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The ageing ear
A clinico-pathological classification

by

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Introduction

The temporal bone collection at the House Ear institute, Los Angeles, contains 151 specimens that belonged to 95 persons over the age of 65. We have studied the histological features and medical histories in these cases. Additionally, we have examined the medical records of many thousands of patients over 65 years of age. From these combined studies, we have attempted to classify the ageing changes in the peripheral auditory system in an operational way based on clinical, etiologic and histological findings. The evidence indicates that the passage of time produces changes in the auditory system undoubtedly related to numerous influences that are casually related. Three groups of changes seem to occur in the peripheral auditory system of the ageing ear (Table I). The first, presbyacusis, represents the effects of biological ageing on the ear. These changes have no detrimental effects on hearing.

The second, accelerated presbyacusis, shows exaggeration of the biological histological changes in the cochlea, and their tendency to affect one morphological layer of the cochlear duct. The type of hearing-loss varies with the type of morphological layer involved.

The third, nosoacusis, consists of cases with specific ear diseaes commonly associated with ageing.

Presbyacusis

Presbyacusis, biological ageing, is charac-

TABLE I

CLASSIFICATION OF THE AGEING EAR

Group	History	Audiological criteria	Histological criteria
Presbyacusis	No noise-exposure, ototoxic drugs or severe systemic disease.	Pure tones: 15–25 dB. above 2,000 Hz. SDS: Excellent.	SN degeneration in basal coil of the cochlea.
Accelerated presbyacusis	No noise-exposure, ototoxic drugs or severe systemic disease.	Pure tones: Over 25 dB. loss. SDS: Very poor-excellent.	(1) Severe SN degeneration. (2) Localization to one morphological layer of the cochlea.
Nosoacusis	Noise exposure, ototoxity, diabetes . . .	Any combination of hearing-loss and discrimination scores.	Specific ear disease, e.g. otosclerosis, otitis media, acoustic tumor, Menière's disease.

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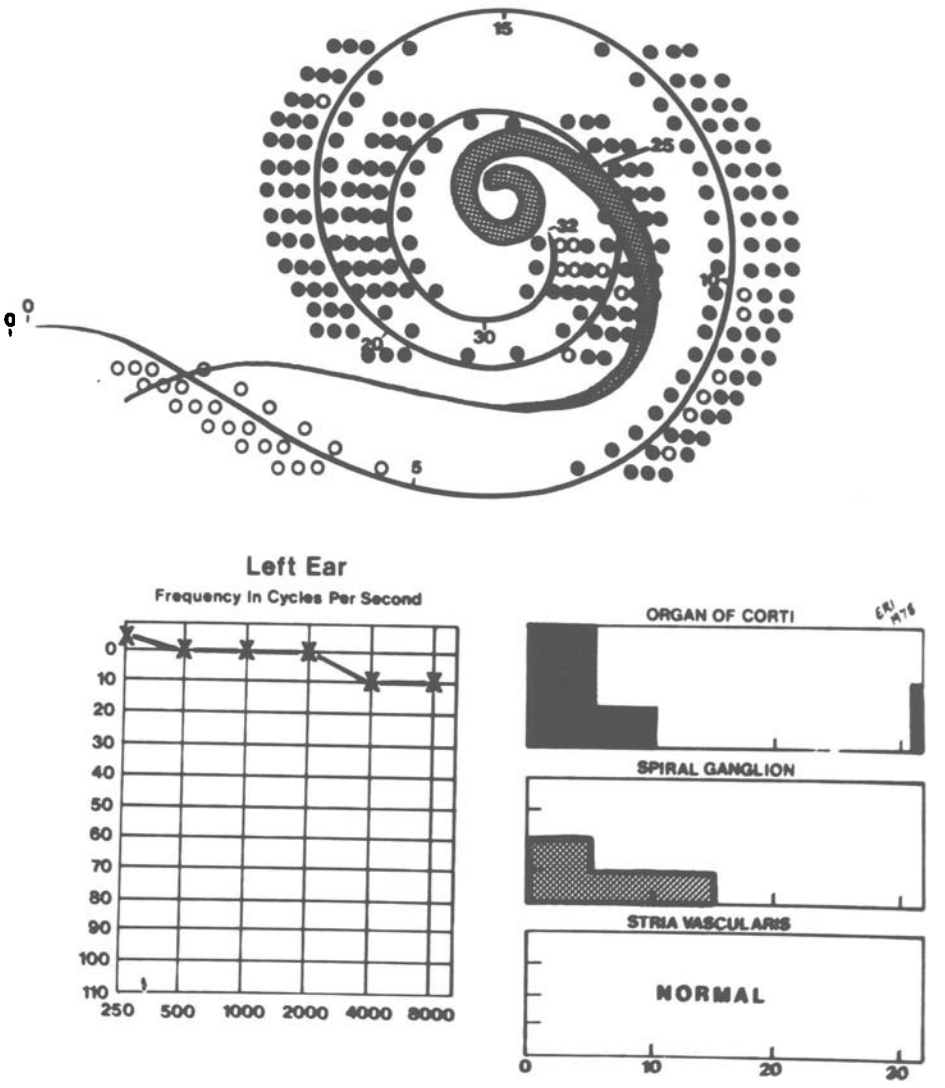


FIG. 1

Presbyacusis. There is a hearing-loss in the high frequencies of less than 25 dB. The sensorineural structures have degenerated in the basal 5 mm. of the cochlea. The stria vascularis is normal throughout.

terized by pure tone audiograms with no threshold hearing levels greater than 15 dB. for frequencies up to 2,000 Hz. and greater than 25 dB. for frequencies above 2,000 Hz. Speech discrimination scores are excellent (92–100 per cent). Rosen *et al.* (1962) found an impressive difference between the hearing of the elderly Maaban and the hearing of most elderly persons in today's major cities. According to the audiological criteria, subjects in Rosen's study would be classified under this group.

Histological examination of the cochlea shows degeneration of the sensorineural structures in the basal coil (Fig. 1).

It is the authors' feeling that age produces

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organistic changes in the auditory system that are biological in nature, just as age produces biological changes in the skin, hair, joints, muscles, ligaments and other organ systems. These general changes are common to all organisms, but the degree of change varies with different organisms.

Accelerated presbyacusis

Accelerated presbyacusis, environmental ageing, is defined as a decrement in hearing due principally to ageing plus the effects of other unknown factors, possibly heredity, diet . . . Whether aging changes in the cochlea predispose it to disease remains to be answered.

Threshold hearing levels exceed 25 dB. at one or all frequencies tested. Speech discrimination scores vary from poor to excellent.

The histological changes are generally similar to those in presbyacusis. Two main differences characterize the changes in accelerated presbyacusis: first, the degenerative changes are more severe than in presbyacusis; secondly, these changes tend to be localized to one morphological layer of the cochlea (Fig. 2). The most common single layer involved is the stria vascularis.

Schuknecht (1964, 1974) classified presbyacusis into sensory, neural, strial, and cochlear conductive. It is the authors' feeling that these subdivisions all fit into the accelerated presbyacusis group.

Nosoacusis

Nosoacusis is defined as a decrement in hearing due principally to the influences of specific diseases, such as Menière's disease, otosclerosis, otitis media . . .

Politzer (1926) noted that diminished hearing in the aged was due partially to frequent, chronic insidious inflammations of the middle-ear. Rosenwasser (1964) indicated that, since many conditions of ageing depress general bodily functions, this would explain the high incidence of infection and hearing difficulties in the elderly.

Farrior (1963) reported that geriatric patients are vulnerable to otosclerosis. In more than one-third of his 125 reported cases, stapes fixation developed after 50 years of age. After stapedectomy, the geriatric patient is not significantly more subject to vertigo. Similar findings were noticed by House (1979).

The high incidence of diabetes associated with arteriosclerosis in the aged enhances the possibility of vascular-related hearing loss. Endarteritis obliterans may be the underlying mechanism in cases of atrophy of the stria vascularis, but occlusion of the main blood vessels to the inner ear is improbable. Recent histological examination of human temporal bones (Belal, 1979) has shown degenerative changes and ossification in the cochlea following vascular occlusion, which are not present in the ageing ear.

The probability of drug-induced ototoxicity is high in the elderly. This may be the result of impaired kidney function or of high utilization of ototoxic medications, or it is possible that older people are more susceptible to ototoxic drugs.

Hearing loss with ageing is commonly accompanied by tinnitus and dizziness. The dysequilibrium of ageing is mild, non-progressive, and of short duration. Severe progressive dizziness should suggest other conditions, such as Menière's disease or acoustic tumor. Menière's disease usually occurs in person between the ages of 30 and 60. However, Harrison and Naftalin (1968) reported that 17.3 per cent of cases of Menière's disease occurred in persons over 60. Acoustic tumors occur most frequently in the fourth and fifth decades of life. House and Luetje (1979) found that 9.4 per cent of 500 cases of acoustic tumors occurred between 65 and 76 years of age.

In conclusion, the majority of auditory dysfunctions observed in the elderly are due to cochlear degenerative changes. However, the fact remains that age does not prevent other forms of middle and inner ear disorders commonly seen in the general population.

Summary and conclusions

While it is clear that the majority of the world's population suffers some deterioration of hearing—especially at high frequencies—

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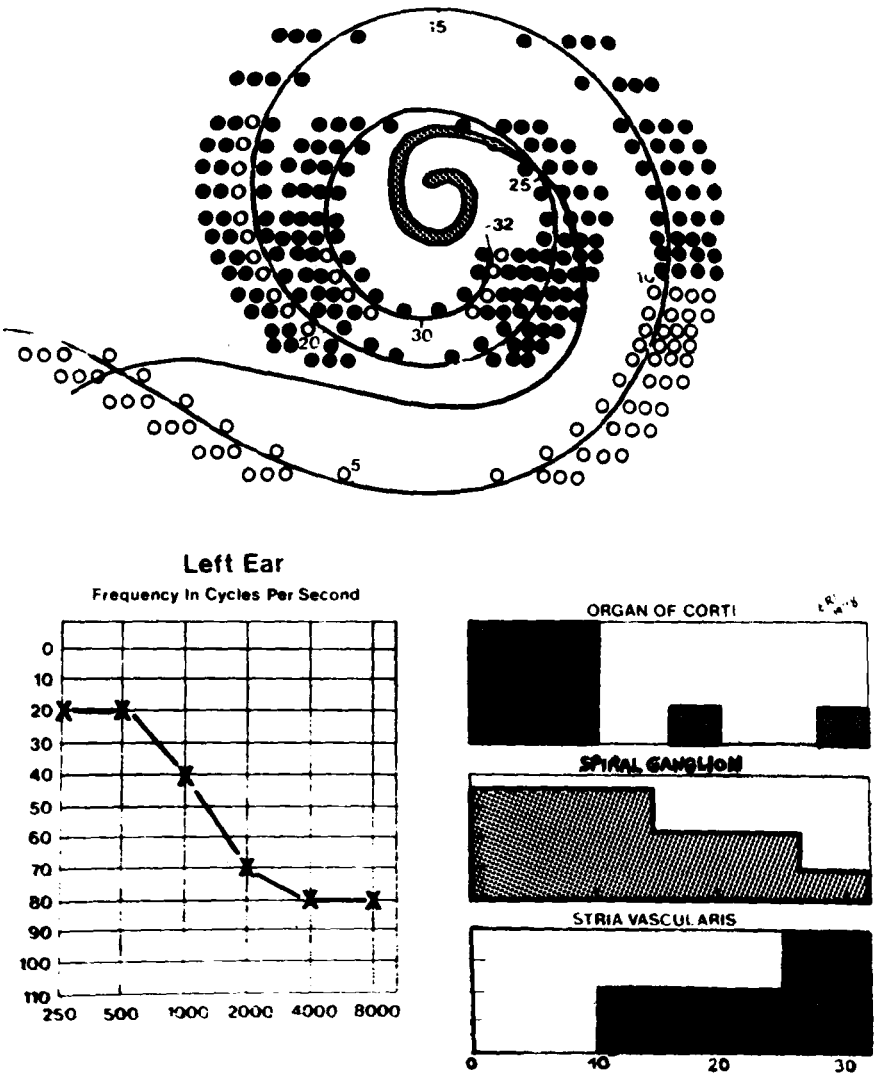


FIG. 2

Accelerated presbyacusis. The most common audiometric configuration is descending. There is severe degeneration of the sensorineural structures of the basal two coils of the cochlea as well as of the stria vascularis in the apical half.

with the advance of age, it is equally clear that some individuals reach very old age with clinically normal hearing. It is often difficult to separate the biological changes of senility from the effects of auditory environmental changes, and of specific pathological changes associated with specific disease entities.

A better understanding of the etiology of presbyacusis is needed.

The first step towards this end is the recognition that not all hearing impairment in the aged is due to biological ageing. This is important becasue hearing loss due to the acceleration of biological and environmental effects (accelerated presbyacusis) may be preventable, while hearing loss due to biological ageing (presbyacusis) is not treatable.

The second step is the realization that not

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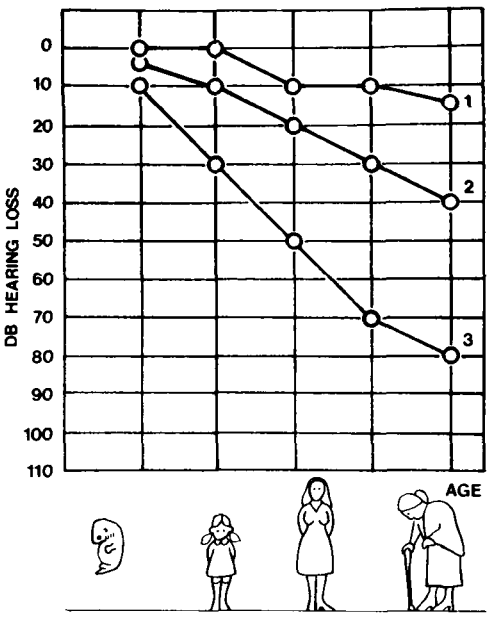


FIG. 3

Auditory threshold curves, 6,000 Hz. frequency:
(1) Presbyacusis, biological aging (Rosen *et al.*, 1964).
(2) Accelerated presbyacusis, environmental aging (Glorig and Davis, 1961).
(3) Nosoacusis, noise-exposure (Glorig and Davis, 1961).

all hearing impairment over age 65 is due to ageing.

Hearing impairments that are rapidly progressive, profound, asymmetrical, or fluctuating, and those associated with a marked conductive element or severe dizziness might well be associated with specific ear disease (Nosoacusis) such as infection, otosclerosis, Menière's disease, or acoustic tumor. A full neuro-otological evaluation including ABR, CT scan, ENG and others should be done in any patient over 65 suspected of having a specific ear disease.

The classification presented demonstrates the need to revise the criteria used in determining 'Presbyacusis Curves'. These provide a reference standard for normal hearing at any age or decade. There are too many variables in the averages obtained from different subjects to make those averages a dependable standard reference. Acoustic impairment among the aged varies from minimal changes (Presbyacusis) to total deafness (Nosoacusis). Yet simply because elderly people are elderly, and with no regard to their level of hearing, their hearing abilities are routinely categorized as 'average normal' for their age group.

Fig. 3 illustrates the changes in hearing thresholds as a result of biological ageing (Preabyacusis), environmental ageing (Accelerated Presbyacusis), and noise (Nosoacusis).

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