



## DOES POST OPERATIVE SNHL DUE TO MASTOIDECTOMY INCREASE WHEN OSSICULOPLASTY IS COMBINED WITH IT.

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**ABSTRACT** **AIMS AND OBJECTIVES:** Sensory neural Hearing Loss (SNHL) after tympanomastoid surgery is often reported by many authors. The severity of this complication is often less emphasized by the surgeon as well as the patients because it is often presents as a temporary threshold shift in bone conduction, because the patients who undergo surgery are often hearing impaired and are not aware of previous bone conduction, and also because it usually presents as high frequency hearing loss which may not affect day to day life. In some cases it may present as a permanent threshold shift in mid frequency which may affect quality of life. **METHOD:** Post operative pure tone audiometry is collected on 1st month 3rd month and 6th month. Bone conduction of 0.5k, 1k and 2k are noted and an average of this 3 frequency is calculated. This average of pre-op, 1st visit, 2nd visit and 3rd visit for different surgeries compared **CONCLUSION:** A temporary threshold shift after hearing loss is noted in normal hearing frequencies in 1<sup>st</sup> and 2<sup>nd</sup>.

**KEYWORDS :** Tympanoplasty, Cortical mastoidectomy, Chronic suppurative otitis media, SNHL

### INTRODUCTION

When the sound is not conducted well through a disordered outer or middle ear the result is conductive hearing loss. When sensory or neural mechanisms within cochlea are not functioning properly it called a sensory neural hearing loss

The middle ear couples sound energy to the cochlea. As well as providing physical protection to the cochlea, the middle ear serves as an acoustic transformer to match the impedance of the air to the much higher impedance of the cochlear fluids. The middle ear apparatus also serves to couple sound preferentially to only one window of the cochlea, thus producing a differential pressure between the windows, required for the movement of the cochlear fluids

Bekesy evolved his traveling-wave theory: a sound impulse sends a wave sweeping along the basilar membrane. As the wave moves along the membrane, its amplitude increases until it reaches a maximum, then falls off sharply until the wave dies out. That point at which the wave reaches its greatest amplitude is the point at which the frequency of the sound is detected by the ear. And as Helmholtz had postulated, Bekesy found that the high-frequency tones were perceived near the base of the cochlea and the lower frequencies toward the apex."

Tympanomastoid Compartment surgery include surgeries like Tympanoplasty, Ossicular chain reconstruction, Canal wall up mastoidectomy, Open cavity mastoid surgeries, surgery for otosclerosis, surgery for implantable middle ear and bone conduction hearing device and all these can produce sensory neural hearing loss as their complication

Sensory Neural hearing loss can be attributed to trauma to intact ossicular chain from middle ear surgeries or from contacting ossicular chain with a high speed drill. SNHL may occur with Semi Circular Cannal fistula or an acoustic trauma.

All middle ear surgeries and particularly mastoid surgery has to potential to cause a temporary threshold shifts or sometimes permanent threshold shift. These temporary threshold shifts can usually be a result of a serous labyrinthitis or due to high speed drill induced thermal or acoustic No reliable study has been conducted on is conducted on relation of Ossiculoplasty an SNHL

### MATERIALS AND METHODS

Patients presenting to the outpatient department of ENT in ASRAM, Eluru who are having middle ear disease and also who underwent surgery for the same between August 2016 and March 2018

Details of the candidates are recorded at the time of first visit, including clinical and radiological findings. All patients undergoing mastoidectomies and ossiculoplasties are subjected to pure tone pre-operatively. Post operative pure tone audiometry is collected on 1st month 3rd month and 6th month. Bone conduction of 0.5k, 1k and 2k are noted and an average of this 3 frequency is calculated. This average of pre-op, 1st visit, 2nd visit and 3rd visit is compared. Significance in hearing gain or loss, between each visit to pre-op value and between

each visit is calculated and P value is measured. P value less than 0.005 is considered significant. Patients who had previous severe SNHL or degenerative disease or who had intracranial complications are excluded

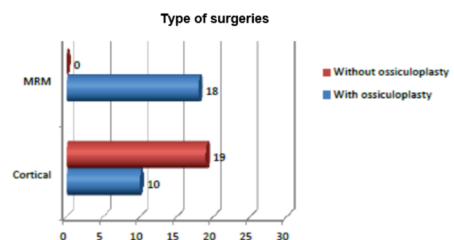
### OBSERVATIONS AND RESULTS

Out of 47 patients who underwent surgery 2 were below 10 years. They underwent mastoidectomy with ossiculoplasty. Majority of patient s were between ages 10 and 20 and most of them underwent ossiculoplasty and mastoidectomy. All of the patients who were included in the study were those who underwent surgery for CSOM.

There were few patients with B/L CSOM. In case of inactive mucosal disease the ear with more A-B gap was selected for surgery. In case of ear with Squamosal disease the severity of the disease and type (Active squamosal given priority over inactive squamosal) was considered. Those who presented with a inactive mucosal disease underwent myringoplasty. All the patients of this category had intact ossicular chain

All patients with intact ossicular chain underwent type 1 tympanoplasty and those with disrupted ossicular chain underwent ossiculoplasty. Autologous incus, PORP and TORP are used for ossicular reconstruction.

All patients who underwent MRM underwent ossiculoplasty as well but only 34.48% of patient who underwent cortical mastoidectomy underwent ossiculoplasty. Which gives an idea ossicles are eroded in almost all cases of Squamosal type active and but less in squamosal inactive and tubotympanic type. This reminds us the Scott Brown otorhinolaryngology and head and neck surgery 7th edition references which say pathology of ossicular erosion is same in both mucosal and squamosal disease but is more common in squamosal disease.



11 patients who was diagnosed to have CSOM inactive squamosal. Out of them 6 of them had intact ossicular chain. These patients underwent cortical mastoidectomy with myringoplasty. 5 had ossicular disruption and underwent ossiculoplasty stapes head to membrane or malleus

18 patients were diagnosed with CSOM active squamosal (Cholesteatoma). All the patients in the group had disruption of ossicular chain. All of them underwent canal wall down procedure. 1 underwent inside out technique, while others underwent modified radical mastoidectomy through a postauricular approach. All of them underwent ossiculoplasty as well. All of them had erosion of incus. A

few had erosion of stapes suprastructure as well. Ossiculoplasty was done accordingly. PORP, TORP, cortical bone and conchal cartilage are used for ossiculoplasties. 1 patient had a post aural fistula for which repair was done along with the surgery. The patients with facial nerve palsies who underwent facial nerve decompression are not included in the study as it is considered as a neurological complication of ear disease

Post op air conduction of the whole sample in different visit is compared with pre op air conduction. The change in AC or BC with improvement in hearing (decreased threshold) is mentioned as positive values and those with hearing deterioration (increased threshold) are mentioned as negative values.

SURGERIES	t- test value. P value in brackets (Significant P values specified with a * mark)					
	Pre op BC Vs 1 <sup>st</sup> visit of BC	Pre op BC Vs 2 <sup>nd</sup> visit of BC	Pre op BC Vs 3 <sup>rd</sup> visit of BC	1 <sup>st</sup> visit Vs 2 <sup>nd</sup> visit of BC	1 <sup>st</sup> visit Vs 3 <sup>rd</sup> visit of BC	2 <sup>nd</sup> visit Vs 3 <sup>rd</sup> visit of BC
CORTICAL + MYRINGOPLASTY	3.74 (0.0007*)	1.45 (0.08)	1.47 (0.07)	0.41 (0.343)	0.42 (0.33)	0.43 (0.31)
CORTICAL + OSSICULOPLASTY	2.65 (0.013 *)	1.91 (0.04 *)	1.91 (0.04 *)	0.44 (0.33)	0.44 (0.33)	0.01 (1.00)
MRM + OSSICULOPLASTY	3.61 (0.001*)	3.43 (0.001*)	0.28 (0.38)	3.10 (0.003*)	0.40 (0.30)	0.29 (0.38)

The above table compares 4 surgeries with comparison of pre-op bone conduction with bone conduction on different visit and their T-test value and P values are evaluated. P value less than 0.05 is considered significant.

On examining each surgery individually the P value for mastoidectomies are found to be significant for 1st visit, 2nd visit and in some cases 3rd visit also produced significant P value suggesting an increase in hearing threshold. When MRM is combined with ossiculoplasty it resulted in a permanent threshold shift in few cases when compared with cortical.

But it is clear that ossiculoplasty when combined with mastoidectomy is producing more significant temporary threshold shift than a mastoidectomy alone in at least up to 2<sup>nd</sup> post op visit.

Here we have to remember that SNHL due to ossiculoplasty unlike in mastoidectomy not due to acute noise induced hearing loss but due to a serious labyrinthitis (temporary) or a acoustic trauma (Permanent).

There are studies which claims that a acute noise induced hearing loss can be reversed by post operative steroids but acoustic trauma cannot be.

Even though there are published documents which is well accepted and debated among otorhinolaryngologist that all middle ear surgeries (even a myringoplasty) can result in sensory-neural hearing loss, most of the surgeons consider

1. Acoustic trauma generated from drill
2. Acute noise induced hearing loss due to drill
3. Labyrinthitis serous or purulent post surgery
4. Perilymphatic Fistula post surgery
5. Round window rupture
6. Mantling with ossicles during ossiculoplasty mainly stapes
7. Accidental drill contact to ossicular chain
8. Laser exposure to inner ear during surgery for otosclerosis
9. Heating of inner ear fluid by endoscope while doing a endoscopic ear surgery
10. Even a general anaesthesia can sometimes produce a sensori-neural hearing loss
11. The sound of the suction tube As causes of sensori-neural hearing loss after middle ear surgery

In our study we are not evaluating all the causes but concentrating on the causes of SNHL which affect normal hearing (mean BC .5k, 1k, 2k,) due to

1. Drill or suction induced hearing loss (acoustic trauma /acute noise

induced hearing loss).

2. Sensori-neural hearing loss due to handling of ossicles in stapedotomy and ossiculoplasty (acoustic trauma / perilymphatic fistula)
3. Whether this SNHL causes a permanent threshold shift.

Kylen and Arlinger in 1976 calculated the drill induced noise levels in the cochlea from vibration measurements performed on intact skulls and temporal bones of human cadavers. They concluded that the ipsilateral cochlea was exposed to a noise level of 100dB and the contralateral cochlea to 5dB to 10dB lower. They concluded that noise trauma may in fact have been responsible for some of the high-frequency sensori-neural hearing losses after tympanoplasty. In our study high frequency hearing loss was not investigated. Our study shows type 1 tympanoplasty does not produce hearing loss in mid and low frequencies.

Spencer MG in 1980 reported when a group of twenty-four ears is investigated and the noise levels generated by the suction tube are measured at operation by means of a probe microphone lowered into the external auditory meatus. The conclusions reached are that, although the sound levels attained are at times quite high, they are not of sufficient amplitude, nor are they present for a sufficient length of time, to produce a sensori-neural hearing loss. Our study agrees with this report. There is no over all Bone conduction threshold reduction in myringoplasty group post surgery at any visit but a mild gain in Bone conduction is observed.

Post operative reduction after mastoidectomy often remains unreported because.

- 1) Usual insult is to basal turn of cochlea which results in a high frequency hearing loss. A high frequency hearing loss may not often affect quality of life and don't produce discomfort since the subject may have good hearing in frequency around human voice.
- 2) The post operative hearing loss is often a temporary threshold shift which often come to normal within 1 week. So by the time ear heals BC may come back to normal.
- 3) Most of the patient who undergo surgery for hearing reconstruction have a wide AB gap. The hearing gain in air conduction is often larger when compared to hearing reduction in bone conduction. So patient may not be only aware of bone conduction depression
- 4) Post op measurement of bone condition immediately after surgery or on 1st or 2nd day is often difficult because the middle ear and external ear component of bone conduction may show misleading values.

**TYMPANOMASTOID SURGERIES AND SNHL**

Tympanomastoid Surgeries are done for middle ear diseases. The surgery includes simple surgery like myringotomy to surgeries like modified radical mastoidectomy and facial nerve decompression. The surgeries which we are concerned in this study are tympanoplasty, Ossiculoplasty, Cortical mastoidectomy, Modified radical mastoidectomy and stapedotomy. All Surgeries are prone for post operative SNHL

In tympanoplasty SNHL may result while

1. Noise produced by suction apparatus. Suction apparatus in middle ear is believed to produce a sound of around 30-40dB.
2. Drill used in canaloplasty may result in noise induced hearing loss. Usually a temporary shift in tympanoplasty
3. All middle ear surgery may cause inflammatory cells to enter middle ear through round window which result in a low grade serous labyrinthitis. And this may result in mild SNHL which is usually a temporary shift which may revive completely in 7 days.
4. Drills for mastoid surgeries is considered as one of the major cause for post surgery hearing loss. Drill induced hearing loss are categorised as acoustic trauma by some surgeons and as acute noise induced hearing loss as some surgeons. The difference is that hearing loss due to an acoustic trauma will never improve as that with acute noise induced hearing loss may improve completely or improve partially leaving residual hearing loss .Especially if corticosteroids are administered in post op period.

Most of the hearing loss induced by drill are found to be temporary threshold shift, while permanent threshold shift are also noted rarely. These affect high frequencies usually 2000Hz and above. It is

published by P. kylen that larger burr produce more noise trauma. Cutting burr produce more noise than diamond burr and low RPM speed is also another factor which may result in noise trauma.

Most of the drill induced hearing loss categorised as acute noise induced hearing and is usually a temporary threshold shift of high frequencies which the patients or the surgeons are not aware of and only noted in a audiometry since it does not affect the quality of life and is under reported. The heat generated by drill is considered as another factor which result in a drill induced hearing loss.

- 5) Acoustic trauma will result in tissue damage to cochlea mainly the upper basal turn. Since the basal turn is selective for high frequency, usually the higher frequency is affected more than the lower frequency.

Acoustic trauma can be due to drill sound, or accidental contact of drill to ossicles or due to manipulation of ossicles mainly stapes. Movement of footplate of stapes can result in sudden displacement of perilymph which causes damage to organ of corti in upper basal turn.

- 6) Peri lymphatic fistula or a round window rupture during surgery itself can result in a cochlear damage and a post operative sensorineural hearing loss. If such an ear is infected it may lead to a suppurative labyrinthitis and result in a severe sensorineural hearing loss.
- 7) Thermal injury of inner ear may in turn causes damage to neurosensory organ of inner ear and in turn may cause sensory neural hearing loss. Most commonly seen in Endoscope assisted ear surgery. An Endoscope in middle ear can increase the temperature of middle ear from 40-60 degree which in turn cause heating of perilymphatic fluid and cause damage to neurosensory organ of inner ear. Withdrawal of endoscope in specific interval and reintroducing it can reduce the complication.

Another reason for thermal injury to middle ear is due to use of mastoid drills. Especially when the drill is in close proximity to inner ear, while drilling around lateral semi-circular canal, drilling around horizontal part of facial nerve and drilling for stapes surgery. It is proved that diamond burr produces more heat during drilling than a cutting burr. Copious irrigation and intermittent drilling can limit the thermal trauma to middle ear.

Use of lasers is another proposed causes for thermal injury to inner ear. The laser used in stapes surgery considered to be a significant cause post surgery SNHL in otosclerosis patient. How ever there are many studies that conform that the presently used CO<sub>2</sub> is never a threat.

- 8) Hearing loss after a general anaesthesia is noted. But no studies are available to pin point a drug. It is generally believed that NO is responsible of hearing loss. Other drugs proposed are propofol and fentanyl. These drugs can cause a temporary threshold shift, or a permanent threshold shift.

#### LIMITATIONS OF THIS STUDY

- The insult (Thermal, chemical, mechanical or noise induced) to middle ear as a result of tympanomastoid surgeries usually affect upper part of basal turn of cochlea which often result in a high frequency hearing loss. But our study is concentrated on hearing loss in mid frequencies which affect the quality of life.
- Most of authors have reported that the hearing loss after the middle ear surgeries are often transient in nature with a temporary threshold shift. A large majority may return back to normal in 1 week and some within 1 month. These patients may be reported as those with normal hearing in our study.
- The gelfoam kept in middle ear may not be completely absorbed by 1 month and this may affect the pathway of bone conduction due to middle ear component and outer ear component This can present as false increased bone conduction threshold in first visit which may improve in 2nd visit.
- Post bone conduction may give a false audiometry graph if the vibrator is placed over the post operative mastoid cavity. Vertex bone conduction audiometry with masking of opposite ear can be done but the efficacy is still a question mark. We kept the bone vibrator over the mastoid for all cases.
- The no of patients included in stapedotomy is relatively small and is less reliable compared to other groups.
- Tinnitus which developed post operatively after mastoid surgery is

an indication for post-operative sensory neural hearing loss. The relation to post operative tinnitus and sensory neural hearing loss is not studied at all.

- Hearing threshold of each frequency which may give an idea the cause of hearing loss is not studied.
- The status of SNHL post-operatively in opposite ear is not studied.
- There are a few cases which developed significant SNHL in 3rd visit alone. Other causes of SNHL like ototoxicity neuropathies, reparative granulomas are not ruled out
- The exact noise produced by the drilling machine or the exact duration of drilling for each surgery, the effect of each size and type of burr etc are not recorded and studied

#### CONCLUSION

1. There was increase in BC threshold between pre operative and post operative audiometry taken on post op day 30 which conclude a temporary threshold shift.
2. The incidence of mild sensorineural hearing loss after middle ear surgery in immediate post operative period is quite high and often goes undetected
3. On taking individual surgery mastoidectomy and ossiculoplasty are the surgeries which may have more chances to Sensori-neural hearing loss.
4. Acute noise induced hearing loss due to drilling is considered as most common risk factors for post operative sensori-neural hearing loss not only for high frequencies but also for low and mid frequencies.
5. Duration of ear discharge, or size of perforation had no effect on component of threshold shift after surgery.
6. Routine mastoidectomies in patients with dry ear should be discouraged unless it is necessary.
7. Present method of Bone conduction method by placing bone vibrator over the mastoid is less accurate for immediate post-operative period because of various reasons (mentioned in limitations of the study). Vertex audiometry with masking of non test ear is suggested but the efficacy is still a question mark.

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