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Intra operative Ossicular Status in CSOM

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ABSTRACT

Background: Chronic Suppurative Otitis Media is characterized by ear discharge and hearing loss. Hearing loss is because of tympanic membrane dehiscence and oscular chain destruction. Oscular chain destruction can occur in both types of CSOM. Reconstruction of the tympanic membrane along with oscular reconstruction will give cent per cent result.

Objective: To study incidence of oscular chain pathology in CSOM and frequency of involvement of each oscicle.

Material and Methods: 150 patients of CSOM were selected and were subjected for clinical examination, pure tone audiometry and CT scan of temporal bone. These patients were subjected for different types of meddle ear surgery and their intra operative oscular status was recorded.

Results: Oscular chain involvement is seen in both types of CSOM and more often in unsafe type of CSOM. Incus is the most commonly affected oscicle while Malleus is the least affected.

Conclusion: Otolaryngologists should be competent enough to do the proper oscular chain reconstruction during middle ear surgery to give the best hearing result to the patient.

KEYWORDS : CSOM, Malleus, Incus and Stapes

Introduction

Hearing is one of the vital senses of man. Deafness upsets the tranquility of life. When such a great vital sensation is lost, life naturally loses its charm. Chronic suppurative otitis media is characterized by chronic, intermittent or persistent discharge through a perforated tympanic membrane. There are two types of chronic suppurative otitis media. Both should be considered as distinct and separate entities. Both present with conductive deafness and discharge. In both, discharge is through a perforated drum. While one is safe the other is unsafe with potentially serious complications.

Both types of CSOM, may lead to erosion of the ossicular chain. This propensity for ossicular destruction is much greater in cases of unsafe CSOM, due to the presence of cholesteatoma and/or granulations [3]. The proposed mechanism for erosion is chronic middle ear inflammation as a result of overproduction of cytokines—TNF alpha, interleukin-2, fibroblast growth factor, and platelet derived growth factor, which promote hypervascularisation, osteoclast activation and bone resorption causing ossicular damage. TNF-alpha also produces neovascularisation and hence granulation tissue formation. CSOM is thus an inflammatory process with a defective wound healing mechanism [4]. This inflammatory process in the middle ear is more harmful the longer it stays and the nearer it is to the ossicular chain [5]. Pathologies that interrupt the ossicular chain result in large hearing losses. Complete disruption of the ossicular chain can result in a 60 dB hearing loss that affects normal conversation [6, 7]. We present here the intra-operative ossicular chain status of 150 cases of CSOM who underwent surgery, at our institution over a 18 month period from January 2014 to June 2015.

AIMS AND OBJECTIVES

AIM OF THE STUDY:

To study the ossicular chain involvement in both safe and unsafe types of CSOM in patients attending to E.N.T. Department, MGM Hospital, WARANGAL.

OBJECTIVES:

1. To study the incidence of ossicular chain pathology in CSOM.
2. To study the frequency of involvement of each ossicle.
3. To compare the ossicular chain involvement in safe type and unsafe type CSOM.

PATIENTS AND METHODS

This prospective study has been conducted over a period of18 months in the Department of ENT and Head and Neck Surgery, kakatiya medical college / MGM hospital, Warangal, Telangana, India. Total patients studied during the period were150, out of which 72 were males and 78 were females.

Inclusion Criteria:

1. All cases of chronic suppurative otitis media (safe and unsafe) requiring surgery and with pure conductive hearing loss.
2. Patients of 16 to 60 years of age.
3. Patient willing for surgery offered to him or her.
4. Patient giving consent for the study upon him or her.
5. Patient willing to come for regular follow up and obey the medical advice.

Exclusion Criteria:

1. Patients with mixed hearing loss.
2. Chronic suppurative otitis media with complications like facial nerve palsy, labyrinthitis, intracranial complications etc.
3. Revision cases.
4. Patient not giving consent for study upon him.
5. Patients not willing for surgery

The selected patients were subjected to a detailed history and complete ENT examination. The ears were examined by otoscopy initially and subsequently by otoendoscopy to establish a preoperative diagnosis of safe or unsafe disease. All patients underwent a preoperative pure tone audiometry, to find out the hearing status and obtain documentary evidence for the same, and X-ray mastoid (Schueller's view) to assess the pathology and surgical anatomy of the mastoid. Tests for Eustachian tubes function and culture and sensitivity test as per requirement were done. Computed tomography (CT) scan was done in all cases to exclude middle ear and mastoid pathology to assess the ossicular chain status and status of the facial canal and semicircular canals. All patients were sent to pre-anaesthetic checkup and proper preoperative preparation done. Patients with dry perforations in TMs which were dry since more than 6 months, with normal Eustachian tube function, were offered only tympanoplasty despite the status of mastoid air cell system on X-ray. In patients with safe type of CSOM with intermittently or continuously discharging ears despite medical treatment, we choose proper antibiotics by culture and sensitivity test and preferred to do cortical mastoidectomy and tympanoplasty

as one-stage procedure. In cases, patients with cholesteatoma where eradication of the disease was not possible, we preferred modified radical mastoidectomy with or without tympanoplasty. All the patients were evaluated under microscope during surgery.ossicular mobility and round window reflex was checked. Intra-operative middle ear findings including ossicular chain status, erosion of the individual ossicles, and continuity of the malleo-incudal and incudo-stapedial joint were noted. The ossicular chain status in safe and unsafe ear was compared statistically.

Chi square test was used to evaluate the level of significance and the P value <0.05 was considered as significant.

Observations and Results:

A total of 150 cases were selected for this study and divided into 'safe' and 'unsafe' CSOM based on the history and clinical findings. The ossicular chain status in safe and unsafe ear was compared statistically. Chi square test was used to evaluate the level of significance and the P value <0.05 was considered as significant. The number of cases with safe CSOM was 96 (64.00%) and that with unsafe CSOM was 54 (36.00%). The patients were aged between 16 and 60 years. The mean age was 29.78 years.

Intra-Operative Findings:

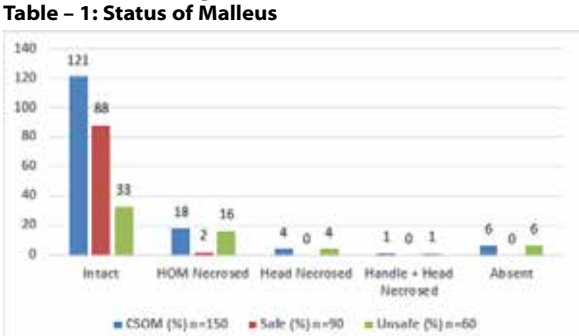
Based on the intra-operative findings, the patients were reclassified into those with safe CSOM, 90 (60.00%) cases, and those with unsafe CSOM, 60 (40.00%) cases. Six (4.00%) cases which were clinically diagnosed as safe were found to be unsafe, intra-operatively.

Ossicular Status:

Malleus	CSOM (%) n=150	Safe (%) n=90	Unsafe (%) n=60	p Value
Intact	121 (80.67)	88 (97.78)	33 (55.00)	0.028*
HOM Necrosed	18 (12.00)	2 (2.22)	16 (26.67)	0.000*
Head Necrosed	4 (2.67)	–	4 (6.67)	0.016*
Handle + Head Necrosed	1 (0.66)	–	1 (1.66)	0.223*
Absent	6 (4.00)	–	6 (10.00)	0.004*
Total:	150 (100.00)	90 (100.00)	60 (100.00)	

*** *P* value < 0.05 is significant**

Table – 1: Status of Malleus



Graph – 1:Status of Malleus

Status of Malleus in CSOM:

The malleus was found to be the most resistant ossicle to erosion in CSOM. It was found intact in 121 (80.67%), eroded in 23 (15.33%) and absent in 6 (4.00%) of the cases. In safe CSOM, 88 (97.78%) of the cases had an intact malleus while in 2 (2.22%) cases the tip of handle of malleus was found necrosed. In unsafe CSOM, the malleus was found intact in 33 (55.00%), necrosed in 21 (35.00%) and absent in 6 (10.00%) cases.

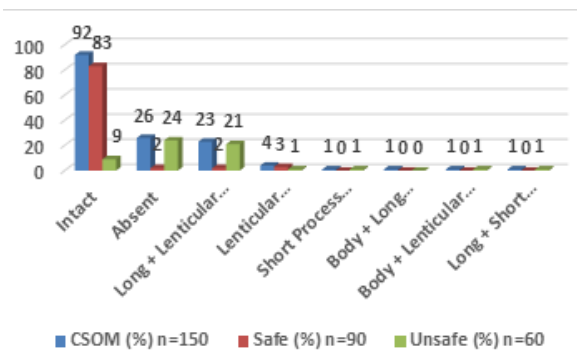
Status of Incus in CSOM:

Incus was the ossicle most commonly found eroded in our study. We found the incus intact in 92 (61.33%), eroded in 32 (21.34%) and absent in 26 (17.33%) cases. The most commonly necrosed parts of the incus were the lenticular process in 29 (19.33%) and the long process in 25 (16.67%) of the cases. In safe CSOM, the incus was found intact in 83 (92.23%), eroded in 5 (5.55%), and absent in 2 (2.22%) cases. Lenticular process was the most commonly necrosed part of the incus and was found eroded in 5 (5.55%) cases.

Incus	CSOM (%) n=150	Safe (%) n=90	Unsafe (%) n=60	p Value
Intact	92 (61.33)	83 (92.23)	9 (15.00)	0.000*
Absent	26 (17.33)	2 (2.22)	24 (40.00)	0.000*
Long + Lenticular Process Necrosed	23 (15.33)	2 (2.22)	21 (35.00)	0.000*
Lenticular Process Necrosed	4 (2.66)	3 (3.33)	1 (0.67)	0.545*
Short Process Necrosed	1 (0.67)	–	1 (0.67)	0.223*
Body + Long Process Necrosed	1 (0.67)	–	1 (0.67)	0.223*
Body + Lenticular Process Necrosed	1 (0.67)	–	1 (0.67)	0.223*
Long + Short Process Necrosed	1 (0.67)	–	1 (0.67)	0.223*
Total:	150 (100.00)	90 (100.00)	60 (100.00)	

*** *P* value < 0.05 is significant**

Table – 2:Status of Incus



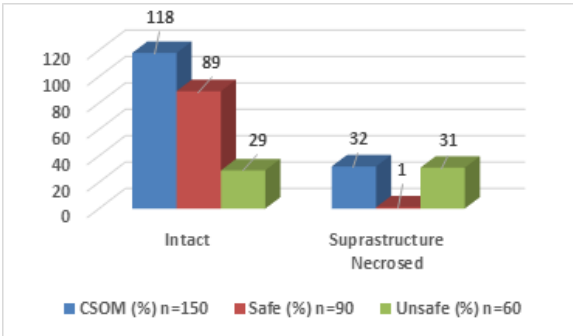
Graph – 2:Status of Incus

In unsafe CSOM, the incus was found intact in 9 (15.00%), necrosed in 27 (45.00%) and absent in 24 (40.00%) cases. Lenticular process was, once again, the most commonly necrosed part of the incus and was found eroded in 24 (40.00%) cases, followed closely by the long process, which was eroded in 23 (38.33%) cases

Table – 3: Status of Stapes

Stapes	CSOM (%) n=150	Safe (%) n=90	Unsafe (%) n=60	p Value
Intact	118(78.67)	89(98.89)	29(48.33)	0.008
Suprastructure Necrosed	32(21.33)	1(1.11)	31(51.67)	0.000
Total:	150(100.00)	90(100.0)	60(100.00)	

*** *P* value < 0.05 is significant**



Graph – 3: Status of Stapes

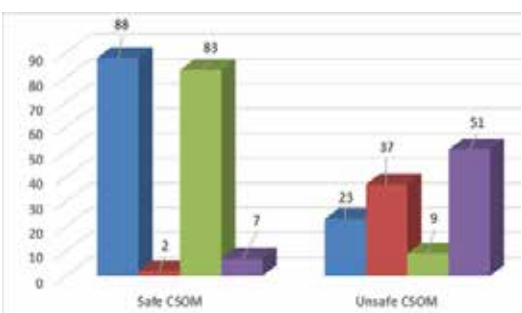
Status of stapes in CSOM:
Stapes was found intact in 118 (78.67%) cases while in 32 (21.33%), the superstructure of stapes was found eroded by the disease. In safe CSOM, 89 (98.89%) of the cases had an intact stapes and only 1 (1.11%) case had erosion of the superstructure. In unsafe CSOM, 29 (48.33%) cases had an intact stapes and 31 (51.67%) showed erosion of the superstructure of stapes.**Status of Malleo-Incudal (MI) and Incudo-Stapedial (IS) Joint:**

The malleo-incudal joint was found intact in 111 (74.00%) and discontinuous in 39 (26.00%) cases. In safe CSOM, malleo incudal joint was intact in 88 (97.78%) cases. In unsafe CSOM, malleo incudal joint was and discontinuous in 37 (61.67%) cases.

The incudo-stapedial joint was found intact in 92 cases (61.33%) and discontinuous in 58 (38.67%) cases of CSOM. In safe CSOM, it was intact in 83 (92.22%) cases of the cases and discontinuous in 7 (7.78%). In unsafe CSOM, it was intact only in 9 (15.00%) cases and discontinuous in 51 (85.00%).

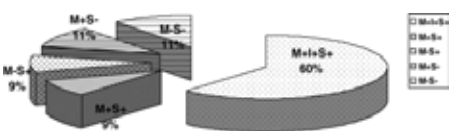
	Safe CSOM	Percentage	Unsafe CSOM	Percentage
MI joint intact	88	97.78%	23	38.33%
MI joint discontinuous	2	2.22%	37	61.67%
IS joint intact	83	92.22%	9	15.00%
IS joint discontinuous	7	7.78%	51	85.00%

Table – 4: Status of MI and IS Joint in CSOM



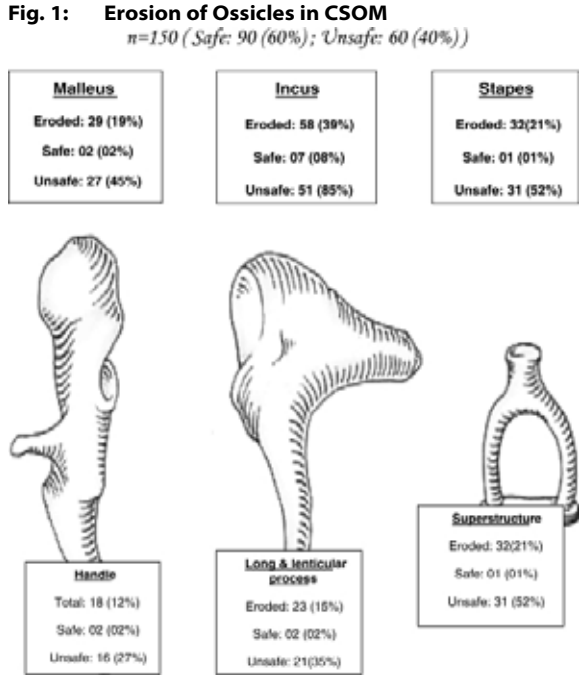
Graph – 4:Status of MI and IS Joint in CSOM

Status of Ossicular Chain:
The ossicular chain was found intact (M+I+S+) in 92 (61.34%) cases. In safe CSOM, 83 cases (92.22%) had an intact chain, 7 cases (7.77%) had ossicular damage. In unsafe CSOM, intact malleus with eroded incus and stapes (M+S–) was seen in 16 (26.67%) cases, followed by M–S– in 15 cases (25.00%) (Figs. 2, 33).



Graph – 5:Ossicular Chain Necrosis in CSOM

Fig. 1: Erosion of Ossicles in CSOM



DISCUSSION

In this study we studied a total of 150 patients of CSOM to assess the intra-operative ossicular status.

The cases were divided clinically into safe CSOM, 96 (64.00%) cases, and unsafe CSOM, 54 (36.00%) cases. Intra-operatively, 90 (60.00%) cases were found to be safe and 60 (40.00%) cases to be unsafe. Six (4.00%) cases which were clinically diagnosed as safe were found to be unsafe intra-operatively. Malleus was found to be the most resistant ossicle, found intact in 121 (80.67%) cases in our study. It was eroded in 23 (15.33%) and absent in 6 (4.00%) cases. The handle of malleus in 19 (12.66%) cases, was the most commonly necrosed part of malleus. In safe CSOM, malleus was intact in 88 (97.78%) and eroded in 2 (2.22%) cases. In unsafe CSOM, malleus was intact in 33 (55.00%), eroded in 21 (35.00%) and absent in 6 (10.00%). These findings were consistent with those of Udaipurwala et al.[8]. Sade et al.[5] found a higher incidence, around 06.00%, of erosion of malleus in cases of safe CSOM. In unsafe disease they found malleus necrosis in 26.00% cases which correlates well with our finding . Incus was observed to be the most common ossicle to get necrosed in cases of CSOM. In our study, incus was found intact in 92 (61.33%) cases, eroded in 32 (21.34%) cases and absent in 26 (17.33%) cases. The commonest defect was erosion of the lenticular process in 29 (19.33%) cases followed by long process in 25 (16.67%) cases. In safe CSOM, incus was intact in 83 (92.23%) cases, eroded in 5 (5.55%) cases and absent in 2 (2.22%) cases while in unsafe CSOM it was intact in 9 (15.00%) cases, eroded in 27 (45.00%) cases and absent in 24 (40.00%) cases. The most frequently involved parts were again the lenticular process (40.00%) and the long process (38.33%) of incus.

I.H. Udaipurwala et al.[8] (1994) in his study including 145 cases of CSOM, majority had damage of more than one ossicle. Involvement of all ossicles was seen in 30 (40%) cases. Extensive cholesteatoma was present in 30 cases. It had a very similar incidence of necrosis of the incus at 41.00%. The long process of incus was found to be the most commonly necrosed part as compared to our study where lenticular process was more commonly necrosed. This can be explained, as Udaipurwala et al. have probably considered the lenticular process to be a part of the long process of incus, since they have not mentioned it separately .

Austin[9] reported the most common ossicular defect to be the erosion of incus, with intact malleus and stapes, in 29.50% cases. Kartush[10] found erosion of long process of incus with an intact malleus handle and stapes supra structure as the most common ossicular defect. Shreshtha et al. and Mathur et al.[11,12] also reported similar findings in unsafe CSOM .shreshtha et al[6] Showing operative findings of Os-

sicular Chain in unsafe CSOM that Malleus was Intact in 38 (76%) Erodedin 3 (6%) Absent in 9 (18 %) cases. Incus was Eroded in 28 (56%), Absent in 22 (44%) cases. Stapes was Intact in 38 (76%), Absent in 12 (24%) cases. In our study, Stapes was found intact in 118 (78.67%) cases and involvement of stapes superstructure was noted in 32 (21.33%) cases of CSOM. The footplate was found intact in all cases. In safe CSOM, stapes was found intact in 89 (98.89%) cases and eroded in 1 (1.11%) case. In unsafe CSOM, stapes was intact in 29 (48.33%) cases and eroded in 31 (51.67%) cases. The incidence of stapedial necrosis in our study was found to be very similar to the study by Udaipurwala et al. They found the superstructure to be necrosed in 21.00% cases, which matches with our findings. Austin reported erosion of stapes at around 15.50% . Sade et al. reported stapes involvement in unsafe CSOM to be 36.00%.

Shreshtha et al**.** found involvement of stapes superstructure in 15.00% cases of unsafe CSOM . Motwani et al**.**[13] reported stapes arch necrosis in 30.00% cases of CSOM .We found an intact and mobile ossicular chain (M+I+S+) in 92 (61.34%) of our cases. In safe CSOM the ossicles were mostly intact. M+S+ configuration was found in 5.55%. M−S+ and M−S− both were 1.11% each. In unsafe CSOM, we found only 9 (15.00%) cases with intact ossicular chain. M+S+ was seen in 8 (13.33%) cases, M−S+ in 12 (20.00%) cases, M+S− in 16 (26.67%) cases and M−S− in 15 (25.00%) cases These findings were in tandem with those of Dasgupta et al**.**[14] in two studies on unsafe CSOM. Toran et al**.**[15] reported similar findings of ossicular chain in M−S− category. S.K. Kashyap et al found in his study that included 100 patients of tubotympanic type of CSOM, 76 (76%) patients have normal ossicular chain and 24 (24%) were having ossicular pathology. These patients with ossicular pathology were classified into two categories: Ossicular necrosis was found in 18 cases, and tympanosclerosis of the ossicles in 6 cases. Out of 18 patients with ossicular necrosis, commonest ossicle involved was incus. The Isolated long process of incus was involved in 14 cases (77.77%) and lenticular process involvement was found in 3 cases (16.66%). Hence in group A 17 cases (Group A-94.44%) were found. 1 patient was having erosion of the long process of incus as well as stapes supra structure (Group C- 5.55%). Hassan Haidar et al[17] recruited 211 patients with CSOM for this study and a total of 279 ears were included. 34 patients had both ears included which were operated sequentially. 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 our study In safe CSOM, 83 cases (92.22%) had an intact chain, 7 cases (7.77%) had ossicular damage in cholesteatoma ears, the ossicular status was intact in 15 cases (30.8%), eroded in 34 ears (69.3%) in our study, vm In unsafe CSOM, intact malleus with eroded incus and stapes (M+S−) was seen in 16 (26.67%) cases, followed by M−S− in 15 cases (25.00%). Malleus erosion was associated with incus erosion in all of the cases except one ear. The disease respected the footplate in all the casesand erosion was localized solely to stapes superstructure and was associated with incus erosion in all of the cases. In our study, ossicular erosion in cholesteatomous eras was as follows: incus 65.3%, malleus 22.5%, and stapes 63.3%. In a study by Kurien et al[18]. these figures were: incus 100%, malleus 67%, and stapes 67%. In another study by Garap and Dubey[19], the figures were: incus 89%, malleus 32%, and stapes 41%. 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**.**[5] reported erosion of malleus in around 26.0% in unsafe CSOM which correlates well with our finding. 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. 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. 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. 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 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 51.67% of cholesteatomous ears. Stapedial necrosis numbers were found to be higher than reported by previous studies. 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. Despite the increased health awareness among the population with easy access to government sponsored medical care, ossicular chain erosion remains to be a frequent and common complication of CSOM. 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. Our study, intact ossicular chain found in 61.34% cases, erosion in 38.66% cases. SHRESHTA et al[6] In their study only in 7 cases ossicles were intact and they were damaged in 93 cases. Thapa et al[16] found similar result with ossicular defect in 96(88.89%) cases of CSOM (AA). [1] In a study done by W.Y. Chao and C.C. Wu. erosion of ossicles was seen in 34 (35.42%) cases and intact ossicles in 13 (13.54%) cases. I.H. Udaipurwala et al[8]**.** showed ossicular damage in 76 (52.05%) cases. The reason for this deviation may be that in our study both atticoantral and tubotympanic diseases were included, where in others only atticoantral type was included. In a study done by V. Jahnke and W. Falk. ossicular destruction was found in 77% cases with cholesteotamous cases. In another study J. Karja. revealed ossicular chain was damaged in 75% cases with cholesteotoma. In another study done by A. Palva et. al**.**[20] ossicular damage was found in 65% of cholesteotomous disease. In this study M+S+ ossicular defect was the commonest type of defect in 47 (50.53%) cases followed by M+S- 24 (25.80%) cases. M-S+ defect was seen in13 (13.97%) cases and M-S- defect was seen in 9(9.67%) cases in a similar study done by Thapa et. al[16].

M+S+ was the commonest defect 41.67% followed by M+S-(25%), M-S+ (5.55%), and M-S-(18%).

In Austin's[9] series , M+S+ defect was found in 59.2% patients followed by M+S- (23.2%), M-S+ (7.8%), and M-S- (8.2%).

	Present Study	Udaipur Wala et al	Shreshtha et al	Thapa et al	Jahnke and Falk	J. Karja	A. Palva
% of Cases shows Ossicular Erosion	38.66%	52.05%	93%	88.89%	77%	75%	65%

CONCLUSIONS

In this prospective study performed at MGM Hospital, Warangal, Telangana, during January 2014 to June 2015 (over a period of 18 months) in 150 patients with chronic suppurative otitis media (both safe and unsafe type) presenting with pure conductive hearing loss posted for surgery.

In our study it is observed that 132 patients (88%) had hearing threshold greater than 30Db Erosion of incus was noted in 32 cases. It is the most common ossicular pathology in my study.

The most commonly necrosed parts of the incus were the lenticular process followed by the long process. In safe CSOM, the incus was eroded in 5 cases. In unsafe CSOM, the incus was necrosed in 27 cases.

We found the malleus to be the most resistant ossicle to erosion in chronic suppurative otitis media whereas incus was found to be the most susceptible. The incidence of ossicular erosion was found to be much greater in unsafe CSOM than in safe CSOM. All patients of CSOM both tubotypanic and atticoantral disease should be checked

for ossicular chain continuity and movement of all ossicles to rule out any ossicular erosion so that we can restore their hearing as early as possible and prevent further increase in hearing loss. 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.

REFERENCES

1. Slattery WH. Pathology and clinical course of inflammatory diseases of the middle ear. In: Glasscock ME, Gulya AJ, editors. Glasscock-Shambaugh surgery of the ear. 5. New Delhi: Reed Elsevier India Pvt. Ltd; 2003. pp. 428–429.
2. Mills RP. Management of chronic suppurative otitis media. In: Booth JB, Kerr AG, editors. Scott-Brown's otolaryngology.
3. Proctor B. The development of middle ear spaces and their surgical significance. J Laryngol Otol. 1964;78:631–648. doi: 10.1017/S002221510006254X.
4. Deka RC. Newer concepts of pathogenesis of middle ear cholesteatoma. Indian J Otol. 1998;4(2):55–57.
5. Sade J, Berco E, Buyanover D, Brown M. Ossicular damage in chronic middle ear inflammation. Acta Otolaryngol. 1981;92:273–283.
6. Shreshtha S, Sinha BK. Hearing results after myringoplasty. Kathmandu Univ Med J. 2006;4(4):455–4599. Singh RK, Safaya A. Middle ear hearing restoration using autologous cartilage graft in canal wall down mastoidectomy. Indian J Otol. 2005;11:10–14.
7. Marfani MS, Magsi PB, Thaheem K. Ossicular damage in chronic suppurative otitis media—study of 100 cases. Pak J Otolaryngol. 2005;21(1):9–11.
8. Udaipurwala IH, Iqbal K, Saqulain G, Jalisi M. Pathlogical profile in chronic suppurative otitis media—the regional experience. J Pak Med Assoc. 1994;44(10):235–237
9. Austin DF. Ossicular reconstruction. Arch Otolaryngol. 1971;94:525–535.
10. Kartush JM. Ossicular chain reconstruction.Capitulum to malleus. Otolaryngol Clin North Am. 1995;27:689–715.
11. Shrestha S, Kafle P, Toran KC, Singh RK. Operative findings during canal wall mastoidectomy. Gujarat J Otorhinolaryngol Head Neck Surg. 2006;3(2):7–9.
12. Mathur NN, Kakar P, Singh T, Sawhney KL. Ossicular pathology in unsafe chronic otitis media. Indian J Otolaryngol. 1991;43(1):9–12.
13. Motwani G, Batra K, Dravid CS. Hydroxylapatite versus teflon ossicular prosthesis: our experience. Indian J Otol. 2005;11:12–16.
14. Dasgupta KS, Gupta M, Lanjewar KY. Pars tensa cholesteatoma: the underestimated threat. Indian J Otol. 2005;11:17–20.
15. Toran KC, Shrestha S, Kafle P, Deyasi SK. Surgical management of Sinus tympani cholesteatoma. Kathmandu Univ Med J. 2004;2(4):297–300.
16. Thapa at alJournal of College of Medical Sciences-Nepal,2010,Vol-6,No-4, 26-30. Types of pathology and ossicularstatus in atticoantral disease undergoingmastoidectomy at Bir Hospital
17. Hassan Haidar, Rashid Sheikh, Aisha Larem, Ali Elsaadi, Hassanin Abdulkarim, Sara Ashkanani and Abdulsalm Ossicular Chain Erosion in Chronic Suppurative Otitis Media
18. Kurien M, Job A, Mathew, et al. Otogenic intracranial abscess: concurrent craniotomy and mastoidectomy: changing trends in a developing country. Arch Otolaryngol Head Neck Surg1998;124:1356-66.
19. Joseph P. Garap and Siba P. Dubey Canal-Down Mastoidectomy: Experience in 81 Cases0tology & Neurotology22:451–456 2001, Otology & Neurotology