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# Tinnitus in children

*by*

JOHN GRAHAM and JANE BUTLER (London)

## Introduction

At the first International Tinnitus Seminar in New York and at the CIBA Foundation Symposium on Tinnitus in London (Graham, 1979, 1981) I reported the results of surveys carried out on children of secondary school age with sensorineural deafness who were attending partial hearing units or schools for the deaf in the Inner London Area. I shall summarize the findings of these surveys, describe the protocol that we use for examining and investigating children with tinnitus, describe some characteristic findings in children we have investigated and suggest some practical steps that can be taken to help children whose tinnitus is troublesome or annoying.

## Results of Surveys

I have studied two overlapping populations of children with sensorineural deafness and tinnitus. A total of 158 children were circulated with a questionnaire: 92 children in partial hearing units and 66 children in schools for the deaf. Forty-nine per cent of the whole group of children reported that they had tinnitus. The proportion was higher in the partial hearing units (66 per cent) than in the schools for the deaf (29 per cent). I should explain that for purposes of education most of the children with sensorineural deafness in the United Kingdom are integrated as far as possible with normal hearing children. They either attend ordinary schools, and are fully integrated with the other pupils or they spend some of their school day in a special 'partial hearing unit' where they can receive special attention from trained teachers of the deaf and part of their day in ordinary classes with hearing children. Schools for the deaf in which deaf children are totally segregated from the rest of the population mainly contain very profoundly deaf children, with very poor speech, or children with other physical, emotional or social problems. Of the children in these two kinds of school who were found to have tinnitus, those in the schools for the deaf had worse average hearing thresholds (95 dB) than those in partial hearing units (52.5 dB). (See Table I). Table II lists the questions asked in these surveys.

I have tried to identify a 'high annoyance group' of children who found their tinnitus particularly troublesome for one or more reasons. The arbitrary criteria used were:

a. *Annoyance*—Those children who said that their tinnitus always annoyed them (graded four out of four degrees of annoyance).
b. *Frequency*—Those children who said that their tinnitus occurred every day.
c. *Duration*—Those with constant tinnitus or tinnitus lasting for more than 30

TABLE I

AVERAGE PURE TONE THRESHOLDS IN CHILDREN WITH TINNITUS ATTENDING PARTIAL HEARING UNITS (PHUs) AND SCHOOLS FOR THE DEAF (SCHOOLS)

| | 250 Hz | 500 Hz | 1 KHz | 2 KHz | Average of four frequencies |
|---|---|---|---|---|---|
| PHUs | 42 dB | 50 | 55 | 63 | 52.5 |
| Schools | 79 dB | 91 | 102 | 108 | 95 |



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TABLE II

QUESTIONS USED IN THE SURVEY OF TINNITUS AMONG CHILDREN OF SECONDARY-SCHOOL AGE

*Questions*

(1) Does the noise appear to come from your left ear/right ear/both ears?
(2) Which ear do you wear your aid on: left/right/both?
(3) Which is the noise most like: whistling/ringing/rushing?
(4) Is the noise there all the time/only sometimes?
(5) If the noise is there sometimes, is it when you are relaxed/tense? or if at any other regular time please state here:
(6) When in a noisy place or using a hearing aid are the noises in your head reduced/no change/greater?
(7) Is the noise like a pulse?
(8) Does the noise worry you not at all/slightly/sometimes/all the time?
(9) Have you ever had ear infections or had to have an operation to take fluid away from the middle ear, grommets, etc?

*Supplementary questions*

(10) If the noise is not there all the time, about how often do you get it? Every day/every week (about how many times a week?)/every month (about how many times a month?)/less often (how often?)
(11) When you get the noise, how long does it usually last? Seconds/minutes (how many?)/hours (how many?)/days (how many?)
(12) How loud is the noise?
(13) When you hear the noise does it make your hearing worse?
(14) Does it make it difficult for you to hear people's voices?
(15) When you get the noise do you feel dizzy or have trouble with your balance?
(16) When you get the noise do you notice anything else?

minutes at a time (only two children in the survey had constant tinnitus).

d. *Loudness*—Those children who graded their tinnitus as 'very loud' (three out of three degrees of loudness).

It is very well known that patients' own assessment of the loudness of their tinnitus may not directly be related to the loudness measured by techniques such as masking or loudness matching. However, this part of the survey was primarily concerned with the annoyance felt by these children so their own assessment of the loudness seemed likely to be relevant.

TABLE III

HIGH ANNOYANCE GROUP

| | |
|---|---|
| Total | 31 out of 78 children (31 per cent) |
| PHUs | 17 out of 59 children (29 per cent) |
| Schools | 7 out of 19 children (37 per cent) |

Table III shows the numbers of children who fell into this category of 'high annoyance'. Thirty-one per cent of the total group of 78 children seemed to find the tinnitus particularly troublesome for reasons listed above.

### *Unilateral tinnitus, unilateral hearing aids and less severe hearing loss in one ear*

In children with unilateral tinnitus and using a hearing aid in one ear only (30 children) tinnitus occurred in the aided ear in 22 children (73 per cent). In children with unilateral tinnitus and a difference of 10 dB or more between the average hearing thresholds of their two ears (27 children) the tinnitus occurred in the better hearing ear in 22 (81 per cent). However, of the children with tinnitus in their aided ears who also had a difference in hearing between the two ears (17 children), 15 had both the aid and the tinnitus in their better ear. It was therefore hard to tell whether the tinnitus was more likely to be associated with better hearing or with the use of a hearing aid.

### *Headache and Vertigo*

Forty-six per cent of the children said that their tinnitus when it occurred was sometimes accompanied by dizziness and 23 per cent of the children stated that the tinnitus was accompanied by headaches. It was speculated that, in a few children, perhaps those with mild degrees of cerebral damage possibly from Rubella or perinatal anoxia, the tinnitus might be a manifestation of a transient, sub-clinical convulsive episode.

## Conclusions from the Surveys

There was a 49 per cent incidence of tinnitus in a group of 158 children of



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secondary school age (12–18 years) with sensorineural deafness. Tinnitus appeared to be commoner in children in partial hearing units than in schools for the deaf and commoner in children with less severe deafness. With two exceptions all the children's tinnitus was intermittent. This is strikingly different from the findings in adults with acquired tinnitus in whom the tinnitus is usually constant. Thirty-one per cent of the children describe features of their tinnitus which were particularly troublesome.

## Comments

Tinnitus is a relatively unrecognized problem among those who look after deaf children. The rareness of *constant* tinnitus is interesting and suggests that the factors (whatever they are) that cause a deaf adult to become aware of constant tinnitus are either absent in most congenitally deaf children or, if present in a steady state, do not result in the child perceiving a sound which could be described as tinnitus.

Children with tinnitus evidently seldom mention it of their own accord. If a child does mention his tinnitus spontaneously, then it is likely that the tinnitus is troublesome to him and the symptom must be taken seriously. Even if a child does not mention the existence of tinnitus, nevertheless the tinnitus may give rise to behavioural problems. It may make it difficult for the child to produce reliable thresholds in pure tone audiometry. The presence of tinnitus may suggest an unrecognized problem in the child's use of hearing aids. Intermittent tinnitus may explain difficulties of concentration or behaviour noticed at home or in the classroom.

## PROTOCOL FOR ASSESSING TINNITUS IN HEARING-IMPAIRED CHILDREN

A. *General details. Age. Sex. Pure tone audiometry. Better hearing ear. Medical diagnosis if known. Aids: side and type.*

B. *Description of tinnitus*

| | |
|---|---|
| Side | Provoking factors |
| Description | Frequency |
| Loudness | Duration |
| Annoyance | |

C. *If tinnitus is not present at the time of examination there are various manoeuvres which may provoke it*

| | |
|---|---|
| Aids turned off | Lie down |
| Aids removed | Exercise |
| Ear defenders | Shake head |
| | Exposure to sound |

In addition to these manoeuvres the child may suggest some further manoeuvre or factor which may provoke the tinnitus.

In a child who states that he develops tinnitus after exposure to loud noises we present pure tones at 250 Hz, 2 kHz and 8 kHz and white noise for 30 seconds in one or both ears at 100–110 dB.

D. *If tinnitus cannot be provoked then the child is given an appointment to come back on a different occasion*

If the tinnitus is either present from the beginning of the consultation or can be provoked by one of the manoeuvres mentioned above, the following basic list of tests is presented.

—Otoscopy.
—Listening for audible tinnitus using low impedance microphone and occluded external auditory meatus.
—Change in subjective loudness of tinnitus with ears occluded and with ear defenders.
—Frequency match using pure tones or narrow band noise.
—Ascending audiometry.
—Descending audiometry.
—Pulsed audiometry.
—Loudness discomfort levels.
—White noise threshold and tinnitus masking level.
—Residual inhibition after 60 seconds masking noise at 10 dB masking level.
—Impedance measurement and stapedius reflex thresholds.

We have encountered several children who developed tinnitus during pure tone



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audiometry and in whom the tinnitus mimicked the frequency of each pure tone presented. Ascending audiometry using tones of increasing loudness is less likely to provoke such tinnitus and may make audiometry more reliable. An alternative technique is to use a pulsed tone similar to that used in Békésy tracking audiometry.

## Results

It has not been possible to produce a strict classification of children with tinnitus. However, a few groups of broadly similar children have begun to emerge. These children are similar either because of the type of tinnitus or the problems the tinnitus produces or because of the way in which the problem of their tinnitus might be handled.

1. *Problems with audiometry.* We have collected a group of five children (Table IV) in whom the presence of tinnitus seems clearly to be muddling them when they try to produce a pure tone audiogram. These children may invariably find it difficult to perform audiometry in one or both ears or they may have days, when the tinnitus is present, when they find it difficult to do audiometry. All these children produced better thresholds by up to 30 dB when audiometry was performed by presenting tones of increasing intensity, beginning quieter and becoming louder. This is the reverse of the normal situation. Although this reversal has been described in non-organic hearing loss, there was nothing to suggest that there was a non-organic component in any of these children's deafness. Here are two examples:

S.H. a girl of 12. This girl had pure tone tinnitus produced by the tones used in audiometry and mimicking the frequency of each tone presented. The tinnitus occurred in either ear, particularly on the left. It was hard to be sure of the duration of the tinnitus but it lasted for at least one minute. Ascending audiometry thresholds were 20–25 dB better than descending thresholds on the left and 5–10 dB better on the right.

R.J. a boy of 13. He had had tinnitus for several years, occurring whenever he removed his hearing aids. Audiometricians and his teachers had com-

TABLE IV
MASKING

| Child | Tinnitus | Masking | Result |
|---|---|---|---|
| J.S. 14 boy | L s-n deafness<br>L tinnitus. Constant | L masker | Complete masking<br>30 mins R.I. |
| C.B. 16 girl | Normal hearing<br>Two yrs. buzz in head<br>matched 7 KHz | L&R maskers | Controlled |
| K.L. boy | Normal hearing<br>Five yrs. Click L&R<br>Palatal myoclonus | Masker moulds<br>L&R | Myoclonus abolished<br>after two months |
| R.B. 11 girl | Rubella deafness<br>Two yrs. bilat. tinnitus | R aid-masker<br>worn at night | Helps to sleep |
| C.A. 15 girl | Normal hearing<br>bilat. high fr. tinnitus | Maskers L&R | Partial masking |
| M.B. 15 girl | Normal hearing<br>deep hum L&R | Maskers L&R | Hum masked<br>no R.I. |
| N.B. 11 boy | L congenital deafness<br>L intermittent tinnitus | Masker L | Complete masking<br>R.I. lasting 'hours' |



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mented he produced unreliable thresholds on pure tone audiometry. The tinnitus was particularly loud on the left. Ascending audiometry gave thresholds 30 dB–50 dB better than descending audiometry at 4 kHz in both ears. In a test for residual inhibition, white noise was presented to both ears simultaneously at 70 dB in the left and 80 dB in the right for one minute and this produced complete residual inhibition and enabled him to do an audiogram with descending intensities with no difficulty. He commented that this was the first audiogram he had ever done without tinnitus and he found it extremely easy. Five months later white noise at 105 dB HL was presented to both ears simultaneously and this produced long term residual inhibition lasting for over a year until he fell and hit his head and developed worse hearing in the left accompanied by tinnitus.

*Hums*

We have seen at least three children with audible hums, heard mainly over the neck using a stethoscope and assumed to be venous in origin. Two of these children were not troubled by hearing this hum but a third patient was given a masker which suppressed his hearing of the hum but did not, of course, produce residual inhibition.

*Hearing Aids*

Many children comment that their tinnitus is noticeable when they remove the hearing aids. This may represent a beneficial effect of wearing an aid in the form of masking from amplification. However, it is important to recognize occasions where the aid itself may be contributing to the tinnitus.

Where the tinnitus is unilateral there may be an obvious difference in hearing between the two ears or a less obvious difference. An example of each situation is given below:

J.M. a boy of 12. Audiometry shows gently sloping high frequency hearing loss in the right ear but a 'trough' on the left with reasonably good high frequency hearing. Bilateral aid. Very high frequency tinnitus noticed on the left whenever he takes his aids out. On removing the aids at night the tinnitus lasts until he goes to sleep. His aids were removed while he was examined and after audiometry the tinnitus had disappeared. However, it returned after wearing his aid for one minute. Both hearing aids had a powerful high frequency response: we have suggested the aid for his left ear should be changed.

P.B. a boy of 12. Bilateral high frequency congenital hearing loss. Wears two high powered aids. Right sided tinnitus lasting one or two days, precipitated by loud noises when wearing his aid. Tinnitus in right ear matched by 2 kHz pure tone and incompletely masked by white noise at 100 dB HL. Although the audiogram curves were exactly the same for the two ears there was evidence of recruitment in the right ear measured by uncomfortable loudness level and stapedial reflex thresholds. Both these tests gave 15 dB quieter thresholds on the right. We have suggested that he gets a new aid for the right ear with some form of automatic high frequency sound control.

*Masking*

I am indebted to my colleague Jonathan Hazell and to Mrs Susan Wood, audiological scientist, for information about children fitted with tinnitus masking devices. Table IV shows details of seven children who have been issued with tinnitus masking devices; one child (R.B.) was issued with a combination of masker and hearing aid. There is a clear place for tinnitus masking in children who find tinnitus annoying or distressing.

*In conclusion* I have tried to summarize the data collected about tinnitus in children with sensorineural deafness both from surveys of deaf children at school and from examination and investigation of individual children. I have tried to point out the problems that tinnitus can produce in children and to suggest ways in which the



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children may be helped.

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