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Tympanic membrane atelectasis in childhood otitis media with effusion

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Abstract

A prospective study on the dynamics of tympanic membrane atelectasis during the treatment for glue ear was performed in a sample of 115 ears of 83 children aged between one and 11 years. The progression in the degree of pars tensa atelectasis was analysed in relation to six potentially relevant factors. Multivariate analysis showed that the factor with the most predictive value on the progression of the pars tensa retraction was the grade of atelectasis at initial detection ($p<0.0001$). The use of grommets did not have any significant influence on the outcome grade of atelectasis. There was an association between previous grommet insertion and localized retractions in the inferior segment of the pars tensa ($p<0.0001$). However, localized retractions in the postero–superior quadrant were **not** associated with previous grommet insertion ($p<0.02$). Although the hearing thresholds of atelectatic ears were significantly worse than normal ears especially at 4 kHz ($p<0.006$), the difference was less than 5 dB.

Key words: Atelectasis; Tympanic membrane; Otitis media with effusion

Introduction

Tympanic membrane atelectasis is a recognized sequel of otitis media with effusion (Sade, 1979). These weakened atrophic segments are associated with destruction of the lamina propria and in the presence of negative middle ear pressure cause retraction pocket formation. While the aetiology of cholesteatoma remains controversial, there are histological and clinical studies which provide evidence supporting the important role of retraction pockets (Smyth, 1980; Tos, 1981; Sade *et al.*, 1982; Wells and Michaels, 1983).

In the last 30 years, the insertion of ventilation tubes has become the standard surgical treatment for otitis media with effusion. Some authors have reported epidemiological data which suggest that grommets might prevent the progression of retraction pockets to cholesteatoma formation (Thomson, 1974; Pfaltz, 1988). However, other authors have not confirmed this observation (Padgham *et al.*, 1989; Roland *et al.*, 1992) and have highlighted the hazards of relying on epidemiological data. There are reports of an increased incidence of atelectasis in ears which had previous grommet insertion (Buckley and Hinton, 1991). Tos *et al.* (1987), however, found no difference in the incidence of atelectasis in ears with, or without, previous grommet insertion.

In this study, the course, stability or progression of retraction pockets and the effect on the degree of atelectasis of previous grommet insertion was analysed in a cohort of children with otitis media with effusion. The degree of hearing impairment, if any, due to tympanic membrane atelectasis was also studied.

Methods

The study was carried out as part of an ongoing prospective investigation of children with otitis media with effusion (OME). The children in the cohort were new cases of bilateral OME recruited between October 1988 and October 1990. Data which was collected, at the time of presentation, from follow-up clinic visits, and the type of operations was maintained on a computer database. Children with bilateral established middle ear effusion for a three-month period were listed for grommet insertion. At operation, myringotomies were performed in both ears but grommets were only inserted in those with an effusion. They were then reviewed every three to six months until resolution of their glue ears. At each visit, the following information was obtained: history, otoscopy, pure tone audiograms and impedance tympanograms. Particular attention was given to the documentation of the state of the middle ear and tympanic membrane.

All children with pars tensa atelectasis detected during the initial consultation and follow-up period were included in the study. The degree of retraction

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(grades I to IV) was recorded using the Sade classification (Sade, 1979). The site of the retraction was recorded using the four-quadrant scheme described by Mills (1991). The retractions may be generalized involving all four quadrants of the pars tensa, or localized to one, two or three quadrants. Pure tone audiograms of air conduction thresholds in the frequencies 500 Hz, 1, 2 and 4 kHz were obtained. No children in this study had any other surgical procedures (such as excision or grafting) to the ears with which to treat the retraction pockets.

Statistical analysis

The following three areas of analysis were carried out.

(1) Factors influencing the progression of the grade of retraction pockets from the time of initial detection. Six potentially relevant factors were analysed: (a) age and (b) sex of the patient, (c) the initial grade of atelectasis present, (d) the presence, or absence, of middle ear effusion, and finally (e) the presence of previous or (f) subsequent grommet insertion from the time of initial detection of atelectasis. The outcome variable was the numerical grade of atelectasis at the end of the follow-up period. Multiple regression was used for statistical analysis.

(2) To determine whether grommets were associated with localized atelectasis. Chi-square analysis was used.

(3) To determine whether an atelectatic tympanic membrane caused hearing impairment. Only those patients who satisfied the following two conditions were included: (i) unilateral pars tensa retraction pocket and a normal contralateral eardrum; (ii) bilateral aerated middle ear cavities with intact eardrums (i.e. no grommet *in situ*). The air conduction thresholds of the atelectatic ear was compared with the normal ear in the four octave frequencies between 500 and 4000 Hz. In this way each patient served as his, or her, own control in the analysis of the null hypothesis that there was no significant difference in the hearing threshold between the atelectatic ear and the normal ear. Student's paired *t*-test was used to compare the mean hearing thresholds (500 Hz, 1, 2 and 4 kHz) and the thresholds at each frequency.

Results

There were 83 children with 115 involved ears (58 right and 57 left) with detected pars tensa atelectasis in the study group. The mean age of the 52 boys and 31 girls was 4.7 years (range 1–11 years). The mean follow-up period was two years and nine months (range 1.0–5.5 years).

TABLE I
MULTIPLE REGRESSION ON THE OUTCOME OF THE GRADE OF ATELECTASIS

Factors	*p* value
Age (in years)	0.895
Sex	0.269
Middle ear status	0.145
Initial atelectasis grade	<0.0001
Previous grommet insertion	0.982
Subsequent grommet insertion	0.618

At initial detection of atelectasis, there were 108 ears with grade I, five ears with grade II and only two ears with grade III retractions. However the corresponding number of ears with atelectasis seen at initial consultation was 19 ears with grade I (17.6 per cent), three ears with grade II (60 per cent) and one ear with grade III (50 per cent). Eighty-two ears (71.3 per cent) showed atelectasis in all four quadrants. The next most common site was the antero–inferior quadrant found in 16 ears (13.9 per cent).

One child aged five years presented with a grade III retraction pocket in the postero–superior quadrant of the pars tensa and later developed a cholesteatoma in a grade IV pocket at the same site. This ear had had no grommet and a perforation appeared insidiously in the pocket before the appearance of the cholesteatoma.

Table I shows the results of using multiple regression in the analysis of potential factors affecting the grade of retractions. Out of the six factors, only the grade of atelectasis at initial detection was shown to influence the outcome atelectatic grade. Table II shows that grade I retractions seldom progress to deeper retractions whereas grade III rarely improves.

The distribution of the site of retraction pockets in relation to previous grommet insertion is shown in Tables III and IV. They show that previous grommet insertion was significantly associated with atelectasis formation in the inferior segment of the eardrum. However, retraction pockets in the postero–superior segment were not associated with previous grommet insertion and in fact most of these ears had had no grommets in the past.

There were 30 children (30 pairs of ears) who satisfied the criteria for hearing threshold analysis. Out of the 30 atelectatic ears, 26 were grade I, three were grade II and one grade III. The mean hearing threshold for the ears with atelectasis was 16.25 dB

TABLE II
THE COURSE OF PARS TENSA ATELECTASIS (N = 115 EARS)

	Outcome grade				
Initial grade	0	I	II	III	IV
Grade I	92	13	3	0	0
Grade II	1	1	2	1	0
Grade III	0	0	0	1	1

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TABLE III
THE SITE OF PARS TENSA RETRACTION AND PREVIOUS GROMMET INSERTIONS

	Site of retractions	
	Generalized	Inferior segment
No previous grommet	61	8
Previous grommet insertion	21	14

Chi-squared = 27.06; $p<0.0001$.

and 14.375 dB for the normal ears. This difference was statistically significant using Student's paired *t*-test ($p<0.006$). Table V shows that the mean hearing threshold in atelectatic ears was significantly worse at 4 kHz and 500 Hz.

Discussion

Clinical studies on the epidemiology of acquired cholesteatoma in children have shown that it occurs most often in the postero–superior quadrant of the pars tensa and in the pars flaccida (Palva *et al.*, 1977; Sade *et al.*, 1981). Many believe that otitis media with effusion is the most important risk factor for their occurrence (Tos, 1981). In certain instances, retraction pockets may progress to form cholesteatoma. Although, the use of grommets to treat otitis media with effusion has rapidly increased since 1970, there is as yet no conclusive work to show that there is any decrease in the incidence of cholesteatoma due to the widespread use of grommets (Padgham *et al.*, 1989).

Pars tensa atelectasis is a common observation in children with otitis media. Most of these are minor retractions (grade I) involving all four quadrants and the prognosis is good. By contrast, grade III and some of grade II atelectasis will not improve. In this study, one ear with grade III retraction progressed to develop a cholesteatoma.

TABLE IV
THE INCIDENCE OF POSTERO–SUPERIOR RETRACTIONS AND PREVIOUS GROMMET INSERTIONS. GENERALIZED ATELECTASIS EXCLUDED

	Site of retractions	
	Postero–superior segment	Anterior and inferior segments
No previous grommet	7	9
Previous grommet insertion	1	16

Chi-squared = 6.44; Fisher's exact test $p = 0.0149$.

TABLE V
THE MEAN HEARING THRESHOLDS (DB) OF ATELECTATIC EARS COMPARED WITH NORMAL EARS (N = 30 CHILDREN)

	500 Hz	1 kHz	2 kHz	4 kHz
Atelectatic ears	22.67	17.33	13.00	16.50
Normal ears	20.00	15.67	12.17	12.83
Student's paired *t*-test (*p* value)	<0.02	0.057	0.455	<0.006

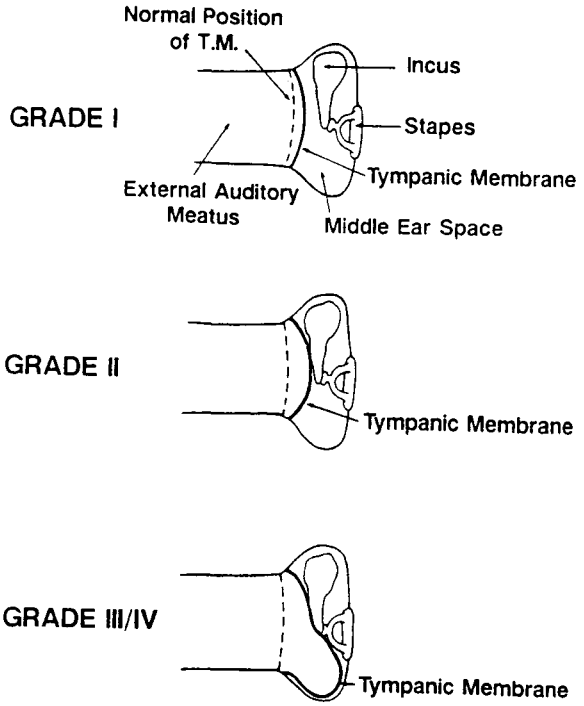

FIG. 1
Classification of retraction pockets of the pars tensa proposed by Sade (1979). Grade I: The drum is displaced slightly medially. Grade II: The drum is touching the incus or the stapes, if the lenticular process is eroded. Grade III: The drum is lying on, but not adherent to, the promontory. Grade IV: The drum is adherent to the promontory.

This study showed that grommet insertion did not affect the eventual outcome of the grade of atelectasis. Grommets were shown to cause localized atelectasis at the site of insertion (inferior segment of eardrum). However, there was no association between the use of grommets and the development of localized retraction pockets in the postero–superior or posterior segment of the pars tensa.

It is interesting that the grade of atelectasis when first detected has a predictive value in the progression of the degree of atelectasis. A significant proportion of higher grade atelectases seem to present without any record of preceding drum

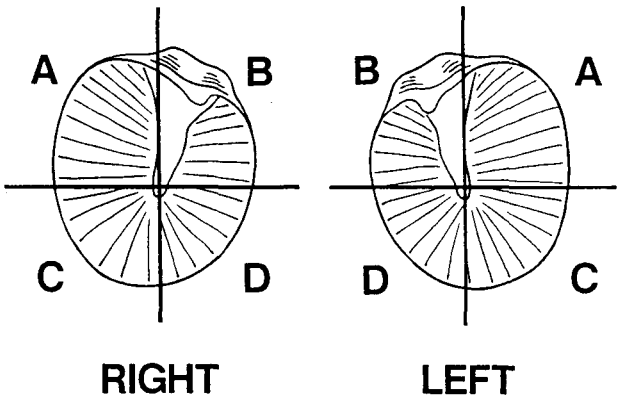

FIG. 2
Scheme for recording the site of pars tensa retractions.

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atelectasis. This observation implied three possible explanations. Firstly, the higher grade atelectases may be presenting late. Secondly, they may develop from a relatively normal eardrum without going through a lesser grade and this can happen if the retraction pocket was formed from a tympanic membrane perforation. Finally, the progression to a higher grade atelectasis may be very rapid in these predisposed ears so that intermediate grades were not detected.

There was a significantly worse hearing threshold especially at 4 kHz in the atelectatic ears when compared to normal ears. However, the mean difference was small and less than 5 dB. This confirms the findings of Mills (1991) that it is uncommon for these patients to complain of hearing loss.

Conclusions

Children with grades III and IV atelectatic ears should have long-term clinic review to detect the development of cholesteatoma. For this reason, there is an argument for surgical treatment of these advanced retraction pockets. There is no evidence that grommets influence the outcome of the degree of retractions and cause localized atelectasis at the site of insertion. Also, there is no evidence that grommets are associated with the development of the clinically important postero–superior retractions in the pars tensa.

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