Mechanical Reaction of the Labyrinth

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In 1923 Karlefors and Nylen[1] reported a fistula-like reaction in cases of chronic suppurative otitis media without presence of any fistula on the labyrinth. According their describtion the symptom started after a short latent period and was absent after repeated procedure. It could be only elicited when the pressure exerted in the external auditory meatus was higher than 80 to 100 mm.Hg. This phenomenon is called pseudo fistula reaction and explained in various thoughts: for instance; there is a decrease of the threshold for mechanical stimuli or an increase of motility of the content of the labyrithine windows.

In the present paper we propose to review the mechanical reaction of the labyrinth in normal subjects and cases with chronic suppurative otitis media. Our present review of its clinical features is based upon the study, made possible through the courtesy of our colleagues in the Dept. of Otology, Yamaguchi University School of Medicine, of over 100 cases. These we have examined in the course of the last few years.

Our normal subjects consisted of 25 males and 20 females. Their ages ranged from 17 to 24 (average 21) years. They were volunteer studnets of the medical or nursing school in our University, who had normal ear drums and no abnormalities of cochlear or vestibular response proved by examinations.

The total number of 48 ears were from 38 individuals with unilateral suppurative otitis media and 5 individuals with bilateral one. Their ages ranged from 21 to 63 (average 41) years. Twenty five were males and eighteen were females. Regarding the clinical appearances in 48 ears, the great majority of ears (39 ears) had a central perforation, small or moderate in size, on the ear drum without discharge in the tympanic cavity or external auditory meatus showing a 10 to 25 dB hearing loss characterized by a flat audiometric pattern, and the remaining 11 ears had a radical mastoidectomy before examination of the present study showing a 50 to 60 dB hearing loss. In all 43 cases with chronic suppurative otitis meadia in

the present study we could not find out abnormal responses of equilibrium and caloric reaction by examiantions, and history of onset of vertigo.

We come, now, to explain the mothods of mechanical stimulation in the labyrinth in the present study. The subjects lay comfortably upon a couch with his head raised some 30° above the horizontal. This brings the lateral semicircular canal into a position of maximum sensitivity to mechanical stimuli, because in this head position the lateral semicircular canal is parallel to the horizontal line. It provides a most effective means for immobilizing his head, and so make it easy for the examiner to make accurate observations of eye movement. To avoid fixation of the gaze Frenzel's glasses was used.

The stimulus air pressure flowed into the external auditory canal was 40 and 80 mm. Hg. The air temperature was 35° Centigrade and the stimulation lasted for 30 seconds in each test. In order to adjust the air temperatures, a constant temperature tank (thermostat) was used, in which hot air of 35°C flows through a small coil pipe. Air at correct pressure was availabe from an air pump. Air pressure was measured by aneroid barometer connected with the tube in which the air flows through to the ear canal. The air temperature was measured by thermister inserted into the external auditory canal.

Having induced eye movements in this way, their recording was carried out using electronystagmography, with which the stimulus pressure was synchronized. The block diagram showed in Fig 1.

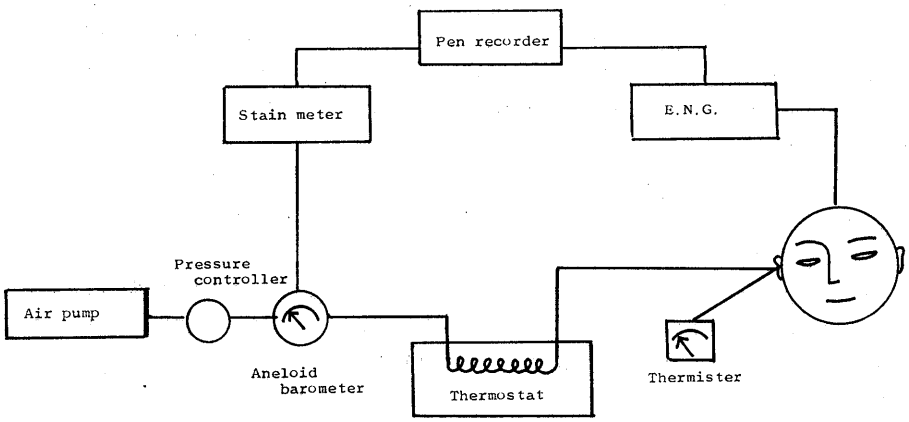

Fig. 1. Block diagram of the methods

As shown in Table 1, we found that in three (6.7 per cent) of 45 normal subjects positive mechanical reactions (nystagmus) were present by air pressure of 80 mm. Hg., although in all subjects negative mechanical responses occurred by air pressure of 40 mm.Hg. As to the direction of nystagmus, in all three subjects they were towards the opposite side. The duration of nystagmus lasted for 10 to 5 seconds (Fig. 2).

In 18 ears with chronic suppurative otitis media, we found that by air pressure of 40 mm.Hg four (22.2 per cent) were present nystagmus towards the opposite side, without exception, lasting for 8 to 5 seconds.

Table 1. Percent of positive mechanical responce

Subjects	Air Pressure	Number Subjects and ears	Number Positive M. R.	Percent
1. Normal	40mmHg	22	0	0
subjects	80mmHg	45	3	6.7
2. Cases of chr.	40mmHg	18	4	22.2
middle ear infection	80mmHg	39	14	35.9
3. Cases of mastoidectomy	80mmHg	9	7	77.8

Notice: M. R.-Mechanical response

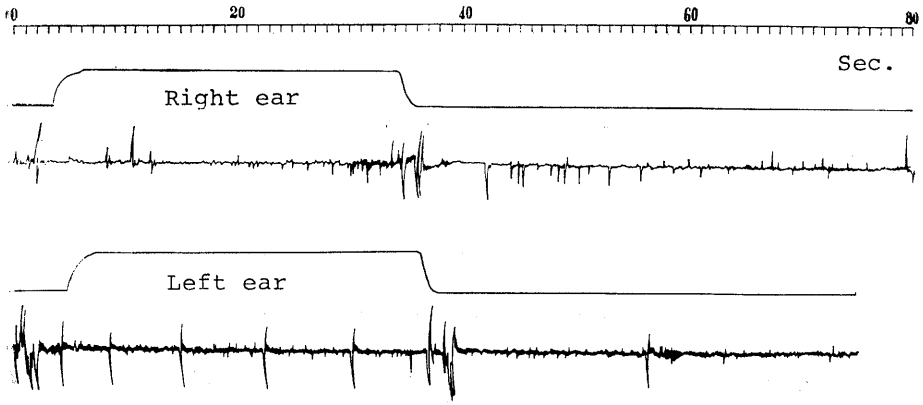

Fig. 2. Normal subject (21-year-old medical student) Air pressure of 80 mmHg on the external auditory canals elicited nystagmus towards the opposite side.

In 39 ears with chronic suppurative otitis media, we found that by air pressure of 80 mm.Hg. fourteen (35.9 per cent) occurred nystagmus towards the opposite side in all ears lasting for 15 to 8 seconds (Fig. 3).

In 9 ears with mastoidectomy before examination, seven (77.8 per cent) were present nystagmus by air pressure of 80 mm.Hg. Their direction of nystagmus were towards the opposite side without exception. The duration of nystagmus lasted for 20 to 11 seconds (Fig. 4).

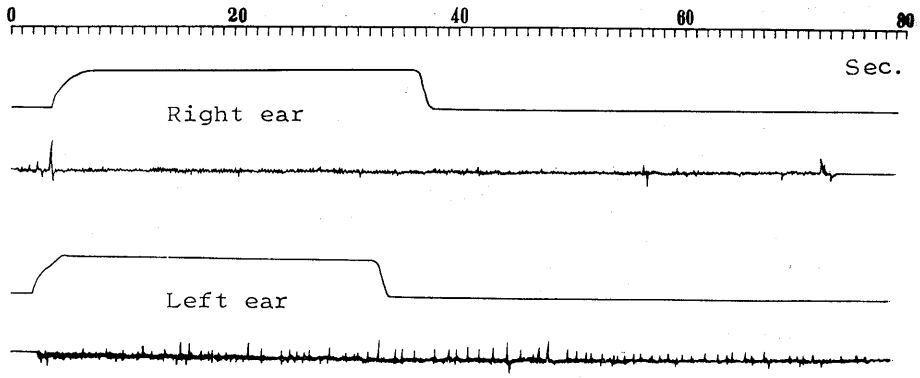

Fig. 3. 32-year-old male with suppurative otitis media on the left side complaining of a small central perforation on the left sided ear drum without discharge. No history of vertigo.
Air pressure of 80 mmHg for 30 minutes on the left sided ear canal elicited nystagmus towards the right side (opposite side), notwithstanding no nystagmus elicited on the right ear.

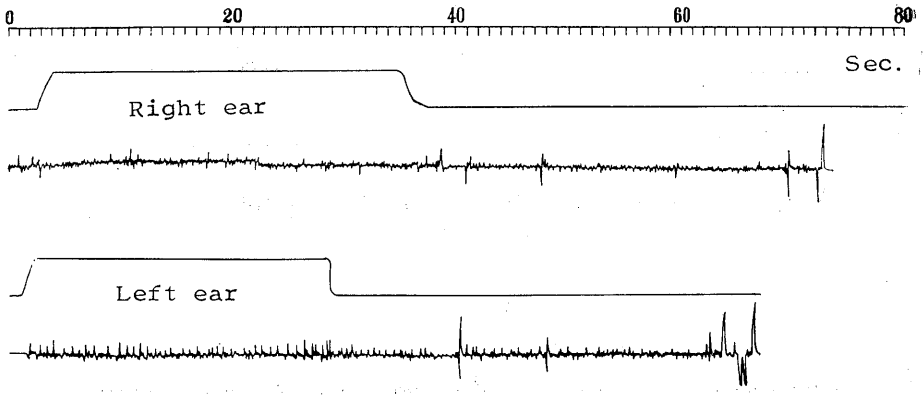

Fig. 4. 42-year-old female with post radical mastoidectomy on the left side in condition. The mastoid and tympanic cavities were clear without discharge. No history of vertigo.
Air pressure of 80 mmHg for 30 minutes on the left sided exteral canal elicited nystagmus towards the right side (opposite side), notwithstanding no nystagmus elicited on the right ear.

COMMENT

We come, finaly, to discuss the subject of the mechanical reaction of the labyrinth. According to Fischer[2] the term mechanical reaction of the labyrinth is used when the reaction is a result of the mechanical stimuli of compression or aspiration, which lead respectively to increase or decrease of the endolabyrinthine pressure. In order to elicit this reaction certain pathological changes in the labyrinth must be present, so that this reaction does not occur in normal persons. The most common condition involving this reaction is a circumscribed defect of the wall of the bony labyrinthine capsula.

From theoritical point of view, the conception above mentioned seems to be true, however, in the clinical experiences of our otologists we are able to find out that some case with chronic suppurative otitis media occurs nystagmus towards the opposite side by mechanical stimulation of compression or aspiration on the external auditory meatus.

As above described in the present study, the authors also proved that in the cases with chronic suppurative otitis media the nystagmus towards the opposite side elicited by air pressure of 40 and 80 mm.Hg. flowing into the external auditory meatus. Moreover the authors provided with the nystagmus occuring by air pressure of 80 mm.Hg. on the external auditory meatus in the normal sujects.

It is of importance to keep in mind that the direction of the nystagmus eliciting in the normal subjects and chronic suppurative otitis media in the present study are towards the opposite side without exception. According to the law of Ewald the direction of the nystagmus depends on the direction of the endolymphatic flow. For the horizontal semicircular canals, the ampullopetal flow is the effective stimulus, thus eliciting a nystagmus in the same direction; while an ampullofugal flow produces a nystagmus in the opposite direction. In other words, compression causes a nystagmus in the direction of the compressed side, while aspiration leads to a nystagmus in the direction of the opposite side.

Judging from the law of Ewald, it is considered, beyond any doubt, that the nystagmus elicited by air pressure in the present study are due to the ampullofugal flow of the endolymph, because all the directions of the nystagmus are towards the opposite side. From this point, we would be rather inclined to think that air pressure flowed into the external auditory meatus seems to act on the oval or round window, which causes the nystagmus towards the opposite side.

SUMMARY

Air pressure of 40 and 80 mm.Hg. at 35°C were flowed into the external auditory meatus for 30 sec. in the normal subjects and the cases with chronic suppurative otitis media.

1. In the normal subjects air pressure of 80 mm.Hg. elicited nystagmus (6.7 per cent) notwithstanding no nystagmus by 40 mm.Hg.

2. In the cases with chronic suppurative otitis media air pressure of 40 mm.Hg. elicited nystagmus (22.2 per cent) and of 80 mm.Hg. elicited nystagmus (35.9 per cent).

3. In the cases with mastdectomy nystagmus (77.8 per cent) occurred.

REFERENCES

1) Karlefors, J., and Nylen, C. O.: Om Pseudofistel. *Acta Oto-laryng.*, 3 : 156, 1923.
2) Fischer, J. J.: *The labyrinth.* Grune and Stratton, New York, 1956.