Two siblings with progressive, fluctuating hearing loss after head trauma, treated with cochlear implantation

M J F de Wolf, J Honings, F B M Joosten, L Hoefsloot, E A M Mylanus and C W R J Cremers

DOI: 10.1017/S0022215109990296, Published online: 23 June 2009

Link to this article: http://journals.cambridge.org/abstract_S0022215109990296

How to cite this article:

Request Permissions : Click here
Two siblings with progressive, fluctuating hearing loss after head trauma, treated with cochlear implantation

M J F de Wolf, J Honings, F B M Joosten*, L Hoefsloot†, E A M Mylanus, C W R J Cremers

Abstract
Objective: Description of two siblings with unexplained, progressive, perceptive hearing loss after head trauma.
Design: Case report.
Subjects: Two siblings aged six and eight years old with bilateral, intermittent but progressive hearing loss.
Results: These patients had a c.1172G>A (p.Ser391Asn) mutation in the SLC26A4 gene, which has not previously been reported and which caused Pendred or enlarged vestibular aqueduct syndrome. The diagnosis was based on the perceptive hearing loss, computed tomography findings and mutation analysis. The patients were each fitted with a cochlear implant because of their severe, progressive, perceptive hearing loss with deep fluctuations. The results were good.
Conclusion: Further testing for the presence of an enlarged vestibular aqueduct is recommended when children present with sudden progression in perceptive hearing loss, whether or not in combination with head trauma. Cochlear implantation is indicated in patients with persistent, progressive hearing loss that leads to deafness. Implantation can be undertaken successfully despite cochlear hypoplasia.

Key words: Pendrin protein; Sensorineural Hearing Loss; Head Injury; Child; Diagnosis

Introduction
When perceptive hearing loss in children follows a fluctuating course, it may have a hereditary cause. Besides DFNB1 (CX26, CX30), the most common hereditary form of hearing loss or deafness in childhood is the Pendred or enlarged vestibular aqueduct syndrome. This syndrome is estimated to account for 4.3–7.5 per cent of all cases of early childhood perceptive hearing loss or deafness.

Pendred syndrome was first described in 1896 by Vaughan Pendred, as persistent deafness in children combined with Goitre. It comprises an autosomal recessive hereditary disorder which was originally characterised as perceptive hearing loss and disturbed thyroxin synthesis. In about 80 per cent of Pendred syndrome patients, struma develops in the first 10 to 20 years of life. As a result of partial deficiency in the organification of iodine, the perchlorate test is generally positive. Later, enlargement of the vestibular aqueduct became a more or less obligatory characteristic for diagnosis of the syndrome, in addition to perceptive hearing loss. After the recognition of mutations in the SLC26A4 gene as the cause for the Deafness, it appeared that mutations in the same gene were also responsible for the enlarged vestibular aqueduct syndrome. Thus, the clinical spectrum of Pendred or enlarged vestibular aqueduct syndrome expanded.

This case report describes a patient with unexplained perceptive hearing loss and post-traumatic progression. Enlarged vestibular aqueduct syndrome was suspected. With the aid of computed tomography (CT) scanning of the petrous bones and mutation analysis to detect the SLC26A4 gene, the diagnosis was confirmed.

Case report
A six-year-old girl was referred to the Radboud University Medical Centre (UMC) Nijmegen ENT out-patient clinic because of bilateral, intermittent but progressive, perceptive hearing loss. Anamnesis revealed that, during episodes of diminished hearing, the child was also less secure on her feet. Her parents reported that there were periods of several days when she was profoundly deaf and unable to walk. Notably, the hearing loss had deteriorated following head trauma.

The patient’s ENT medical history was negative for otitis media. Bilateral otoscopic findings were normal. The girl’s hearing seemed normal until she failed the Ewing test. At the age of one and a half years, she had responded only to stimuli of 60–70 dB in the free field hearing test. Brainstem evoked response audiometry had confirmed bilateral perceptive hearing loss of about 60 dB. After bilateral hearing aid fitting at the age of two years, the patient’s speech perception had improved strongly. At the age of four years and two months, her hearing loss had been 63 dB in the right ear and 77 dB in the left ear. At the age of five and a half years, these values had increased to >110 dB and 90 dB, respectively. At this time, speech perception was a maximum of 75 per cent at 95 dB with the hearing aid in the patient’s left ear. Figure 1 shows the course of the patient’s hearing loss over time. Figure 2
shows the course of the hearing loss over time for each ear. Vestibular testing at the age of five years, with the aid of electronystagmography and a rotatory chair, showed normal vestibular function. A general physical examination did not reveal any signs of struma.

Family anamnesis showed that the patient’s parents were second cousins of Caucasian origin, without any hearing impairment. The patient’s sister (two years older) was known to have asymmetrical, stable, perceptive deafness (Fletcher index of 90 dB on the right and 55 dB on the left).

The patient’s fluctuating and progressive hearing loss, her unsteady balance and the occurrence of head trauma as a possible initiating factor prompted suspicion of enlarged vestibular aqueducts. Computed tomography scanning of the petrous bones revealed salient bilateral enlargement of the endolymphatic ducts and an incomplete number of turns in both cochleae (Figure 3). The fact that the patient’s parents were second cousins and that their only other child had hearing impairment made it very likely that there was an autosomal recessive predisposition.

Mutation analysis identified a homozygous missense mutation (c.1172G>A (p.Ser391Asn)) in the SLC26A4 gene in both the patient and her sister. Both parents appeared to be heterozygous carriers of the same mutation. This mutation has not previously been described. It concerns a relatively drastic change in the amino acid configuration of a conservative part of the protein. The diagnosis of Pendred or enlarged vestibular aqueduct syndrome was ultimately proven by mutation analysis.

It was decided to fit the patient with a cochlear implant (CI) on the right side (contralateral to the existing hearing aid) at the age of seven years and six months, because of her severe, progressive, perceptive hearing loss with deep fluctuations. Two months after implantation,
the patient’s word score and speech score on the monosyl-
lable identification test were 76 per cent. Six months
post-implantation, her word and speech scores were
100 per cent at 60 dB and her Fletcher index was 25 dB.
At one year and two months post-implantation, the
patient’s phoneme score with the CI increased to 91 per
cent, while her Fletcher index remained stable at 25 dB.

The patient’s thyroid levels were analysed at the age of
seven years: her thyroid-stimulating hormone (TSH) level
was 2.2 mU/l and her thyroxine concentration was
20 mU/l. The patient was referred to a paediatrician to
monitor her thyroid biochemistry.

The patient’s sister

The patient’s sister was also diagnosed with Pendred syn-
drome. After a long period of stability, her hearing loss
also deteriorated dramatically after head trauma, fluctu-
ated and then gradually improved (with a Fletcher index
of 93 dB on the right and 103 dB on the left). With the
right hearing aid alone, this girl’s speech recognition was
54 per cent, compared with 9 per cent with the left
hearing aid alone. With bilateral hearing aids, her
phoneme score was 75 per cent at 70 dB.

This patient received a CI at the age of 10 years. Two
months after implantation, she achieved a phoneme score
of 89 per cent at 70 dB with the CI. The scores with the
CI were higher than the scores with her bilateral hearing
aids immediately before implantation, and in agreement
with the expectations of the audiological scores at that
level of hearing loss.

At the age of 9.2 years, thyroid gland analysis for this
patient showed a TSH level of 1.4 mU/l and a thyroxine
concentration of 18 mU/l.

Discussion

Fluctuating, progressive, perceptive hearing loss in child-
hood or adolescence is a typical presentation in patients
with enlarged vestibular aqueduct syndrome. In the
present case, there was salient bilateral enlargement of
the endolymphatic ducts and an incomplete number of
turns in both cochleae (Mondini’s malformation). Episodic
of head trauma were invariably followed by periods of
partial, transient deterioration of the perceptive hearing
loss. Our patient’s vertigo was also transitory.

The clinical presentation of patients with SLC26A4 gene
mutations is variable. Features range from nonsympto-
matic, autosomal recessive, perceptive hearing impairment
with enlarged vestibular aqueducts (DFNB4) to classical
Pendred syndrome (profound childhood perceptive deaf-
ness and the development of struma in early childhood
adolescence). Azaiez et al. found that the hearing loss in
patients with two mutant SLC26A4 alleles was more severe
than that in patients with no mutations or one
mutant allele. Diverse mutations were found to be associ-
ated with different phenotypes and varying degrees of
inner-ear pathology. Ongoing research into genotype-
phenotype correlations in the most common SLC26A4
mutations (‘hotspot mutations’) could help to match clini-
cal and pathological features to specific mutations.

In the present case, a new mutation (c.1172G>A
(p.Ser391Asn)) was found in the SLC26A4 gene. In 1997,
Pendred syndrome was discovered to be caused by
mutations in the SLC26A4 gene on the long arm of
chromosome seven, which encodes for the transmembrane
protein pendrin. Expression of pendrin was found in
the endolymphatic duct and sac, where it probably plays a
role in the regulation of endolymph composition, as a trans-
membrane anion transporter.

There is considerable overall variation in the severity
of the symptomatology of Pendred or enlarged vestibular
aqueduct syndrome. For instance, the present case
showed rapid progression of hearing loss over only a few
years. Pendred syndrome patients generally have fluctuat-
ing, progressive, moderate to severe, perceptive hearing
loss and disequilibrium symptoms. The syndrome can
also be expressed as total deafness in early childhood, or
sudden deafness in one ear in adolescence. The classical
form of Pendred syndrome comprises severe early child-
hood deafness, cochlear dysplasia and enlarged endolym-
phatic ducts, with or without struma. Struma and
decreased thyroid function can occur in approximately
50–80 per cent of children with Pendred or enlarged vestib-
ular aqueduct syndrome. It is assumed that one of the
functions of the vestibular aqueduct is to minimise differences in intracranial pressure.

An increase in intracranial pressure in an enlarged aque-
duct, such as occurs in Pendred syndrome, may have a
stronger effect on the cochlea than in vestibular aqueducts
of normal diameter. Head trauma may cause a shockwave
of endolymph from the endolymphatic sac through the duct
into the vestibulum. Mixing of endolymph from the sac and
duct with endolymph in the cochlea, which has different
ion concentrations, may disrupt the action potential in
the cochlea. In time, this may lead to progression of
hearing loss. This might explain why head trauma in
Pendred syndrome patients can cause deterioration in
hearing loss. Jackler and De La Cruz observed the same
clinical features and CT abnormalities in patients with
enlarged vestibular aqueduct syndrome. In an earlier
report, the hearing loss in patients with enlarged vestibular
aqueduct syndrome was described as progressive and step-
wise, often triggered by relatively mild head trauma. As
yet, no studies have confirmed a correlation between the
diameter of the vestibular aqueduct and the deterioration
in hearing loss after head trauma. However, a recent
study showed that the diagnosis of Pendred syndrome was
related to poorer prognosis following hearing loss.

Cochlear implantation is indicated for persistent, pro-
gressive hearing loss that leads to deafness, and it can be
applied successfully despite cochlear hypoplasia.

Conclusion

When a child presents with sudden progression of percep-
tive hearing loss, imaging of the cochlea is indicated to
detect or exclude enlargement of the vestibular aqueducts
and hypoplasia of the cochlea.

When enlargement of the vestibular aqueducts is found,
whether or not upon routine diagnostic preparation for
cochlear implantation, SLC26A4 gene mutation analysis is
recommended to confirm the diagnosis and to identify any
autosomal recessive predisposition. Genetic counselling is then worthwhile in order to discuss such issues as the cause of symptoms. Nowadays, mutation analyses form part of the routine deoxyribonucleic acid diagnostic procedure.

Patients with enlarged endolymphatic ducts should be advised to avoid head trauma. This can be achieved by avoiding contact sports and other high risk activities. Referral to a paediatrician is recommended to analyse thyroid function. Supplementary thyroid hormones can be administered to treat hypothyroidism, and may even prevent struma. Cochlear implantation is indicated in patients with persistent, progressive hearing loss that leads to deafness. It can be applied successfully despite cochlear hypoplasia.15

References

2 Pendred V. Deaf-mutism and goitre. Lancet 1896; ii(Suppl. 2):532
4 Morgans ME, Trotter WR. Association of congenital deafness with goitre; the nature of the thyroid defect. Lancet 1958;i:607–9
11 Jackler RK, De La Cruz A. The large vestibular aqueduct syndrome. Laryngoscope 1989;99:1238–42
14 Valvassori GE, Clemis JD. The large vestibular aqueduct syndrome. Laryngoscope 1978;88:723–8

Address for correspondence:
Dr M J F de Wolf,
Department of Otorhinolaryngology,
Radboud University Nijmegen Medical Centre,
PO Box 9101, 6500 HB, Nijmegen, The Netherlands.
Fax: 0031 24 354 02 51
E-mail: m.dewolf@kno.umcn.nl

Dr M J F de Wolf takes responsibility for the integrity of the content of the paper.
Competing interests: None declared