Cholesteatoma: Ossicular destruction in adults and children

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Abstract

The records of 148 adults (aged 14 years and older) presenting previously untreated aural cholesteatomas are analysed with particular emphasis on ossicular destruction and other bony lesions in the middle ear. The findings are compared with those obtained in an earlier study of 63 children (aged 13 years and younger), also with untreated cholesteatomas. The rate of stapes and malleus destruction was similar in adults and children. The rate of incus destruction was significantly higher in adults. Semicircular fistulas as well as facial paralysis were also more prevalent amongst adults. Therefore, the notion of childhood cholesteatoma aggressiveness cannot be related to its effect on these bony structures. It may stem from its higher recurrence rate and from the more troublesome post-operative mastoid cavities, which are often larger in children than in adults.

Key words: Cholesteatoma; Ear ossicles

Introduction

It is commonly claimed that cholesteatomas in children are more aggressive than those in adults (Baron, 1977). However, so far the differences have been neither precisely defined nor systematically characterized. In a previous study (Sadé and Shatz, 1988) we presented the frequencies of ossicular and other middle ear bony destruction related to cholesteatomas in children. We present here a similar description of such lesions in adults, and compare them with our earlier findings. Our comparison of the aggressiveness of cholesteatomas in adults and children also considers the frequency of semicircular fistulas and facial paralysis.

Materials and methods

Between 1977 and 1987, 325 patients presented at the ENT Department of the Meir Hospital, Kfar Saba, Israel, with aural cholesteatomas not previously treated surgically. We defined cholesteatoma as the presence in the middle ear cleft of stratified squamous epithelium producing keratin that does not clear by itself spontaneously and which cannot be cleared by suctioning. Clean or infacted retractions that had no dead space and were amenable to conservative treatment (Sadé *et al.*, 1981a; Sadé, 1982a) were considered to be retraction pockets rather than cholesteatomas, and were not included in this series. On the other hand, a retraction pocket in which keratin had accumulated and whose fundus could not be visually reached with a suction tip was considered to be a cholesteatoma. Cholesteatomas associated with pars flaccida or posterior superior perforations were regarded as retraction pocket cholesteatomas (Sadé, 1993). Cholesteatomas behind an intact drum were regarded as congenital or primary cholesteatomas.

Since the mastoid is assumed to be fully developed at puberty (Diamant, 1952; Doland, 1979; Valvassori *et al.*, 1980), patients aged 13 and younger were considered as children and those aged 14 and older as adults. The average age of the 190 adult patients at presentation was 34 years. The average age of the children's group was eight years. Data on the cholesteatomas were compiled from outpatient and hospital records, radiographs and operative reports. Out of the 325 patients, 109 (33.5 per cent) were children and the findings pertinent to them are described in a previous study (Sadé and Shatz, 1988).

The data concerning 26 adult patients were incomplete. Additionally, 35 adults and 15 children presented a central perforation of their tympanic membrane, which made it impossible to know whether they started as retraction pocket cholesteatomas or congenital cholesteatomas. Those 76 patients were excluded from the study. The analysed sample thus included 148 adults and 63 children with retraction pocket cholesteatomas and seven adults and 31 children with congenital cholesteatomas (Table I). In our previous study (Sadé *et al.*, 1981b) we found that over 80 per cent of ears affected by cholesteatoma had some ossicular destruction. Using the frequencies of ossicular damage as the primary criterion for assessing the aggressiveness of the cholesteatoma, we try to elucidate, in the present study, whether children whose cholesteatoma is supposed to be particularly aggressive (Baron, 1977) have a higher probability of suffering from ossicular destruction than adults do. For each adult patient, the data concerning the destruction of the incus, stapes and

TABLE I

FREQUENCIES (AND PERCENTAGES) OF OSSICULAR LESIONS OCCURRING IN THE TWO MAIN TYPES OF CHOLESTEATOMAS IN ADULTS AND CHILDREN

	Adults		Children	
	Retraction pocket cholesteatomas	Congenital cholesteatomas	Retraction pocket cholesteatomas	Congenital cholesteatomas
Incus	122 (82.4%)	3 (42.8%)	35 (55.6%)	21 (67.7%)
Stapes	78 (52.7%)	2 (28.6%)	27 (42.8%)	16 (51.6%)
Malleus	54 (36.5%)	1 (14.3%)	15 (23.8%)	11 (35.7%)
Total	148	7	63	31

malleus as well as semicircular distules and facial paralysis, were recorded and the results were compared with the findings from our previous study which focussed on cholesteatomas in children (Sadé and Schatz, 1988).

For each of the ossicles (incus, stapes and malleus), three-way contingency tables were created. In those tables, the first variable represented the *status* of the ossicle at two levels ('destroyed' or 'not destroyed'). An ossicle which was found to have lost enough of its bony structure to be easily discerned without magnification was considered 'destroyed'. The second variable was the *age*, again with two categories: adults or children. Finally, the third variable represented the *types* of cholesteatoma also had two categories: retraction pocket or congenital cholesteatoma. The entries in the eight 'cells' of each table are the number of patients who had the particular configuration of levels for the three variables. The analysis of the data included the fitting of appropriate log-linear models to each of the three $2 \times 2 \times 2$ tables constructed for the three ossicles and testing the relevant hypotheses.

For each of the three ossicles, the model fitting process (Table II) starts with the model of independence. Independence between variables is usually denoted by separating the variables by commas, and we use this standard notation in Table II. In terms of our study, a model of independence postulates that the probability of an ossicle being destroyed is independent of the type of cholesteatoma and whether the patient is an adult or a child. The χ^2 (chi-square) value in the table measures the distance between the actual frequencies and the frequencies computed according to the model. The statistical significance of a result is judged by comparing the χ^2 value in the sample with the critical value from the χ^2 distribution with the appropriate number of degrees of freedom. The degree of freedom is the difference between the number of cells in the table (in our case $2 \times 2 \times 2 = 8$) and the number of parameters in the model.

When the model of independence is not supported by the data (as is the case in our study for all the ossicles) the model fitting process continues by adding an interaction to the model. An interaction is denoted by a multiplication sign between two variables. A model which contains, say, an interaction between *status* and *age* would thus postulate that children have a different probability of having an ossicle destroyed than adults. A model which includes the interaction between *status* and *age* but not the interaction between *status* and *type*, will postulate that while the probabilities of having an ossicle destroyed differ in the two *age* groups, those probabilities are the same for the two types of cholesteatomas.

The statistical significance of an interaction is measured by the difference in the χ^2 of two models: a model which does include and a model which does not include that interaction. If that difference is larger than a

TABLE II

ANALYSIS OF THE ASSOCIATION OF THE OSSICLES' STATUS WITH AGE AND WITH THE TYPES OF CHOLESTEATOMAS†

Log-linear model			Difference from the previous model		
	Chi-square	D.F.	Chi-square	D.F.	*p* value
Incus					
Status, age, type	55.92	4			
Status, age × type	19.31	3	36.61	1	0.0002
Status × age, age × type	6.48	2	12.83	1	0.0002
Status × age, age × type, status × type	6.47	1	0.01	1	N.S.
Stapes					
Status, age, type	39.56	4			
Status, age × type	3.05	3	36.51	1	0.0002
Status × age, age × type	2.24	2	0.81	1	N.S.
Status × age, age × type, status × type	2.20	1	0.04	1	N.S.
Malleus					
Status, age, type	40.97	4			
Status, age × type	4.94	3	36.03	1	0.0002
Status × age, age × type	3.10	2	1.84	1	N.S.
Status × age, age × type, status × type	2.96	1	0.14	1	N.S.

†Stepwise fitting of log-linear models for ossicular lesions occurring in the two main types of cholesteatomas in adults and children. No significant association is detected between the *status* of the ossicles (destroyed or not destroyed) and the *type* of cholesteatomas (retraction pocket or congenital). In the incus (but not in the other ossicles) the distribution of the *status* of the ossicles is significantly different in the two *age* groups (adults or children).

prespecified critical value, we conclude that the interaction is necessary. Otherwise, the difference is considered to be not significant (NS). The model fitting process stops when all the significant interactions have been included in the model.

Results

Incus

The frequency table with the ossicular destruction data is presented in Table I. From the general table we created the relevant contingency table for the analysis of the destruction rates of each ossicle separately. Upon analysis of the table which contained the data on the destruction of the incus, using the BMDP 4F computer program (Brown, 1985) we found that the fitted models (Table II) showed a statistically significant interaction between the *status* of the ossicle and the *age*, namely there is a statistically significant difference in the prevalence of incus destruction between children and adults. The estimated proportions based on the fitted log-linear model are about 81 per cent for adults and 60 per cent for children. Since the interaction between the *type* of cholesteatoma and the *status* of the ossicle was not significant, those percentages are valid for both types of cholesteatomas. In other words, we could not find a statistically significant difference in the prevalence of the incus being destroyed between persons with retraction pocket cholesteatomas and those with congenital cholesteatomas. The small sample size with congenital cholesteatomas in adults can be a possible explanation for the lack of statistical significance for this type of cholesteatoma.

Stapes and malleus

The analysis of the other two contingency tables yielded different conclusions. In both cases the 'best models' which were fitted to the data neither included the interaction between the *status* of the ossicle and the *age*, nor the interaction between the *status* of the ossicle and the *type* of cholesteatoma. Translated into the terms of the problem, the lack of statistical significance of those interactions indicate that in our study we found no statistical significant differences in the prevalence of stapes and malleus destruction either for the two *age* groups or for the two *types* of cholesteatomas. The estimated rate of ossicular destruction is 49 per cent for stapes and 33 per cent for malleus, regardless of the *age* category of the patient and the *type* of his/her cholesteatoma.

Damage to other structures

Twelve adult patients (6.5 per cent) and one child (one per cent) presented fistulas of the lateral semicircular canal. One adult (1.6 per cent) exhibited facial nerve paralysis pre-operatively. None of the children presented a facial nerve paralysis.

Discussion

Surgeons commonly describe cholesteatomas as more or less aggressive, despite the lack of a clear criterion for aggressiveness. We attempted to define the aggressiveness of cholesteatomas mainly in terms of the amount of dam-

age caused to the bony structures of the middle ear i.e. the probability of having each of the ossicles severely damaged or destroyed, the incidences of fistulas in the semicircular canals, and the incidences of facial paralysis.

A comparison of the frequency of ossicular destruction in adults and children revealed that for two ossicles (stapes and malleus) the cholesteatomas in children had a similar rate of aggressiveness as the adults' cholesteatomas that presented pars flaccida perforation or a superior posterior perforation of the pars tensa did not differ from that caused by cholesteatomas appearing behind an intact drum.

Other complications, such as facial paralysis or fistulas of the semicircular canals, were seen more in adults than in children. Facial paralysis was observed in three adults and semicircular canal fistulas in 12, as compared to one case of semicircular canal fistula amongst the children. Ears with these kinds of complications had a posterior–superior perforation. The characterization of the cholesteatomas in children as more aggressive can be understandable if one considers other aspects of aggressiveness as represented by the following factors:

(a) cholesteatomas in children appear more often in association with larger mastoids than adults (Sadé, 1993). When these large mastoids are converted surgically into radical cavities they are particularly difficult to keep dry (Sadé *et al.*, 1982b);

(b) cholesteatomas in children recur earlier and twice as frequently in children as in adults (Sadé, 1977);

(c) the disease history of children is likely to be shorter than that of adults. Thus, without further data we cannot refute the hypothesis that the *relatively* aggressive process in children is more intense than in adults. In this respect we recall that Sheehy *et al.* (1977) as well as Ritter (1977) also suggested that the increased frequency of complications in adults, such as semicircular canal fistulas and facial paralysis, can be partly attributed to the longer time the cholesteatoma is present.

Acknowledgement

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