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The high-pitch notched audiogram: a cohort of patients without causative noise-induced hearing loss

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Main Article

Mr P J Moore takes responsibility for the integrity of the content of the paper

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Abstract

Background. One still encounters opinion that hearing loss with high-pitch notched audiogram is invariably due to noise-induced hearing loss. This paper tests this misapprehension.
Methods. A study was conducted of patients identified in a prospective manner with notched audiograms but no history of noise exposure occurring in an otolaryngological practice over a 20-year period.
Results. A cohort of 26 hearing loss patients, in whom notched audiograms were not associated with historical evidence of noise exposure, was documented.
Conclusion. The findings confirm that a notched audiogram is not pathognomonic of noise-induced hearing loss.

Introduction

In the clinical and medicolegal practice of otolaryngology, one continues to encounter, at times, the opinion that a high-pitch notched audiogram is invariably due to a noise-induced hearing loss.

It had been the author's past observation that, in some patients presenting with such high-pitch notched audiograms, no causative noise exposure could be identified. This subsequently led to the current study objective to identify any such patients in a prospective manner.

Materials and methods

This prospective study was undertaken over a period of 20 years in the author's private otolaryngological practice that served urban and regional patients.

Patients presenting because of hearing loss or tinnitus (and occasionally only other otological presenting symptoms) underwent assessment by history, physical examination, appropriate audiometry and with further investigations as pertinent. Those with sensorineural hearing loss featuring high-pitch notched audiograms underwent a comprehensive history to identify any possible past noise exposure. Occupational, domestic, leisure and recreational history was also sought to identify any feasible noise exposure.

Any conceivable historical evidence of past ear or head trauma, acoustic trauma, ototoxic drug exposure, family history and ear disease or surgery was also pursued.

The described cohort represents those patients in whom no underlying noise exposure cause for a sensorineural hearing loss with a high-pitch notched audiogram was found.

Results and analysis

Twenty-six patients were identified with the criterion of sensorineural hearing loss featuring a high-pitch notched audiogram, in the absence of any history of noise exposure.

No conductive component to the hearing loss was identified in any case. Masked thresholds were obtained when indicated. The consequent pure tone audiometric data are shown in Table 1.

Twenty-one patients (81 per cent) were male and five (19 per cent) were female. Ages ranged from 22 to 77 years, with a mean of 54 years. All had bilateral hearing loss. Twelve patients (46 per cent) had 15 dB or greater notch asymmetry. A family history of hearing loss was noted in six patients (23 per cent).

Discussion

This study identified 26 patients with sensorineural hearing loss featuring a high-pitch notched audiogram but no history of noise-induced hearing loss. The underlying cause of such presentation has been a longstanding enigma, at times being erroneously attributed to noise exposure even without any history of such.[1] It is widely accepted that a diagnosis of noise-induced hearing loss cannot be made on the basis of the audiogram alone,[1–5] but it is not uncommon in otolaryngological practice to encounter such erroneous opinions.

Table 1. Audiograms of patient cohort with high-pitch notch but no noise exposure

		Right ear frequency (kHz)								Left ear frequency (kHz)							
Case	Age (years)	0.25	0.5	1	2	3	4	6	8	0.25	0.5	1	2	3	4	6	8
1	54	15	15	15	10		45	65	55	15	20	15	20		40	80	60
2	52	15	15	10	20		60	55	60	10	15	10	15		75	70	40
3	60	10	5	15	30		50	85	75	10	5	25	30		60	90	80
4	52	5	5	5	20		50	20	10	10	10	10	15		55	35	10
5	52	10	0	10	20		35	25	20	0	0	10	5		35	25	0
6	73	35	40	35	25		55	35	40	35	35	20	55		75	55	55
7	50	15	15	15	10		30	0	5	10	10	10	10		40	30	25
8	60	10	5	15	45		75	80	65	10	5	10	35		70	70	60
9	49	20	30	30	25		55	60	60	20	25	25	35		65	75	60
10	48	15	10	20	20		60	50	30	15	10	20	30		50	60	40
11	56	10	15	10	10		60	75	70	25	30	25	30		40	70	55
12	47	25	25	20	30		35	25	20	10	20	15	35		50	35	30
13	77	20	20	25	25		65	80	70	25	25	15	25		70	90	100
14	58	10	10	10	0	40	55	45	40	10	5	10	10	30	50	30	20
15	34	5	10	15	15	10	70	60	50	5	10	20	15	15	55	40	25
16	59	10	10	10	25	25	35	55	50	5	10	10	15	25	30	45	45
17	55	5	5	5	0	0	0	25	10	10	15	10	10	20	30	35	25
18	44	5	5	15	5	5	40	50	25	5	5	10	5	20	60	60	35
19	64	10	5	15	10	40	50	35	30	25	20	20	25	40	60	55	55
20	62	5	5	0	0	40	40	50	20	10	5	5	0	30	30	40	25
21	51	5	5	15	15	15	25	10	20	5	5	10	15	25	40	30	30
22	54	0	0	5	0	20	30	30	20	5	5	0	0	40	40	55	40
23	61	15	15	20	20	35	80	100	85	15	10	15	10	40	75	90	70
24	48	15	20	15	25	30	85	75	70	15	25	20	15	60	70	90	70
25	22	20	15	15	25	20	30	45	15	15	5	15	30	30	35	50	20
26	56	20	20	15	15	20	25	55	55	15	20	10	5	25	45	70	55

Data represent hearing levels in decibels (International Organization for Standardization)

There have been a few past reports of high-pitch notched audiograms in the absence of a history of noise exposure, mostly based on retrospective, non-clinical analysis of questionnaires, without the benefit of a detailed clinical history collected in a prospective manner. Lie *et al.*[6] used data based on audiograms and questionnaires from a large population of hearing loss patients who were originally part of the Nord-Trøndelag Health Study. They found audiometric notches occurring in both noise-exposed and non-exposed residents. Nondahl *et al.*[7] used data from a population questionnaire-based study of older adults designed to evaluate published algorithms for identifying notched audiograms. In addition, they found that 11 per cent of participants had no history of exposure to noise. Osei-Lah and Yeoh[8] retrospectively reported a group of patients attending an audiovestibular clinic with high-frequency audiometric notches that were not attributable to noise exposure.

Audiograms notched at 4 kHz have been described in association with clinical events such as viral infections,[9] barotrauma, closed head injury, labyrinthitis, perilymph fistula,[4] ototoxins,[5] and neonatal jaundice with kernicterus.[10] Notches on audiograms at 6 kHz may be artefactual.[11] Genetic causes, seen as familial high-pitch notched audiograms in the absence of noise exposure, have been demonstrated in two studies,[12,13] in addition to other observations.[14–16]

In considering the cause of these high-pitch notched audiograms, one could entertain the possibility that a history of past noise exposure may have simply been forgotten by patients. Whilst otic trauma and acoustic trauma events may be single and forgotten, noise-induced hearing loss is a gradual process, requiring a long time of repeated exposure, rather than a single or few salient events.[2,17–19] The benefit of this prospective clinical study has been the ability to thoroughly question the patient about possible past noise exposure at the time of clinical assessment; thus, it is very unlikely that a history of repeated causal exposure to noise over a long period of time leading to noise-induced hearing loss was not detected.

- Patients with noise-induced hearing loss often have a high-pitch notched audiogram
- There is an opinion that such a notch is pathognomonic of noise-induced hearing loss
- A prospective study was designed in an otolaryngological practice
- This study identified a group of patients where no noise exposure history was associated with such a notch
- The findings confirm that a notched audiogram is not pathognomonic of causal noise exposure

The concept of susceptibility ('soft' and 'hard' ears) does show variation in the effect of noise-induced hearing loss on ears.[20–23] However, as noted in the previous paragraph, this still requires a history of repetitive exposure over a long period of time that is unlikely to elude a detailed history in a prospective study, and no such history of repetitive noise exposure was found in this group. Such a concept of higher susceptibility does not therefore seem a tenable explanation in this group with high-pitch notched audiograms and a lack of any history of progressive noise exposure.

Conclusion

This paper presents a prospective study over a 20-year period of a cohort of patients with hearing loss, with a high-pitch notched audiogram, in whom there was no evidence of a noise-induced cause. The findings confirm that a notched audiogram is not pathognomonic of causal noise-induced hearing loss.

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