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Clinical Record

Auditory neuropathy in a patient exposed to xylene: case report

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Abstract
Objective: To report the case of an adult patient who developed auditory complaints following xylene exposure, and to review the literature on the effects of solvent exposure on hearing.

Case report: The patient presented with a gradual deterioration in his ability to hear in difficult acoustic environments and also to hear complex sounds such as music, over a 40-year period. His symptoms began following exposure to the solvent xylene, and in the absence of any other risk factor. Our audiological investigations revealed normal otoacoustic emissions with absent auditory brainstem responses and absent acoustic reflexes in both ears, consistent with a diagnosis of bilateral auditory neuropathy. Central test results were also abnormal, indicating possible involvement of the central auditory pathway.

Conclusions: To our knowledge, this is the first report of retrocochlear hearing loss following xylene exposure. The test results may provide some insight into the effect of xylene as an isolated agent on the human auditory pathway.

Key words: Auditory Neuropathy; Hearing; Xylene; Solvent Exposure

Introduction
Organic solvents are common in industrial environments and are used in large quantities across the world. Some of the more common solvents include xylene, toluene and styrene and can be found in household items such as paints, pharmaceuticals, adhesives, pesticides and household cleaners. However, research suggests that long term or acute exposure to solvents can have noxious, neurotoxic and ototoxic effects.1

Humans with long term or acute exposure to solvents have demonstrated hearing losses greater than would be expected for their age2–6 and, when working in industrial environments using solvents, greater than would be expected for noise exposure alone.3–5 There is also evidence that solvent exposure may result in retrocochlear rather than peripheral cochlear lesions in humans. For example, impaired speech recognition scores consistent with a retrocochlear pattern and/or abnormal cortical responses and/or abnormal reflex decay have been reported in populations working with toluene,7 jet fuels,8 styrene9 and mixtures of solvents.8,10–12

It is now documented that solvents should be considered as individual substances with different specific toxicities,12 and that solvents may act on transmitters specific for certain neural structures and pathways.10 For example, significantly delayed auditory brainstem responses (ABRs) were measured in a group of normally hearing workers professionally exposed to toluene.13

Xylene is a solvent structurally related to toluene.14 There is no literature on the effect of xylene, acting as a single agent, on the auditory pathway in humans.

We present a case of an adult patient with hearing loss and auditory complaints attributed to auditory nerve pathology, i.e. auditory neuropathy or dys-synchrony. This patient’s hearing complaints developed at the time of xylene exposure, in the absence of any other risk factors for auditory neuropathy or dys-synchrony (as per his medical history).

Case report
A 60-year-old man presented to the otoneurology department with a 40-year history of hearing difficulties. His symptoms had begun in his 20s while researching for his PhD and after exposure to the solvent xylene. He had worked in a small basement hut where xylene leaked into a water tank and escaped into the atmosphere. It was estimated that this exposure had occurred over a six-month period; the basement hut had been small with little or no ventilation.

A few months after the xylene exposure, the patient had noticed problems hearing in the presence of background noise. His symptoms had gradually deteriorated over time. However, he had been discharged from audiology departments on two occasions due to normal pure tone audiometry results. He had been diagnosed with auditory neuropathy or dys-synchrony at the age of 50 years, at which time he had tried both analogue and digital hearing aids but found them of no benefit.

On presentation to our clinic in March 2006, the patient described an inability to hear speech in the presence of noise and to understand people with accents, and the need to lip-read and concentrate when anyone spoke to him. He had given up using the telephone and avoided noisy social situations. The patient had no family history.

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of early onset hearing impairment. He could not recall any other significant event or illness before his hearing problems began.

The patient’s medical history included a right-sided sphenoid wing meningioma removal in October 2005. Due to the tumor’s location, it was deemed highly unlikely that this had caused the patient’s audiological symptoms. No neurological impairments were identified and the patient had normal nerve conduction. No central nervous system deficits or sense impairment (often associated with solvent exposure) were identified. Previous magnetic resonance imaging and computed tomography (CT) scans, performed following surgery, did not show any residual tumor and were otherwise normal.

Pure tone audiometry and acoustic reflex threshold results are illustrated in Figure 1. In this patient, the combination of absent or raised (>110 dBHL) ipsi- or contralateral acoustic reflex threshold and absent ABR in the presence of otoacoustic emissions was consistent with the diagnosis of bilateral auditory neuropathy or dys-synchrony. Maximum speech recognition scores of 66 and 63 per cent at 60 dBHL were present on the right and left respectively, with a significant rollover of 55 and 5 per cent at higher intensities; this was worse than would be predicted from the audiogram. Poor temporal processing was demonstrated by this patient’s inability to complete gaps in noise testing, which had to be abandoned due to the patient’s random answers (Table I). Central auditory processing tests, which are sensitive to lesions of the central auditory pathway, were abnormal in at least one ear for each test (Table I).

Discussion

This case report presents a sequence of events and facts that may be linked, and the authors are aware that there is no hard evidence of pathology caused by xylene exposure. Our subject was exposed to xylene over a relatively small time scale (six months), and there is no quantitative information regarding the concentration of xylene in the atmosphere at the time (although the laboratory was small and inadequately ventilated). However, Dick reported that there is no real definition of what is regarded as a significant exposure to solvents, and no verdict on whether the important determinant of adverse effects is the lifetime (cumulative) exposure or the peaks (intensity) of exposure. In addition, the subject could have idiopathic auditory neuropathy or dys-synchrony, although the majority of reported cases (80 per cent) present in conjunction with specific medical risk factors and generalised neuropathic disorders. Despite these factors, reporting this case may be of some importance, given the clinical setting, regarding the possible specific toxicity of xylene on the auditory nerve and/or central auditory system in humans.

Auditory neuropathy or dys-synchrony is defined as reduced and/or asynchronous auditory nerve function, in the presence of normal outer hair cell function.
possible sites of lesion in this condition include the cochlear inner hair cells, the synapse between the inner hair cells and the type I auditory nerve fibres, and the auditory nerve itself.25 The mechanism of auditory dysfunction may vary between individuals, and is thought to relate to either a dys-synchrony of the auditory nerve (e.g. due to myelin damage) or a reduction in the numbers of neural elements contributing to the volume-conducted response (e.g. due to axon-related neuropathies and inner hair cells lesions).

An inability to follow temporal fluctuations is likely to be the underlying cause for the poor speech recognition experienced by patients with auditory neuropathy or dys-synchrony;26 this was demonstrated by the inability of our patient to complete gaps in noise testing. The abnormalities detected in the central auditory processing tests may be attributed to disordered auditory nerve input and/or central auditory involvement. However, in view of the potential toxicity of solvents recorded previously at this higher level, central involvement at the level of the auditory cortex cannot be ruled out. Therefore, we may have a mixed picture: intact cochlea, impaired auditory nerve, but also possible impairment at the level of the brainstem and above.

In humans, many studies have investigated the effect of mixed solvents (including xylene) on the auditory system, but none have investigated the effect of xylene acting as a single agent. Xylene is structurally related to toluene,14 and some human studies have examined the auditory pathway in a human with retrocochlear hearing loss.27 This is the first report on the possible effects of xylene acting as a single agent on the auditory pathway in a human with retrocochlear hearing loss.28 Xylene is more liposoluble than toluene;14 due to its possible site of lesion in this condition include the cochlear inner hair cells, the synapse between the inner hair cells and the type I auditory nerve fibres, and the auditory nerve itself.25 The mechanism of auditory dysfunction may vary between individuals, and is thought to relate to either a dys-synchrony of the auditory nerve (e.g. due to myelin damage) or a reduction in the numbers of neural elements contributing to the volume-conducted response (e.g. due to axon-related neuropathies and inner hair cells lesions).

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structural similarity, it could be proposed that xylene has a similar mechanism of toxicity on the human auditory nerve.

This is the first report of retrococlear hearing loss in a human adult patient following xylene exposure and in the absence of any other risk factor. Caution should be noted regarding the length of time the subject was exposed to the solvent, and the fact that no inferences can be made about the concentration or biochemical properties of the solvent. However, the test results may provide some insight into the effect of xylene as an isolated agent on the human auditory pathway.

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References


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