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Hearing in rheumatoid arthritis

A clinical and audiometric survey

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Copeman (1963) reported three patients with rheumatoid arthritis in whom deafness occurred with increased activity of the arthritis; in two the deafness was known to be conductive. He suggested that, since both the incudo-stapedial and incudo-malleolar joints are synovial in type (Anson and Donaldson, 1967), they could be involved in the rheumatoid process thus causing conductive deafness.

Material and methods

In 1968 a clinical and audiometric survey of 76 patients attending King's College Hospital with classical (64) or definite (12) rheumatoid arthritis was carried out to investigate any possible relationship between hearing loss and duration or activity of the arthritis. Patients were excluded from the series if there was a scarred or perforated tympanic membrane, history of otorrhoea, middle ear effusion, Menière's disease, previous aural surgery, acoustic trauma, severe head injury, or previous use of ototoxic drugs. The activity of the arthritis was assessed by the Systemic and Articular Indices of Lansbury (1958); in calculating the Systemic Index the number of aspirins required per day was excluded because many patients were on regular dosage. There were twelve men and 64 women. Their ages ranged from 19 to 69 years (mean 52·8); the age distribution by decades is shown in Table I.

The duration of the arthritis, sheep cell agglutination titre, and the presence of nodules were noted, and the functional capacity graded 1 to 5 on the Oxford scale.

The patients were examined clinically for deafness, and pure tone air-conduction (250–8,000 Hz) and bone-conduction (500–4,000 Hz) audiometry was carried out by one observer using a Peters SPD 5 audiometer. All salicylates were stopped 3 days before audiometry, paracetamol being substituted where required.

Three sets of ossicles were obtained at autopsy from patients with rheumatoid arthritis who were not included in the present series and these ossicles were examined histologically.

Results

Only three patients complained of deafness spontaneously. In two there was bilateral sensorineural deafness. One woman of 73 years with a family history of deafness, had had progressive deafness since childhood, long ante-dating her rheumatoid arthritis; audiometry confirmed bilateral conductive hearing loss and this was the only patient with a negative Rinné test. Four further patients admitted to mild deafness on questioning; in three there was a small sensorineural loss on audiometry and in one a small conductive loss. No patient was found with conductive deafness sufficiently severe to merit exploratory tympanotomy.

Two female patients each had a single 'dead ear' on audiometry; this deafness ante-dated the rheumatoid arthritis by many years and in each case the audiogram of the other ear was almost normal; these two patients were excluded from the analysis, leaving 74 patients in the study.

Fig. 1 (opposite) shows the mean conductive and sensori-neural hearing loss for the 148 ears. Of the 74 patients, 62 were between the ages of 45 and 64 years; excluding those outside these age limits the mean hearing loss was not significantly altered.

There was no relation between hearing loss and the duration of the arthritis, the activity of the arthritis as measured by the erythrocyte sedimentation rate, the Systemic or Articular Indices, or the sheep cell agglutination titre, the last being less than 1:16 in fifteen patients. In the sixteen patients with rheumatoid nodules (4 men, 12 women) there was a significantly greater hearing loss at 250, 500, 1,000, and 8,000 Hz for air-conduction and at 500 Hz for bone-conduction, compared with the hearing loss in the 58 patients without nodules. Separate analysis

Table I *Age distribution of 76 patients*

Age (yrs)	*Under 24*	*25–34*	*35–44*	*45–54*	*55–64*	*65 and above*
No. of cases	1	3	6	29	33	4

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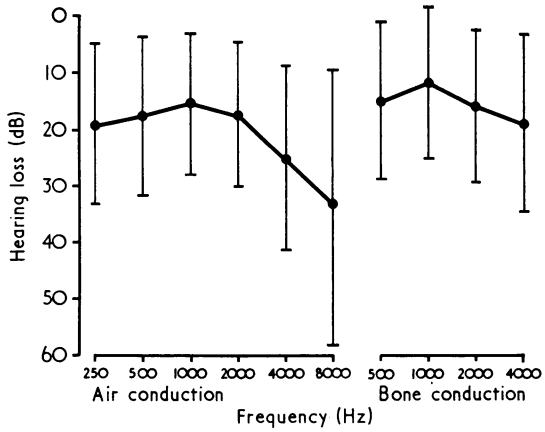

FIG. 1 *Mean hearing loss* (±1 S.D.) *in 74 patients*

of hearing loss in the right ears showed that these differences did not reach significance on that side, although the trend was the same as that in the left ears in which the findings were significant.

The patients with nodules had a significantly higher systemic index and more severe arthritis as judged by the functional classification but were otherwise comparable to those without nodules (Table II; Fig. 2).

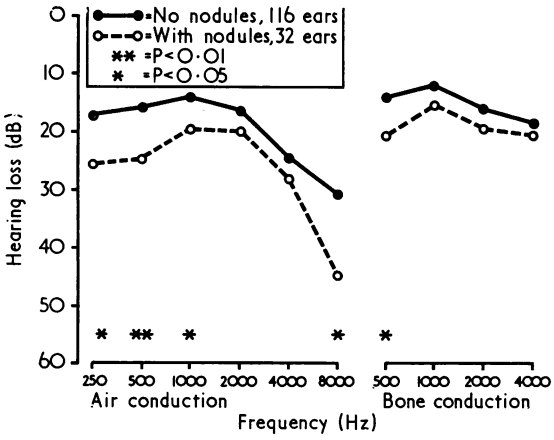

FIG. 2 *Comparison of mean hearing loss for patients without rheumatoid nodules (58) and with rheumatoid nodules (16)*

PATHOLOGY

Microscopic sections from the three sets of ossicles removed *post mortem* from other rheumatoid patients did not show rheumatoid nodules or erosive changes in the joints. In one patient there was a large area of bone absorption and replacement by highly cellular fibrous tissue in the lenticular process of the incus, and also extensive inflammatory bone absorption in the long process of the incus; this differed from the inflammatory bone absorption seen in chronic otitis media (Fig. 3, overleaf).

Case report

A man aged 60 years, who was seen before the study commenced, had classical nodular rheumatoid arthritis starting in April, 1965; he noted deafness in his right ear starting in September, 1967, which was found to be of conductive type, and there was no family history of deafness. At tympanotomy in July, 1968 (Mr. Harold Ludman), the ossicular chain was intact, no adhesions were present in the middle ear, and there was no apparent cause for the conductive deafness (Fig. 4).

Discussion

In this series of patients we have not found any relationship between the activity of the arthritis and the hearing loss measured on one occasion. However, in the three patients reported by Copeman (1963), deafness occurred with increased activity of the arthritis, and was certainly conductive in two patients, which suggests that involvement of the middle ear ossicles does occur in rheumatoid arthritis. Only repeated audiometry on a series of patients during exacerbation of their arthritis would show the true frequency of such temporary changes in hearing loss, and these are likely to be rare. Consideration of the physical properties of the ossicular chain indicates that considerable increase in the frictional resistance of the synovial joints must be present before any hearing loss can be detected. An increase in frictional resistance of 100 times results in a 20 dB reduction in hearing at the most susceptible frequency of 2,000 Hz (Appendix).

Table II *Rheumatoid data for all 74 patients and for those with and without nodules*

Mean clinical data	*Nodules*		
	Absent (58)	*Present* (16)	*Total* (74)
Age (yrs)	52	55	53
Duration of RA (yrs)	10	13	11
Sheep cell agglutination titre	1:128–1:256	1:256–1:512	1:128–1:256
Systemic index	42	59*	46
ESR (Westergren)	46	53	48
Articular index	71	82	73
No. of active joints	14	15	14

* $P < 0.01$.

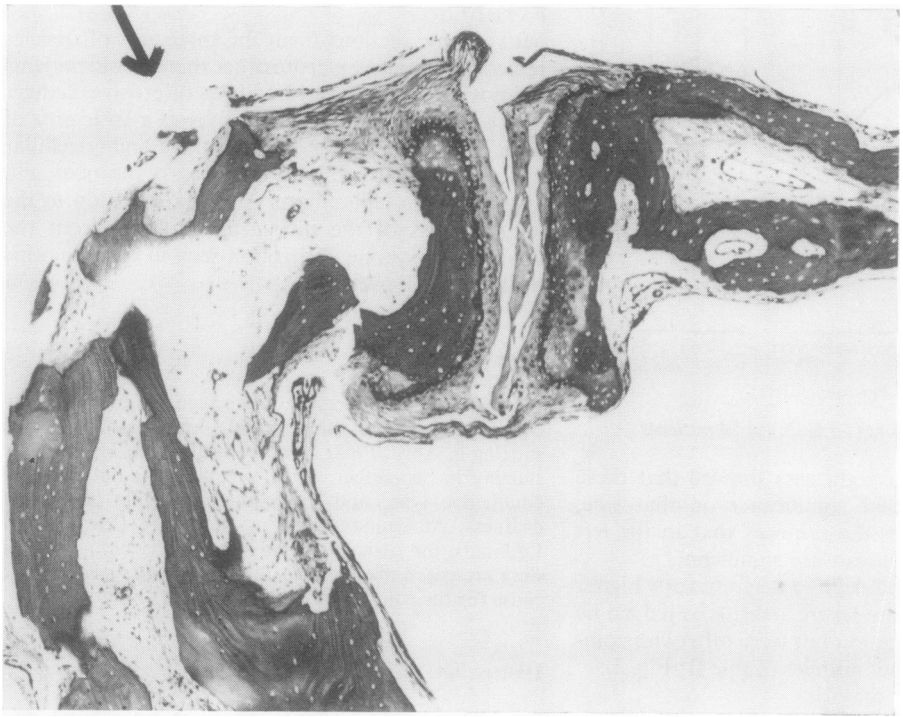

FIG. 3 *Photomicrograph of incudo-stapedial joint, showing extensive area of bone absorption (arrow) in lenticular process of incus. The incudo-stapedial joint is normal.* × 75

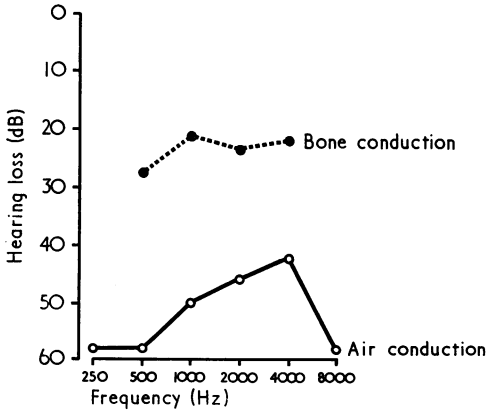

FIG. 4 *Audiogram of a man aged 60 years*

The significantly greater hearing loss in the twelve patients with rheumatoid nodules was of sensorineural type and not conductive as would be expected by consideration of the possible effects of rheumatoid arthritis on the ossicular joints. Although no patient had evidence of arteritis elsewhere, it seems possible that this hearing loss was due to neuropathy of the auditory nerve, perhaps because of arteritis of the vasa nervorum. The greater activity of the arthritis in those with nodules was probably not a factor contributing to this deafness, because we found no relation between hearing loss and activity of the arthritis as measured by the Systemic or Articular Index for the series as a whole.

It seems unlikely that this effect could be due to drugs, because the deafness due to salicylates is reversible within 24 to 72 hours of stopping the drug (Myers and Bernstein, 1965), and all patients stopped salicylates 72 hours before audiometry. Although antimalarial drugs have been reported as causing sensorineural deafness (Toone, Hayden, and Ellman, 1965), the hearing loss in the eighteen of our patients who had these drugs was similar to that in the other 56 patients.

In the synovial joints of the sets of ossicles examined no erosive changes were seen. The macroscopic appearance of all the ossicles was normal and there was no obvious explanation for the area of bone absorption seen in one incus.

Summary

76 patients with classical or definite rheumatoid arthritis have been examined by pure tone air-conduction and bone-conduction audiometry. Hearing loss was not related to duration or activity of the arthritis, but the sixteen patients with rheumatoid nodules had an increased incidence of sensorineural deafness compared with the other 58 patients.

One man is reported in whom unilateral conductive deafness was probably related to his rheumatoid arthritis, no other cause being found for it, even at exploratory tympanotomy.

We wish to express our thanks to Dr. Eric Hamilton and Mr. Harold Ludman for advice during the course of this work, to Prof. E. A. Wright and Prof. I. Friedmann, who kindly examined the histological sections, and to Mr. Bernard Morley, B.Sc., for advice on the mechanics of the middle ear.

APPENDIX

The acoustic impedance (Z) refers to the ease with which the ossicles can be moved, it varies with frequency and depends on:

R Frictional resistance
M Effective mass of moving parts
S Effective elasticity of the ligaments

These are related by the following simplfied general formula which is applicable to any mechanical system:

$$\text{Acoustic impedance } Z = \sqrt{R^2 + \left(2\pi fM - \frac{S}{2\pi f}\right)^2},$$

where f = frequency in Hz

For the normal ear, R, M, and S, can be derived from observed data (Wever and Lawrence, 1954), and Z varies with frequency, Z being lowest at 2,000 Hz, at which frequency one would therefore expect any hearing loss to be most apparent. Assuming that M and S remain constant, that the Eustachian tube is functioning normally, and that the range of movement at the incudo-stapedial and incudo-malleolar joints is small, as R increases one can calculate the increase in acoustic impedance and hence the hearing loss for each frequency. Hearing loss is related to frequency as shown in Fig. 5.

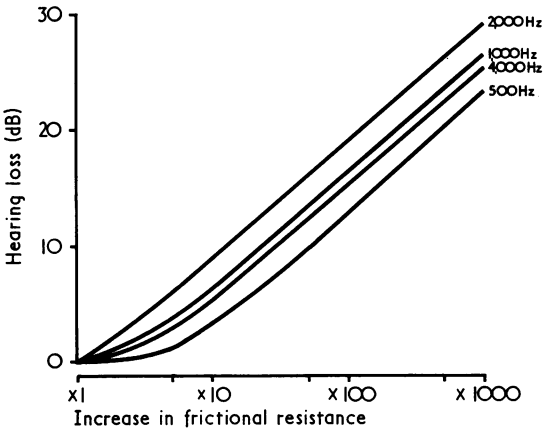

FIG. 5 *Relation of hearing to increase in frictional resistance for frequencies 500–4,000 Hz.*

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