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Clinical Records

Audiological, vestibular and radiological abnormalities in Kallman's syndrome

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Abstract

Kallman's syndrome is a multifaceted congenital disorder with predominantly endocrine abnormalities. We have characterized the associated mixed hearing loss and identified consistent radiological evidence of abnormal temporal bone anatomy. Abnormal labyrinthine morphology is accompanied by a complete absence of response to vestibular stimulation with caloric or rotational chair testing.

The endocrine abnormalities are correctable and Kallman's syndrome is a diagnosis worthy of consideration when assessing children with congenital hearing loss.

Introduction

Isolated gonadotrophin deficiency or Kallman's syndrome was first described in 1944 by Kallman *et al.* The syndrome occurs in sporadic and familial forms and essentially consists of gonadotrophin deficiency resulting in failure of secondary sexual characteristic development and primary anosmia due to developmental failure of the olfactory lobes. The other features of the syndrome are more variable, these include colour blindness, high arched palate, cleft lip and palate, synkinesia, mental deficiency and hearing loss.

The incidence of the disorder has been estimated by Jones and Kemman (1976) to be one in 10,000 in men and one in 50,000 in women. This makes it second only to Klinefelters syndrome as a cause of hypogonadism in males.

The incidence of hearing loss associated with Kallman's syndrome was found to be 2 out of 7 in the study of Bordin *et al.* (1969) and 5 out of 23 in that of Lieblich *et al.* (1982). Individual cases of hearing loss were noted by Walsh *et al.* (1978), Santen and Paulsen (1973) and Kallman and his colleagues in 1944.

The hearing loss in the above cases was described as being sensorineural but no more detail is provided except by Lieblich *et al.* who indicated that the loss in all five of their cases was mild and bilateral in two of these. There are no published descriptions of vestibular or radiological abnormalities associated with Kallman's syndrome.

The aim of this study was to characterize the hearing and vestibular deficits in this syndrome using full radiological, audiological and vestibulometric investigations.

Materials and methods

One patient (Case 1) had been referred to the department for management of the hearing loss. The remaining 10 patients with Kallman's syndrome known to the Endocrinology unit at the Royal Victoria Infirmary, Newcastle, were contacted and sent a questionnaire. The patients were asked 'Do you or have you ever suffered from any hearing or balance problems' and if so were asked to attend for pure tone audiometry and clinical vestibular investigation. The two patients who had abnormal results proceeded to full audiometric, vestibulometric and radiological investigation.

The same series of audiological tests were used to obtain an auditory profile for each patient. Pure tone threshold audiometry, speech audiometry and threshold tone decay tests were performed on a clinical audiometer (Graystad GS1 16) calibrated to ISO 389. These subjective tests were found to be well within the intellectual capabilities of both patients. Tympanometry and acoustic reflex threshold measurements were performed on a middle ear analyser (Graystad 1720 B) and brainstem auditory evoked potentials in response to 90 dBnHL clicks were measured using a Medelec ER94 Sensor electrophysiology system.

Radiological assessment consisted of computerized tomography using a GE9800 scanner. Unenhanced 1.5 mm thick contiguous axial images were taken through the petrous bones using a 512 × 512 matrix and bone reconstruction algorithm.

Vestibular assessment consisted of:-

1. Standard caloric testing with electronystagmographic (ENG) recording using bithermal water irrigation for 30 s at 30°C, 44°C. Additional iced water stimulation at 0° for 10 s was also used. Both ears were tested in each patient.
2. Rotational testing with ENG recording was performed in a torsion swing chair with the head in three positions, 30° flexed, 60° extended and with maximum lateral neck flexion. Three cycles of pendular motion (periodic time 14 s) were executed in each head position. In addition, forced pendular motion with periodic time of about 4 s with the head in the 30° flexed position was used to provide a stronger rotational stimulus.
3. Body sway measurements were made using the technique developed by Fitzgerald using a two channel magnotometer (Dean, 1986; Fitzgerald *et al.*, 1991). Measurements of lateral and antero-posterior movement at the patient's hips were taken with eyes open and closed, on a firm surface and on a foam rubber surface.

Results

All 10 patients responded to the questionnaire. Six responded and denied any hearing or vestibular disturbance. Three patients were concerned that they may have had mildly reduced hearing

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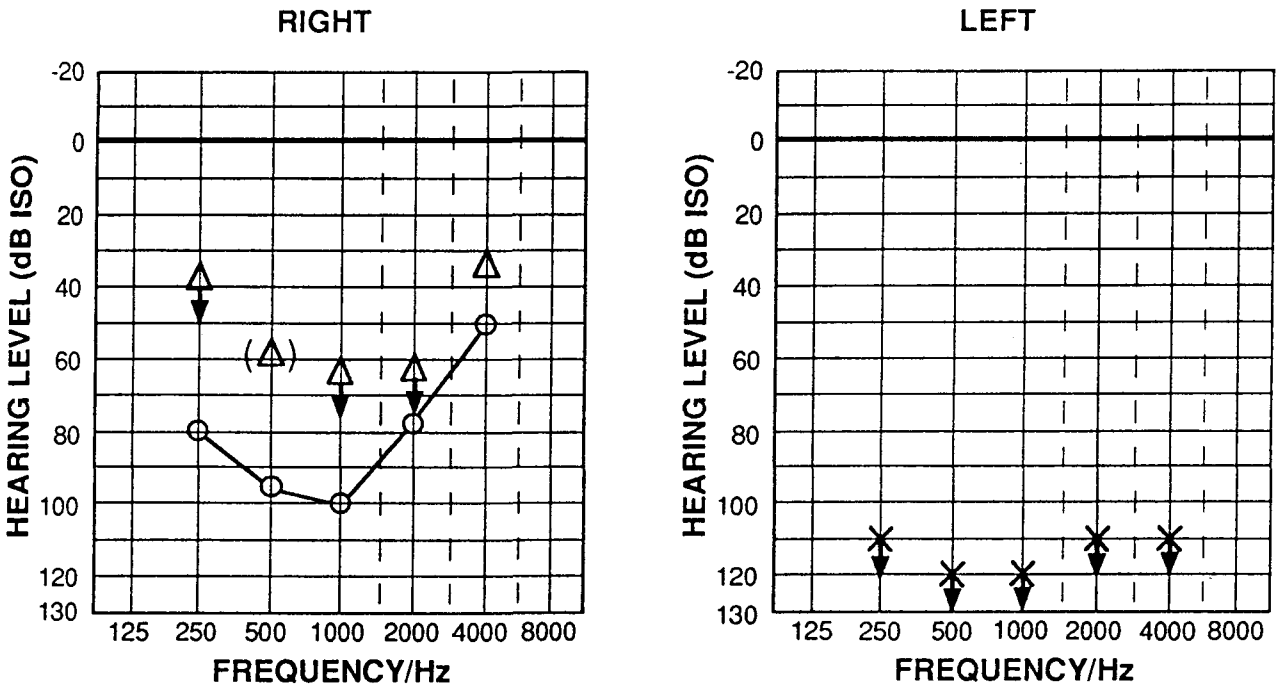

Fig. 1

but denied balance problems. All three had normal Pure Tone Audiometry and responded normally to clinical tests of vestibular function. Further vestibular and radiological investigation was not therefore considered justifiable. One patient (Case 2) did have an abnormal pure tone audiogram and was investigated fully.

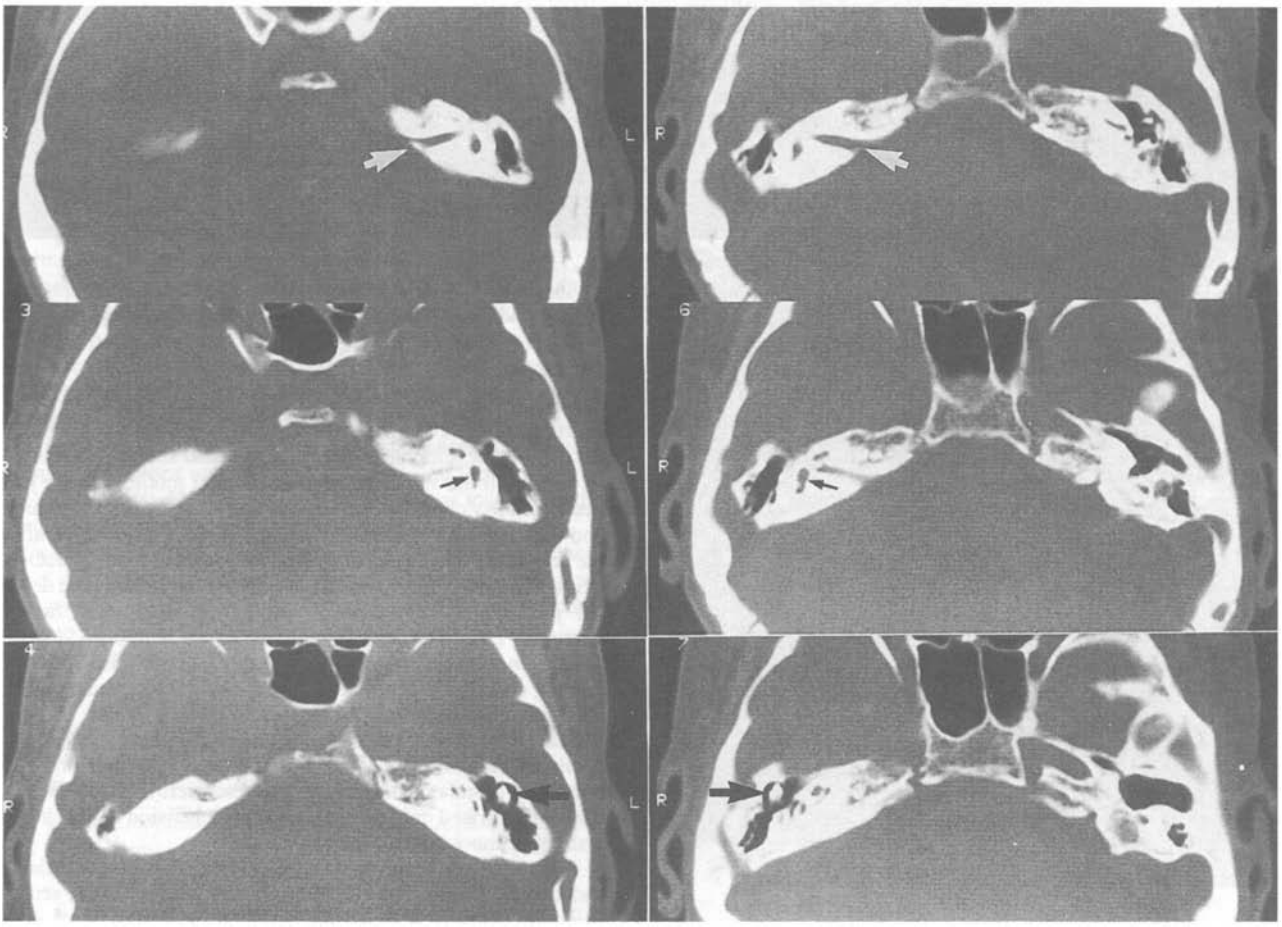

Fig. 2

Case 1. Contiguous 1.5 mm thick axial images. Window level +500 and window width 400. The IAM's (white arrow) are unusually slender and their lateral termination is unusually high in relation to the heads of the malleus and incus (large black arrow). Note the vestibule (thin black arrow). No discernible normal semi-circular canal structure.

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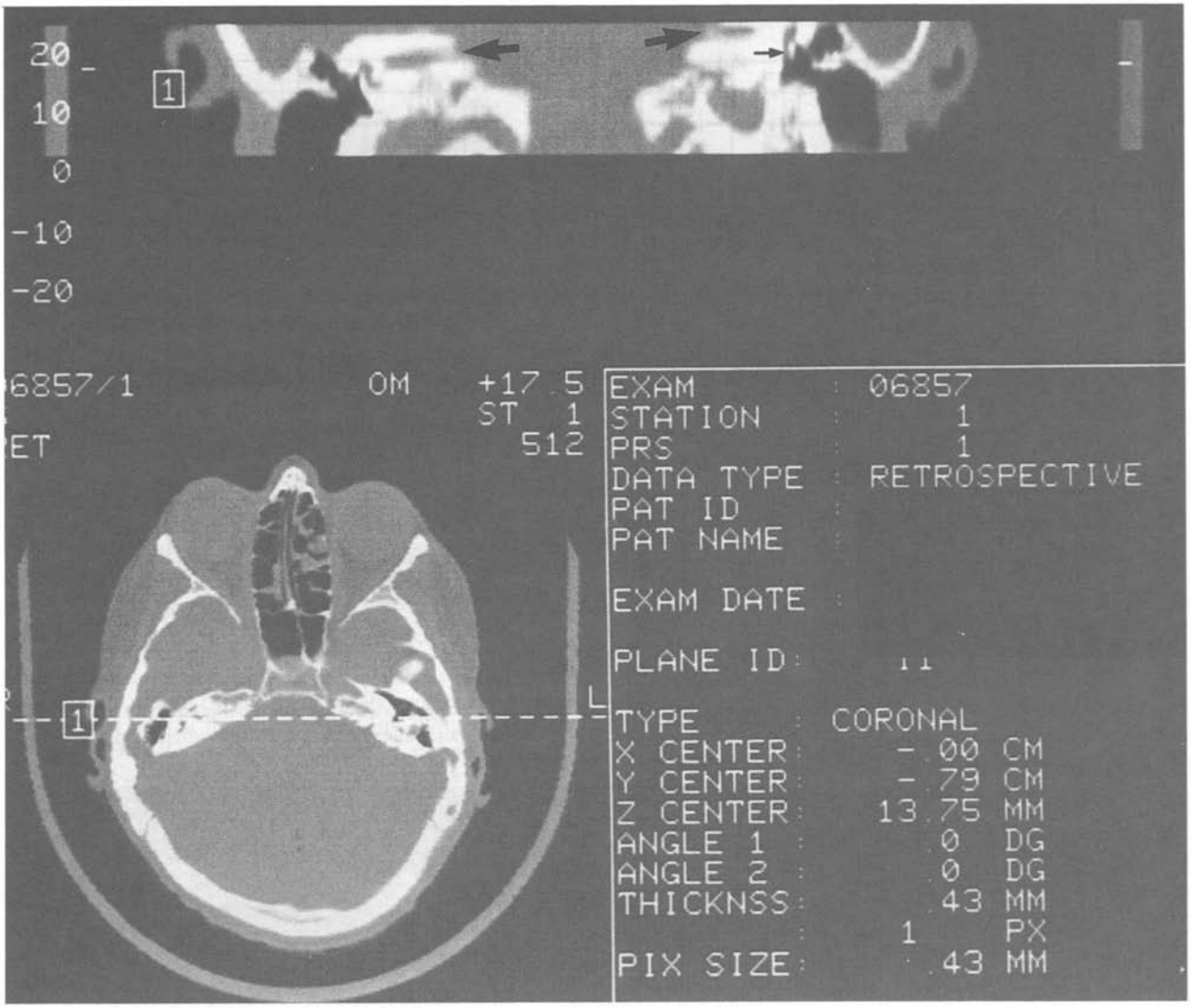

Fig. 3

Case 1. Coronal reconstruction of the axial images taken through the IAM's. Window level +500 and window width 4000. The high termination of the IAM's (large black arrow) laterally in relation to the heads of the malleus and incus (thin black arrow) on the left, is more apparent.

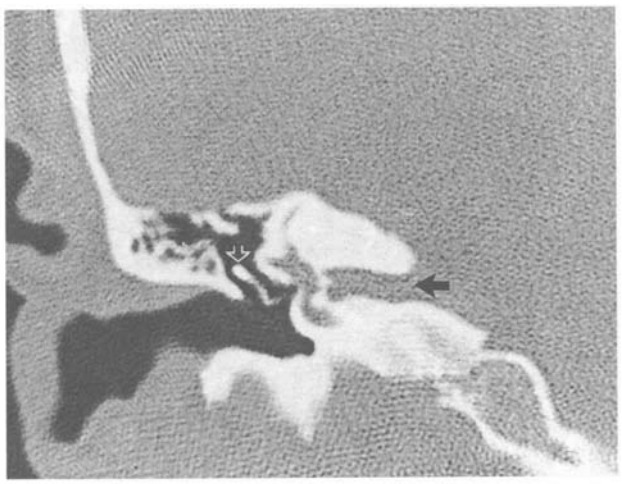

Fig. 4

Normal direct coronal image through the IAM (large black arrow). The lateral end of the IAM terminates at the level of the stapes/oval window complex, below the level of the heads of the malleus and incus (hollow white arrow).

Case 1

History: a 41-year-old female who had first been noted to be hearing impaired at the age of five and had been fitted with an aid. Speech development had been slow and she had not started to walk until the age of two and a half. Her mother felt she had been a clumsy child. The anosmia became apparent in childhood and the diagnosis of Kallman's syndrome was made at 20 after the failure of development of her secondary sexual characteristics. She is of below average intelligence but able to hold down her job as a laundry worker. There was no relevant family history.

Examination: Confirmed the anosmia and clinical tests of hearing are consistent with the subsequent audiological findings. The tympanic membranes were normal and mobile. Neurological examination was otherwise normal with no evidence of cerebellar dysfunction. There was no colour blindness or facial deformity. Romberg and Unterberger tests were normal although she demonstrated mild difficulty and apprehension in walking in a straight line with eyes closed.

Pure tone audiometry: (Fig. 1). There was no recordable function on the left. The loss on the right is predominantly sensorineural. There is a 15 dB air bone gap at 4 kHz. Bone conduction thresholds were beyond the range of the audiometer at 250 Hz, 1 kHz and 2 kHz. The response at 500 Hz was thought to be vibrotactile.

Speech audiometry: The right ear showed an optimum dis-

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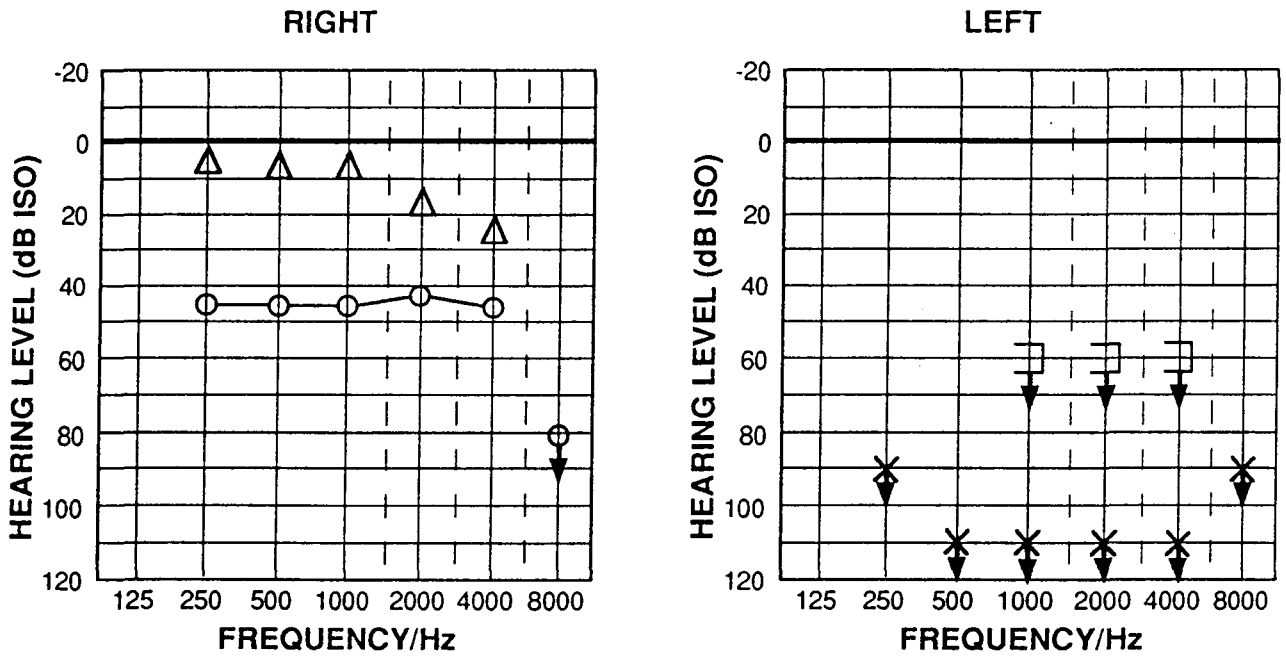

Fig. 5

crimination score of 70 per cent at 110 dB Relative Speech Level with half peak elevation of 75 dB, consistent with cochlear loss.

Threshold tone decay: The right ear showed no pathological adaptation at 2 or 4 kHz.

Impedance: The right tympanogram showed low compliance (0.3 ml) and normal middle ear pressure (OPa). The peak was asymmetrical about the maximum and showed marked hysteresis with increasing and decreasing pressure.

The left tympanogram showed low compliance (0.1 ml) and normal middle ear pressure (OPa). No acoustic reflex could be elicited at the maximum available stimulus levels with ipsilateral or contralateral stimulation in either ear.

BSER: On the right only peak V was discernible. The latency 5.8 ms, was not abnormally increased, consistent with cochlear hearing loss. There was no response on the left.

Computerized tomography: The IAM's are unusally slender and their lateral termination is unusually high in relation to the malleus and incus—see (Fig. 4). The vestibule can be seen but no normal semicircular canal structure can be identified on either side. The external auditory meatus, middle ear cleft, facial nerve canal and cochlea appear on both sides normal (Figs. 2–4).

Caloric testing: No vertigo or electronystagmographic evidence of caloric responses were obtained with 44°C, 30°C and 0°C.

Rotation tests: No nystagmus or dizziness was induced by the pendular rotation or the more vigorous forced rotation.

Sway tests: No gross abnormality in body stability was detected. Sway was within normal limits under all conditions except with eyes open, off the foam, when it just exceeded normal limits (compared to a group of 20 normal subjects aged 20 to 30 years).

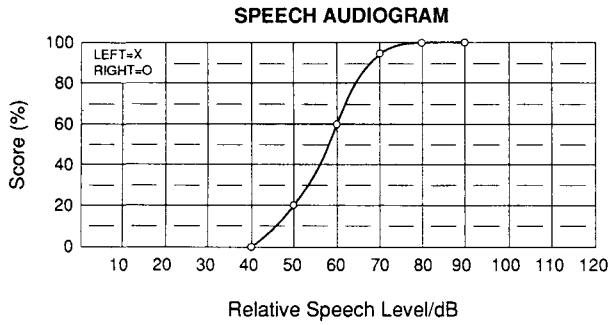

Fig 6

Case 2

A 43-year-old man. He first walked at the age of three and was diagnosed as hearing impaired at five although poor speech development and parental history suggest an earlier onset. He had a cleft lip and bat ears. Anosmia became apparent in childhood. Hypogonadism and Kallman's syndrome were diagnosed at 18 years. He is of below average intelligence but has held down manual employment intermittently. There was no relevant family history.

On examination both tympanic membranes were normal and mobile. Clinical tests of hearing were consistent with audiological findings (see below). As in Case 1 neurological examination

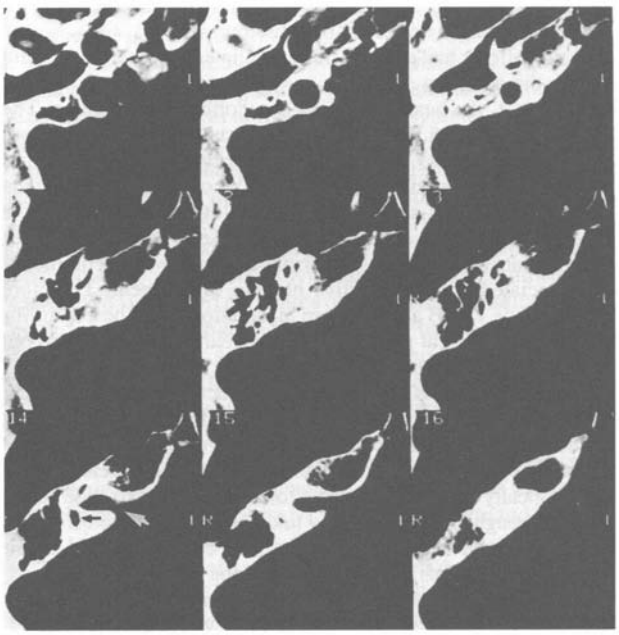

Fig. 7

Case 2. Contiguous 1.5 mm thick axial images through the right petrous bone. Window level +250 and window width 3000. Although the IAM is of a more normal shape (white arrow) the lateral termination is unusually high in relation to the heads of the malleus and incus (large black arrow). Note the vestibule (thin black arrow). No discernible normal semi-circular canal structure.

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including cerebellar, Romberg and Unterberger testing was normal. On walking with eyes closed he was apprehensive but did not deviate from a straight line.

Pure tone audiometry: There was no recordable hearing in the left ear. There was a conductive loss on the right with mild bone conduction loss at 4 kHz (Fig. 5). This finding was substantiated by three previous pure tone audiometry results obtained at intervals up to 14 years previously.

Speech audiometry: The right ear showed a 100 per cent optimum discrimination score and a curve displacement consistent with a conductive loss (Fig. 6).

Tone decay: No pathological adaptation was observed at 2 kHz or 4 kHz in the right ear.

Impedance: The left tympanogram showed normal compliance (0.7 ml) and normal middle ear pressure (10 daPa). The right tympanogram showed a low compliance (0.3 ml) and normal middle ear pressure (10 daPa). The curve on the right was asymmetrical about the maximum, suggesting that the ear drum is more readily stiffened by negative than by positive ear canal pressure. No acoustic reflex was obtained in either ear to the maximum available levels of ipsilateral and contralateral stimulation.

BSER: There was a reproducible peak at 6.3 ms on the right, presumed to be wave V. No other peaks were identifiable. The prolongation of wave V is thought to be largely due to the conductive hearing impairment, although the abnormal waveform morphology also suggests some sensorineural deficit. The left ear was not tested by BSER due to the total hearing loss.

Computerized Tomography: The findings are similar to those in Case 1, except that the internal auditory meatuses are of a more normal shape. (Fig. 7).

Vestibulometry: Vestibular tests produced very similar findings to those obtained in Case 1.

Caloric stimulation, including iced water, produced no nystagmus or vertigo. Rotational testing induced no nystagmus or subjective imbalance and body sway measurements were normal in all conditions except with eyes open, off the foam, which was slightly outside the normal range.

Discussion

The incidence of hearing loss in our 11 cases of Kallman's syndrome is consistent with the previous studies.

Both patients had one non-functioning ear and partial hearing loss in the other ear.

In Case 1, the hearing loss was predominantly cochlear. The air-bone gap of 15 dB at 4 kHz suggests the presence of conductive hearing loss, although the severity of the sensorineural loss makes it impossible audiometrically to confirm or refute the presence of minor conductive loss at lower frequencies. The bilaterally reduced compliance and absent acoustic reflexes demonstrate a mechanical abnormality which would commonly be associated with conductive hearing impairment. Therefore although the 15 dB air-bone gap in isolation could be a spurious finding it is thought probable that the hearing loss is mixed but previously sensorineural.

In Case 2, the loss was primarily conductive in the functioning ear with a sensorineural devient. The cause of the conductive deficit is unclear. The slight abnormalities on the tympanogram would not explain the observed air bone gap. The middle ear appears normal radiologically and therefore some form of ossicular fixation seems likely although the tympanotomy findings would be interesting in a patient in whom surgical exploration is not contra-indicated, as it is in these two patients with only one hearing ear.

The radiological findings were more consistent, both patients showing similar evidence of bilaterally symmetrical abnormalities of the inner ear in relation to the abnormal morphology of the semi-circular canals and internal auditory meati.

The vestibulometry was consistent with the radiological find ings. We were unable to demonstrate any reflex nystagmus or sensation of vertigo to either caloric or rotational testing. This marked deficit produced remarkably little problems for the patients. Both were slow to learn to walk and were thought to have been slightly clumsy by their parents. The second patient had always been very apprehensive of using ladders. However, clinically it was not possible to demonstrate any specific balance problem and sway posturography confirmed this although they were less stable than normal controls when standing with eyes open on a firm surface. These patients have little or no vestibular input to help maintain their balance. They are, therefore, heavily reliant on visual and proprioceptive information. The remarkable stability that these patients have is in marked contrast to the symptoms of dysequilibrium and bobbing opscillopsia seen in the acute bilateral labyrinthine failure of ototoxicity. This may be the consequence of the lesion being congenital in origin. Both patients were slow to walk as children but presumably were able to develop their proprioceptive and visual inputs to compensate for the lack of vestibular information. Even reducing proprioceptive input and abolishing visual input by standing the patients on a foam rubber surface with eyes closed did not lead to an abnormal increase in body sway. It would be interesting to observe the effect of complete removal of gravitational proprioceptive input by underwater immersion, but neither patient had ever been taught to swim.

It would therefore seem prudent to bear the diagnosis of Kallman's syndrome in mind when assessing children with congenital hearing loss and to seek a history of anosmia. The vestibular and radiological findings mentioned above should provide further evidence and allow early referral to the endocrinologist and thus anticipate and correct the failure of secondary sexual characteristic development.

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