Ossicular Chain Lesions in Tympanic Perforations and Chronic Otitis Media without Cholesteatoma

OSSICULAR CHAIN LESIONS IN TYMPANIC PERFORATIONS AND CHRONIC OTITIS MEDIA WITHOUT CHOLESTEATOMA

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INTRODUCTION

Pathological conditions affecting the tympanic membrane and the middle ear cleft may cause ossicular chain suffering (OCS), with or without interruption of its anatomical continuity. OCS is principally reported in chronic otitis with cholesteatoma (COM) since it has been reported in up to 82% of cases; incus is the ossicle more frequently involved, about 78% of cases, and in 45% of cases lesions can be found in more than one ossicle (1,2,3). The rate of OCS is strictly related to the extension of COM in middle ear cavities and this condition determines a greater conductive hearing loss than in cases without OCS, however the degree of hearing deficit is not related to the extent of OCS (1).

Chronic otitis media without cholesteatoma (NCOM) is a pathological condition characterized by irreversible tympanic perforation (TP) associated with chronic inflammation of the middle ear and mastoid mucosa causing otorrhea lasting for at least 2-6 weeks (4). NCOM must be differentiated by the irreversible TP without otorrhea, in which the mucosa of the middle ear is normal and the episodes of otorrhea are absent or rare. TP is the most frequent pathology of the drum (5). Tos classified these conditions in: constantly discharging ear, intermittently secreting ear and constantly dry ear with perforation (5). In this paper we will address the first two conditions as NCOM and the last as TP.

An analysis of OCS in chronic otitis without cholesteatoma is less frequently reported and the rate of incidence of ossicular suffering is evaluated in about 15-62% of cases; OCS is more frequently found in granulating otitis media (5,6).

The aim of this retrospective study, based on a series of patients submitted to tympanoplasty, was to determine incidence and kind of ossicular defects in TP and NCOM; the second aim of the study was to correlate the modifications of the ossicular chain with clinical parameters and hearing function.

MATERIALS AND METHODS

The cohort of study was composed by 250 consecutive subjects affected by TP or NCOM that underwent to tympanoplasty. Patients submitted to previous surgery at the same ear were excluded by the study group.

In the sample 111 patients (44%) were males and 139 (56%) females. In 117 cases (47%) the affected side was the right and in 132 (53%) the left; in 79 cases (32%) the pathology was bilateral. Mean age was 40 years (min 4, max 83, standard deviation 19).

TP interested no more than two quadrants of the drums in 170 cases (68% of cases) while in 80 cases (32%) it was extended to three or four quadrants (subtotal perforation). In two quadrant perforations the site of the hole was anterior in 23 cases (14%), inferior in 69 cases (40%), posterior in 78 cases (46%).

NCOM, according to Roland (4), was defined on the basis of the presence of otorrhea lasting for at least 2 weeks at time of surgery or in cases in which the recurrence of long lasting episodes of otorrhea in the previous two years was documented. A constantly dry ear with perforation was classified as TP. On this basis 186 patients (74%) were affected by TP and 64 (26%) by NCOM. In tab I the distribution of perforations site in the two groups is reported. Differences are not significant.

Tab. I. Site of MT perforation in TP and NCOM. Differences are not significant (p=0.8719)

	Subtotal	Anterior	Inferior	Posterior
TP (186 cases)	57 (31%)	19 (10%)	54 (29%)	56 (30%)
NCOM (64 cases)	23 (36%)	7 (11%)	14 (22%)	20 (31%)

Each patient was submitted to pure tone threshold audiometry (PTA) with the descending technique in a sound proof booth the day before surgery. PTA threshold was determined as the mean value at 0.5-1-2-4 kHz; in the overall sample mean air conduction (AC) threshold was 41 dB (SD=19), mean bone conduction (BC) threshold 20 dB (SD=12) and mean air-bone gap was 21 dB (SD=11).

For continuous and categorical variables data was represented as mean (standard deviation) and frequency (percentage) respectively. Comparison between group for continuous variables was made using the t-test.

A one-way ANOVA was used to test the differences of means in more groups. A post-hoc analysis was performed using Bonferroni correction. Comparison between group for categorical variables was made using the Chi-square or the Fisher's exact test as appropriate. All statistical tests were two-sided and P values of 0.05 or less were considered statistically significant. Statistical analyses were conducted using SAS software package (SAS Institute, Cary, NC; version 9.2).

RESULTS

OCS was found in 26 out of the 250 patients included in the overall sample (10%). It was found in 14 cases out of 186 patients affected by TP (7%) and in 12 out of 64 patients affected by NCOM (19%). Difference is significant (p=0.0112). In 6 of these 26 patients (23%), nevertheless the presence of OCS, we observed the preservation of the continuity among the ossicles; 3 of them belonged to the TP group and 3 to the NCOM group.

Among the 26 patients affected by OCS the perforation was subtotal in 1 case (4%), anterior in 1 case (4%), inferior in 7 cases (30%) and posterior in 16 cases (62%). The highest rate of OCS was, therefore, observed in inferior and, above all, in posterior eardrum perforations.

The malleus presented signs of atrophy in 4 cases (15%), the incus in 24 cases (92%) and the stapes in 7 cases (27%). In 5 cases (19%) the lesion involved both incus and stapes and in 4 cases (15%) all the three ossicles were affected.

In tab II the kind of ossicular lesion in TP and in NCOM are compared. The most frequent lesion found in both groups was the atrophy of the long process of the incus.

Tab. II. Ossicular lesions found in TP and in NCOM.

	Kind of lesion	TP	NCOM	p
Malleus (4 cases)	Absent Head Handle	0 1 (100%) 0	1 (33%) 1 (33%) 1 (33%)	>.999
Incus (24 cases)	Absent Long process	1 (8%) 11 (92%)	4 (33%) 8 (67%)	0.3217
Stapes (8 cases)	Absent	3 (100%) 0	4 (80%) 1 (20%)	>.999

Fifty percent (50%) of patients with OCS had bilateral disease (either TP or NCOM). In these patients the rate of OCS was significantly higher p=0.033 than in patients affected by unilateral disease (tab. III). Rates did not change between TP and NCOM patients.

Tab. III. Relationship between the condition of the other ear and the condition of the ossicular chain. The difference is significant at the chi square test (p=0.0098).

	Normal contralateral ear	Pathological contralateral ear
Normal ossicular chain	158 (71%)	66 (29%)
Pathological ossicular chain	13 (50%)	13 (50%)

As regards age, TP subjects were significantly younger at the Student's t test than NCOM's (mean age 38 versus 45 years, SD respectively 19 and 18, p=0.05). In TP group mean age was 38 years (SD 18) in case of OCS and 39 years (SD 19) in its absence; in

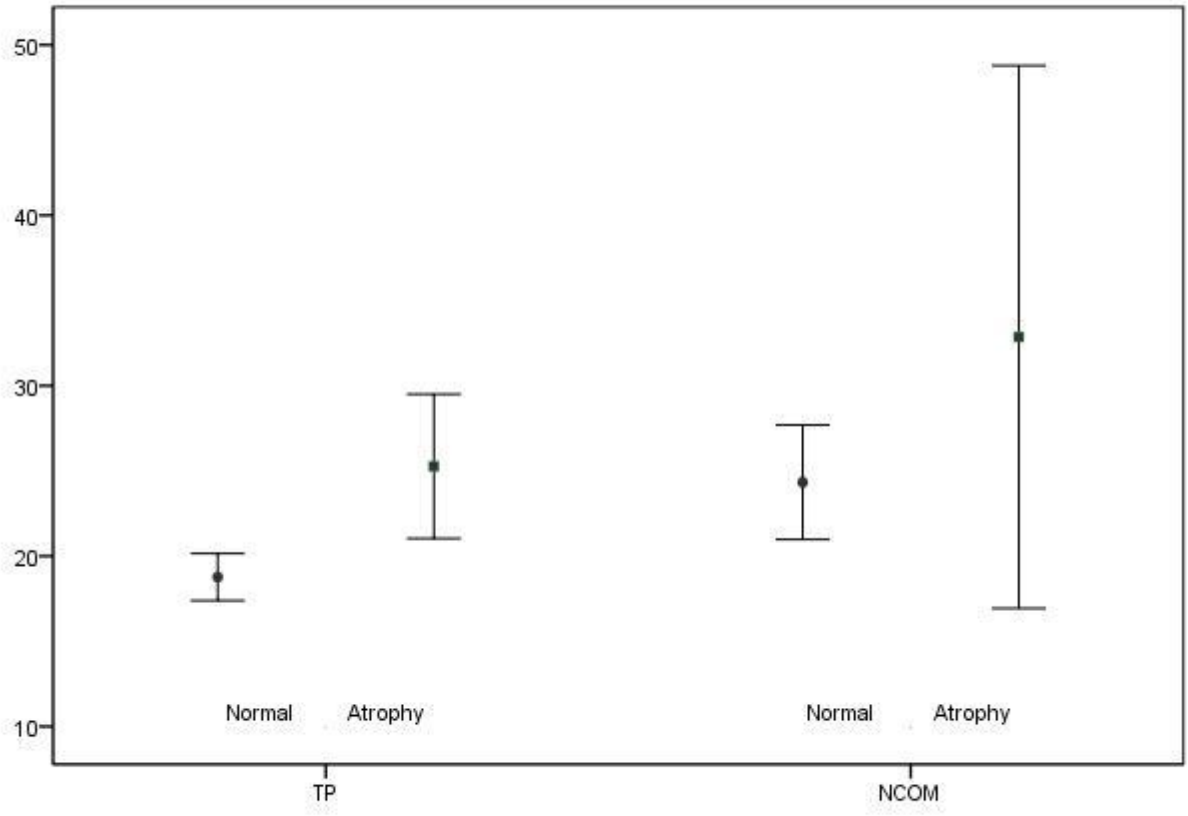
NCOM mean age was respectively 49 (SD 21) in presence of OCS and 45 (SD 19) in its absence; in both groups differences are not significant ($p>0.05$). Therefore there was no relation between age and OCS.

Threshold values in normal ossicular chain, in both TP and in NCOM, are reported in tab IV and in fig 1. BC threshold did not differ significantly at the ANOVA analysis, among the four conditions ($p>0.05$) while in both TP and NCOM AC and ABG were higher in presence of atrophy of the ossicular chain, even if differences are not significant. In TP ABG was significantly lesser than in NCOM ($p<0.05$ at the Student's t test), therefore the presence of inflammatory tissue in the middle ear causes a more important sound transmission impairment.

Tab. IV. PTA values in TP and NCOM in relationship to the presence or absence of OCS.

	TP		NCOM	
	Normal ossicular chain 172 cases	Atrophy of the ossicular chain 14 cases	Normal ossicular chain 52 cases	Atrophy of the ossicular chain 12 cases
AC	38 (17) *	47 (17)	47 (20) *	53 (25)
BC	19 (12)	21 (15)	23 (13)	20 (12)
ABG	19 (9) **	25 (8)	24 (12)*	33 (26)**

Fig. 1. Mean air-bone gap values in absence and in presence of ossicular chain lesions in relationship to the pathology (TP and NCOM). * $p<0.01$ and ** $p<0.0001$.



ABG was not significantly related to the number of ossicles involved by OCS (tab. V).

Tab. V. Air bone gap in the 20 patients who presented OCS with discontinuity of the ossicular chain. Differences are not significant at the ANOVA test of variance (p>0.05).

	1 ossicle involved (14 cases)	2 ossicles involved (3 cases)	3 ossicles involved (3 cases)
Air-bone gap	19 (19)	25 (9)	25 (12)

DISCUSSION

The aim of this study was, firstly, to describe ossicular chain defects in non-cholesteatomatous otitis media and, secondly, to correlate them with clinical parameters.

The non-cholesteatomatous pathology of the middle ear is currently classified in TP and NCOM (4); the only difference between these two conditions is the presence or absence of inflammatory reaction of the middle ear mucosa. In our sample the majority of the patients were affected by TP (74%). In these cases the surgical indication aimed at restoring tympanic integrity in order to prevent recurrent otitis, allow normal water contact and improve hearing function while in case of NCOM surgery aimed at curing the chronic discharge; according to data presented in this study and since a relevant number of patients affected by TP is not operated on, because of comorbidities or own will, we can conclude that TP in far more frequent than NCOM.

Data about OCS in non-cholesteatomatous chronic otitis are scarce in the literature and few papers systematically present and discusse the modifications found. In 1979 Tos (3) compared OCS in cholesteatomatous and non-cholesteatomatous otitis media finding ossicular lesions in 62% of granulating otitis media, in 43% of sequelae to otitis and in 77% of adhesive otitis media. More recently Zanhert (6) reported OCS in 15% of non-cholesteatomatous middle ear pathology. In our sample we found OCS in 10% of cases. This rate is lower if compared to data reported in previous reports but in our sample there was a larger number of minor middle ear lesions (for example Tos reported a large number of adhesive otitis excluded in this study).

OCS was more frequently found in posterior TP. This correlation can be explained by the anatomical contiguity between the ossicular chain and the site of TP. This conclusion is consistent with Tos's (3-5) who reported a lesser degree of correlation in presence of middle ear inflammatory reaction.

OCS is significantly more frequent in case of NCOM therefore the presence of mucosal chronic inflammation determines a higher risk of ossicular atrophy. The ossicle more frequently affected is incus, and in particular its long process, while malleus and stapes suffering is present in about 7-33% of cases of OCS; this is consistent with previous data reported in both COM and NCOM (1,3,6). In general the distribution of malleus, incus and stapes suffering in NCOM is quite similar to that found in COM (1) while in TP there is a higher prevalence of incus suffering, found in about 80% of the overall cases of OCS.

The rate of bilateral middle ear pathology was higher in case of OCS. This condition, therefore, can help us in predicting the condition of the ossicular chain perhaps as an expression of a longer or more severe disease, correlated to local or biological factors. On the contrary age is not related to the presence of OCS.

As regards hearing function, ABG in patients affected by chronic otitis media is normally referred to the ossicular chain condition; in particular, narrow ABG would suggest ossicle integrity, whereas wide ABG would predict ossicular erosion (8); this is partially confirmed in our study since ABG is higher in case of OCS but differences are moderate and not significant. In particular, on the basis of data reported in fig. IV, we can hypothesize that two-third of ABG is related to TP and one-third only to OCS. Moreover ABG in this sample is larger in case of NCOM than in TP, as the consequence of the impairment on sound transmission in presence of middle ear inflammatory tissue.

Finally ABG is not related to the extension of ossicular chain damage since, from a functional point of view, chain discontinuity leads to hearing impairment regardless of the type or number of involved ossicles (1).

Mean BC threshold values did not differ in relation to the kind of pathology and to the presence/absence of OCS, therefore the cochlear function in non-cholesteatomatous chronic middle ear pathologies is not compromised; this is an important difference with COM with cholesteatoma, in which we observed BC impairment in presence of OCS (1) This finding could be related to differences in middle/inner ear interaction in COM versus NCOM and TP, conclusion supported by histopathological and biological evidences (9, 10).

In conclusion ossicular chain damages in case of non-cholesteatomatous middle ear pathology are not frequent, being present in no more than 10% of cases. As regards NCOM, ossicles defects distribution is similar to COM, while it is practically limited to the incus in case of TP. Considering TP, the following parameters, otorrhea**,** posterior perforation, bilateral disease and mean ABG of about 30dB, can all be considered as good predictors of ossicular chain suffering.

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