts which empty directly into the crypts of the circumvallate and foliate papillae.

Four main types of taste have been described: salt, sweet, bitter, and sour. A fifth taste quality which has been described in mammals is 'umami'. Umami is elicited by glutamate, particularly monosodium glutamate, which is frequently used to enhance the flavor of foods. Contrary to common belief that certain taste qualities are perceived by specific locations of the tongue, all the taste bud populations can perceive all taste qualities.[4]

INNERVATION

Depending on the location, taste buds are innervated by different cranial nerves. Taste from the anterior 2/3rd of the tongue and soft palate is carried by two divisions of the facial nerve – the chorda tympani nerve and the greater petrosal nerve. The tonsillar branch of the glossopharyngeal nerve innervates the circumvallate and foliate papillae which are present in the posterior 1/3rd of the tongue. Pharyngeal branch of glossopharyngeal nerve supplies the taste buds present in the nasopharynx. The vagus nerve via the internal branch of its superior laryngeal branch innervates the epiglottis, aryepiglottic folds, and esophagus.[6]

CENTRAL TASTE PATHWAY

Taste fibers (Figure 3) travelling from the facial, glossopharyngeal, and vagus nerves terminate in the NST (nucleus of the solitary tract). Second-order taste neurons in the NST project to the parabrachial nuclei (PBN) of the pons and send their axons to terminate in the parvicellular division of the ventral posteromedial nucleus of the thalamus by way of the tegmental tract. From the thalamus, fibers project to the insular cortex and frontal operculum. A second projection from the PBN connects areas of the ventral forebrain, including the lateral hypothalamus, amygdala, and nucleus of the stria terminalis, involved in central autonomic regulation and in control of feeding. In contrast to other sensory pathways, the gustatory pathway is entirely ipsilateral.[7]

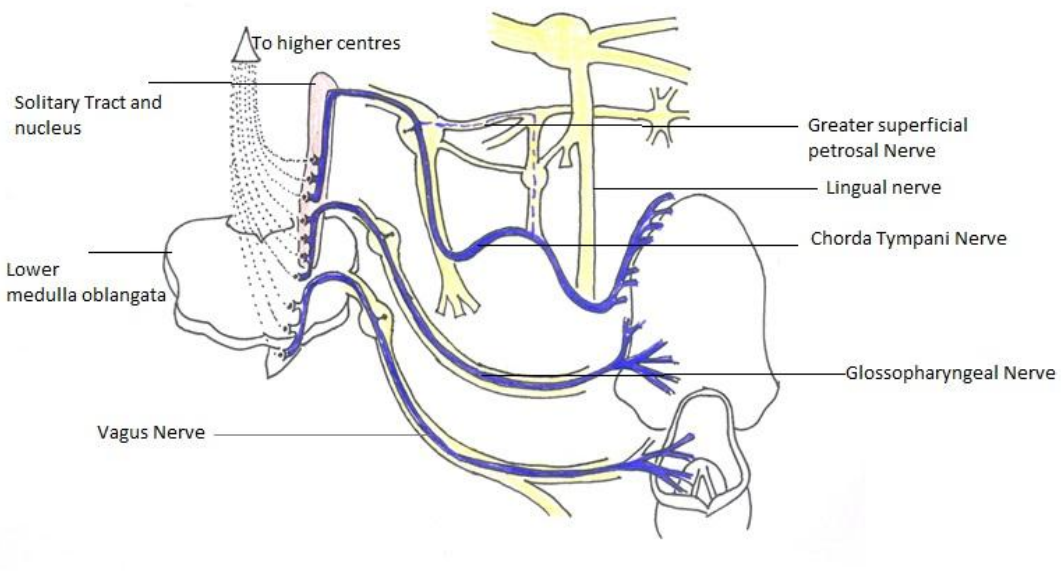


Figure 3: Central taste pathway

ANATOMY OF THE FACIAL NERVE

The facial nerve is the nerve of the second branchial arch. It contains both motor as well as somatosensory components. The somatosensory component of the facial nerve is carried by the nervus intermedius, pars intermedia of Wrisberg. The facial nerve contains approximately 10,000 neurons:

- 7,000 myelinated neurons: to form the motor part of the facial nerve which innervates the muscles of facial expression and the Stapedial muscle.
- 3,000 neurons: to form the nervus intermedius which carries secretory and somatosensory components. They include:

1. The afferent taste fibers from the chorda tympani nerve which carry impulses from the anterior two-thirds of the tongue

2. The afferent taste fibers from the soft palate by the palatine and greater petrosal nerves

3. The parasympathetic secretory innervations to the salivary and lacrimal glands.

4. The cutaneous sensory component from afferent fibers originating from the skin of the auricle and post auricular area.[8]

The facial nerve exits the brainstem at the Ponto medullary junction. It travels through the cerebellopontine angle (CPA) and enters the internal auditory canal (IAC). Then it travels in the temporal bone in a bony canal called the `Fallopian canal´, until it reaches the stylomastoid foramen through which it exits the temporal bone and enters the parotid gland

The Cerebellopontine Angle (CPA) Segment

At the pontomedullary junction, the facial nerve (CN VII) leaves the brainstem almost 1.5 mm anterior to the vestibulocochlear nerve (VIII) .The facial nerve then courses through the cerebellopontine cistern for 15–17 mm and then enters the porus of the IAC in the temporal bone.

The Internal Auditory Canal Segment (IAC)

This segment occupies the anterosuperior quadrant of the IAC and measures 8–10 mm, it passes above the crista falciformis. The nervus intermedius passes between the motor root and the cochlear nerve. The "Bill's bar" is a crest of bone which hangs in the Vertical plane of the IAC separating the superior vestibular and the facial nerve, the latter being anterior to the vestibular nerve. At the fundus, the facial nerve enters the Fallopian canal.

The Fallopian canal (aqueduct)

The facial nerve enters the bony Fallopian canal. It is 25–30 mm in length. The Fallopian canal can be divided into three distinct segments separated by two genus:

The Labyrinthine Segment (First Segment)

The labyrinthine segment of the facial nerve has a length of 3-5mm, this is the shortest and the narrowest segment of the Fallopian canal. It lies beneath the middle cranial fossa and extends between the meatal foramen and the geniculate ganglion. The nerve just lateral and superior to the cochlea angulates sharply forward, nearly perpendicular to the long axis of the petrous bone, to reach the geniculate ganglion. Facial nerve and the nervus intermedius meet just before joining the geniculate ganglion.[9]

Geniculate Ganglion

It is situated at the lateral end of the labyrinthine segment. The auricular branch of facial nerve and the taste fibers of the chorda tympani synapse with the second sensory neuron at this level. The facial nerve turns posteriorly at the level of the geniculate ganglion, forming an acute angle ranging from 48–86° forming the "first genu" which lies between the first and the second segment of the facial nerve.

The Greater Superficial Petrosal Nerve (GSPN)

This is a secretomotor branch of the facial nerve. It emerges from the upper portion of the ganglion and carries secretory fibers to the lacrimal glands. The greater superficial petrosal canal also houses the superficial petrosal artery which supplies the geniculate ganglion region

The Tympanic Segment (Second Segment)

This segment extends from the geniculate ganglion to the second genu of the facial nerve. The tympanic segment turns inferiorly and posteriorly and then descends obliquely along the medial wall of the middle ear, above the cochleariform process and the oval window, below the dome of the lateral semicircular canal. The second genu is situated posterior to the oval window. The length this segment of the facial nerve is between 9 and 12 mm.[10]

Second Genu

The second genu is the junction between the tympanic and mastoid segments of the facial nerve. Lateral and posterior to the pyramidal eminence, the facial nerve changes its direction and turns inferiorly about 2–3 mm to form an angulation of about 90–125° called the second genu.[8]

The Mastoid Segment (Third Segment)

This segment is vertical and length is about 15 mm. The mastoid segment travels downwards in the posterior wall of the tympanic cavity from the second genu to the stylomastoid foramen. As the nerve descends inferiorly its position becomes more lateral. This segment lies in the posterior wall of the middle ear in a position lateral to the pyramidal process, stapedial muscle, and the sinus tympani. The facial nerve leaves the Fallopian canal via the stylomastoid foramen. When the nerve exits the stylomastoid foramen it gives three branches (the posterior auricular nerve, muscular branches to stylohyoid and posterior belly of digastric) and it travels between the bellies of digastric and stylohyoid and pierces the parotid gland. Below the stylomastoid foramen, a sensory branch is given from the facial nerve which innervates the posterior wall of the external auditory canal and partly the tympanic membrane.

The landmarks for the mastoid segment of the facial nerve superiorly are the lateral semicircular canal, to which the facial nerve runs anteroinferiorly, the posterior semicircular canal, to which the nerve lies 2.5 mm anteriorly. The digastric ridge forms the inferior landmark for the mastoid segment of the facial nerve. [10]

The Nerve of Stapedius Muscle

The nerve of the stapedius muscle is a small branch given from the facial nerve as it descends in the posterior wall of the tympanic cavity behind the pyramidal eminence.[8]

THE CHORDA TYMPANI NERVE (CTN)

Chorda tympani which is the largest intrapetrous branch of the Facial nerve arises anterolaterally below the nerve of stapedius. It passes in the posterior canaliculus anterosuperiorly where it is accompanied by the posterior tympanic artery (stylomastoid artery). In the middle ear the posterior canaliculus opens via an aperture which is situated at an angle between the posterior and lateral walls of the tympanic cavity, medial to the annulus of the tympanic membrane. This opening is at level with the upper end of the handle of malleus and the round window. The diameter of the posterior canaliculus is approximately 0.3-0.5 mm and at an angle of 22^0 from the facial canal (Plester's chorda facial angle).[11]

After branching off the facial nerve, the CTN accompanies it for a variable distance before it enters the posterior canaliculus, which joins the facial canal on average at about 4-5 mm proximal to the stylomastoid foramen, close to the lower margin of bony annulus. Facial recess is bounded medially by the vertical segment of facial nerve laterally by the tympani annulus or CTN and superiorly by the incudal buttress. This area between the facial nerve and the CTN can be used to approach the middle ear, this is called as facial recess approach also known as posterior tympanotomy. Sinus tympani lies medial to the facial recess and is one of the most inaccessible areas of the middle ear.[12]

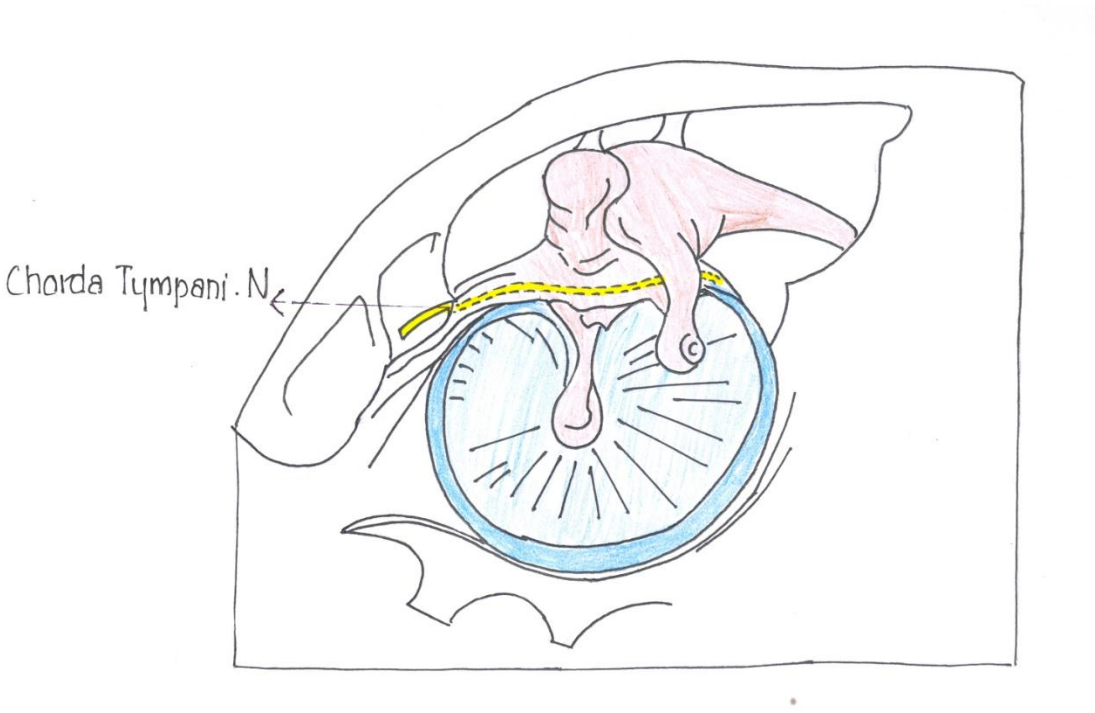


Figure 4: CTN viewed laterally.

The CTN travels upwards to cross the pars flaccida, it passes medial to the upper part of the handle/ neck of Malleus and above the insertion of tensor tympani. It lies medial to the mucosal layer of the tympanic membrane.

Tympanic segment of CTN on Electron microscopy shows to consist of about 5000 nerve fibers, two-thirds of which are myelinated.[13]

The CTN exits the middle ear by a separate bony canal, i.e. the anterior canaliculus (Canal of Hugier), which runs in the slit like petrotympanic fissure in its medial part. The entrance to this canal is through a foramen immediately above the petrotympanic fissure.[14]

In the petrotympanic fissure the CTN is accompanied by the anterior tympanic branch of the maxillary artery, lymphatics and two wedge shaped ligaments, the anterior mallear ligament and the discomallear ligament.[15] The anterior canaliculus runs parallel and anterior to the Eustachian tube. It crosses the temporo-sphenoidal suture and exits the skull behind the base of the sphenoid via a minute foramen. It is closely related to the medial surface of the temporomandibular joint. As it exits the sphenoid bone, it generally gives off a branch to the cartilaginous part of the Eustachian tube.[16]

Medial to the spine of sphenoid the CTN descends and angulates forward to join the lingual nerve approximately 1-2 cm below the skull base, just above the lower border of the lateral pterygoid muscle.[17]

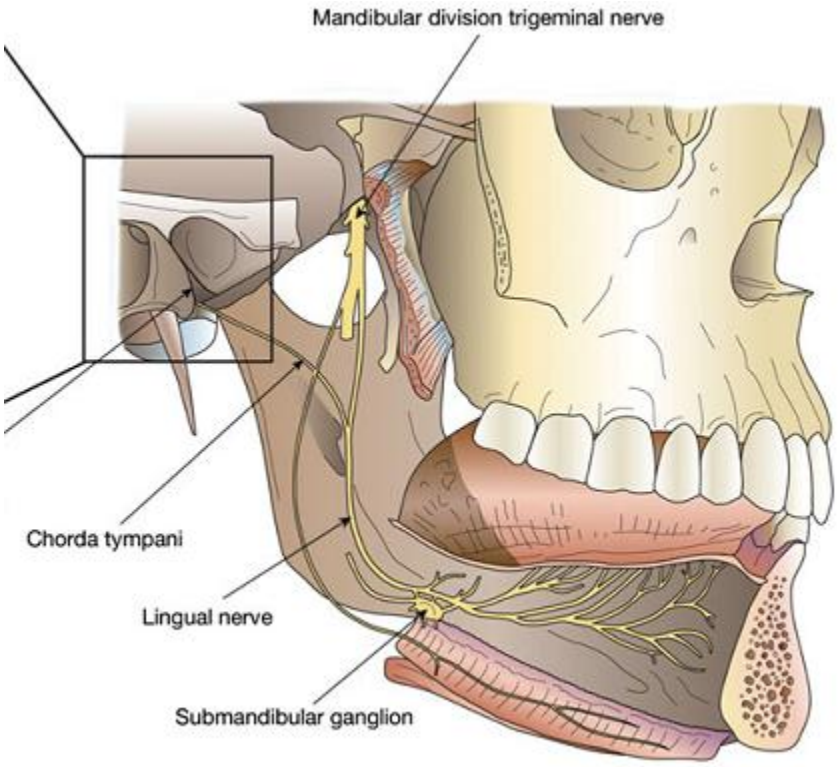


Figure 5: CTN and its relation to lingual nerve.

The lingual nerve travels down anteriorly (Figure 5) between the lateral surface of the medial pterygoid muscle and the mandible, causing a groove on the medial surface of the mandible. The lingual nerve then continues forward medial to the posterior root of the mandibular third molar tooth. After crossing the superior aspect of the deep part of the submandibular gland, it loops under the submandibular duct in the floor of the mouth, from lateral to medial, to enter the tongue.[18] The submandibular ganglion lies on the surface of the hyoglossus muscle, above the deep part of the gland, suspended from the lingual nerve by several filamentous branches. Preganglionic parasympathetic nerves from the CTN synapse in the ganglion, and postsynaptic fibres either pass directly to the submandibular gland and its duct or rejoin the lingual nerve to innervate the sublingual salivary gland. [19]

The CTN has two components:

• Sensory afferent taste fibers: these fibers of the CTN have their cell bodies in the geniculate ganglion and carries taste sensation from the anterior two-thirds of the tongue.

• Preganglionic efferent secretory fibers: their cell bodies are in the superior salivary nucleus, they synapse in the submaxillary ganglion, and then it provides secretory motor impulses to the submaxillary and sublingual glands.[8]

Blood supply of the facial nerve

The segments of the facial nerve receive their arterial supply from branches of the vertebrobasilar artery and the external carotid artery systems. Within the pons, the facial nucleus receives its blood supply primarily from the anterior inferior cerebellar artery (AICA). The labyrinthine artery, a branch of the AICA, enters the IAC and provides blood supply to the meatal portion of the facial nerve.

The external carotid system supplies the tympanomastoid segments of the facial nerve two branches: the superficial petrosal artery and the stylomastoid artery.[20]

SURGICAL ANATOMY

EXTERNAL EAR:

It is involved primarily with transmission of sound from external source to middle ear. It consists of the pinna or auricle and the external acoustic meatus.

AURICLE:

The shape of the auricle is formed by the thin, convoluted, continuous sheet of yellow elastic cartilage that curves forward to enclose the floor and anterior wall of the external cartilaginous meatus but not the roof. Superiorly the cartilage of the meatus is defecient, leaving a deep cleft, the incisura terminalis, utilized by the surgeon in making the extra cartilaginous endaural incision for surgical exposure of the temporal bone.[21]

EXTERNAL AUDITORY CANAL

It is a communicating passage between the concha and tympanic membrane. In the adult the average length is 24 mm. It is composed of two portions, an outer cartilaginous portion which is around 8 mm in length and an inner bony portion which is around 16 mm long and it is constricted slightly in the middle by an isthmus. There are two constrictions in the canal one at the junction of cartilaginous and bony part and other in the osseous part 5 mm from the tympanic membrane where a prominence of the anterior canal wall reduces the diameter.[22]

TYMPANIC MEMBRANE

It is an elliptical disc stretched obliquely across the medial end of external auditory canal. It is broader above than below forming an angle of 55° with the floor of the external auditory canal. It forms the lateral wall of the mesotympanum and small part of the epitympanum, separates the tympanic cavity from the external auditory canal. It is convex towards the tympanic cavity. The diameter from posterosuperior to anteroinferior is 9-10 mm, perpendicular to this is 8-9 mm. The circumference is thickened to form a fibro cartilaginous ring, the tympanic annulus which sits in a groove in the temporal bone, the tympanic sulcus. This sulcus does not extend to the roof of the canal, which is formed by squamous portion of the temporal bone. Form the superior limits the annulus becomes fibrous bands which run centrally as anterior and posterior mallear folds to the lateral process of malleus. The mallear folds divide the tympanic membrane into pars flaccida and pars tensa. Pars flaccida is a triangular region of tympanic membrane above the mallear folds, while pars tensa forms rest of tympanic membrane. The handle of malleus lies within the layers of the TM.

TM contains three layers:

(a) Outer epidermal layer

(b) Middle fibrous layer – lamina propria

(c) Inner mucosal layer.[23]

MIDDLE EAR CLEFT

It consists of the eustachian tube, the tympanic cavity, the aditus, and the mastoid air cell system. It is lined by a continuous layer of epithelium of respiratory type. Near the eustachian tube and anteroinferior part of the tympanic cavity it is columnar epithelium. Above and behind this level the epithelium is flattened.[22]

MIDDLE EAR CAVITY

It lies between the external ear and inner ear and measures about 15 mm above downwards and 13 mm from behind forwards. It is very narrow in its transverse diameter measuring 6 mm across in the upper part, 4 mm in its lower part and 2 mm at its centre which is the narrowest part.

It has 6 walls, floor, roof, medial, lateral, anterior and posterior walls. It is divided into 3 compartments.

The epitympanum or attic lies above the level of the anterior and posterior mallear folds.

Mesotympanum lies medial to the TM.

Hypotympanum, lies below the level of the inferior part of the tympanic sulcus medially.

ROOF:

It is formed by Tegmen tympani which is formed partly by petrous part of the temporal bone and partly by the squamous portion of the temporal bone. This wall separates the middle ear cavity, mastoid antrum and canal of tensor tympani from middle cranial cavity. Incomplete ossification of the petrosquamous suture may allow passage of infection from the middle ear cavity or mastoid antrum to the middle cranial fossa. Similarly venous channels passing through this fissure may allow infection to reach the superior petrosal sinus.[24]

FLOOR

It is formed by a thin plate of bone which separates it from the dome of jugular bulb. This floor may be deficient and thus jugular bulb may project into the tympanic cavity.[17] Anteromedial to the vein, the tympanic branch of the glossopharyngeal nerve pierces the floor on its way to arborize over the promontory in the formation of the tympanic plexus.[25]

ANTERIOR WALL

The anterior wall (Figure 6) which is vertical is angulated acutely with the floor, and forms a hypotympanic recess where inflammatory secretions accumulate. The portion of the recess is indicated by the ‘cone of light’ on the membrane, whose base points towards it.

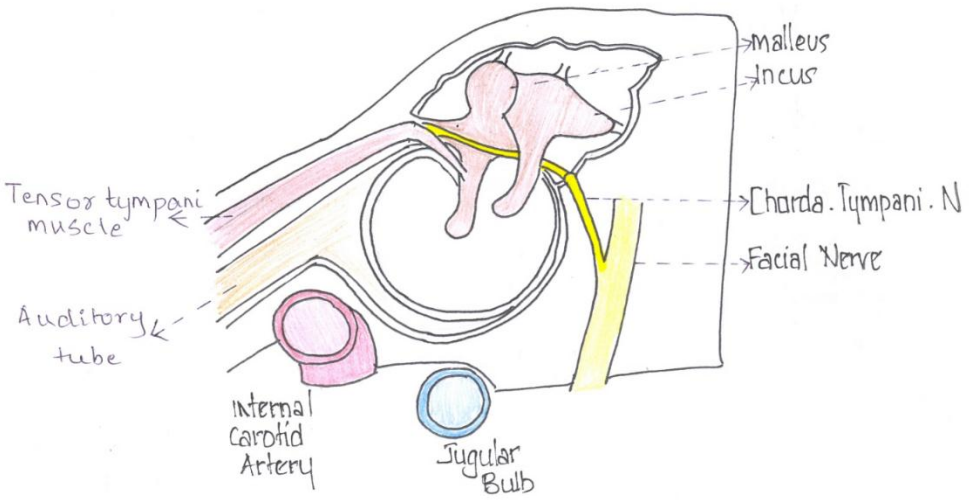


Figure 6: Anterior wall of tympanum

This wall has '4' openings. The eustachian tube opening is seen in the lower part of the anterior wall. A thin plate of bone separates the eustachian tube and the middle ear from the internal carotid artery, which is perforated by caroticotympanic nerves derived from the sympathetic plexus on the internal carotid artery sheath. The canal for tensor tympani muscle is above the opening for eustachian tube. Canal of Huguier is a small opening in upper part which transmits the CTN. Glasserian fissure is the 4th opening, which transmits tympanic artery and anterior ligament of malleus.[23]

POSTERIOR WALL

The posterior wall is the highest wall of the middle ear and measures about 14 mm. It separates the middle ear from the mastoid air cells, except at the area of the aditus ad antrum,

where it is deficient and permits communication between the attic and the mastoid antrum. The posterior wall can be divided into two distinct parts: the upper third which corresponds to the aditus ad antrum and represents the posterior limit of the epitympanum, and the lower two thirds which correspond to the posterior wall of the retrotympanum. The two parts are separated by the incudal buttress which is a compact bone that runs from the tympanic ring laterally to the lateral semicircular canal medially. It houses the incudal fossa in its superior surface which lodges the short process of the incus

The Aditus Ad Antrum**:** connects the epitympanum of the middle ear to the mastoid antrum posteriorly. Has a triangular shape with dimensions of 4 × 4 × 4 mm height, length, and width.

The Posterior Wall of the Tympanum**:** It is a bony wall and bridges the bony annulus tympanicus to the bony labyrinth. It is the extension of the styloid eminence upward to the pyramidal eminence and to the level of the fossa incudis. It houses the vertical segment of the facial nerve. This wall is wider above than below. The posterior wall presents three bony eminences and ridges. The three eminences together form what is called the styloid complex.

The pyramidal eminence

The pyramidal eminence is situated at the center of the posterior wall immediately behind the oval window; it is about 2 mm height. Its base is fused with the canal of the facial nerve. It lodges the body of the stapedius muscle and its apex gives passage to the stapedial tendon. The pyramidal eminence communicates with the facial bony canal by a minute aperture which transmits the stapedial branch of the facial nerve

The chordal eminence

The chordal eminence is situated lateral to the pyramidal eminence and 1 mm medial to the TM. The chordal eminence shows a foramen: the iter chordæ posterius through which the CTN gains access to the middle ear cavity

The styloid eminence

The styloid eminence or Politzer eminence is a recognized smoothed elevation at the inferior part of the posterior wall; it represents the base of the styloid process.

The chordal ridge of Proctor

The chordal ridge runs laterally and transversally from the pyramidal eminence to fuse with the chordal eminence.

The pyramidal ridge

The pyramidal ridge is very prominent. It runs inferiorly from the base of the pyramidal eminence to the styloid eminence.

The styloid ridge

The styloid ridge connects the styloid prominence to the chordal eminence.

The ponticulus

The ponticulus is a central structure in the retrotympanum. It is a bony ridge extending from the pyramidal process to the promontory.

The subiculum

The subiculum is a smooth bony projection that is situated posterior to the promontory and extends inferiorly from the posterior lip of the round window niche towards the styloid eminence.[46]

MEDIAL WALL OF TYMPANIC CAVITY

The medial wall separates the tympanic cavity from the inner ear. Its surface possesses several prominent features and two openings. The promontory is a rounded elevation occupying much of central portion of the medial wall, over whose surface is the nerves which form the tympanic plexus. The promontory covers part of the basal coil of cochlea and in front merges with the anterior wall of the tympanic cavity.

Behind and above the promontory is the fenestra vestibuli (oval window), a kidney shaped opening that connects the tympanic cavity with the vestibule, which in life is closed by the foot plate of the stapes and its surrounding annular ligament. The long axis of fenestra vestibuli is horizontal. The size is 3.25 mm long and 1.75 mm wide. Above the fenestra vestibuli is the facial nerve and below is the promontory. The fenestra cochlea (round window) which is closed by the secondary tympanic membrane (round window membrane) lies below and a little behind the fenestra vestibule. The round window niche is triangular in shape, with anterior, posterosuperior and posteroinferior walls. The latter two meet posteriorly and lead to the sinus tympani.

LATERAL WALL

It is mainly composed of the TM. Scutum or (outer) attic wall is a party wall between the epitympanic recess and the roof of the EAC. The fibro cartilaginous circumference of the pars tensa of the TM is fixed into the tympanic sulcus. The upper limits of the sulcus are marked behind by the posterior canaliculus and in front by the anterior canaliculus of the CTN. The anterior canaliculus is placed at the medial end of petrotympanic fissure, which lodges the anterior ligament of the malleus and admits the anterior tympanic branch of the maxillary artery.

The contents of middle ear cavity are: auditory ossicles, muscles, and the facial nerve.[23]

OSSICLES (Figure 8)

1. Malleus

It is about 7.5 mm in length has a head, neck, anterior and lateral (short) process and a handle. The head is in the attic or in the epitympanic recess of the middle ear. The handle or manubrium is crescentic, concave laterally. The lower horn of the crescent terminates flatly at the umbo. The upper horn projects into the lumen of the external meatus as the lateral process. The neck is set at about 135° to the medial aspect of the handle, where the upper quarter joins the lower three quarter.

The Chorda tympani branch of facial nerve lies on the medial aspect of the neck of malleus between the malleus and incus. (Figure 7)

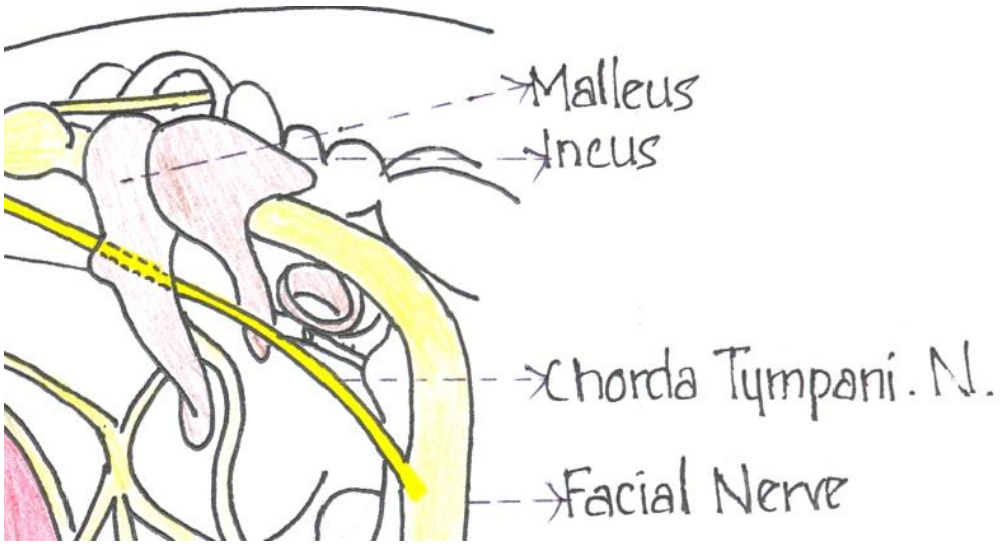


Figure 7: Relation of the malleus with chorda tympani nerve

The anterior surface of the neck is thickened and drawn forwards into a small spicule known as the anterior process, which is connected to the petrotympanic fissure by ligamentous fibres, occasionally augmented by muscle fibres (luxator tympani muscle).

2. The incus

It consists of a body and two processes. The processes are set on to the body at right angles to each other. The long process is slender, and descends posteromedially and parallel to the slightly longer handle of malleus. The lower end of the long process is bent inwards and surmounted by a small tubercle covered with cartilage, the lentiform nodule, which articulates with the head of the stapes. The short process is thicker and shorter and passes horizontally backwards to obtain lodgment in and ligamentous attachment to fossa incudis.

A shallow saddle shaped depression in the anterior face of the head of the incus accommodates the convex facet on the posterior aspect of the head of the malleus. This joint allows a rotatory gliding movement. The excessive motion of the malleus on its outward swing is countered by the disengagement mechanism, while excessive inward swing is believed to be opposed by the mutual action of tensor tympani and stapedius muscle.

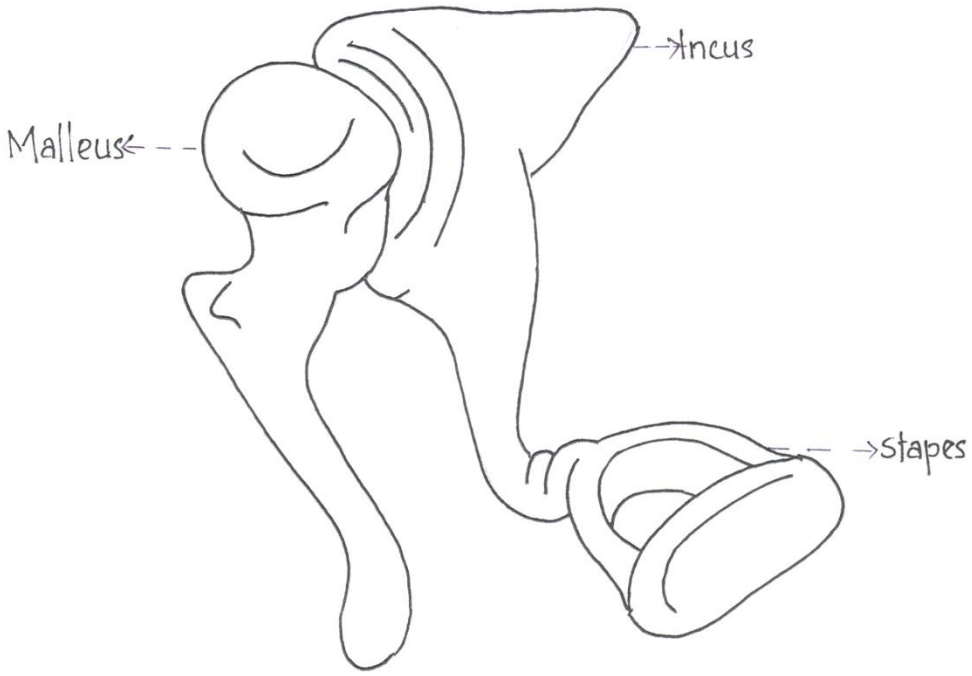


Figure 8: Ossicular chain

3. The stapes

The stapes consists of the head (Capitulum), neck, two crura (limbs) and a footplate. The footplate of the stapes is around 3mm x 1.4mm wide and covers the fenestra vestibule where it attaches to the bony labyrinth by an annular ligament. To the footplate is attached the two crura. The head of the stapes articulates with the lenticular process of the incus. The stapedius muscle is inserted into the posterior part of the neck and the upper portion of the posterior crura. [22]

Auditory muscles

The two auditory muscles tensor tympani and stapedius muscle exert a dampening effect on the amplitude of the vibratory waves, thus protecting the cochlea from excessive stimulation by loud noise.[23]

PHYSIOLOGY OF TASTE

Taste is perceived when a molecule binds to a receptor on the surface of the apical microvilli of the receptor cells. This can cause depolarization or hyperpolarization of the receptor cell. On depolarization the levels of intracellular Ca^{2+} rises and causes a release of neurotransmitters at the afferent synapse. The exact neurotransmitter involved is not known.

Different types of transduction mechanisms are in place for taste. For salty and sour taste, transduction of stimuli maybe the result of direct interaction between the taste molecules and specific ion channels. Where ions are involved in the stimuli, they either permeate or block ion channels by themselves within the cell membrane.

Studies in mammals have shown transduction of Nacl involves movement into the receptor cell via amiloride sensitive cation channels which are located along the apical membrane of the receptor cells, it is also known to occur by a paracellular pathway through amiloride- insensitive Na^{+} channels located along the basolateral region of the taste receptors.

Transduction of acids can involve multiple pathways. In mammals it appears to involve a paracellular pathway through basolateral channels.

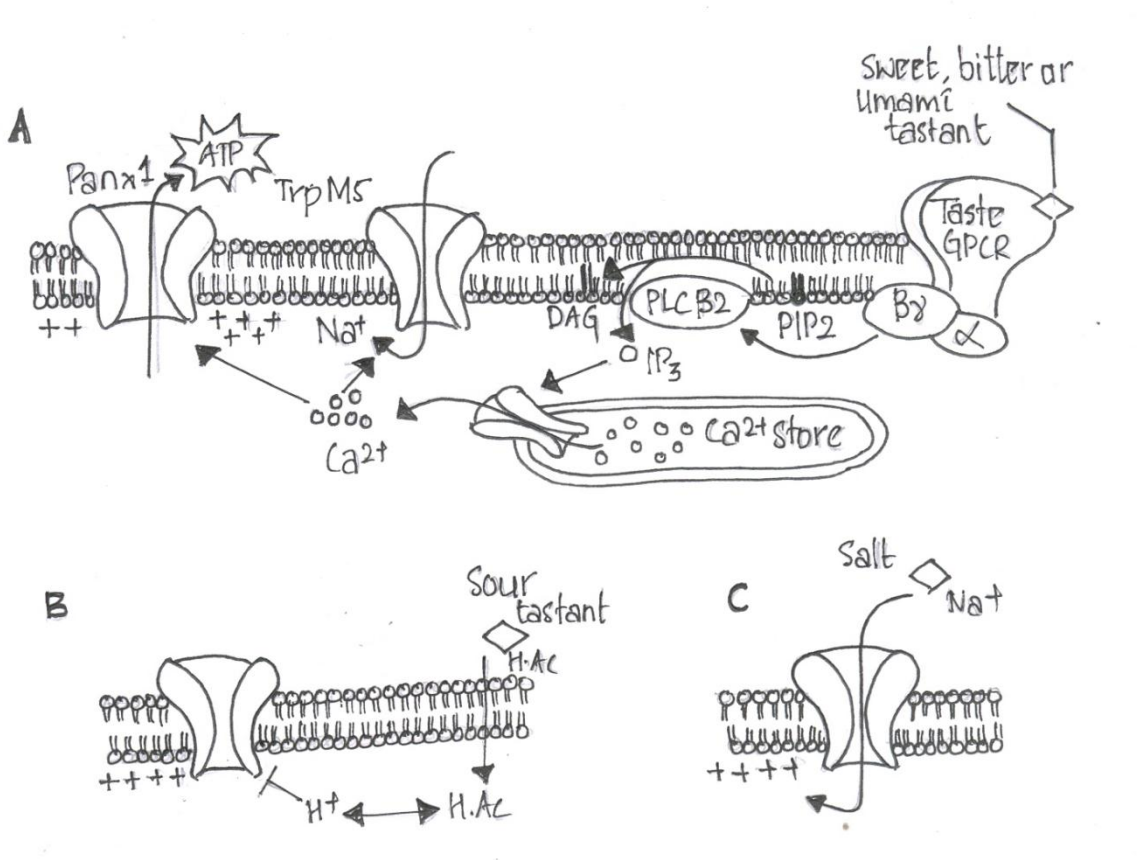


Figure 9: Physiology of taste

Transduction of sweet, bitter and umami is by specific membrane receptors (Figure 9) which activate a G-protein second messenger system. These mechanisms cause depolarization of the cell membrane and an inflow of Ca^{2+} via voltage dependent Ca^{2+} channels.

Processing of taste information allows different classes of taste to be recognized separately and simultaneously. Processing also appears inhibitory, where one region of the tongue inhibits adjacent regions. Similar to other senses, taste also exhibits adaptation to continued stimuli on the tongue. This adaptation is specific to class, i.e., for example, prolonged placement of sweet stimuli on the tongue decreases stimulation with other sweet substances.[4]

TASTE TESTING

Isolated taste disturbances are very uncommon. In majority of the cases patients suffering from olfactory dysfunction complain of alteration in taste. This is revealed by normal findings on gustatory testing. This is termed 'flavour disturbance'. Retro nasal olfaction has a strong influence on flavor perception hence the need for standardized taste and smell tests rather than relying on patient's symptomatology.

Taste disorders can be quantitative or qualitative

Quantitative taste disorders can be described as

- Total – all the taste classes are involved
- Partial – affecting several taste classes
- Specific - affecting one taste class. [26]

Qualitative taste disorders or dysguesia is the impaired ability to taste. Unpleasant taste sensation is termed parageusia .A permanent taste in the mouth for which no external stimulus can be found is called Phantogeusia.

The different methods of taste testing are described below:

QUESTIONNAIRE

The reliability of self-reporting in diagnosing taste disorders have been found poor.[27]

PSYCHOPHYSICAL TASTE TESTING

These tests are designed to assess peripheral taste sensitivity. They are of two types

1) Using natural stimuli to measure the ability to taste
2) Tests taste by applying electric currents to the tongue surface to elicit taste perception. It is called Electrogustometry(EGM).

Some of the widely accepted taste tests are described below

1) Three drop method

In this method using a micropipette 3 drops of a liquid solution is placed on the patients tongue. The subject is asked to identify its taste quality. Four verbal gustatory descriptors i.e., sweet, sour, salty and bitter are presented. Multiple forced choice procedure is used. Triplets are presented to the patient in ascending order of concentration. Patient is asked to rinse the mouth with water in between each triplet presentation. This is done until the patient recognizes the taste class correctly. Scores are assigned to each taste class, a total score is obtained by adding the score of all taste classes.[28]

2) Taste tablets and wafers

These can be used an alternative to liquid solutions. The procedure of testing is comparable to that of taste solutions.

3) Taste strips

This is a well-established method where taste is tested using impregnated taste strips. Filter paper strips with different concentrations of the four tastants are used. The strips are placed

on either side of the anterior two-thirds of the tongue. Similar to the above methods, in between each tastant mouth is rinsed with water.[29]

4) Filter paper disc (FDP) method

In this method a round filter paper disc of 5mm diameter is used. This FDP is impregnated with a drop of tastant solution. The FDPs are placed on the tongue and the rest of the procedure remains similar to the above methods.[29]

ELECTROGUSTOMETRY

Electrogustometer is commonly used in the quantitative assessment of lateralized gustatory function. It has been used for multiple purposes like,

- In patients with facial palsy to evaluate function of peripheral nerves
- To evaluate damage to peripheral nerves in diabetes mellitus
- After middle ear surgery to evaluate function of Chorda tympani

The apparatus consists of an anode, a cathode and a switch which initiates the stimulation. A neutral electrode is placed on the neck to prevent the electric current from passing through the heart. Ideally patients using a pace maker for the heart, cochlear implants etc. should not be examined by this method.

Photo 1: Electrogustometer

When a stimulus produced from a direct-current stainless steel node is applied to the tongue, a metallic taste is perceived. Taste is measured by this apparatus by measuring the magnitude of stimulus required for the taste perception. For evaluation of the chorda tympani nerve, a point at the edge of tongue 2cm away from the center of the tongue tip is measured. For testing the glossopharyngeal nerve, stimuli are presented on the circumvallate papillae. For the area innervated by the greater petrosal nerve a point 1 cm above the arch of the palate and 1 cm lateral to the center is tested. The magnitude of electrical stimulation can be varied. The lowest current level is 4µA and highest is 400µA. The stimulus is applied to regions innervated by the three gustatory nerves using 5mm diameter stainless steel electrodes.[30, 31, 32]

Somatosensory test

An established test to evaluate the somatosensory perception in man is the 'capsaicin threshold test'. In this filter paper strips impregnated with different concentrations of capsaicin are used. These strips are placed on the tongue in the midline for whole mouth testing or on the tongue edge for lateralized testing. Thresholds are measured in relation to sensory perception and intensity. This test is used in basic research, so far no clinical application has been noted. [33]

OBJECTIVE MEASUREMENTS

Gustatory Event related potentials

Gustatory event related potential is elicited by gaseous stimuli. A continuous flow of water is present to avoid thermal or mechanical stimulation.[34]

Magnetic Resonance Imaging

The neural processes involved in taste perception and intensity can be visualized using functional magnetic resonance imaging (fMRI). So far fMRI has been used for research purposes, in future fMRI shows promise as a tool for objective testing of taste in clinical practice. [35, 36]

In Vivo Imaging of taste buds.

Attempts to visualize the taste buds in vivo have been made using confocal laser scanning microscope. Using this single taste bud can be identified and volume of taste buds over time assessed. Studies have shown differences in taste bud volume over time in healthy persons.

Further research is needed to look into this novel in vivo method for diagnosing taste disturbances. [37]

Chronic otitis media (COM)

Chronic otitis media (COM) is defined as a chronic inflammation of the middle ear cleft causing permanent abnormality in the tympanic membrane.[38]

COM is a major global cause of hearing impairment and this may have serious long term effects on language, auditory, cognitive development and educational progress.

As per WHO, despite the shortage of accurate, standardized data, the prevalence of COM in Indian population is approximately 2% which is comparatively higher than that found in developed countries like that of USA and UK where the prevalence is <1%.[39]

Clinical Classification of COM

COM Classification	Otoscopic findings
Healed COM	Thinning and/or localized or generalized opacification of the pars tensa without perforation or retraction
Chronic Inactive mucosal	Permanent perforation of the pars tensa but the middle ear mucosa is not inflamed
Chronic inactive squamous	Retraction of pars flaccid or tensa which has the potential to become active with retained debris
Chronic active mucosal	Permanent defect of the pars tensa with an inflamed middle ear mucosa which produces mucopus that may discharge
Chronic active squamous	Retraction of the pars flaccid or tensa that has retained squamous epithelial debris and is associated with inflammation and production of pus from the adjacent mucosa

Table -1: Classification of Chronic Otitis Media [41]

ETIOPATHOGENESIS:

A variety of underlying pathologies can cause COM including:

1. An episode of acute otitis media can result in a perforation of the ear drum and does not settle within two weeks;
2. Recurrent episodes of acute otitis media in an ear with a perforation from a previous episode of acute otitis media; or
3. An ear with a persistent perforation with active chronic otitis media with metaplastic changes to the mucosa of the middle ear and mastoid air cell system.[40]

Chronic otitis media gives rise to symptoms such as otorrhea and hearing loss. One if the cardinal symptoms of COM is otorrhea, which can be distressing to the patient and limit his daily activities. It imposes certain restrictions on the patient and prevent him from enjoying activities such as swimming, and the patient needs to be very cautious even during routine activities like taking a head bath to prevent entry of water in the ear canal which could trigger an episode of infection. In cases of foul smelling ear discharge it might cause social embarrassment to the patient which could isolate the patient from the society. COM can cause hearing loss which limits the patient's activities in multiple ways. In pediatric cases of COM where there is early onset of hearing loss it can lead to disordered development of speech, language and cognition skills. COM may also give rise to a defect in the taste function due to involvement of Chorda tympani in the middle ear inflammatory process. This impairment in taste would alter a person's dietary preferences and affect his quality of life.

TREATMENT OF CHRONIC OTITIS MEDIA

COM can be managed both medically and surgically. Medical treatment using antibiotics, anti-inflammatory drugs and analgesics helps in the management of acute episodes in terms of controlling the infection, pain and discharge. However repeated episodes of COM cannot be controlled by medical line of management alone. In such cases surgery is the treatment of choice.

Tympanoplasty

It is a procedure to eradicate the disease in the middle ear and reconstruct the hearing mechanism with or without tympanic membrane grafting as given by the American academy of ophthalmology and otolaryngology subcommittee on conservation of hearing in 1965.[42] This procedure can be combined with either an intact canal wall mastoidectomy or canal wall down mastoidectomy to eradicate the disease from the mastoid area.[43]

Principle of tympanoplasty[43, 44]

1. To accomplish the sound protection for the round window by placement of a graft so that sound does not reach the oval window and round window at the same time and a phase difference is provided
2. To improve the sound pressure transformation by providing an increased surface after placement of the graft and reconstructing the hearing mechanism.

Chronic otitis media implies a chronic inflammation of the middle ear cleft. Some of the well-recognized distressing outcomes of COM are otorrhea, hearing impairment, facial nerve palsy and numerous other complications which may arise as the disease process progresses.

One of the relatively unrecognized effect of COM is the involvement of chorda tympani nerve which may lead to taste impairment, thereby hence affecting the person's quality of life.

It has been noticed by various studies that patients seldom complain of taste disturbance when suffering from COM, hence it is rarely picked up by the surgeon.[1,45] This may be due to the patient giving importance to hearing and not taste, thereby creating lacunae of data on the subject. Some of the factors which possibly explain the lack of subjective perception of taste loss are

- Taste is perceived as a whole mouth experience, and localized loss of taste function may not be appreciated by the patient.
- Multiple nerves supply the tongue hence, dysfunction of one maybe compensated by the multiple neuronal network.
- Owing to the chronic nature of the disease patient may not have noticed the gradual evolution of the taste impairment.

Although patients do not complain of taste impairment, testing of gustatory function by quantitative methods have revealed an elevation of taste threshold in patients suffering from middle ear disease. [1, 3]

The mechanism for dysfunction of chorda typmani could be as a result of exposure to toxins by the offending organism, by the inflammatory mediators triggered by the chronic inflammatory process or due the immune response by the host. It is believed that sensitized T-cells attract macrophages to peripheral nerves and activate these macrophages which induce cause nerve damage.[47]

In 1999 a study was conducted in the Suleyman Dermirel University School of Medicine in Turkey where twenty inadverdently cut Chorda Tympani nerves from patients suffering from COM were histopathologically studied. These 20 patients were divided into 2 groups, one with patients suffering from suppurative COM and another with patients having a dry ear. On microscopy the nerves showed thickening of the perineural and epineural connective tissue, vacuolar degeneration of the Schwann cells. Proliferation of connective tissue of endoneurium and disorganization in the axons was also noted on some specimens.[48]

Chorda tympani was sectioned from 10 patients who underwent canal wall down mastoidectomy for COM in Vakif Gureba Training and Research Hospital, Faith, Istanbul. These nerves were examined by electron microscopy. The observations made by this study were that, all the chorda tympani displayed signs of damage of varying severity. The nerves showed a scarcity of unmyelinated nerve fibers, Schwann cell nucleus condensation, scarcity of Schwann cell cytoplasm, adaxonal vacuolation and edema, myelin sheath disintegration, shrunken electron-dense axoplasm, increased collagen fibers, adaxonal circular lamellar complex, interstitial edema, and vacuolation of Schwann cell cytoplasm. These findings suggest that chorda tympani undergoes degenerative changes in COM.[49]

A Swedish study published in 2015 supports the hypothesis that chronic inflammation causes injury to the Chorda tympani nerve. This study examined five chorda tympani nerves from patients suffering from COM, which could not be saved during surgery. They used five healthy chorda tympani sectioned from patients operated from acoustic neuroma as controls. These nerves were examined by light and electron microscopy. They noted that nerves from patients with COM showed a high rate of axon and myelin sheath degeneration as compared to

the controls. An interesting finding in this study was that the Chorda tympani also showed sprouting, which signifies nerve regeneration. Hence the potential for recovery of nerve function after the causative factor is eliminated.[50]

In Fukui, Japan a study comprising of 371 subjects who had undergone middle ear surgery was done. Here the authors examined the patients taste post operatively for subjective and electrogustometric changes in function. The authors concluded that even in the presence of a high incidence of elevated threshold on EGM, incidence of subjective taste disorders were low. Here they noted that the elevation of taste threshold on EGM was in accordance documented nerve injury, but they were disproportional to the occurrence of subjective taste disorder. In the few that did complain of an alteration in taste, there was a recovery in subjective taste function with time, even when the EGM thresholds remained high. [45]

Taste function of 130 patients suffering from COM was evaluated using EGM in 1974 in London. 100 patients without COM were used as controls. Here the author noted that there was an elevation of taste threshold in patients with COM. In this study the results suggested that impairment of taste was influenced by the type of disease i.e., taste impairment was significantly more in patients suffering from squamous type of COM compared to those with mucosal type of COM. The author also found that the association between duration of disease and degree of taste impairment was directly proportional in cases of squamous COM , but no such association was found in mucosal type of COM. Age does not appear to influence the taste function according to this study. [3]

A prospective study designed in Hyogo College of medicine, Japan in 1999 analysed 163 patients undergoing middle ear surgery. The patients underwent tests for taste function by EGM

2 days prior to surgery and post-operatively at 2 weeks and 6 months. The authors noted that pre-operatively there was an elevation in EGM thresholds in patients suffering from COM. At 2 weeks post-operative period there was an elevation in EGM was elevated in majority of the patients. This could be due to the short follow up period. Majority of the patients in whom Chorda tympani nerve was preserved during surgery showed a recovery in taste function at 6 months follow up. It was also noted that younger patients had a much higher recovery rate of taste function when compared to their older counter parts. [51]

In 2005 at Dresden Medical School, Germany, 46 patients suffering from COM were evaluated for their taste function. The taste function in these patients were tested prior to surgery using filter paper strips impregnated with taste solutions of different concentration. The authors of this study came to the conclusion that taste function in these patients were affected on the side of the disease, the degree of taste impairment was proportional to the severity of inflammation of the middle ear and more pronounced in patients with cholesteatoma. Although alterations in taste were noted on quantitative testing, the incidence of subjective taste disorder was low. The authors attribute this loss on concordance between subjective taste disorder and quantitative testing to the "whole mouth" taste perception. The authors suggest that even in the absence of subjective taste disorder, routine pre-operative taste testing is beneficial as post-operatively taste disorder can be wrongfully attributed to the surgery. Pre-operative documentation of taste disturbance would prevent such occurances.[1]

Forty five patients were investigated in the Federal University of Rio de Janerio, Brazil in 1999 to identify the gustatory alterations in COM. These patients were evaluated pre-operatively using taste strips with different concentrations of tastants. Only patients with unilateral ear

disease were included and the healthy side was used a control. The authors noted that there was a deterioration in taste function on the affected side. The authors also studied the association of age, duration of disease and presence of co-morbidities like diabetes on taste scores. They found that older age, longer duration of the disease and presence of diabetes had a detrimental effect on the taste outcome. [52]

A study by done in Taiwan, by the China Medical University attempted to evaluate the gustatory function in patients suffering from COM before and after surgery. In this study taste was tested using taste solutions of various concentrations. The patient's gustatory function was tested pre and post operatively. The results of this study suggested that an alteration in taste function on the diseased side is present pre-operatively. Majority of the cases show a complete recovery of taste function post-operatively, provided the Chorda tympani remains undamaged during surgery. In cases where the chorda sustained severe damage during surgery, it was noticed that the taste function deteriorates. [53]

These studies suggest that chronic inflammation of the middle ear can lead to a dysfunctional chorda tympani nerve which would in turn be detrimental to the taste function. Disease clearance by surgery, improves the taste function, subject to preserving the chorda tympani intraoperatively.

It would be prudent to routinely document the taste function in all cases undergoing middle ear surgery. Even when the patients do not complain of alteration in taste, significant changes may be found on quantitative testing. When in doubt regarding the destructive nature of the disease, aguesia on the diseased side may become an important clue.[3] In cases with unrecordable taste thresholds, valiant efforts to preserve the chorda tympani during surgery can be spared. Pre-operative documentation of taste threshold would prevent unfair attribution of taste impairment to the surgery.[1] Patients can be made aware of the possible effects of the disease process and an informed consent can be taken.

Part-II

Materials & Methods

MATERIALS AND METHODS

Source of data

All patients who were diagnosed to have mucosal COM and undergoing Tympanoplasty in the department of Otorhinolaryngology and Head and Neck Surgery of R L Jalappa Hospital and Research Centre, Tamaka, Kolar from December 2014 – August 2015 were included in this study.

STUDY DESIGN: This is a prospective observational study.

Inclusion criteria

Patients diagnosed with mucosal type of COM and undergoing Tympanoplasty

Exclusion criteria

1. Patients who had previously history of ear surgery
2. Patients in whom chorda tympani nerve was inadvertently cut during surgery
3. Patients with dysosmia, pregnancy, cognition barrier, history of alteration in taste function.
4. Patients below 16 years of age

METHODS OF DATA COLLECTION

Patients presenting to the department of ENT with a history suggestive of chronic otitis media (mucosal type) were diagnosed by detailed history, clinical examination, otoscopic and otomicroscopic examination. Audiological examination was done and routine hematological and radiological investigations were done. An informed written consent was taken for both Tympanoplasty and to include

the patient into the study. The selected patients were subjected to evaluation of gustatory function using different concentrations of taste solutions one day prior to surgery and the readings were noted down. The patients underwent Tympanoplasty and were instructed to come for follow up visits at 6^{th} week and 3 months post-operatively. The taste scores hence obtained were recorded and analysed. A difference in the taste score of 2 was considered significant.

Gustatory function was analysed using taste solutions of 4 classes i.e., sweet, sour, salty and bitter. In each taste class different concentrations of the solution was used to test the function quantitatively. Sucrose, citric acid, sodium chloride and quinine hydrochloride were used to test sweet, sour, salty and bitter tastes respectively. Five solutions with varying concentrations were prepared for each taste class (Photo 3). The above mentioned solutes were weighed precisely to attain the desired concentration and dissolved in 100ml of distilled water to obtain the solution. These solutions were placed in food grade plastic bottles and stored in the refrigerator. It was ensured that the solutions were at room temperature and only then administered to the patient. Solutions

were freshly prepared and replaced every month. The different concentrations of the solutions used and the score allotted to each is as denoted in the following table

SWEET	SOUR	SALTY	BITTER	SCORE ALLOTED
Sucrose (gm/m)	Citric acid(gm/ml)	Sodium chloride(gm/ml)	Quinine hydrochloride (gm/ml)	
0.4	0.3	0.25	0.006	5
0.2	0.165	0.1	0.0024	4
0.1	0.09	0.04	0.0009	3
0.05	0.05	0.025	0.0004	2
0.01	0.01	0.005	0.0001	1

Table 2: Different concentrations of taste solutions

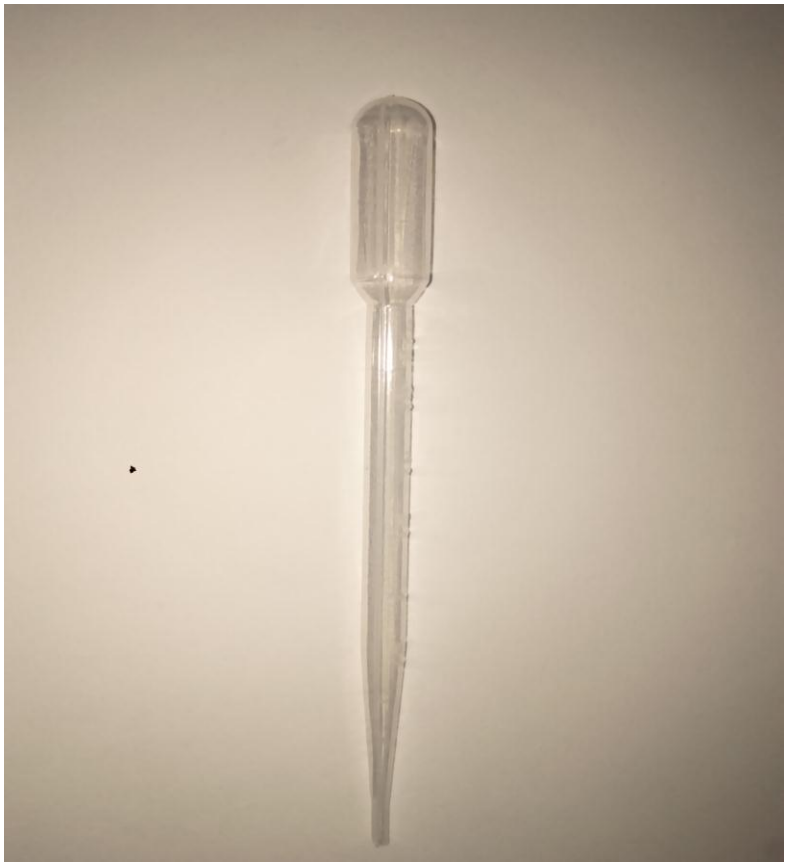


Photo 2: Pipette

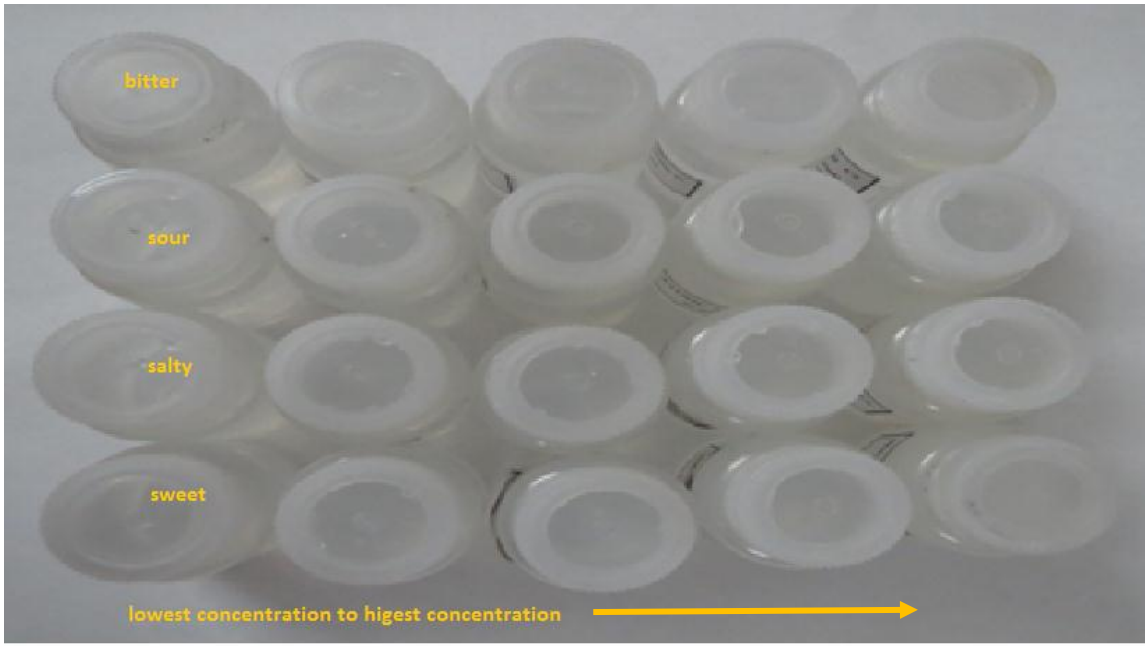


Photo 3 : Taste solutions of various concentrations

Evaluation of gustatory function was done using taste solutions of different concentrations mentioned in the table. The concentration of taste solutions was determined based on previous studies conducted by Mueller C A et al., and Huan C C and colleagues.

The patient was instructed not to consume any food or drink half an hour prior to testing. The patient was asked to open his mouth and partially outstretch his/her tongue.

With the help of a pipette (Photo 2) a series of 3 drops of a taste solution of a particular class and concentration unknown to the patient was placed on the lateral aspect of the diseased side of the anterior 2/3rd of the tongue and the patient was asked to identify the taste class (sweet, salty, sour or bitter). The solutions were presented in increasing order of concentration until the patient was able to recognize the taste. Between each triplet presentation the patient was asked to rinse the mouth with water to wash out any residual taste molecules which may bias the test result. The concentration at which the patient recognized the taste was recorded and a score was allotted for the particular concentration. Scores were allotted for each taste class, the minimum score being 1 and maximum being 5 per taste class. The minimum concentration of the solution was assigned the score of 1 and the maximum assigned as 5, hence the lower the score of the patient corresponds to a better gustatory function. The minimum overall score a patient could get was 4 and 20 the maximum. Different classes of taste were presented in random order except bitter taste which was presented as the last to minimize the unpleasant sensation and hence ensure better cooperation of the patient.

All the patients in the study underwent Tympanoplasty

Patients with mucous COM in inactive phase were included in the study

Preparation of the patient for surgery:

- The patient was kept nil orally for a period of 6 hours prior to the surgery.
- Injection Tetanus toxoid 0.5cc intra muscular was given the previous day.
- Lignocaine sensitivity test was done previous day (0.1ml intra dermal).
- Tablet Diazepam 10 mg oral, previous night and 5 mg early in the morning.
- Part preparation: The hair was shaved, about half an inch above and behind the auricle on the side of surgery for the purpose of good surgical field exposure.

Anaesthesia:

Patients were operated either under local or general anaesthesia.

Pre-medication for local anaesthesia:

- Pethidine: 1.0 – 1.5 mg/kg body weight, intra muscular (analgesic and sedative)
- Promethazine: 25 mg, intra muscular (antiemetic)
- Atropine: 0.6 mg, intra muscular (vagolytic and cardioprotective)

The premedication is given 30 minutes before surgery.

Surgical technique:

Preparation of part:

The patient was made to lie down in supine position with the operating ear facing upwards and towards the operating surgeon. Ear canal was instilled with 4% lignocaine. The ear and adjacent areas were painted with 5% povidone iodine solution. The patient was then draped with sterile surgical towels.

Infiltration:

About 0.5 cc of the prepared lignocaine solution was infiltrated each into the bony cartilaginous junction of the external auditory canal at 2, 4, 8 and 10 O' clock positions, without creating blebs. The branches of the great auricular nerve to the auricle and meatus are blocked by injection of 1 ml of solution at several points behind the auricle over the mastoid process.

SURGICAL TECHNIQUE:

Through the external auditory meatus inferior vertical canal incision 5 mm lateral to the fibrous annulus at 7 o'clock position (5 o'clock position for left ear) is made using canal side knife. The medial ends of the incisions were joined by a horizontal incision using circular angled knife parallel to fibrous annulus. A rectangular posterior meatal skin flap between the above incisions was elevated laterally up to bony cartilaginous junction to develop a laterally based posterior meatal skin flap. Post-auricular William Wilde's incision and temporalis fascia graft was harvested.

Two incisions were made over the subcutaneous tissue along the posterior bony canal wall close to the meatal skin and the horizontal incision just above the spine of Henle along the linea temporalis. The soft tissue with periosteum over the mastoid was elevated posteriorly by Lempert's periosteal elevator. The cartilaginous canal along with posterior meatal skin flap was separated from its attachment at spine of Henle by Lempert's periosteal elevator. The posterior meatal skin flap was separated from the attachments along the tympanomastoid and tympanosquamous sutures by sharp dissection. In indicated cases cortical mastoidectomy was done.

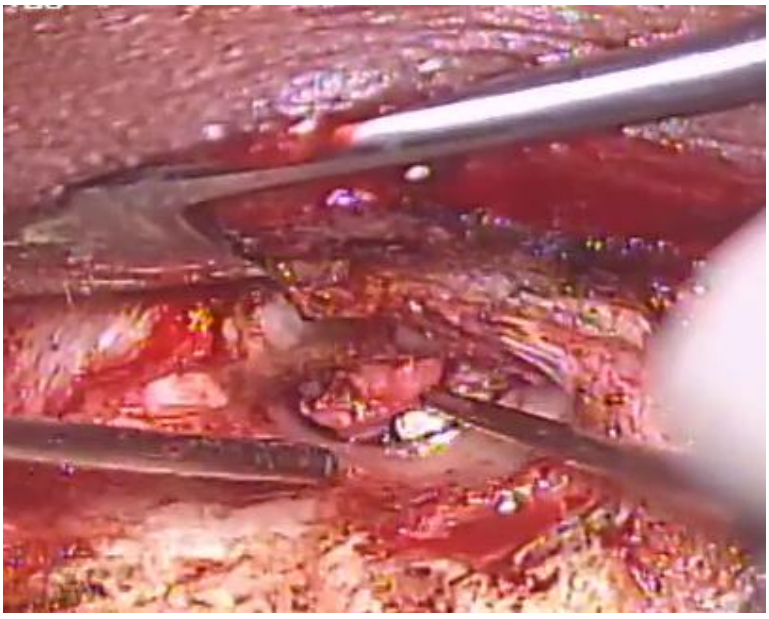
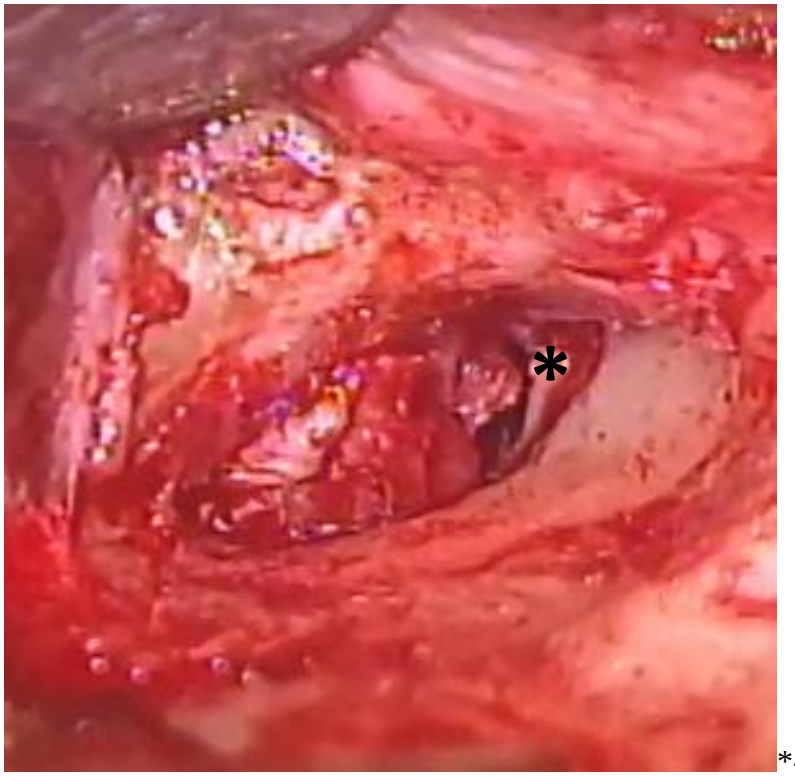
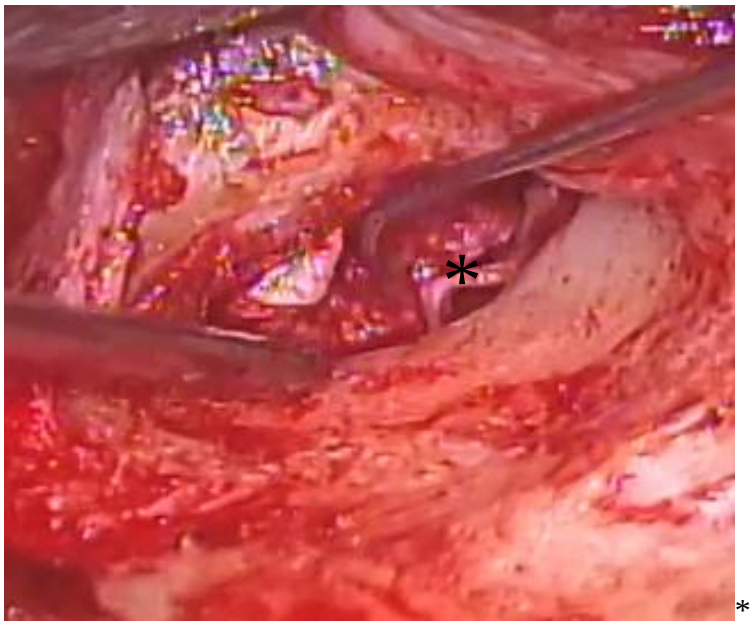


Photo 4 : Elevation of posterior meatal flap



*-malleus

Photo 5: Malleus seen after skeletonization



* - CTN

Photo 6: CTN seen near the annulus

The mucosa in the undersurface of remnant tympanic membrane was scraped through the perforation. The margins were freshened by small sickle knife and micro scissors.

The tympanomeatal incision was extended superiorly and inferiorly based on the size and location of the perforation. The semicircular tympanomeatal flap was now elevated (Photo 4) first from the posterior bony canal wall in a lateral to medial fashion till the fibrous annulus was reached. The middle ear mucosa was entered (Figure 10) below 9 o'clock position (3 o'clock for left ear) by separation of fibrous annulus using a sickle knife, with caution not to injure the underlying CTN(Figure 10). The handle of malleus was then skeletonised using a sickle knife (Photo 5).

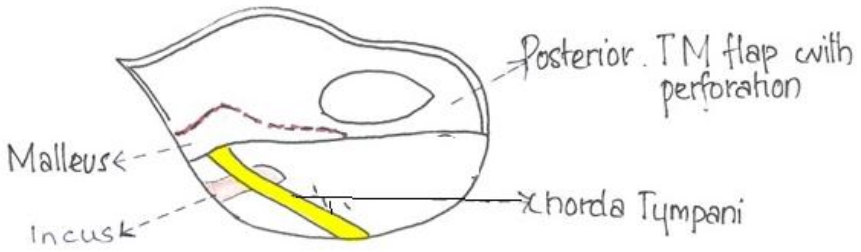


Figure 10: Elevation of posterior TM flap

The status of ossicular chain was evaluated for continuity and mobility by eliciting the round widow reflex. The graft bed was prepared by placing gel foam in the middle ear. The temporalis fascia was placed (Photo 7) by holding it from the anterior end and tucked anteriorly under the remnant of the anterior part of the tympanic membrane. The tympanomeatal flap was then repositioned. Gelfoam was placed in the external auditory canal. The curled up posterior meatal skin was unfolded and repositioned in the external auditory canal. The canal was filled

with gel foam soaked in antibiotic drops and plugged with a cotton ball impregnated with an antibiotic and steroid.

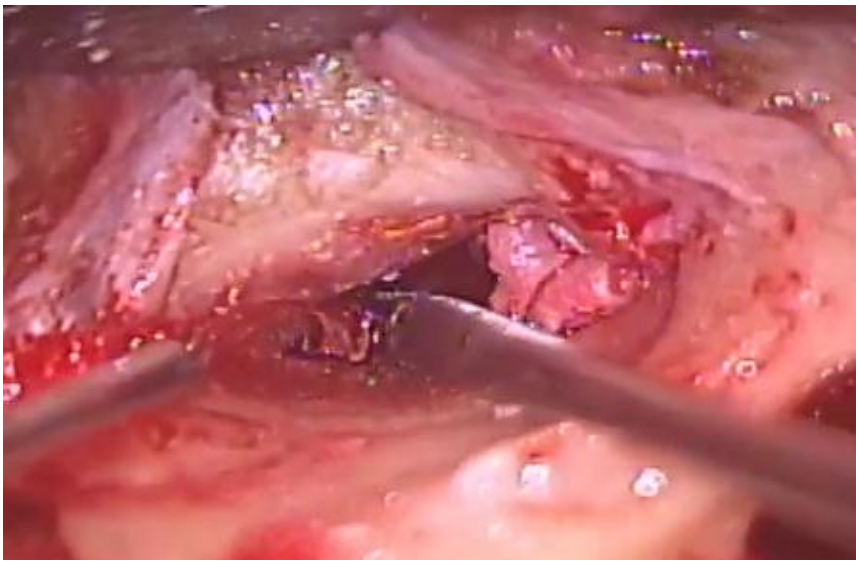


Photo 7: Graft placement

The subcutaneous tissue was closed using vicryl/catgut and skin was closed using ethilon. Mastoid dressing was then applied.

Postoperative care

In the immediate post-operative period patient was checked for any facial nerve palsy, presence of nystagmus, bleeding and treated accordingly. All the patients were treated with a course of antibiotics, analgesics, and antihistaminics for a period of one week. The mastoid dressing was removed after 4days and the suture removal done on the 7^{th} post-operative day. External auditory canal pack was removed after 3 weeks.

Follow up:

All the patients were followed up at the end of 6 weeks and 3 months after surgery. Patients were subjected to test of gustatory function by using taste solutions as mentioned above and taste scores were noted.

Statistical analysis

We used the IBM SPSS software (v.22) to perform the statistical analysis. The collected data was analysed using descriptive statistics like mean, standard deviation and proportions. The significance of difference in the taste scores were done using paired t-test. Comparison of taste scores at 6 weeks and 3 months post-operative period was done by Chi square test. Anova was applied to test for statistical significance. p-value less than or equal to 0.05 was considered significant.

Results

OBSERVATION AND RESULTS

A total of 107 patients were included in the study. Of the 107 patients 59 were male and 48 were female (Table 3). The age of the patients included in the study ranged from 16 years to 76 years. The mean

age of the patients was 33.2 years. In this study 47 patients underwent surgery for right sided COM, and 60 patients for left sided COM .

Gender	Frequency	Percent
Male	59	55.1
Female	48	44.9
Total	107	100.0

TABLE 3 : Sex distribution of patients

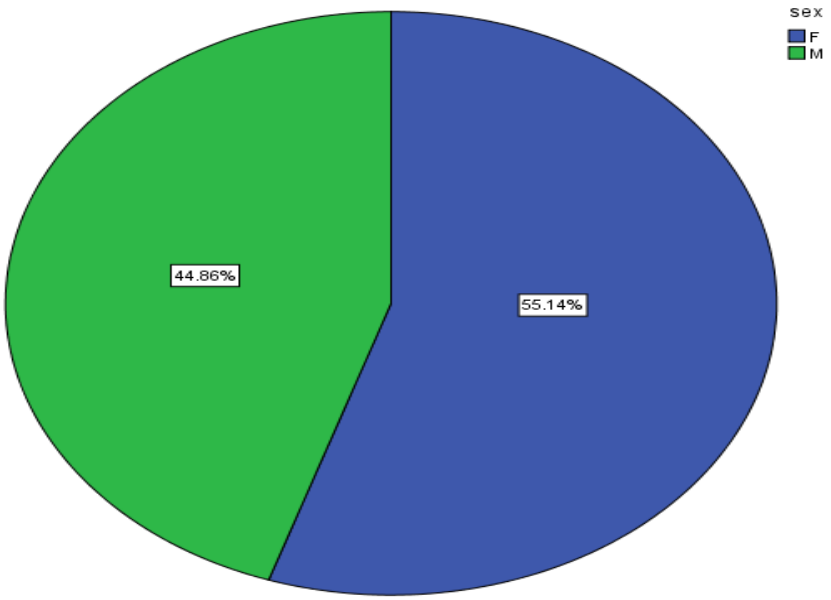


Figure 11 : Sex distribution of patients (n=107)

Age group	Frequency	Percent
15-30	55	51.4
31-45	35	32.7
46-60	13	12.1
61-75	3	2.8
More than 75	1	.9
Total	107	100.0

Table 4: Age distribution of patients

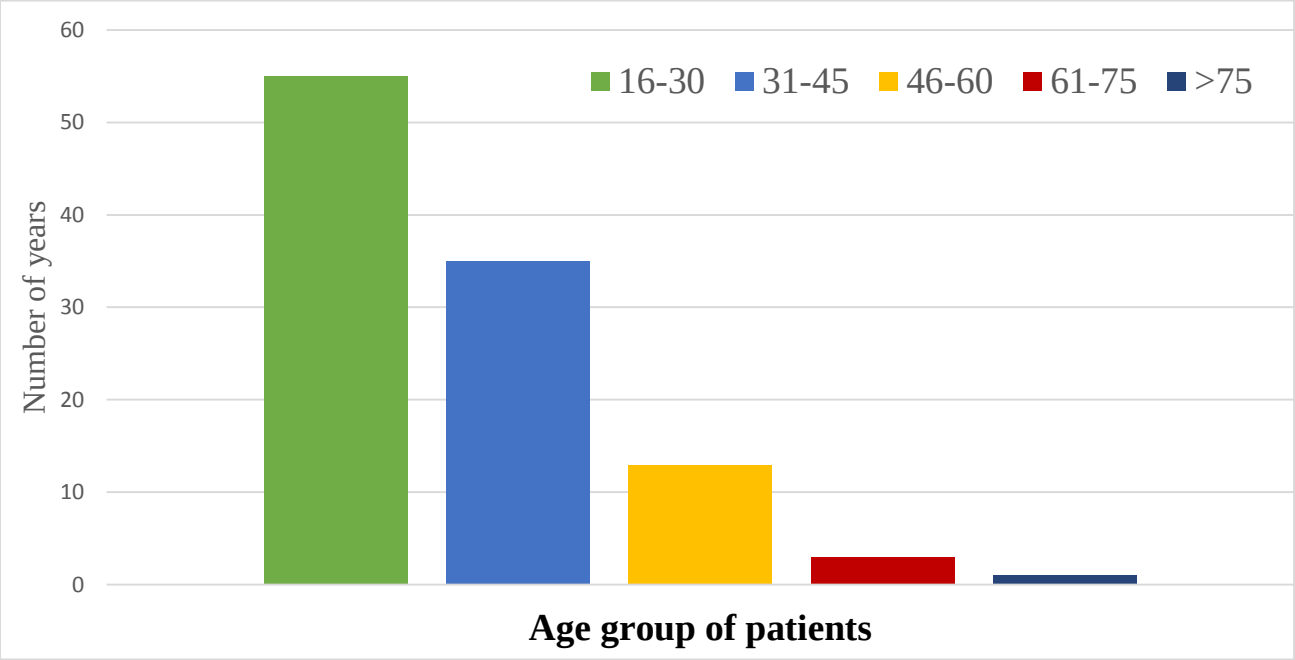


Figure 12: Age distribution of patients

The mean of pre-operative taste score was 12.35 with a standard deviation of 2.61

The lowest score was 6 and highest was 18 (Table 5).. Taste scores in different age groups were compared.

Age	Number	Mean taste score
<20	10	12.4000
20 to 40	76	11.9737
>40	21	13.6667
Total	107	12.3458

Table 5: Pre-operative mean taste scores in different age groups

The mean taste score of patients aged more than 40 was 13.66 which was higher than the overall mean value (Figure 13).

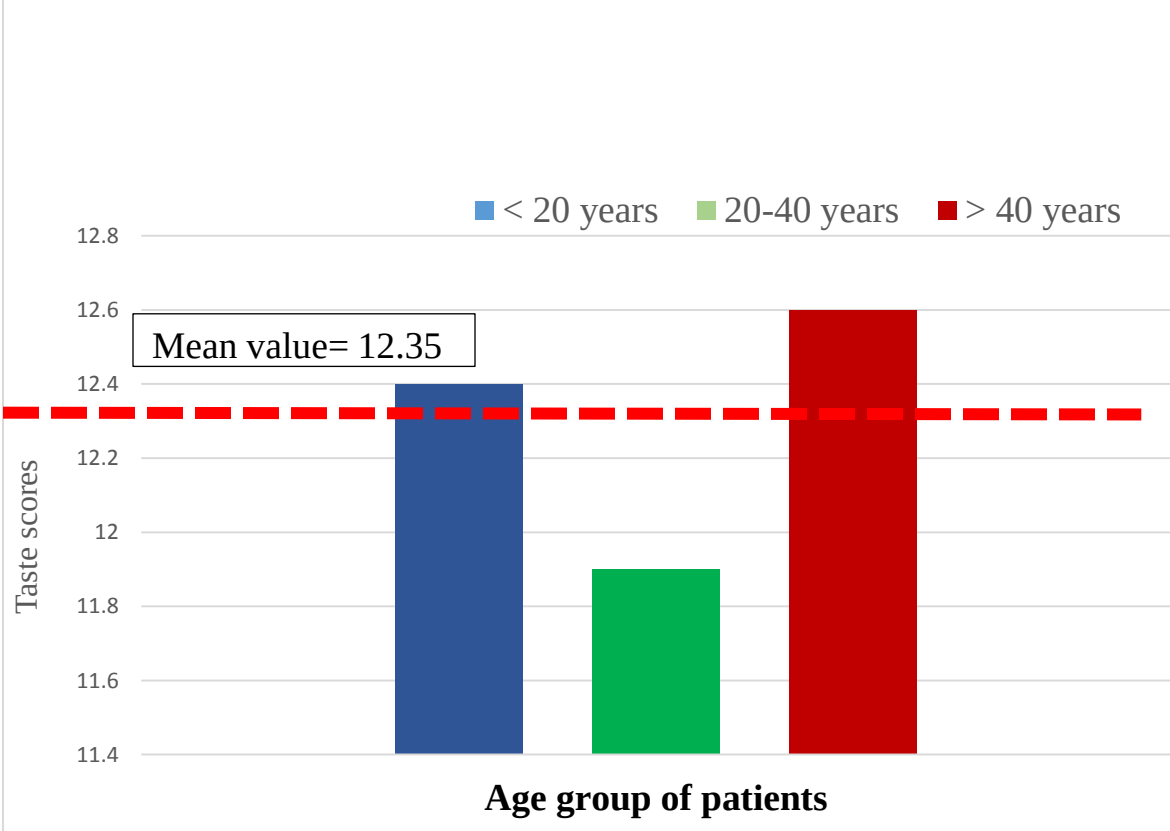


Figure 13: Mean taste scores in different age groups in comparison to overall mean value

< 2Years	43	10.9535
2-5 Years	38	12.6053
>5 Years	25	14.5200
Total	106	12.3458

Table 6:Pre-operative mean taste scores in relation to duration of illness

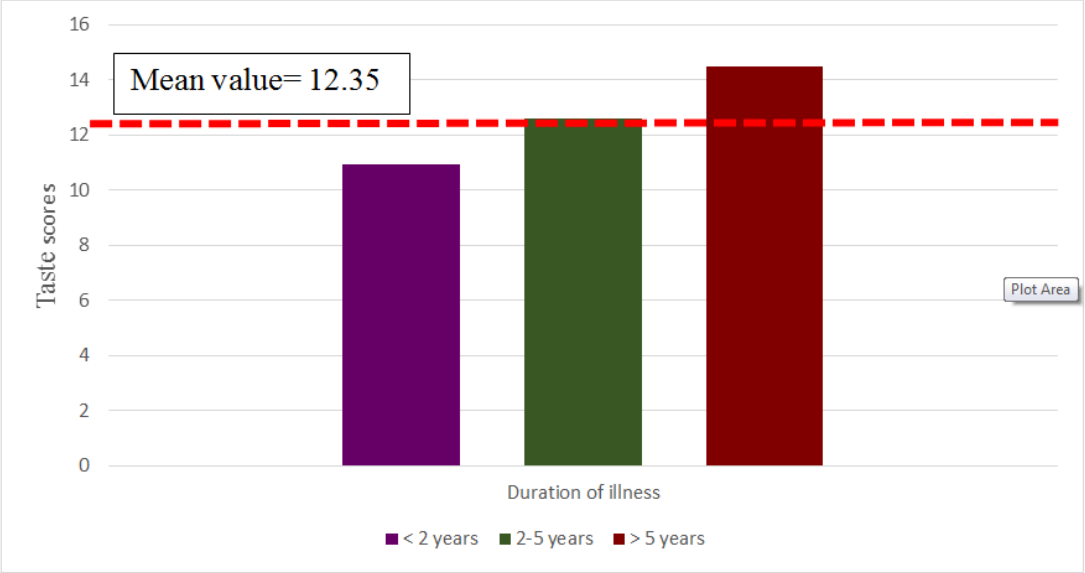


Figure 14: Mean pre-operative taste score in duration of illness

Taste threshold seems to increase with the duration of illness. The mean score for patients with 2-5 years of disease was 12.6 and those with more than 5 years was 14.45 (Table 6 and Figure 14).

	Mean	N	Paired T value	p-value
Pre – operative	12.35	107	6.795	
6 weeks post op	10.67	107	3.021	0.001

Table 7: Comparison of taste scores (pre-operatively and 6 weeks post-operative period)

	Mean	N	Paired T value	p-value
Pre – operative	12.35	107	10.694	
3 months post op	9.96	107	2.861	0.001

Table 8: comparison of taste scores (pre-operatively and 3 months post-operative period)

The mean of pre-operative taste score is 12.35 with a standard deviation of 2.61. Mean at 6 week post- operative period has reduced to 10.67 and at 3 months post-operative period is 9.96

There is a significant reduction in taste scores at 6 weeks post-operative period (an average reduction of 1.68 from pre-operative to 6 weeks post-operative period) which is very statistically significant (p=0.001). Paired T-test is applied to check for statistical significance

There is a significant reduction in taste scores at 3 months post-operative period (an average reduction of 2.39 from pre-op to 3 months) which is statistically significant (p=0.001)

At 6 weeks post-operative	Frequency	Percent
Increased in taste threshold	24	22.4
Decreased in taste threshold	75	70.1
0-1(No change)	8	7.5
Total	107	100.0

Table 9: 6th week post-operative taste scores

At 6 weeks post operatively 24 patients showed an increase in taste threshold, 75 patients showed a decrease in taste threshold and 8 patients showed no significant difference in taste score as compared pre- operatively (Table 9).

At 3 months post-operative	Frequency	Percent
Increased	16	15.0
Decreased	82	76.7
0-1(No change)	9	8.4
Total	107	100.0

Table 10: 3 months post-operative taste scores

At 3 months post operatively 16 patients showed an increase in taste threshold, 82 patients showed a decrease in taste threshold and 9 patients showed no significant difference in taste score as compared pre-operative period (Table 10).

Age	At 6 weeks post-operative period			Total
	Increased	Decreased	No change	
<20	0	8	2	10
20 to 40	13	59	4	76
>40	11	8	2	21
Total	24	75	8	107

Table 11: Results of patients at 6th post-operative week with respect to age.

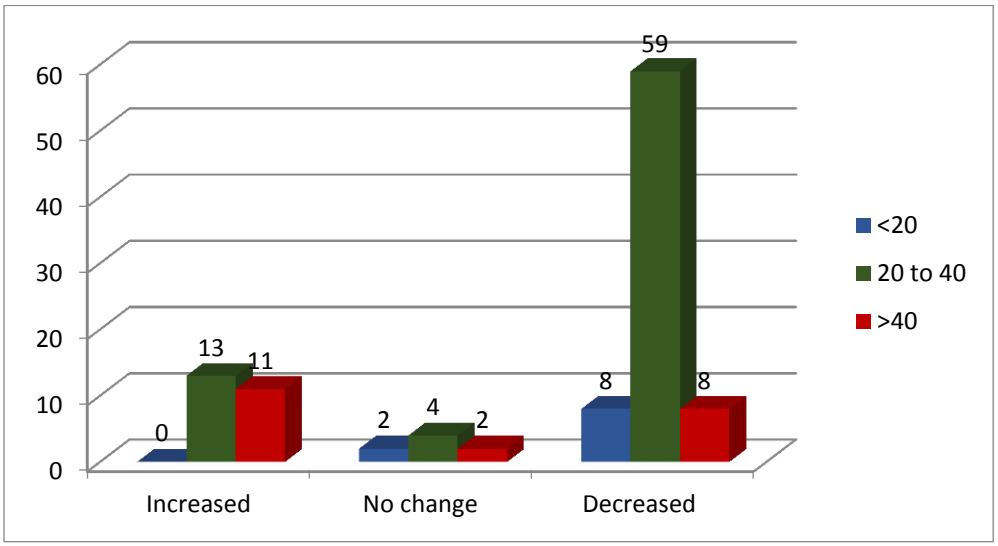


Figure 15: Results of patients at 6th post-operative week with respect to age.

At 6 weeks post-operative period, of the 10 patients within the age of 20 years, 8 patients showed a decrease in taste threshold, 2 patients showed no significant difference in taste score and no patient showed an increase in taste threshold.

76 patients belonged to the age of 20 to 40 years of which 13 patients showed an increase in taste threshold, 59 patients showed a decrease in taste threshold, and 4 patients showed no change in taste threshold.

21 patients were above the age of 40 years among which 11 patients showed an increase in taste threshold, 8 patients showed a decrease in taste threshold and 2 patients showed no change in taste threshold.

Age	3 months post operatively			Total
	Increased	Decreased	No change	
<20	0	9	1	10
20 to 40	5	64	7	76
>40	11	9	1	21
Total	16	82	9	107

Table 12: Results of patients at 3rd post-operative month with respect to age

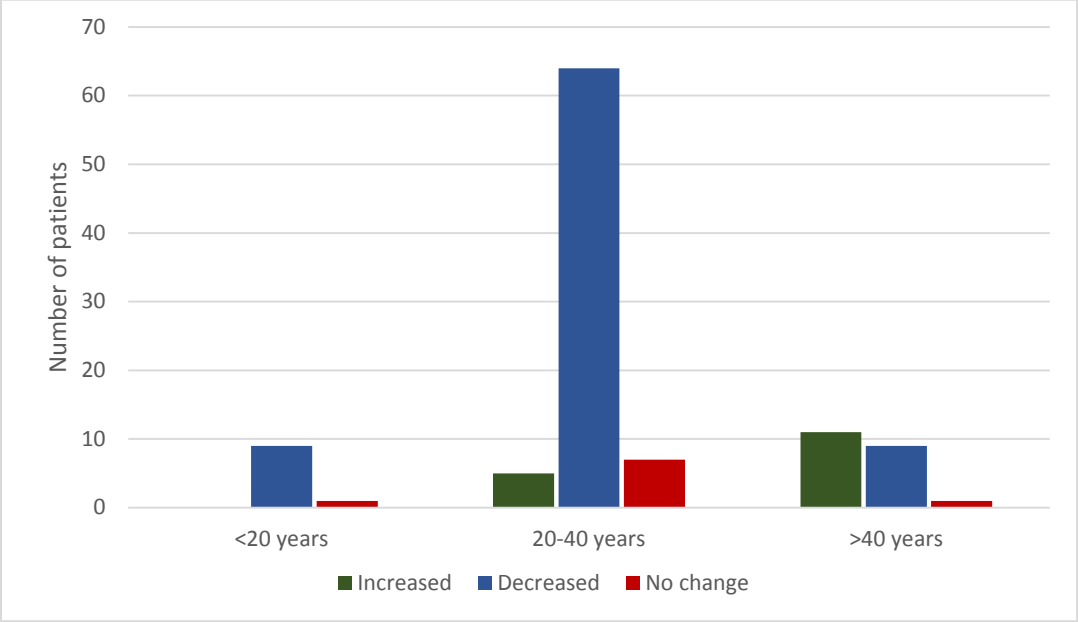


Figure 16: Results of patients at 3rd post-operative month with respect to age

At 3 months post-operative period, of the 10 patients aged less than 20 years, 9 patients showed a decrease in taste threshold, and 1 patient showed no change in taste threshold. No patient showed an increase in taste threshold.

76 patients belonged to the age group of 20 to 40 years of which 64 patients showed a decrease in taste threshold, 7 patients showed no change in taste threshold and 5 patients showed an increase in taste threshold.

21 were patients aged more than 40 years among which 9 patients showed a decrease in taste threshold, 11 patients showed an increase in taste threshold and 1 patient showed no change in taste threshold.

Age	n	Preop taste Scores		Taste Scores at 6 Weeks		Taste Scores at 3 Months		P value
		Mean	SD	Mean	SD	Mean	SD	
<20	10	12.4000	2.22111	8.8000	1.13529	8.4000	1.17379	0.001
20 to 40	76	11.9737	2.57150	9.9474	2.30301	9.2237	2.14537	0.001
>40	21	13.6667	2.61406	14.1905	3.34094	13.3810	2.95764	0.001
Total	107	12.3458	2.61383	10.6729	3.02123	9.9626	2.82150	

Table 13: Mean taste scores in different age groups

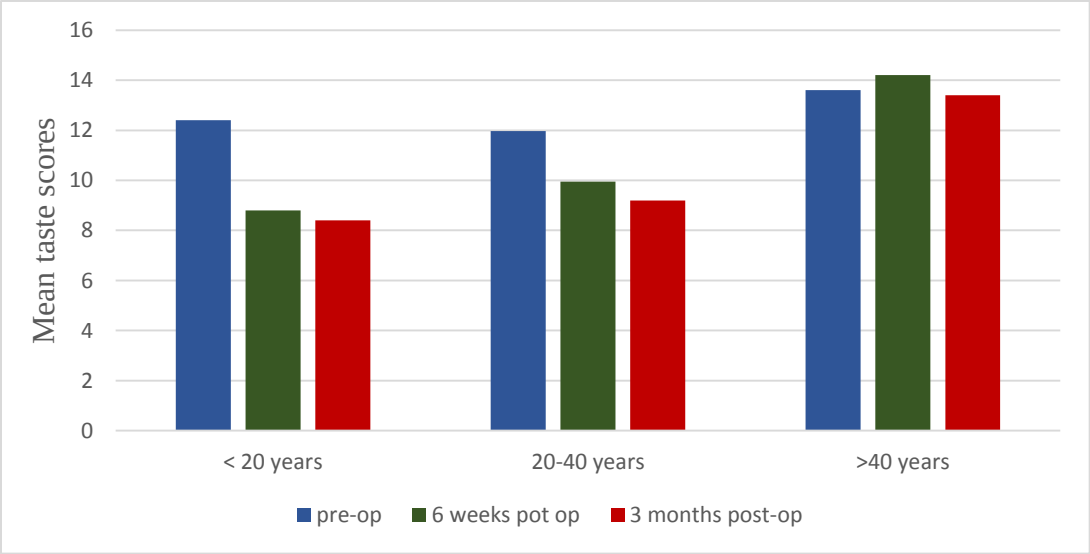


Figure 17: Mean taste scores in different age groups

This represents the mean scores in different age groups at pre-operative period, 6 weeks post-operative period and 3 months post-operative period.

The mean taste score of patients aged less than 20 years at pre-operative period is 12.4, which decreases to 8.8 at 6 weeks post-operative period and further decreases to 8.4 at 3 months

The mean taste score of patients aged 20 to 40 years is 11.9 at preoperative period, which decreases to 9.9 at 6 weeks post operatively and further decreases to 9.2 at 3 months.

Mean pre-operative score of patients aged more than 40 years is 13.6, which further deteriorated to 14.1 at 6th post-operative week. At 3 months post-operative period it was 13.38, which is a marginal improvement compared to the pre-operative value.

A total of 106 patients gave history of ear discharge , among these patients 43 patients gave history of ear discharge for less than 2 years, 38 patients gave history of ear discharge for 2 to 5 years, and 25 patients had a history of ear discharge for more than 5 years

Duration of discharge	At 6 weeks post-operative period			
	Increased	Decreased	No change	Total
<2 Years	10	28	5	43
2-5 Years	6	30	2	38
>5 ears	8	16	1	25
Total	24	74	8	106

Table 14: Distribution of patients in relation to duration of discharge (6th post-operative week)

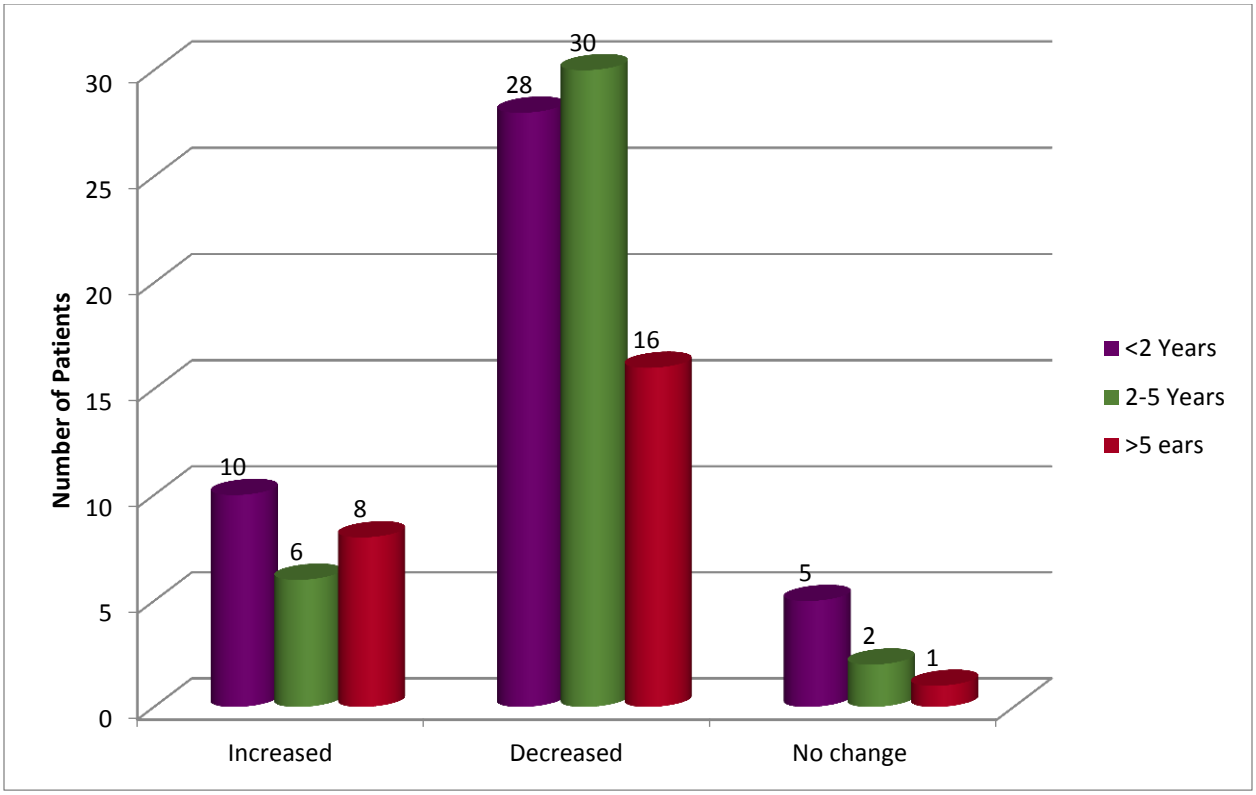


Figure 18: Distribution of patients in relation to duration of discharge (6th post-operative week)

At 6 weeks post-operative period, among the patients with less than 2 years of ear discharge (n=43) , 28 patients showed a decrease in taste threshold, 10 patients showed an increase in taste threshold and 5 patients showed no change in taste threshold.

38 patients who had ear discharge for 2 to 4 years, among them 30 patients showed a decrease in taste threshold, 6 patients showed a decrease in taste threshold and 2 patients showed no change in taste threshold.

25 patients had a history of ear discharge for more than 5 years, of which 16 patients showed a decrease in taste threshold, 8 patients showed an increase in taste threshold and 1 patient showed no change in taste score.

Duration	At 3 months post-operative period			Total
	Increased(1)	Decreased(2)	No change(3)	
<2 Years	5	31	7	43
2-5 Years	3	34	1	38
>5 ears	8	16	1	25
Total	16	81	9	106

Table 15: Distribution of patients in relation of duration of discharge (3rd post-operative month)

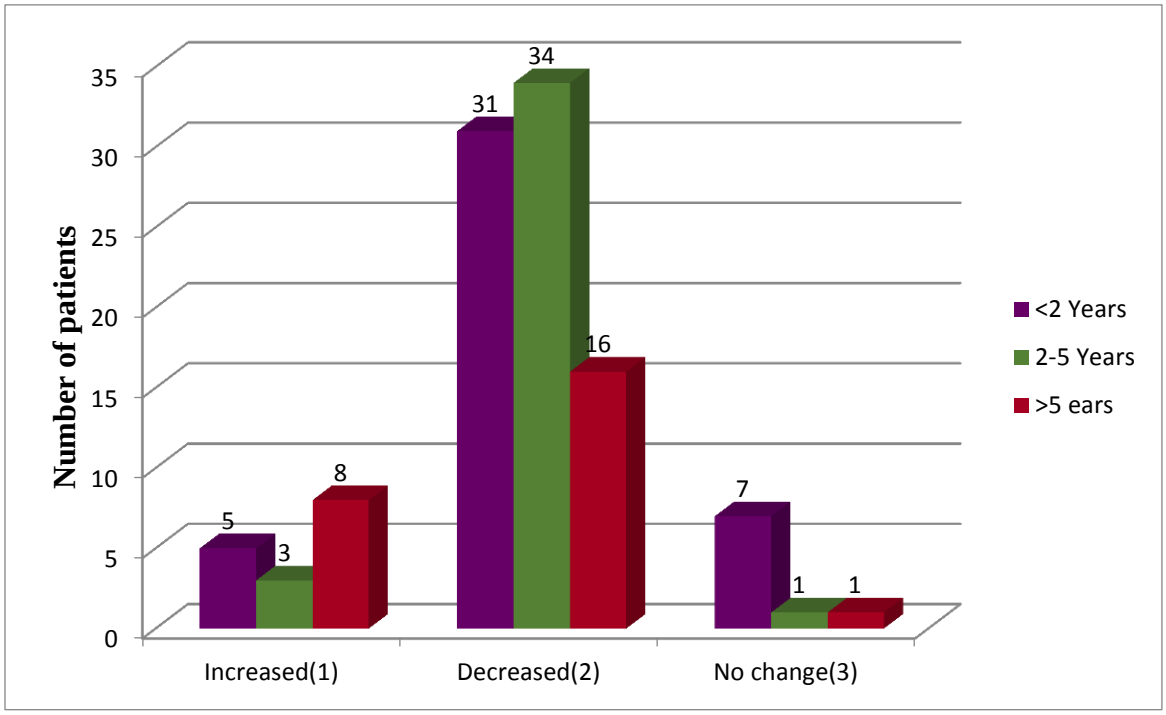


Figure 19: Distribution of patients in relation of duration of discharge (3rd post-operative month)

At 3 months post-operative period, of the 43 patients with less than 2 years of ear discharge 31 patients showed a decrease in taste threshold, 5 patients showed an increase in taste threshold and 7 patients showed no change in taste scores compared to pre-operative score.

38 patients had a history of ear discharge for 2 to 5 years and 34 of these patients showed a decrease in taste threshold, 3 patients showed an increase in taste threshold and 1 patient showed no change in taste score.

25 patients had a history of ear discharge for more than 5 years, 16 of them showed a decrease in taste threshold, 8 showed an increase in taste threshold and 1 patient showed no change in taste threshold.

Duration	n	Pre op taste Scores		Taste Scores at 6 Weeks		Taste Scores at 3 Months		P value
		Mean	SD	Mean	SD	Mean	SD	
< 2Years	43	10.9535	2.40984	9.5581	2.49096	8.8837	2.08406	0.001
2-5 Years	38	12.6053	1.91070	10.552	2.46815	9.6842	2.19465	0.001
>5 Years	25	14.5200	2.25684	12.960	3.38477	12.4000	3.32916	0.001
Total	106	12.3458	2.61383	10.672	3.02123	9.9626	2.82150	

Table 16: Mean taste scores of patients in relation to duration of disease

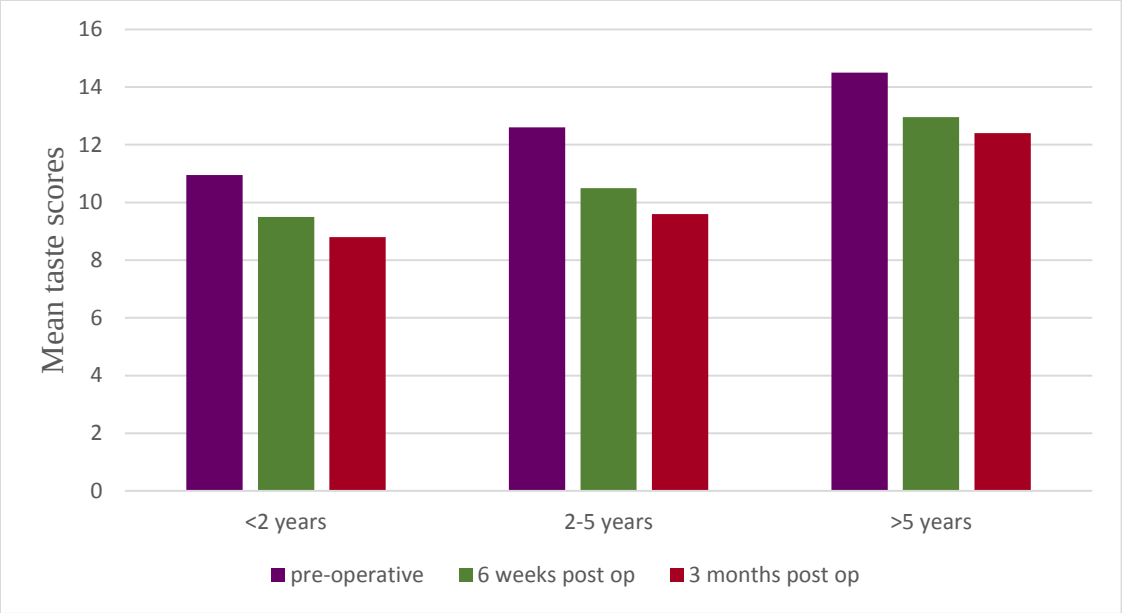


Figure 20: mean taste scores of patients with different duration of disease

This represents the mean taste score of patients at pre-operative , 6 weeks post-operative and 3 months post-operative period with respect to duration of ear discharge, which is divided into groups of , less than 2 years of ear discharge, 2-5 years of ear discharge and >5 years of ear discharge.

The mean taste score for patients with less than 2 years of ear discharge is 10.9 preoperatively, it decreases to 9.5 at 6 weeks post-operative period, further decreases to 8.8 at 3 months post operatively.

The mean taste score for patients with 2-5 years is 12.6 pre-operatively, it decreases to 10.5 at 6 weeks post-operative period, and further decreases to 9.6 at 3 months post-operative period. The mean taste score for patients with more than 5 years of ear discharge is 14.5 pre-operatively, it decreases to 12.9 at 6 weeks post operatively and further decreases to 12.4 at 3 months post-operative period.

Taste Scores	Mean	N	Std. Deviation	P-Value
Pre-op Taste score	13.6429	14	2.84489	
Taste scores at 6 weeks	14.7143	14	3.79126	0.689
Taste scores at 3 Months	13.8571	14	3.65549	

Table 17: Mean taste scores in diabetic patients

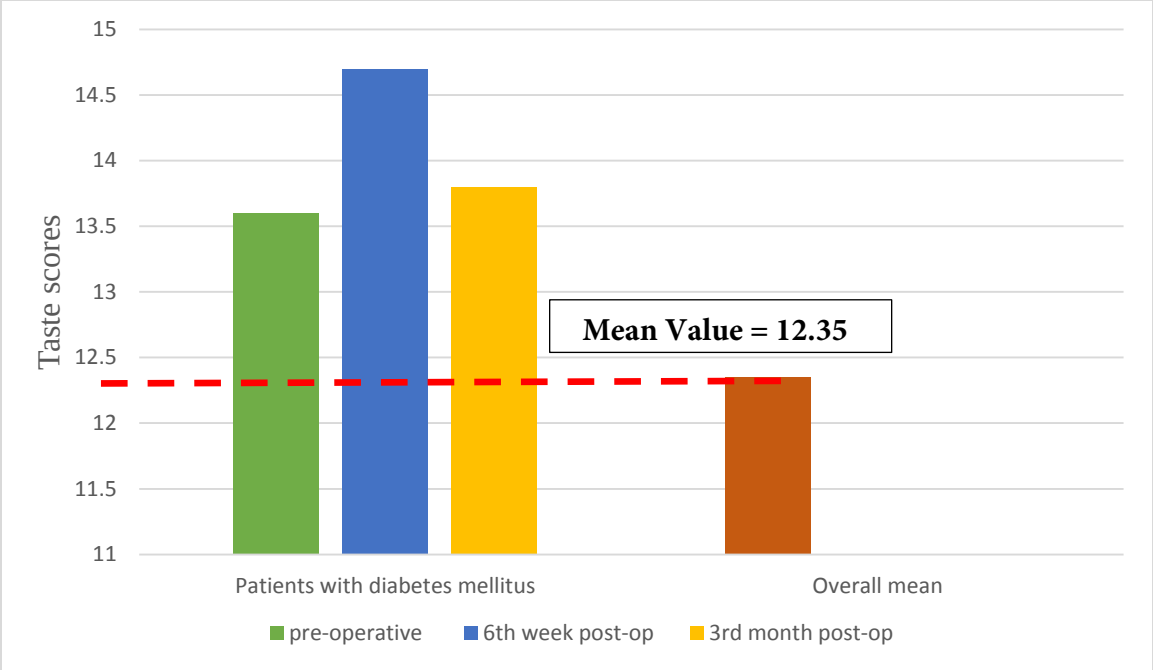


Figure 21: Mean taste score of diabetic patients in comparison to overall mean

In our study 14 patients were diabetic. Their pre-operative mean taste score was 13.6, at 6th post-operative week it deteriorated to 14.7. In the 3rd post-operative month the mean score decreased to13.8, but it was higher than the pre-operative value. The mean threshold of these patients was elevated in comparison to the overall pre-operative mean at all times. The difference in taste score was however statistically insignificant with a p value of 0.689.

	Increased	Decreased	No change
Taste Scores at 6 weeks	24	75	8
Taste Scores at 3 months	16	82	9

Table 18: Comparison of scores between 6 weeks and 3 months post-operative period

Chi-square value = 1.971, p=0.373

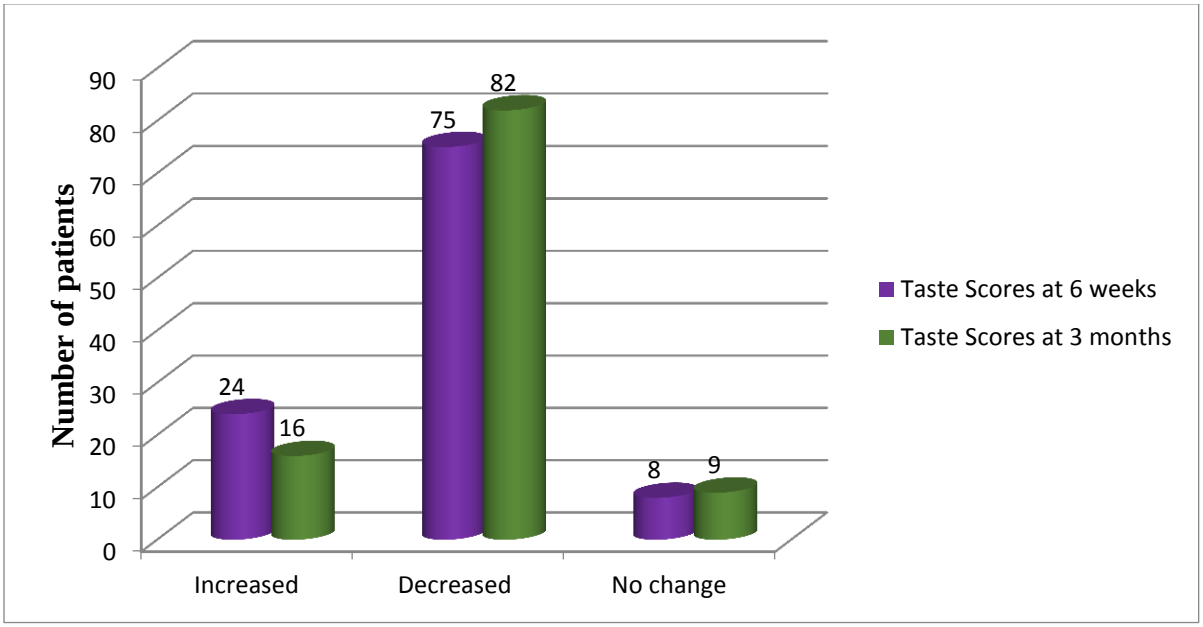


Figure 22: Bar diagram showing the trends in taste scores at 6 weeks and 3months

The number of patients who showed a decrease in taste threshold increased from 75 at 6 weeks post-operative period to 82 patients at 3 months post-operative period. The number patients with an increase in taste threshold at 6 weeks was 24 and it decreased to 16 at 3 months post-operative period. 8 patients showed no change in taste threshold at 6 weeks post operative period , at 3 months 9 patients showed no change in post operative period.

The Chi square is 1.971 and has a p value of 0.373.

Correlation between duration of 6 weeks post-operative score and 3 months post-operative score

Variables	Correlation Coefficient(r)	P- value
Duration and at 6^{th} week	0.504	0.001
Duration and at 3 month	0.566	0.001
Duration and Preop scores	0.492	0.001

Table 19: Correlation of scores with post-operative duration

There is a significant Moderate Positive correlation between duration and Preoperative score, 6 weeks post-operative score and 3 month post-operative score, which suggests improvement in taste function with time.

This suggests that although the difference between taste scores at 6 weeks and 3 months though not statistically significant, there is a favorable improvement in taste function with time.

Discussion

DISCUSSION

'Tell me what you eat, and I will tell u who you are.' This popular quote by Jean Anthelme Brillat-Savarin demonstrates the importance of food and dietary preferences in a person's life. An impaired sense of taste will adversely affect a person's dietary habits and in turn affect his quality of life.

Taste from the anterior two-thirds of the tongue is carried by the chorda tympani branch of facial nerve which in its course travels unprotected in the middle ear.[2] In patients suffering from COM, the CTN is vulnerable to the effect of toxins and inflammatory mediators in the middle ear. This may render the CTN dysfunctional and thus impair the taste function. [47, 48]

In our study 107 patients who were affected with COM underwent evaluation of gustatory function by taste solutions of different concentration. We used the three drop method where a pipette was used to deliver 3 drops of the solution to the ipsilateral side on the anterior two-thirds of the tongue. The limitations of this method are that there is a possibility that the solution may diffuse into other areas of the tongue, or there may be a loss of solution to areas other than the intended test area which may give rise to a potential bias.

We documented the pre-operative scores, and evaluated the impact of factors such as age, duration of disease and presence of co-morbidities on the taste threshold. In our study we noticed that the mean taste score of patients aged more than 40 years was elevated in comparison to the total mean score. Duration of disease and presence of diabetes mellitus also seemed to contribute to the impairment of taste function. The mean score for patients with duration of 2-5 years(12.6) had a marginal elevation, and those with more than five years duration(14.5) of the disease had a significant elevation in comparison to those with shorter

duration(10.9) of the disease. Although the number of patients with diabetes mellitus was a limiting factor, we noticed that these patients had higher taste threshold pre-operatively than the overall mean.

Forty five patients of COM were evaluated pre-operatively in Rio de Janerio for disturbances of taste function. They found that there is a reduced taste sensation on the diseased side. The findings of their study are in agreement with our results. They found that age and duration of the disease have a negative impact on the taste function. They also noted that presence of co-morbidities like diabetes mellitus cause further impairment in taste.[52]

In a study conducted in London in 1974, involving 130 patients suffering from COM and 100 normal controls, an elevation of taste threshold using EGM was found on the diseased side. Unlike our study they found that duration of the disease was directly proportional to the taste impairment in cases with cholesteatoma, but no such relationship was found in cases with mucosal type of COM. Age of the patient did not appear to influence the taste outcome.[3]

Pre-operative taste scores of 46 patients was tested using filter paper strips impregnated with tastants in a study done in 2005 in Dresden, Germany, which concluded that there is an impairment in taste in patients suffering from COM. They noted that the impairment in taste is proportional to the severity of inflammation.[1]

In an Indian study involving 85 patients with unilateral COM, filter paper strips impregnated with tastants were used to test taste pre-operatively. The unaffected side was used as a control. The results of this suggested that presence of an altered taste function is present pre-operatively even in the absence of subjective taste loss and patients with cholesteatoma have

a higher impairment in taste than those without it. This study contradicted our findings by stating that duration of the disease has no bearing on the taste function.[54]

We found that on comparing the pre-operative and post-operative taste scores, that there is an improvement in taste function after surgery. There was a statistically significant improvement in taste scores at 6 weeks as well as 3 months after surgery with a p value of 0.001. We acknowledge that evaluation of subjective taste perception with the help of a questionnaire would have enhanced our understanding of taste physiology in these patients.

A study done in Taiwan, China evaluated the taste function in patients suffering from COM before and after middle ear surgery using solutions of different taste concentrations showed similar results where impairment in taste function pre-operatively improved after disease clearance by middle ear surgery.[53]

In our study the association between age and recovery in taste function after surgery was analysed. A good improvement in taste threshold was observed in patients aged less than 40 years. It was noted that not only was the mean taste scores for patients above 40 years was higher pre-operatively , but also scores at 6^{th} post-operative week showed a deterioration. Taste threshold at 3 months showed marginal improvement in comparison to 6 weeks but remained higher that the pre-operative mean value.

In a Japanese study involving one hundred and fifty six patients, the taste function in patients suffering from COM, EGM was employed to record the taste threshold pre and post-operatively. In this study improvement in taste was noticed after patients underwent middle ear surgery. The findings of this study are in agreement with our results and, it was recognized that age plays an important role in recovery of taste function after surgery.[51]

Duration of the disease appeared to have an impact on taste function in our study. We found that as the duration of the disease increased, higher was the taste threshold. The mean taste scores in patients with more than 5 years of COM was high pre-operatively , even after 3 months post-operative period the threshold remained higher than the mean taste score. Felix and colleagues in their study noted likewise that duration of the disease adversely affects the taste function, but post-operative recovery was not assessed in their study.[52]

Sheila M A in her study noted that, in contrast to our findings, in mucosal type of COM duration of disease did not have an impact on the taste threshold pre-operatively. Post-operative assessment of taste threshold was not done in the mentioned study.[3]

The difference in taste thresholds at 6 weeks and 3 months was evaluated using Chi square test and p value was 0.37. Correlation co-efficient was calculated and it was found to that there is a significant moderate positive correlation in between taste score and duration. This implies that the difference in thresholds between 6 weeks and 3 months post-operative period, though not statistically, there is a favorable improvement in taste function with time. Hence patients who do not show an improvement in taste at 3 months, should be on follow-up for a longer period, as it is likely that with time their taste function improves.

From the results of our study we are of the opinion that routine taste testing for all COM patients undergoing surgery would be beneficial in many ways.

Pre-operative recording would provide a clue about the severity of the disease, help us create an awareness among the patients about the possible taste dysfunction due to the disease and inform about potential use of surgery in the recovery of taste function. In cases where the taste is significantly altered by the disease, it would protect the surgeon from potential litigation attributing this dysfunction to surgery.

Conclusion

CONCLUSIONS

- In patients with mucosal chronic otitis media, the taste perception improved over a period of time after adequate surgical clearance of the disease by Tympanoplasty.
- Pre-operatively, mean taste threshold is higher in patients aged more than 40 years and in patients with long duration of the disease.
- Recovery of taste function post-operatively is affected by factors such as age and duration of the disease. Older the age, poorer the recovery of taste function. Diseases of longer duration have a poorer taste outcome.
- In patients with chronic otitis media routine pre-operative taste testing would be beneficial.

Summary

SUMMARY

A total of 107 patients diagnosed to have mucosal type of COM and meeting the inclusion criteria in the department of Otorhinolaryngology and Head and Neck Surgery of R L Jalappa Hospital And Research Centre, Tamaka, Kolar from December 2013 – August 2015 were included in this study.

Once the diagnosis of mucosal type COM was made on the basis of history and routine ENT examination, the patients were subjected to microscopic ear examination, pure tone audiometry, mastoid radiography and haematological investigations.

After the patient was included in the study, his/her taste scores were recorded using taste solutions of different concentrations on 3 occasions, pre-operatively, at 6 weeks and 3 months after Tympanoplasty.

- Taste scores of all patients were recorded pre-operatively, and compared with the post-operative scores to look for any change in taste threshold.
- After noting the scores, results were analysed using SPSS(V.22)
- Mean pre-operative taste score was 12.35
- We found that pre-operative taste threshold is higher than the mean value for patients aged more than 40 years. As the duration of illness progresses taste dysfunction increases.
- A significant improvement was noted in the post-operative taste thresholds after patients underwent Tympanoplasty. Mean post-operative taste score at 6 weeks was 10.67, and at 3 months was 9.96 (p value=0.001).

- The recovery of taste function is significantly influenced by factors such as age and duration of illness with a p value of 0.001 Taste outcome in patients aged more than 40 years was poorer than that seen in younger patients. As the duration of the disease increases, taste function deteriorates.
- We found a significant moderate positive correlation between duration and taste outcomes with a p value of 0.001, which implies that taste function in patients improves with time.
- Routine taste testing for all patients undergoing Tympanoplasty would be beneficial.

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ANNEXURES

PROFORMA

GUSTATORY FUNCTION IN CHRONIC OTITIS MEDIA (MUCOSAL TYPE) BEFORE AND AFTER TYMPANOPLASTY

Name :

Age / Sex:

Date :

Contact no:

Chief complaints :

History of presenting illness:

Past medical history :

Past surgical history:

Family history :

Examination :

General physical examination:

Systemic examination :

CVS:
RS:
CNS:

ABDOMEN :

ENT Examination :

Ear :

Nose:

Oral cavity and oropharynx :

Taste scores

	Pre-operative	Post-surgery(6 weeks)	Post-surgery (3 months)
Sweet			
Sour			
Salty			
Bitter			

Surgery done :

Follow up:

Post-op complications:

INFORMED CONSENT

GUSTATORY FUNCTION IN CHRONIC OTITIS MEDIA (MUCOSAL TYPE) BEFORE AND AFTER TYMPANOPLASTY

I have read this consent form/ have been read to me and I understand the purpose of this study, the procedures that will be used i.e., testing of taste by taste solutions, the risks and benefits associated with my involvement in the study and the confidential nature of the information that will be collected and disclosed during the study.

I understand that I remain free to withdraw from the study at any time and this will not change my future care.

I have had the opportunity to ask questions regarding various aspects of the study and my questions have been answered to my satisfaction.

I, the undersigned agree to participate in this study and authorize the collection and disclosure of my personal information as outlined in this consent form.

Subjects / guardians name and signature/ thumb impression date:

Name and signature of the witness date:

KEY TO MASTER CHART

F ⇨ FEMALE

M ⇨ MALE

DOS ⇨ DATE OF SURGERY

DM ⇨ DIABETES MELLITUS

Rx ⇨ TREATEMENT

Htn ⇨ HYPERTENSION

NAD ⇨ NO ABNORMALITY DETECTED

T ⇨ TYMPANOPLASTY

T-1 T ⇨ TYPE-1 TYMPANOPLASTY

CM ⇨ CORTICAL MASTOIDECTOMY

Sl No	name	age	sex	hospital no	occupation	DOS	Ear discharge	Duration in years	Type of discharge	Comorbidities	Family History	Diseased ear	size	preop score	surgery	6 weeks	3 months
1	noor ayesha	28	F	904599	housewife	4/10/2014	present	0.5	mucopurulent	no	NAD	left	moderate	8	T-1 T	9	8
2	Md. Lober	20	M	988135	bussinessman	4/10/2014	present	1	mucopurulent	no	NAD	left	large	10	T-1 T	7	7
3	srinivas	21	M	897231	student	4/21/2014	present	2	mucoid	no	NAD	right	moderate	12	T-1T+CM	8	9
4	gangulamma	45	F	141	agriculturist	4/26/2014	present	4	mucopurulent	no	NAD	left	moderate	14	T-1T+CM	17	12
5	Mubeena Taj	27	F	998577	housewife	4/28/2014	present	1	mucopurulent	no	NAD	left	small	10	T-1T+CM	8	7
6	Rasheeda	21	F	698	housewife	5/12/2014	present	4	mucoid	no	NAD	left	small	14	T+CM	11	10
7	Ratna	27	F	1004628	farmer	5/22/2014	present	2	mucopurulent	no	NAD	left	moderate	16	T+CM	12	12
8	Rathnamma	25	F	1246	labourer	6/3/2014	present	3	mucopurulent	no	NAD	left	large	12	T-1T+CM	13	13
9	Sujatha	48	F	3350	teacher	6/5/2014	present	7	mucopurulent	no	NAD	right	moderate	16	T+CM	14	14
10	obalappa	76	M	1018391	farmer	6/7/2014	present	7	mucopurulent	DM on Rx- 10 yrs	NAD	right	moderate	16	T+CM	19	17
11	Shabeena Taj	31	F	10428	housewife	6/9/2014	present	20	mucopurulent	no	NAD	right	large	15	T+CM	16	15
12	Chandrappa	55	M	13334	farmer	6/17/2014	present	10	mucoid	DM on Rx- 10 yrs	NAD	left	large	12	T+CM	16	14
13	Asma	23	F	18120	housewife	6/19/2014	present	5	mucoid	no	NAD	left	moderate	13	T-1 T	9	9
14	Nirmala	38	F	8776	shopkeeper	6/19/2014	present	1	mucoid	Htn on Rx - 4yrs	NAD	left	moderate	8	T-1 T	8	9
15	Mangamma	48	F	8643	housewife	6/23/2014	present	10	mucoid	DM on Rx-6 yrs	NAD	left	large	10	T+CM	14	13
16	Narayanappa	45	M	8896	agriculturist	6/24/2014	present	0.4	mucopurulent	DM on Rx- 2 yrs	NAD	left	large	12	T-1T+CM	12	12
17	Suguna	24	F	15703	clerk	6/24/2014	present	0.5	mucoid	no	NAD	left	small	12	T-1T	8	7
18	Shoba	25	F	11710	housewife	6/26/2014	present	3	mucopurulent	no	NAD	right	moderate	11	T+CM	8	8
19	srinivas	44	M	20688	teacher	7/8/2014	present	2	mucopurulent	DM on Rx- 2 yrs	NAD	right	moderate	12	T+CM	16	14
20	Prakash	27	M	20791	shopkeeper	7/8/2014	present	5	mucopurulent	no	NAD	right	adhesive Otits media	14	T+CM	11	10
21	Jayamma	70	F	24253	housewife	7/10/2014	present	10	mucopurulent	DM on Rx - 15 yrs	NAD	right	large	18	T+CM	20	20
22	Naveen Kumar	18	M	19234	student	7/15/2014	present	12	mucoid	no	NAD	left	large	14	T+CM	10	9
23	Manjushree	26	F	23048	stenographer	7/15/2014	present	3	mucoid	no	NAD	left	moderate	8	T-1 T	11	6
24	Pushpa	25	F	17160	housewife	7/24/2014	present	13	mucopurulent	no	NAD	right	large	16	T+CM	10	8
25	Mamatha	22	F	8370	student	7/24/2014	no(itching)	3		no	NAD	right	moderate	10	T-1 T	8	8
26	Bharath	22	M	28910	factory worker	7/31/2014	present	10	mucoid	no	NAD	right	moderate	13	T+CM	10	11
27	Annappa	28	M	21184	agriculturist	8/2/2014	present	4	mucopurulent	no	NAD	left	large	15	T	12	13
28	Muninarayanappa	62	M	32119	labourer	8/11/2014	present	5	mucopurulent	htn on Rx -1yrs	NAD	right	large	10	T	13	12
29	Venkatesh	30	M	404278	technician	8/20/2014	present	0.5	mucopurulent	no	NAD	left	moderate	10	T+CM	7	6
30	Fayaz Baig	27	M	45052	Tailor	9/6/2014	present	3	mucopurulent	no	NAD	right	small	12	T+CM	8	9
31	Muniraj	23	M	454469	student	9/23/2014	present	1	mucopurulent	no	NAD	left	moderate	9	T+CM	7	6
32	Kouser	40	F	20273	housewife	9/29/2014	present	10	mucopurulent	no	NAD	left	moderate	14	T+CM	12	11
33	Swapna	16	F	47992	student	10/9/2014	present	5	mucopurulent	no	NAD	right	moderate	14	T	8	8
34	Devamma	32	F	15106	labourer	10/9/2014	present	1	mucopurulent	no	NAD	left	large	12	T	10	10
35	Natish	39	M	854305	clerk	10/13/2014	present	2	mucoid	no	NAD	right	small	10	T	8	7
36	Veena	35	F	47886	cook	10/21/2014	present	2	mucopurulent	no	NAD	right	moderate	14	T	10	11
37	Mahalakhmi	34	F	13952	housewife	10/28/2014	no	0	no	no	NAD	right	moderate	6	T-1T	7	6
38	Ramakka	35	F	57154	agriculturist	11/3/2014	present	3	mucopurulent	no	NAD	left	large	12	T-1T	10	9
39	Laksmamma	30	F	49948	housewife	11/4/2014	present	4	mucopurulent	no	NAD	left	large	14	T+CM	10	9
40	Devendra	24	M	68345	mechanic	11/11/2014	present	2	mucoid	no	NAD	right	moderate	10	T+CM	8	7
41	Laksmamma	47	F	38919	housewife	11/15/2014	present	8	mucoid	DM on Rx -2 yrs	NAD	left	large	18	T+CM	14	12
42	Sharadamma	27	F	52662	nursery teacher	11/15/2014	present	3	mucoid	no	NAD	right	moderate	12	T+CM	10	9
43	Srinivas Reddy	52	M	50032	bussinessman	11/17/2014	present	20	mucopurulent	no	NAD	right	large	10	T+CM	14	14
44	Nasir Unnisa	32	F	75057	housewife	11/18/2014	present	0.5	mucopurulent	no	NAD	right	large	10	T	8	7
45	Manikanta	25	M	76167	shopkeeper	11/24/2014	present	1	mucoid	no	NAD	right	moderate	13	T-1T	10	10
46	Muniswamy Shetty	35	M	1019672	agriculturist	11/25/2014	present	0.3	mucopurulent	no	NAD	left	moderate	14	T	14	13
47	Ganji Reddy	32	M	1019797	farmer	12/2/2014	present	2	mucoid	no	NAD	right	large	12	T+CM	10	9
48	Munirathnamma	27	F	76752	labourer	12/12/2014	present	15	mucopurulent	no	NAD	right	large	16	T+CM	12	13
49	Renukumar Reddy	25	M	86970	factory worker	12/23/2014	present	1	mucopurulent	no	NAD	left	moderate	12	T	8	8
50	Manjunath	34	M	79837	farmer	12/29/2014	present	3	mucoid	no	NAD	left	small	13	T	10	9
51	Parveen Taj	20	F	850592	student	1/9/2015	present	3	mucoid	no	NAD	left	moderate	14	T	9	8
52	Pramila	35	F	91453	housewife	1/12/2015	present	7	mucopurulent	no	NAD	left	moderate	12	T+CM	10	9
53	Manjula	46	F	84610	dairy worker	1/13/2015	present	0.5	mucopurulent	no	NAD	left	moderate	10	T-1T	8	8
54	Rakesh	21	M	88732	student	1/17/2015	present	1	mucopurulent	no	NAD	left	moderate	10	T	7	8
55	Iliaz Baig	50	M	96950	shopkeeper	1/27/2015	present	5	mucopurulent	DM on Rx - 3 yrs	NAD	left	large	15	T	12	13

Sl No	name	age	sex	hospital no	occupation	DOS	Ear discharge	Duration in years	Type of discharge	Comorbidities	Family History	Diseased ear	size	preop score	surgery	6 weeks	3 months
56	Sakamma	30	F	95269	vegetable vendor	1/28/2015	present	1	mucopurulent	no	NAD	right	moderate	16	T	18	14
57	Padma	37	F	95019	housewife	1/31/2015	present	0.5	mucoid	no	NAD	left	moderate	9	T	9	10
58	Narayanswamy	35	M	12176	farmer	19/2//15	present	15	mucoid	no	NAD	left	large	16	T+CM	12	12
59	Usha	17	F	909360	student	3/2/2015	present	7	mucoid	no	NAD	right	moderate	14	T+CM	8	9
60	Chandrashekar	25	M	118003	bussinessman	3/4/2015	present	3	mucopurulent	no	NAD	left	large	12	T+CM	10	9
61	Devathamma	30	F	118163	housewife	3/6/2015	present	4	mucopurulent	no	NAD	left	moderate	13	T+CM	7	8
62	Girija	30	F	57325	housewife	3/7/2015	no	0	no	no	NAD	left	moderate	8	Myringoplasty	9	8
63	Hanumanthappa	54	M	11800	agriculturist	3/9/2015	present	15	mucoid	DM on Rx-6 yrs	NAD	left	large	12	T+CM	14	14
64	Savitha	31	F	119108	clerk	3/27/2015	present	4	mucopurulent	no	NAD	right	moderate	11	T+CM	8	8
65	Farhan Unnisa	45	F	77262	housewife	3/27/2015	present	10	mucoid	DM & Htn on Rx- 3 yrs	NAD	left	moderate	14	T+CM	14	15
66	Neelamma	55	F	15416	labourer	3/28/2015	present	8	mucoid	no	NAD	right	large	15	T+CM	13	12
67	Saraswathi	30	F	122221	Tailor	4/4/2015	present	4	mucoid	no	NAD	right	large	10	T	8	7
68	Nagaraj	35	M	926451	factory worker	4/17/2015	present	2	mucopurulent	no	NAD	right	large	12	T+CM	10	9
69	Papaiah	38	M	917470	farmer	4/24/2015	present	5	mucopurulent	no	NAD	left	moderate	14	T+CM	11	10
70	Tulasi	26	F	966501	housewife	4/24/2015	present	3	mucopurulent	no	NAD	right	moderate	14	T	13	11
71	Laksmamma	40	F	910170	agriculturist	5/6/2015	present	1	mucopurulent	DM on Rx - 2yrs	NAD	right	large	9	T+CM	7	6
72	Vasudev Reddy	53	M	1001283	bussinessman	5/20/2015	present	4	mucoid	no	NAD	right	small	14	T	10	11
73	Muralidhar	37	M	1004489	shopkeeper	5/22/2015	present	3	mucoid	no	NAD	right	moderate	16	T+CM	14	13
74	Harish	21	M	914248	student	5/27/2015	present	6	mucoid	no	NAD	left	moderate	14	T+CM	10	9
75	Shivraj	35	M	997057	agriculturist	5/27/2015	present	2	mucoid	no	NAD	left	moderate	11	T+CM	12	8
76	Srinivasappa	37	M	991698	labourer	5/29/2015	present	5	mucopurulent	no	NAD	right	large	16	T+CM	13	12
77	Kalesh	26	M	144612	factory worker	5/25/2015	present	1	mucopurulent	no	NAD	left	moderate	8	T+CM	6	6
78	Jagadish	17	M	1021447	student	5/25/2015	present	7	mucopurulent	no	NAD	left	moderate	13	T+CM	8	7
79	Jayamma	38	F	139132	Tailor	5/23/2015	present	4	mucoid	no	NAD	left	large	14	T-1	12	11
80	Naveen	18	M	130940	student	5/23/2015	present	5	mucoid	no	NAD	left	large	10	T-1	10	8
81	Hemavathi	40	F	139665	housewife	5/22/2015	present	10	mucopurulent	no	NAD	left	large	18	T+CM	14	14
82	Nagaraj GV	22	M	117756	dairy worker	5/9/2015	no	-	-	no	NAD	right	large	8	T	6	6
83	Museeba	20	F	131126	student	5/9/2015	present	0.5	mucopurulent	no	NAD	left	moderate	8	T+CM	8	8
84	Shashikala	20	F	147633	student	5/27/2015	present	2	mucoid	no	NAD	right	small	14	T-1	10	11
85	Lakshminarayna	65	M	130476	agriculturist	5/30/2015	present	5	mucopurulent	DM on irregular Rx- 6 yrs	NAD	left	moderate	14	T	18	16
86	Shamala	21	F	131999	student	6/4/2015	present	1	mucopurulent	no	NAD	right	moderate	10	T	11	10
87	Mamatha	20	F	146225	student	6/6/2015	present	2	mucoid	no	NAD	right	large	13	T	10	9
88	Radhamma	30	F	144107	housewife	6/10/2015	present	4	mucopurulent	no	NAD	left	moderate	10	T+CM	7	6
89	Ganesh	25	M	153646	technician	6/17/2015	present	7	mucoid	no	NAD	left	large	14	T+CM	10	9
90	Narayana Swamy	40	M	143652	driver	7/6/2015	present	0.5	mucopurulent	DM on Rx - 2yrs	NAD	left	moderate	12	T-1	10	9
91	Krishnaswamy	36	M	62940	engineer	7/9/2015	present	1	mucoid	no	NAD	right	moderate	12	T+CM	13	10
92	Narasimha Murthy	22	M	161261	autodriver	7/10/2015	present	4	mucopurulent	no	NAD	left	large	14	T+CM	11	10
93	Srinivas	47	M	134645	agriculturist	7/15/2015	present	9	mucopurulent	HTn on Rx- 4 yrs	NAD	right	large	16	T+CM	10	10
94	Sarojamma	60	F	152631	labourer	7/17/2015	present	20	mucopurulent	DM not on Rx	NAD	right	moderate	17	T+CM	20	19
95	Anusuyamma	53	F	164778	housewife	7/20/2015	present	2	mucopurulent	no	NAD	left	large	12	T+CM	10	9
96	Manjunath	26	M	162693	labourer	7/22/2015	present	3	mucopurulent	no	NAD	left	moderate	10	T+CM	8	7
97	Lakshmi	40	F	163728	cook	7/24/2015	present	1	mucopurulent	no	NAD	left	moderate	13	T	10	9
98	Veena	21	F	173557	student	7/31/2015	present	0.5	mucopurulent	no	NAD	left	moderate	8	T-1	12	11
99	Saraswathi	32	F	47361	teacher	8/1/2015	present	2	mucoid	no	NAD	right	moderate	14	T+CM	10	9
100	Mansoor	24	M	172144	shopkeeper	8/3/2015	present	1	mucopurulent	no	NAD	right	moderate	10	T+CM	8	8
101	Nawab	30	M	152169	driver	8/3/2015	present	3	mucopurulent	no	NAD	left	small	12	T	9	8
102	Gangappa	36	M	106218	labourer	8/10/2015	present	5	mucoid	no	NAD	right	moderate	14	T	11	10
103	Deepika	21	F	181645	technician	8/12/2015	present	0.5	mucoid	no	NAD	left	large	6	T	7	7
104	Heena Sulthana	34	F	159224	housewife	8/19/2015	present	3	mucopurulent	no	NAD	right	moderate	11	T	9	8
105	Lalitha	26	F	97708	housewife	8/26/2015	present	4	mucoid	no	NAD	left	large	11	T	12	11
106	Sahera	35	F	177143	teacher	8/29/2015	present	2	mucopurulent	no	NAD	left	moderate	14	T	11	10
107	lakshmi	26	F	177189	professional	8/29/2015	present	3	mucopurulent	no	NAD	right	large	12	T	10	9