

TYMPANOGRAPHIC STUDY OF NORMAL SUBJECTS DURING HYPOBARIC CHAMBER
EXPOSURE - A PRELIMINARY STUDY

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Tympanometry facilitates a more complete evaluation of the auditory apparatus and is particularly useful for aircrew selection and evaluation. This preliminary study presents tympanometric data of 15 healthy adults following exposure to simulated altitudes of 2,438 m (8,000 ft) and 4,572 m (15,000 ft).

Keywords: altitude chamber; tympanometry; tympanogram; auditory compliance; eustachian tube patency.

PATENCY of the eustachian tube and adequate ventilation of the middle ear under all conditions of flight are of importance in flying. Eustachian insufficiency due to any cause may lead to acute distress, pain in the ear and even aerotitis posing a hazard to flight safety.

Tympanometry is a relatively new procedure in clinical practice and specially in aviation environment, its modern clinical use dating back to 1946. With sophistication and improvement achieved in the past 15 years its use has been greatly expanded. This procedure facilitates a more complete

evaluation of the total auditory apparatus namely the patency of the eustachian tube and the acoustic compliance of the ear drum, ossicular chain and stapedius reflex measurements. For safe performance of the highly skilled task of flying these functions are of paramount importance in aircrew.

Aviators are exposed to rapid changes in barometric pressure during ascent and descent during flying specially in military aviation. The incidence of aerotitis is still a major aeromedical otological problem much more so in training flights than in operational flights, consequently upsetting the

training schedules and operational conversion. Any method which will aid in predicting the possible middle ear or eustachian tube dysfunction or will aid in following up the status of aerotitis media, once it is present, is highly desirable. Tympanometry is one such aid to evaluate the mobility of the tympanic membrane, the functional condition of the middle ear and the ventilation capability of the eustachian tube. The present preliminary study was undertaken on healthy volunteers at simulated altitudes in an altitude chamber.

Material and Methods

The equipment used was the American Electromedic AE-85 Tympanometer. It emits a 220 Hz tone into the ear canal from an ear canal sealing probe tip, at the same time varying the pressure in the ear canal from +200 to -400 mm of water in a 3 sec period. With this quick painless procedure the compliance or mobility of the eardrum is graphed automatically.

Fifteen healthy adults participated in the study. They underwent thorough ENT examination including audiometry immediately prior to exposure to altitude in the hypobaric chamber in order to exclude any upper respiratory infection, wax in external auditory canal and any middle ear pathology. Baseline tympanometry was done inside the hypobaric chamber at ground level.

The altitude exposure run profile used was as follows:

- a. Ascent to 4,572 m at the rate of 915 m per min and level out. Record tympanogram for each ear.

- b. Descent to 2,438 m at the same rate and level out. Record tympanogram for each ear.

- c. Descent to ground level at the same rate and record tympanogram for each ear.

All the subjects underwent post-test ENT examination including audiometry. The subjective feelings of the participants in the trial were noted. The tympanograms were analysed and compared. Two subjects were exposed to the same altitude profile on four consecutive days and the tympanograms compared.

Results and Discussion

The age group of the 15 subjects ranged from 27 to 52 years. ENT evaluation including audiogram prior to exposure to altitude did not reveal any abnormality in the test subjects. During altitude exposure, two subjects complained of mild discomfort during descent from 4,572 m to 2,438 m. They were able to ventilate their middle ear by valsalva procedure. Post-run examinations revealed mild congestion of the tympanic membranes, slight retraction of the ear drum and sluggish mobility indicating mild aerotitis media in both of them. All other subjects were asymptomatic during altitude exposure runs and post exposure evaluation did not reveal any clinical or audiometric abnormality.

A set of eight tympanograms, four each for either ear, was recorded for each subject, totalling 120 records in all. The various parameters of tympanograms were analysed and compared.

Table I - Types of Tympanograms

Type	Left Ear				Right Ear			
	1	2	3	4	1	2	3	4
A	12	5	9	6	9	6	7	7
B	-	2	-	2*	-	1	1	2*
C	-	1	-	1	-	1	-	1
AD	3	7	6	6	6	7	7	5

A - Normal; B, C and AD - Abnormal
 * - Complained of ear discomfort.

1. Ground level baseline record
2. Record at 4,572 m after ascent
3. Record at 2,438 m after descent
4. Ground level post-exposure record

a. Types of Tympanograms

Depending on the characteristics of the tracing, tympanograms can be classified as types A, B, C, AD and AS (Fig 1). Type A is normal and the others abnormal. The types of tympanograms noted in this study are given in Table I. Two subjects complained of mild discomfort during descent. The tympanic membranes showed poor mobility and retraction.

b. Peak Pressure

The normal peak pressure is between ± 100 mm water. Peak pressure findings in this study are given in Table II. The changes noted are statistically not significant.

Table II - Peak Pressure

Peak Pressure (mm water)	Left Ear				Right Ear			
	1	2	3	4	1	2	3	4
± 100 *	14	12	9	14	14	13	14	14
<-100 @	-	1	-	1	-	1	-	1
>+100 @	1	2	6	-	1	1	1	-

* Normal

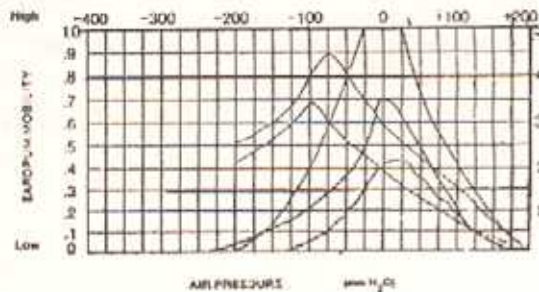
@ Abnormal

Table III - Compliance Data

1		2		3		4	
≤ 1	> 1	≤ 1	> 1	≤ 1	> 1	≤ 1	> 1
LEFT							
0.89	0.2	0.47	0.53	0.6	0.4	0.8	0.2
RIGHT							
0.6	0.4	0.4	0.6	0.53	0.47	0.63	0.33

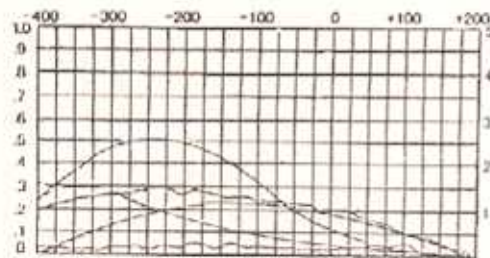
c. Compliance

The normal range of compliance is >0.3 and <1.0 in the scale. Compliance refers to the mobility of the ear drum and ossicular chain. When the ear drum is normal and the middle ear pressure and ear canal pressure are equal, the



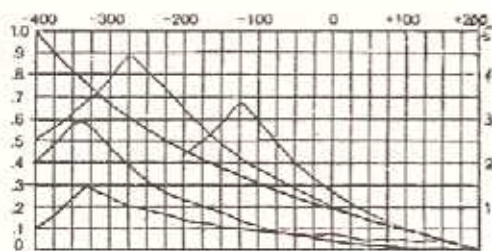
A. PEAK

Peak Falls between + 100 mm of H₂O. Peak above .3 and below compliance scale indicates : Normal



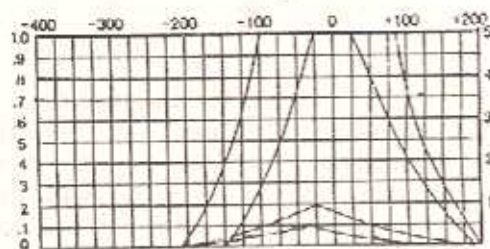
B. No Peak

Height of graph is low and flat. Indicates poorly mobile middle ear system.



C. Peak beyond - 100 mm

Height may vary. Indicates Negative middle ear system



D. AD. Chopped appearance Peak above 1

Indicates very mobile TM.

AS. Peak is low below 0.3.s

Poor mobility with stiff middle ear system.

Fig.1 Automatic Tympanographs

day readings in PVT, both at ground level and at altitude in both the subjects. This is shown in Table V.

The reason for this change in PVT values on the 3rd day of exposure as compared to the first day cannot be explained. However, these values return to the 1st day value on the 4th day.

Conclusion

The present preliminary tympanographic study of 15 normal subjects during exposure to altitude changes has given us the response patterns of various parameters of tympanograms. Two subjects had symptoms and signs of mild aerotitis confirmed clinically and also the type of tympanograms. The type and peak pressure parameters of tympanogram was seen during the altitude run has shown no significant changes. The compliance parameters have shown a statistically significant change only in the left ear at 4,572 m as compared to the base line which cannot be explained. The PVT has also shown a significant

change (i.e., increase) at 4,572 m as compared to the basal level. Subjects on exposure to the hypobaric chamber run profile on 4 consecutive days had no significant change in tympanogram parameters except that the PVT showed a change on the 3rd day as compared to the 1st day. This change returns to the 1st day value on the 4th day. Further studies on large number of subjects are warranted to confirm and explain the changes seen in PVT due to altitude exposure.

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