

# Ossicular chain status in ear pathology cases

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## Abstract

**Introduction:** The tympanic cavity contains three ossicles in humans, the malleus, incus and stapes. These ossicles form a chain across the tympanic cavity from the tympanic membrane to fenestra vestibuli respectively. They develop from mesenchymal condensation of tubotympanic recess at the 6<sup>th</sup> week of intrauterine life. Later due to programmed cell death a part of tissue remains as ossicles. It attains adult size in the fetal life itself. However, studies have shown gain in size and weight even 2 years after birth. The ossicles help in sound conducting mechanism in hearing. These ossicles are vulnerable to damage in the various diseases of the middle ear cleft resulting into either partial or total loss. Incus is the most, followed by stapes and least by malleus. 20% mucosal diseases show ossicular damage, while squamous epithelial disease involve in 80% [1,2]. The integrity of the ossicular chain is most important for the transmission mechanism of external sounds to the inner ear fluids.

**Objectives:** 1. To study the percentage of ossicular damage in the diseases of the middle ear cleft among the patients being operated for chronic suppurative otitis media in our tertiary care hospital.

2. To assess the extent and frequency of individual ossicular chain involvement in simple mucosal disease and squamous epithelial diseases.

**Methods:** A prospective clinical study was conducted in our tertiary care hospital over a period of five and a half years in our tertiary care hospital among 100 cases of chronic suppurative otitis media after ethical committee clearance. Detailed clinical and radiological examinations of the patients were done and ossicular chain status was noted on table. Patients were also called up for regular follow up.

**Results:** Ossicular chain erosion was mostly seen in squamosal disease, with incus and incudo-stapedial joint being the most common sites for ossicular erosion.

**Conclusion:** it was concluded that long process of incus was the most commonly eroded structure, with the incus being the most commonly involved ossicle. Few factors that were found to be associated with ossicular erosion were atticofacial disease, pediatric age group and bigger tympanic membrane perforations.

**Keywords:** CSOM, Ossicles, Ossicular chain, PTA-pure tone audiometry.

## Introduction

Chronic suppurative otitis media (CSOM) is an important clinical disease involving middle ear cleft, more prevalent in developing countries causing various complications including hearing loss due to involvement of the ossicles. There are two types of CSOM described in literature: tubotympanic considered as safe variety and atticofacial disease considered as unsafe variety.<sup>[3,4]</sup>

Various reasons and mechanisms for destruction of ossicles are described few of them are as follows:

Overproduction of cytokines, interleukins, TNF alfa

(Tumour necrosis factor alpha), platelet derived growth factor in the inflammatory conditions which induce increased blood supply locally and enhance osteoclast activity which results in bone resorption.<sup>[5]</sup>

Granulation tissue formation causes increased production of fibroblast derived growth factor which results in increased neovascularization and bone destruction.

It has been a general view that bigger the size of perforation and perforation in the posterior inferior quadrant will have more hearing loss.

Pathological conditions resulting in ossicular chain

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damage will cause more hearing loss. A complete disruption of ossicular chain can result in 60 dB loss, total tympanic membrane perforation can cause a loss of 40 dB.

#### Objectives:

- To study the percentage of ossicular damage in the diseases of the middle ear cleft.
- To assess the extent and frequency of individual ossicular chain involvement in simple mucosal disease and squamous epithelial diseases.

#### Methodology

It is a prospective clinical study from Nov 2015 to April 2021 carried out in our department. A total of 100 cases of CSOM (Chronic suppurative otitis media) were included in the study after institutional ethical committee clearance. All patients were subjected to detailed history, clinical examination, investigations such as audiometry, microscopy, otoendoscopy, routine blood investigations, serology, urine tests, culture sensitivity of the ear discharge (if present) and a CT scan mastoid and temporal bone for cases (if required). After informed consent, diseased ear was explored as per standard procedure and ossicular chain status was noted, mobility of joints was tested by round window reflex. The patients underwent tympanoplasty with or without cortical mastoidectomy or modified radical mastoidectomy. The type of surgery was decided on table based on the type of disease, size of tympanic membrane perforation, presence of tympanosclerosis, ossicular chain status of the patient, preoperative hearing status of the patient, etc. Ossicular reconstruction was done whenever required using homograft cartilage. Postoperatively regular follow up of patient was done by PTA (Pure tone audiometry), A-B gap (Air-Bone gap) was recorded.

#### Results

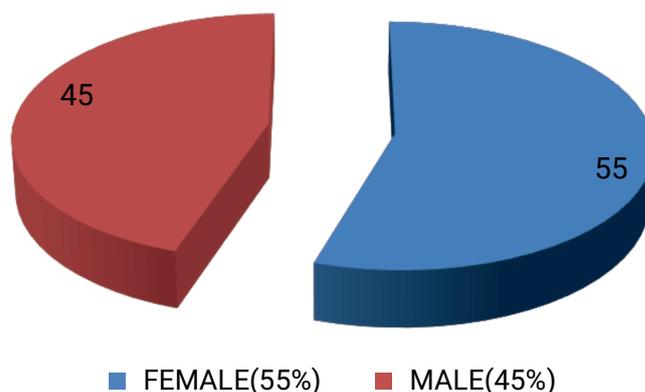
A total of 100 patients were included in the study, out of which 78 patients (78%) were safe type CSOM and 22 patients (22%) were unsafe type CSOM. The age of patients varied from 6 years to 60 years. The incidence of patients was maximum between 25-40 years of age- 40 in number (40%) (Table 1). There were 45 (45%) male patients and 55 (55%) female patients (Fig.1). Left ear was involved in 54 (54%) patients versus right ear in 46 (46%) patients. Table 2 gives the details of various clinical presentations of the patients. All patients underwent ear surgery by standard method.<sup>[6,7,8]</sup> The results were recorded as in fig. 2 and table 3 and table 4. Each patient was followed up weekly for 1 month, monthly for 3 months and once in 3 months for a period of 1 year.

Hearing status of the patients in follow up visits were recorded and is shown in table 5. Graft status in the follow up visits is shown in table 6. Observations of the audiometric evaluation done in 3<sup>rd</sup> month of follow up are shown in table 7. Majority showed hearing improvement following surgery and minority group 12 (12%) showed about 10-20 dB hearing loss. This may be due to post operative fibrosis, adhesions, etc. This possibility of hearing loss has to be informed to patients before surgery.

**Table 1: Age wise distribution of patient**

Age (years)	Number	Percentage
5 -15	11	11%
16 -25	21	21%
25-40	40	40%
41 -55	22	22%
56 and above	06	6%

Table 1 gives the number of patients in each age group, maximum patients being in the age group of 25-40 years



**Figure 1: Sex wise distribution of patients**

Figure 1 shows that there were 55 female patients and 45 male patients included in the study

**Table 2: Clinical presentation of patients**

Symptoms	Number of patients	Percentage
Ear discharge	100	100%
Hearing loss	100	100%
Aural polyp	15	15%
Post aural abscess	05	5%
7th nerve palsy	00	0%
Post aural fistula	03	3%
Giddiness	04	4%
Tinnitus	04	4%

Table 2 gives the various clinical presentation with which the patients presented to the OPD

**Table 3: Intra operative findings- ossicles**

	Malleus	Incus	Stapes	I-S joint	I-M joint
EROSION	06(06%)	15(15%)	11(11%)	15(15%)	08(08%)
SAFE	02(2%)	02(2%)	01(1%)	02(2%)	00
UNSAFE	04(04%)	13(13%)	10(10%)	13(32%)	08(08%)

(I-S joint: incudostapedial joint, I-M joint: incudomalleolar joint)

Table 3 shows that incus was eroded in maximum cases. Ossicular chain erosion was more common in unsafe CSOM

**Table 4: Other findings**

	Cholesteatoma	7th nerve involvement	Polyp	SCC erosion	SP erosion	DP erosion	PA involvement
Safe	2(2%)	0(0%)	04(4%)	0(0%)	0(0%)	0(0%)	0(0%)
Unsafe	20(20%)	00(0%)	08(08%)	02(2%)	04(4%)	03(3%)	01(1%)

(SCC-semicircular canal, SP-sinus plate, DP-dural plate, PA-petrous apex)

Table 4 shows other findings that were noted during surgery

**Table5: Hearing status on follow up**

Hearing Improvement (Group A)	10-20 dB	21-30dB
No. of Patients (78)	58	30
Hearing worsened (Group B)		
No. of Patients(12)	12	00

Table 5 shows that there was hearing improvement in 88 patients and hearing deteriorated in 12 patients during the follow up audiometry

**Table 6: Condition of the graft over months**

Status	1 Month	3 Months	6 Months	12 Months
Graft intact	100	100	90	90
Percentage	100%	100%	90%	90%

Table 6 shows that there was a good graft survival rate over a period of one year

## Discussion

In this study a total of 100 patients of CSOM were included for evaluation of ossicular status. The cases were divided into safe CSOM 78 patients (78%), unsafe CSOM 22 patients (22%), 4 cases diagnosed clinically as safe CSOM were confirmed to be unsafe CSOM intraoperatively.

The duration of ear discharge ranged from 6 months to 20 years and hearing loss was present in all patients. Hearing loss was present in all patients, more common with history of long standing ear discharge. Initially patient failed to recognize minor hearing losses, it was noticed only after the disease had progressed to severe extent to cause significant impairment in hearing. Audiological profile showed 57dB hearing loss when all 3 ossicles found eroded.

The concept of reconstructive middle ear surgery was introduced via tympanoplasty by Mortiz (1952) and Zollner and Wullstein (1953). After introduction of Zeiss operating microscope it became a landmark

achievement in the otologic surgical outcome. Incus was found to be the most common ossicle to get necrosed (attributed to delicate blood supply) in our study. It was found to be eroded in 15 patients(15%). The common site was lenticular process followed by long process. Unsafe CSOM was the cause in 13 cases(13%) and safe CSOM in 2 cases(2%). Udaipurvawla et.al, Varshney et.al had similar incidence of necrosis of incus 41% and 37% respectively<sup>[9,10]</sup>. On contrary Rout et.al had shown involvement of incus of very low incidence of about 17%.<sup>[11]</sup>

Stapes was found to be eroded in 11 cases (11%) in our study. Unsafe CSOM had caused erosion of suprastructures in 10 cases (10%)- mostly posterior crura. 1(1%) stapes erosion was found in a patient with safe CSOM. Footplate of stapes was intact in all patients(0% erosion). Austin et al has reported stapes erosion 15.50%, Sade et al reported 36% and Varshney et al 31%.<sup>[12,1,10]</sup>

In our study, malleus was found to be eroded in least number of patients -06 cases (06%). Unsafe CSOM had malleus involvement in 04 cases (04%) and Safe CSOM in 2 cases (2%). Handle of malleus was more commonly involved by disease process than other parts. Thus, it is a more resistant ossicle compared to other two. Our study has shown similar results as that of Murthy GSN et al.<sup>[13]</sup> However Sade et al found higher incidence of about 6% involvement in safe CSOM.<sup>[1]</sup> Varshney et al reported 18 cases (12%).<sup>[10]</sup>

Post operative audiometry evaluation is an important tool to assess the hearing. In our study we routinely undertook a pure tone audiometry in the third post operative month. Majority 88 (88%) showed improvement while 12 (12%) showed worsening. This was similar to the study conducted by De vos.c.et.al and Podoshin et.al.<sup>[14,15]</sup>

We usually avoid childhood ear surgeries unless unsafe ear diseases, where the need for immediate surgery is a must for safety of the person. This is similar in studies by Tos.M.et al and Podoshin et al.<sup>[16,15]</sup>

Tympanosclerosis, myringosclerosis and plaque were observed as an associated finding in 12 patients (12%) involving tympanic membrane, ossicles and middle ear (as a process of healing). It will also contribute for hearing loss due to mechanical impediments.<sup>[17]</sup> There are no studies done to assess the exact amount of decibel loss produced by above mechanisms.

### Conclusion :

Our study concludes that ossicular involvement is more common in unsafe chronic suppurative otitis media, but not exclusive to it. Ossicular erosion was seen in seven patients with safe chronic suppurative otitis media and in forty eight patients with unsafe chronic suppurative otitis media. It was seen that hearing loss of less than 40 dB indicated no ossicular involvement. Long process of incus is the most common ossicle involved. 15% showed ossicular chain involvement in the form of incus necrosis. Long histories of ear discharge, bigger tympanic membrane perforations and pediatric age group had higher rates of ossicular involvement. Hence, the ear problem is to be addressed at the earliest to save hearing.

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