

## Ossicular Chain Erosion in Chronic Suppurative Otitis Media

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### Abstract

**Objectives:** Hearing restoration surgery in chronic otitis media consists of myringoplasty for drum repair and ossiculoplasty for ossicular defect if present which carries a lower success rate and higher probability of revision surgery. Our objective is to evaluate the frequency of ossicular erosion in chronic suppurative otitis media which could be utilized to predict the probability of need for ossiculoplasty preoperatively then patients could be properly consented about these potential issues.

**Materials and Methods:** A prospective study was conducted in Otolaryngology unit of Hamad Medical Corporation. 279 ears that underwent surgery for chronic otitis media were studied and their ossicular status was reported.

**Results:** Ossicular chain was eroded in 66 (23.66%) out of the 279 ears. Erosion was more frequent in cholesteatoma ears (69.3%) than in safe ears (13.9%). The most frequently impaired ossicle was the incus and was found eroded in 62 (22.2%) ears. Malleus was found to be the most resilient ossicle and was eroded only in 13 (4.7%) ears. The stapes was eroded in 31 (11.1%) ears.

**Conclusion:** Our study shows that in chronic otitis media, approximately one-third patients have ossicular chain discontinuity. More than two thirds of patients with cholesteatoma have ossicular chain discontinuity. Otolaryngologists should be competent enough to do ossiculoplasty during ear surgery to give the best hearing results to their patients.

**Keywords:** Ossicles; CSOM; Erosion; Cholesteatoma

### Introduction

Chronic Suppurative Otitis Media (CSOM) is a prevalent middle ear pathology that constitutes of tympanic membrane perforation together with a chronically inflamed middle ear mucosa.

CSOM can occur with or without cholesteatoma which is an in-growth of eardrum skin into the middle ear cavity.

CSOM is the leading cause of conductive hearing impairment in adults which is secondary to damage of the ear drum and middle ear ossicles induced by chronic inflammation present in the tympanic cavity. Ossicular erosion, a frequent complication of CSOM, may lead to total failure of middle ear mechanics and resulting in substantial hearing loss [1].

Hearing restoration surgery comprises ear drum repair and ossicular chain reconstruction in ears housing defective ossicles. The later scenario is associated with higher rate of long term acoustic failure that may reach 50% [2,3]. Myringoplasty in the absence of ossicular damage is bracketed with a much higher long-term success rate more than 90% even in wet ears [4].

Ossicular integrity or erosion can only be confirmed intra-operatively. The preoperative information given to the patient must be comprehensive, and should include details of the probabilities of

having OCD and the associated risks of acoustic failure and need for revision surgery.

This study was conducted to assess middle ear ossicles state of in 279 ears that required surgery for CSOM. The findings of this study could be exploited to predict preoperatively the probability of having OCD in CSOM ears and thus patients could be therefore properly consented about these potential issues before surgery.

### Materials and Methods

Ethical approval for this study was received from the JIRB (Joint Institutional review board) of our institution (IRB Number 14-00133).

We conducted a prospective study in our institution in the period running from January 2014 to June 2015.

Patients older than 18 who underwent tympanoplasty for CSOM during this period were recruited to our study. Patients younger than 18 or posted for revision tympanoplasty were excluded. Written informed research consent was obtained from recruited subjects.

Recruited subjects were interviewed preoperatively by the senior author for history taking and proper ear examination.

Intraoperatively, all patients had proper exploration of middle ear using microscope and endoscope looking and the status of each ossicle were checked. The presence of cholesteatoma was also checked.

Statistical analysis was done using Statistical Package for Social Sciences v.13.0 (SPSS inc., Chicago, USA). P values less than 0.05 were considered to be statistically significant.

## Results

211 patients with CSOM were recruited for this study and a total of 279 ears were included. 34 patients had both ears included which were operated sequentially. The average age was (33.4 ± 8.9). 179 (84.8%) out of the 211 patients were younger than 40. There was 141 male (66.8%) and 70 female (33.1%). The most common complaint was recurrent otorrhea present the majority of the ears (89.2%), the next most common complaint was hypoacusia and was present in 213 ears (76.3%). Examination findings showed that most of the ears had safe CSOM (230 ears; 82.5%). While only 49 ears (17.5%) had cholesteatomatous or unsafe ear.

### Intra-operative findings

Intra-operative middle ear exploration matched completely our pre-operative diagnosis; none of the patient who presumed to have

safe ear turned to have cholesteatoma and vice versa. Overall, the ossicular chain was eroded in 66 ears out of the 279 (23.66%). In non-cholesteatomous ears, the ossicular status was intact in 198 ears (83.8%), eroded in 32 ears (13.9%). In cholesteatoma ears, the ossicular status was intact in 15 cases (30.8%), eroded in 34 ears (69.3%).

### Ossicular erosion

**Malleus (Table 1):** It was found intact in 266 (95.34%), eroded in 13 (4.66%) ears. Malleus erosion was associated with incus erosion in all of the cases except one ear. In safe CSOM (total of 230), 228 (99.13%) of the ears had intact malleus. Only two ears (0.87%) had erosion of the malleal handle; one of the two ears had isolated erosion of the handle, the second one was associated with incus long process erosion. In cholesteatomous ears (total of 49), the malleus was found intact in 38 (77.5%), eroded in 11 (22.4%). Erosion involved the head of malleus in 7 ears, the handle of the malleus in 3 ears and the whole malleus (head and handle) in 1 ear.

Malleus	CSOM (%) n=279	Non-cholesteatomous ears (%) n= 230	Cholesteatomous ears (%) n=49	P value
Intact	266 (95.3%)	228 (99.1%)	38 (77.5%)	0.028*
Handle necrosed	5 (1.8%)	2 (0.9%)	3 (6.1%)	0.000*
Head necrosed	7 (2.5%)	-	7 (14.1%)	0.016*
Handle+ Head	1 (0.4%)	-	1 (2%)	0.223

\* Statistically significant

**Table 1:** Malleus status in chronic suppurative otitis media (CSOM).

**Incus (Table 2):** We found the incus intact in 216 (77.4%) and eroded in 63 (22.6%) ears. Incus erosion was most frequently localized to the lenticular process (34 ears) and to the long process (29 ears). In non-cholesteatomous ears, it was intact in 199 ears (86.5%) and eroded in 31 ones (13.5%) in which erosion were most frequently localized to

the lenticular process 19 ears. In cholesteatoma ears, it was found intact in 17 (34.7%) and eroded in 32 (65.3%). Lenticular process was anew the most frequently involved portion in 16 ears (32.6%), next most common was the long process in 15 (30.6%) ears. The incus was completely absent in 1 case.

Incus	CSOM (%) n=279	Non-cholesteatomous ears (%) n= 230	Cholesteatomous ears (%) n=49	P value
Intact	216 (77.4%)	199 (86.5%)	17 (34.7%)	0.000*
Lenticular process	35 (12.5%)	19(8.3%)	16 (32.6%)	0.54
Long process	27 (9.6%)	12 (5.2 %)	15 (30.6%)	0.016*
Absent	1 (0.4)	-	1 (2%)	0.000*

\* Statistically significant

**Table 2:** Incus status in chronic suppurative otitis media (CSOM).

**Stapes (Table 3):** It was respected in 248 (88.9%) ears and eroded in 31 (11.1%) ones. The disease respected the footplate in all the cases and erosion was localized solely to stapes superstructure and was associated with incus erosion in all of the cases. Stapes erosion was infrequent in safe ears; it was present in 5.6% of the cases only.

Conversely, the presence of cholesteatoma was associated with stapes superstructure erosion in most of the ears (63.3%).

Stapes	CSOM (%) n=279	Non-cholesteatomous ears (%) n= 230	Cholesteatomous ears (%) n=49	P value
Intact	248 (88.9%)	217 (94.3%)	18 (36.7%)	0.008*
Superstructure erosion	31 (11.1%)	13(5.6%)	31 (63.3%)	0.000*

\* Statistically significant

**Table 3:** Stapes status in chronic suppurative otitis media (CSOM).

## Discussion

We analyzed data collected from a sample size of 279 ears with CSOM to ascertain their ossicular chain status. 49 out of the 279 operated CSOM ears (17.6%) had associated cholesteatoma.

Most of our patients were young which likely reflect increased health awareness among the population of Qatar with easy access to government sponsored medical care, especially, when hearing impairment affects work efficiency. The male to female ratio in our study was almost 2:1 in contrast to previously reported literature which showed almost equal gender distribution [1-4]. The possible explanation for males predominance could be that in the rapidly developing State of Qatar, the majority of the population is male expatriate workers and laborers.

OCD was evident in 66 (23.6%) ears. The most frequently impaired ossicle in both types of CSOM was the incus. It was found unscathed in 216 (77.4%) cases, eroded in 62 (22.2%) cases and absent in 1 (0.4%) case. The majority of the observed erosions were localized to the lenticular process in 35 (12.5%) ears and the long process in 27 (9.6%) ears. Hence, incudal erosion was observed to be the most prevailing ossicular pathology in cases of CSOM correlating with preceding studies in which the prevalence ranged from 20 to 30% [5,6].

Malleus was the most defiant and resilient middle ear ossicle. It was respected in more than 95% of studied ears. In cases of rare malleal involvement, erosion affects mostly the head of the malleus and spares the handle. This could be attributed to the firm attachment of the handle to the tympanic membrane which acts as a mechanical barricade and allows adequate blood flow to the handle. The combined effect diminishes the risk of malleus handle necrosis.

The stapes was unviolated in 248 (88.9%) ears and its superstructure was involved in 31 (11.1%) ears with CSOM. The presence of stapedia necrosis in all cases of CSOM was found to be less than that documented in former literature [1,5,7].

Our results showed that OCD is much more prevalent in cholesteatomous ears (69.3%) vs. in non-cholesteatomous CSOM ears (13.9%).

In non-cholesteatomous ears (230), incus was eroded in 31 ears (13.5%). Incus erosion was most frequently localized to the lenticular process in 35 (12.5%) ears followed by long process in 27 (9.6%) ears. Necrosis typically spared the body of the incus. Malleus handle was eroded in 2 (0.9%) ears; both of them had subtotal perforations. Stapes was eroded in 13 (5.7%) ears.

It is hypothesized that middle ear ossicles damage in CSOM is induced by an active phenomena of osteoclastic osseous resorption rather than by a passive avascular necrosis [8]. The suggested mechanism for bony erosion is excessive formation of inflammatory mediators in the tympanic cavity which induces osteoclast activation

and bony resorption resulting in ossicular destruction. The duration of the inflammatory process and its vicinity to the ossicular chain are factors which appear to be the most harmful for the ossicles [9,10]. The factors that may explain that the incus lenticular and long processes being more vulnerable are possibly their tenuous blood supply, noticeable bone marrow, and their exposure to the external milieu especially in posterior perforations [11,12].

Resorption of malleus handle is more common in subtotal perforations where the handle is completely exposed to the external environment together with the cumulative effect of reduced blood supply from the drum.

The presence of cholesteatoma is associated with a higher prevalence of ossicular erosion. It is also associated with two or more ossicles being affected simultaneously. In our study, ossicular erosion in cholesteatomous ears was as follows: incus 65.3%, malleus 22.5%, and stapes 63.3%. In a study by Kurien et al. these figures were: incus 100%, malleus 67%, and stapes 67% [13]. In another study by Garap and Dubey, the figures were: incus 89%, malleus 32%, and stapes 41% [14].

In cholesteatomous ears, incudal erosion was most frequently localized to the lenticular process (32.6%) and the long process (30.6%).

Malleus erosion is a common occurrence in cholesteatoma (22.5%). Sade et al. reported erosion of malleus in around 26.0% in unsafe CSOM which correlates well with our finding [7]. Malleus erosion due to cholesteatoma was mostly localized to the head of the malleus which occurs most of the time in conjunction with erosion of the body of the incus due to attical extension of the cholesteatoma.

Stapes erosion occurred frequently in the presence of cholesteatoma, it was eroded in more than 60% of cholesteatomous ears. Stapedia necrosis numbers were found to be higher than reported by previous studies [7]. One possible explanation is that our patients were experiencing severe cholesteatoma since we are tertiary referral center and we manage more advanced stages of the disease.

The hypotheses of bone erosion in cholesteatoma ears involve several mechanisms including among others pressure induced erosion and enzymatic destruction by inflammatory products secreted by cholesteatoma matrix [15,16].

Despite the increased health awareness among the population of Qatar with easy access to government sponsored medical care, ossicular chain erosion remains to be a frequent and common complication of CSOM in Qatari population. We think that the patients are referred to tertiary care center for surgical treatment only in advanced stages of the disease. It is known that inflammation in the tympanic cavity is more damaging to middle ear ossicles the longer it stays [9,10].

Studying the frequency and the extent of OCD in CSOM is important as it helps surgeon to predict pre-operatively its probability according to the patient's disease. The presence of extensive OCD implies difficulty of restoring the hearing during a single procedure, and the possible need for revision surgery. So as Otolaryngologists we should be competent enough to do the ossicular chain reconstruction during surgery to give the best hearing results to our patients. Patients must therefore be fully informed and consented about these potential issues before surgery.

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