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Barotitis in children after aviation; prevalence and treatment with Otovent®

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Abstract

Barotitis is an acute or chronic inflammation caused by environmental pressure changes. The most common cause is the pressure change during descent in civil aviation. To prevent barotitis the middle ear pressure has to be equalised several times during descent. This can be achieved by performing the Valsalva manoeuvre, but for children, many of whom have a dysfunction of the Eustachian tube, this is difficult to perform and they are therefore at high risk of developing barotitis during flight. The traditional treatment modalities of barotitis are inflation by a Politzer balloon, myringotomy or prophylactic grommet insertion. An alternative treatment or prophylactic measure is autoinflation using the Otovent® treatment set. This prophylaxis/treatment can be performed by the child with assistance from its parents as soon as possible or rather before the descent has started. The prevalence of barotitis amongst transit passengers was found to be highest in young children, 25 per cent, compared with adults, five per cent. Only 21 per cent of the youngest children with negative middle ear pressure after flight managed a successful Valsalva's manoeuvre, whereas 82 per cent could increase the middle ear pressure inflating the Otovent® set. In conclusion we recommend autoinflation using the Otovent® set by children and adults with problems clearing the ears during flight.

Key words: Acoustic impedance tests; Valsalvas manoeuvre; Eustachian tube

Introduction

Barotitis media, aerotitis, is defined as an acute or chronic traumatic inflammation caused by environmental pressure change (Armstrong and Heim, 1937). The most common cause of barotitis is the pressure change during descent in civil aviation together with the passenger's inability to equilibrate the middle ear pressure with the ambient pressure. In a modern aircraft the cabin pressure at cruising level is adjusted to approximately 3/4 of the atmospheric pressure. During descent the pressure difference between the middle ear and the ambient pressure has to be equalised to prevent barotrauma. Such equilibration is, by many, easily achieved by swallowing, jaw movements, yawning or chewing, while other passengers have to perform Valsalva's manoeuvre several times during descent and even by these means some passengers fail. Since it is known that many children are unable to perform Valsalva's manoeuvre and that also normal healthy children have greater difficulties in clearing their ears compared with adults (Bylander *et al.* 1981 and 1983) they are theoretically at a higher risk of developing barotitis media during flight.

The treatment of barotitis media is often painful, time consuming and has most often to be performed by an ENT-specialist. The traditional treatment modalities are Politzer inflation, myringotomy with, or without, grommet insertion. An ideal way to avoid this would be a noninvasive and painless measure without complications and which could be carried out before descent and landing. The treatment, by autoinflation, using the Otovent® set, has previously been shown to increase the middle ear pressure significantly in children suffering from secretory otitis media (Stangerup *et al.*, 1992; Blanshard *et al.*, 1993). This way could be performed by children assisted by their parents as soon as possible when, or rather before, the descent has started.

The aim of this study was to estimate the prevalence of middle ear problems in children during flight and to evaluate the efficacy of the Otovent® set inflation in order to reduce the risk of barotitis.

Subjects

With permission and help from the Scandinavian Airline System and the authorities at Copenhagen

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FIG. 1
Child inflating the Otovent® through the nose.

Airport, the study was performed during two days in May 1995. Unselected children, in transit at Copenhagen Airport, were recruited with the permission of their parents. The parents completed a questionnaire about the children that enquired about a history of nasal allergy, the presence of current nasal congestion, previous ear problems during flight, otalgia and use of any decongestants during the latest flight. The children underwent an ENT examination including otoscopy and tympanometry before and after Valsalva's manoeuvre and also after inflation using the Otovent® set (Figure 1). Forty-five children were examined, age range two to 14 years, with a median age of seven years. As a comparison group, 49 adults in transit, were also recruited and underwent an identical assessment.

Methods

Otoscopy identified pathological findings according to Teed's classification of barotitis (Teed, 1944) (Table I). A Madsen 901 tympanometer was used for tympanometry and the findings were classified according to a modification (Fiellau-Nikolajsen and Lous, 1979) of Jerger's system, i.e. type A: -5 to -99 mmH_2O; type C1: -100 to -199 mmH_2O; type C2: -200 to -400 mmH_2O and type B: flat curve with no impedance minimum. The children were analysed in three age groups, two to six years, seven to nine years and 10 to 14 years. Each ear was separately analysed and the Mann and Whitney rank sum test for independent samples and the McNemar change test for matched samples was used for evaluation of the outcome and the level of significance was chosen as $p<0.05$.

TABLE I
TEED'S CLASSIFICATION OF MIDDLE EAR BAROTRAUMA

Grade 0:	Normal
Grade 1:	Retraction with redness in Schrapnell's membrane and along the manubrium
Grade 2:	Retraction with redness of the entire ear drum
Grade 3:	Same as grade 2 plus evidence of fluid in the tympanum or haemotympanum
Grade 4:	Perforation of the ear drum

TABLE II
OTOSCOPIC FINDINGS AFTER FLIGHT IN CHILDREN AND ADULTS (TEED'S CLASSIFICATION; BAROTITIS GRADE 0–4)

Otoscopic findings	Group I n	Group II n	Group III n	Adults n
Grade 0	16	21	20	86
Grade 1	8	3	3	7
Grade 2	6	2	3	3
Grade 3	2	—	2	2
Grommet	2	—	—	—
Ears, total	34	26	28	98

Results

Ear problems during previous flights were reported by 28 out of 43 children (65 per cent) and by 166 out of 363 adults (46 per cent). During the recent flight 21 out of 38 children (55 per cent) reported otalgia and difficulties in ear clearing and 72 out of 361 adults (20 per cent) reported otalgia. More than one third, 14 out of 38 children (37 per cent) had used nasal decongestants during the recent flight compared with 18 out of 357 adults (five per cent).

Table II demonstrates the number of ears and degree of barotitis seen by otoscopy after the recent flight. In 16 out of 32 ears (50 per cent) of the youngest children, Group I, signs of barotitis were seen, while in adults, this was seen in 12 out of 98 ears (12 per cent).

Table III show the tympanometric findings recorded after the recent flight. The number of ears with different degrees of negative pressure are given for each group of children as well as for the adult group. As expected, negative middle ear pressure was found significantly ($p<0.05$) more frequently in the youngest children than in the adults. Tympanogms showing a negative middle ear pressure of more than 100 mmH_2O (type C1, C2 and B) were seen in 12 out of 32 ears (38 per cent) of the youngest children, Group I. In Group II, 24 per cent and in group III, 32 per cent were found with such tympanograms and in adults the figures were 15 out of 98 ears (15 per cent).

Children as well as adults were all instructed how to perform Valsalva's manoeuvre. After this man-

TABLE III
TYMPANOMETRIC FINDINGS AFTER FLIGHT IN THE DIFFERENT AGE GROUPS

Tympanometry type	Group I (a) n	Group II (b) n	Group III (c) n	Adults (d) n
Positive	4	4	1	10
zero	—	—	—	10
A	16	15	14	63
C1	4	3	3	6
C2	4	—	3	5
B	4	3	1	4
Total	32	25	22	98

Mann–Whitney: a–d, $p<0.05$; b–d, n.s.; c–d., n.s.

TABLE IV
EFFECT OF VALSALVA'S MANOEUVRE IN EARS WITH NEGATIVE MIDDLE EAR PRESSURE AFTER AVIATION EVALUATED BY TYMPANOMETRY

Middle ear pressure	Group I n	Group II n	Group III n	Adults n
Normalized	1	9	12	40
Improved	5	5	3	16
Unchanged	15	2	6	15
Deteriorated	7	5	—	7
Ears, total	28	21	21	78
McNemar test	n.s.	n.s.	$p<0.011$	$p<0.001$

oeuvre 27 out of 28 ears (96 per cent) in Group I still had a negative pressure while the figures for Group II, III and adults were 57 per cent, 43 per cent and 49 per cent, respectively (Table IV). There was no significant change in middle ear pressures following Valsalva's manoeuvre in Group I and Group II, while in Group III and among adults a significant increase ($p<0.001$) was seen (Table III).

Both children and adults were then instructed how to inflate the Otovent® balloon (Figure 1). Since the initial inflation of the Otovent® balloon requires a pressure of approximately 600 mmH_2O, some of the children and a few of the adults were unable to accomplish this. In cases where the youngest children were unsuccessful, one of the parents orally inflated the balloon which then was held to the child's nostril using the deflation of the balloon as a Politzer inflation. Successful inflation of the balloon was achieved by 53 per cent of Group I, 72 per cent of Group II, 96 per cent of Group III and 94 per cent of the adults. Following Otovent® inflation there was a significant increase (McNemar change test, $p<0.001$) in middle ear pressure, compared with the effect of Valsalva's manoeuvre, in all age groups except Group II. In the ears, with a remaining negative middle ear pressure after flight and also after Valsalva's manoeuvre, the middle ear pressure was normalised after Otovent® inflation in 12 out of 27 ears (44 per cent) in Group I. The corresponding figures in Group II and III were 25 per cent and 44 per cent, respectively. In the adults the figure was 68 per cent (Table IV).

Discussion

In contrast to the different opinions about the pathogenesis of secretory otitis media, barotitis is obviously caused by the negative pressure remaining in the middle ear during and after descent (Armstrong and Heim, 1937). This negative pressure is the result of the increase in cabin pressure during descent and the inability of the passenger to equilibrate the middle ear with the ambient pressure. From simulated flights in a pressure chamber it is documented (Hanna, 1989) that during the simulated descent, when the chamber pressure is increased from 3/4 of, to atmospheric pressure, equilibration of the middle ear pressure has to be repeated at least three to four times to prevent the risk of barotitis. From the otoscopic results in our study 12 per cent of the adults and 34 per cent of the children showed signs of barotitis according to Teed's classification. The clinical relevance of grade I is uncertain, but grades 2 and 3, which were found in five per cent and 17 per cent of the ears in adults and children respectively, represents pathology of clinical relevance.

From the US Air Force chamber flight results, the relative frequency of various types of barotrauma among 101 716 USAF Trainees was reported to be 27 per cent of which 64 per cent were barotitis (Hanna, 1989). It was also reported that 'clearing the ears' was more difficult in cases with nasal congestion. The results of the present study show that only four per cent of the youngest children and 51 per cent of older children and adults were able to normalise the middle ear pressure after performing Valsalva's manoeuvre, whereas improvement of the pressure was managed by 18 per cent of the youngest children and about 20 per cent of older children and adults after performing Valsalva's manoeuvre with instruction from a doctor. In Tables IV and V it can be seen that 25 per cent of the young children, age two to nine years, and nine per cent of the adults were recorded to have an even more pronounced negative middle ear pressure after Valsalva's manoeuvre. The explanation for this could be that some patients, when trying to perform Valsalva's manoeuvre, are performing a Toynbee's manoeuvre. What we can not explain is how some can increase the negative pressure after inflating the Otovent®. The results of the study correlate well with the experiences reported in the questionnaires. Fifty-five per cent of the children and 20 per cent of the adult passengers reported otalgia during the recent flight which also corresponded to the otoscopic findings. In children and adults there was a significant increase in middle ear pressure after Otovent® inflation compared with the effect of Valsalva's manoeuvre. Furthermore, an increase in middle ear pressure after Otovent® inflation was also seen in cases who could not manage to perform Valsalva's manoeuvre successfully. In the youngest age group many children were unable to inflate the Otovent® balloon. From clinical experience is seen that many of these children could have learned to inflate the balloon if tuition from their parents had started one or two days before the flight.

TABLE V
EFFECT OF OTOVENT® INFLATION IN EARS WITH REMAINING NEGATIVE MIDDLE EAR PRESSURE AFTER VALSALVA'S MANOEUVRE EVALUATED BY TYMPANOMETRY

Middle ear pressure	Group I n	Group II n	Group III n	Adults n
Normalized	12	3	4	26
Improved	10	4	3	6
Unchanged	3	3	2	3
Deteriorated	2	2	—	3
Ears, total	27	12	9	38
McNemar test	$p<0.001$	n.s.	$p<0.05$	$p<0.001$

Conclusion

Otovent® inflation is effective in reducing negative middle ear pressure after flying and this treatment is popular among most children and is without side effects. Due to the high incidence of Eustachian tube dysfunction in normal children also they could possibly fly with fewer ear problems if they used the Otovent® set. Young children could learn to perform Otovent® inflation at home before flying and then perform autoinflation as soon as, or even before, the descent starts in order to prevent painful ear conditions.

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