Middle ear function in patients with juvenile chronic arthritis

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Abstract

The conductive hearing of 18 patients with juvenile chronic arthritis was studied. Tympanometry was therefore undertaken for the assessment of functional state of the tympanic membrane, the ossicular chain with its ligaments and muscles, and the air cushion of the tympanic cavity. Acoustic reflex was present in all patients but an abnormal tympanometric pattern (type As) was found bilaterally or unilaterally in 10 (mostly severe cases) patients.

These findings indicate that juvenile chronic arthritis changes middle ear function, probably as a result of inflammation of the synovial ossicular joints, which is followed by stiffness of the tympanic membrane and ossicular chain.

Juvenile chronic arthritis is a heterogeneous disease which has variable modes of onset and many signs, symptoms, and manifestations. Based on clinical grounds, it has been divided into three basic types of onset—namely, pauci-articular, polyarticular, and systemic. Although articular and extra-articular manifestations have been described and are well documented in juvenile chronic arthritis,¹ the spectrum of ear complications remains poorly defined.

A small number of clinical studies have shown dysfunction of conductive or sensorineural hearing, usually clinically mild, in adults with rheumatoid arthritis.² To our knowledge similar studies have not been reported in juvenile chronic arthritis. Because the incudomalleal and incudostapedial articulations are synovial joints with cartilaginous articular discs, they should be subject to the same rheumatoid process which affects other joints in the body.³

The aim of this study was to assess the function of conductive hearing in children with different types of juvenile chronic arthritis and to correlate the findings with the type of onset, the activity, and severity of the disease. For this purpose impedance audiometry was performed using an electroacoustic bridge (Amplaid 702) to carry out the measurement of tympanometry and to determine the threshold for the acoustic reflex.

Tympanometry is a sensitive tool, with great diagnostic value, for assessing the functional importance of middle ear abnormalities, especially in young children.^{4 5}

Several procedures for classifying and interpreting tympanograms have been proposed over the last two decades. The most commonly used

classification is that given by Linden-Jerger.⁶ Type A is a normal tympanogram with peak immission at or near atmospheric pressure. This pattern reflects a normal air-filled middle ear. Type As denotes a tympanogram with reduced amplitude, characteristic of ossicular fixation. Type C has a negative tympanometric peak pressure, indicating negative middle ear pressure. There are also other types such as B, D, and E.

Many clinical studies have shown that the values of acoustic compliance in normal ears for children range from 0.5 to 1.0 cm³.^{7 8}

Methods

Eighteen patients with juvenile chronic arthritis, as defined by European League Against Rheumatism (EULAR) criteria,⁹ were studied. Of these, six had disease of systemic onset (three girls and three boys), five had polyarticular onset (three girls and two boys), and seven had pauciarticular onset (two girls and five boys). Their mean age was 10.6 years (range 6-16 years) and the mean duration of active disease was 2.8 years (range one to six years). All patients had negative latex agglutination tests for rheumatoid factor. Four patients with severe polyarthritis also had striking limitation of temporomandibular joint (TMJ) movement and six severe functional disability (functional class III). Most children were taking non-steroidal anti-inflammatory drugs (NSAIDs); several of them were being treated with second line drugs (gold or D-penicillamine).

A sex and age matched group of 14 healthy children served as controls. This group had neither a history of nor symptoms compatible with any arthropathy. All patients and controls fulfilled the following criteria: intact membrane without visible scarring and negative history for otorrhoea; negative history for upper respiratory tract infection for two months before testing; no conductive hearing loss from other aetiology.

A thorough otoscopic examination was completed for each child and tympanograms were then run by an otolaryngologist (AD) for all participants.

All impedance audiometry was carried out on one commercial electroacoustic impedance audiometer (Amplaid 702). This instrument contains a pressure pump system, which varies the air pressure gradient across the tympanic membrane (from -200 mm H₂O to +200 mm H₂O in this case), and a small probe tip with tubes for air pressure, transmission, and

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reception of acoustic signals. Tympanometric graphs were plotted at probe-tone frequencies of 220 Hz. Acoustic reflexes were measured with the same apparatus.

Results

The results of the impedance audiometry assess-

ment showed that patients with juvenile chronic arthritis had a high incidence of abnormal tympanometric patterns. Type As tympanograms were found in 17 out of 36 ears (table). Mostly, the patients suffered from systemic or polyarticular juvenile chronic arthritis. Six patients with severe, active polyarthritis with a disease duration of more than three years (functional class III) had bilateral abnormal tympanograms and four of them also had TMJ disease.

All controls except one had normal tympanometric patterns (type A). Fig 1 shows a normal tympanogram with acoustic compliance of 0.6 cc and peak immission near 0 mm H₂O.

Patients with abnormal type As tympanograms had peak immission near 0 mm H₂O but reduced amplitude (compliance of <0.5 cm³). Figure 2 shows a tympanogram with bilateral type As shape. Three patients (one from each type of juvenile chronic arthritis) had unilateral abnormal type As tympanograms (fig 3).

Type C pattern, which has negative tympanometric peak pressure, indicating negative middle ear pressure, was found in only three ears (table)—bilaterally in one child with pauci-articular juvenile chronic arthritis and unilaterally in the right ear of a patient with systemic disease (fig 4).

In all patients and controls acoustic reflex was present, both ipsilateral and contralateral, within the normal acoustic reflex threshold (90–100 decibels) at test frequencies of 500, 1000, 2000, and 4000 Hz (figs 1–4). In a few patients with very low acoustic compliance (0.2 cm³) it was noted that the distribution of acoustic reflex graphs was not as narrow and sharp as that seen in controls (fig 1 compared with fig 2).

Discussion

The history of clinical acoustic immission measures has been well known for over 100 years. The term acoustic immission refers to either acoustic admittance or acoustic impedance. Acoustic admittance is a general term expressing the ease with which sound energy flows through a system; acoustic impedance represents the total opposition to the flow of sound energy. Acoustic admittance and acoustic impedance are reciprocal quantities. Many clinicians report the acoustic immission measures as compliance values in cubic centimetres (cm³).

Since Copeman described three patients with rheumatoid arthritis in 1963 with what he termed “otoarthritis”, to bring attention to the possibility of conductive hearing impaired as a consequence of rheumatoid arthritis,¹⁰ other

Figure 1 Tympanogram (type A) with acoustic compliance of 0.6 cm³ and presence of normal acoustic reflex threshold.

Figure 2 Bilateral tympanogram type As.

Tympanometric patterns for all patients with juvenile chronic arthritis*

Subtypes of JCA	Mean disease duration (years)	Total no of ears	Tympanometric pattern		
			Type A	Type As	Type C
Systemic	4.2	12	4	7	1
Polyarticular	2.9	10	4	7	
Pauciarticular	1.2	14	9	3	2

*All data are based on the number of ears.

Figure 3 Tympanogram type A in the left ear and type As in the right ear.

Figure 4 Tympanogram type A in the left ear and type C in the right ear.

more relevant studies have shown that conductive and sensorineural hearing loss often occur in patients with rheumatoid arthritis.² Goodwill *et al* showed that the significantly greater hearing loss in the patients with rheumatoid arthritis was of the sensorineural and not conductive type as would be expected from the possible inflammatory effects of rheumatoid arthritis on the ossicular joints.¹¹ These results might have been due to the method used, because pure tone audiometric measurements are not especially sensitive to changes within the tympano-ossicular system. In the same study the pathological findings were described from three sets of ossicles (removed at necropsy) from patients with rheumatoid arthritis. Microscopic examination did not show rheumatoid nodules or erosive changes in the joints, but a large area

of bone absorption and replacement by highly cellular fibrous tissue in the lenticular process of the incus. The findings of other investigations in patients with rheumatoid arthritis by measuring oto-admittance variables showed a high incidence of type D pattern (notched) in tympanograms using high probe frequency (660 Hz).¹² Such findings were suggestive of decreased stiffness in the tympano-ossicular system but may also occur in ears in which stiffness is increased.³ Previous clinical studies have shown that types D and E patterns are rarely observed with a low probe frequency of 220 Hz.⁶ In an otological evaluation of 23 patients with rheumatoid arthritis Reiter *et al* found type D tympanograms in 22%, using a frequency of 660 Hz, but normal type A tympanograms, using a low probe frequency (220 Hz).³

In this study we investigated 18 patients with juvenile chronic arthritis for conductive hearing loss, because the incudomalleolar and incudostapedial joints are synovial in type and could be involved in the inflammatory process. To our knowledge there have been no relevant clinical studies in juvenile chronic arthritis to date. Patients and controls were evaluated using acoustic immision procedures (low-probe frequencies of 220 Hz) and acoustic reflex measurement, because the diagnostic applications of the acoustic reflex considerably outweigh the contribution of tympanometry and acoustic compliance.¹³ Moreover, these procedures are valuable in young children for whom behavioural audiometry is not always a feasible or reliable alternative.

Our results showed that ipsilateral and contralateral acoustic reflexes were observed in all patients and controls. The acoustic reflex threshold, which means the lowest intensity of an acoustic stimulus at which a minimal change in the middle ear compliance can be measured, was 90 to 100 decibels in both groups, which has been documented as a normal value.¹⁴ A few patients with very low compliance, shown in their tympanograms, did not have as narrow and as sharp an acoustic reflex graph as controls. Conductive hearing loss was virtually impossible in these ears, because even in mild bilateral conductive hearing loss the ipsilateral and contralateral reflexes are completely absent.

Type C tympanometric patterns were found in three patients' ears and in two control ears, all these patients were younger than 10 years. This pattern is not unusual in young children in whom eustachian tube obstruction may be an undetected middle ear problem.⁵

Abnormal tympanometric pattern type As was noted in almost 63% (14 of 22) of the ears of patients with systemic and polyarticular juvenile chronic arthritis and in only 21% (three of 14) ears of patients in the pauciarticular group (table). Audiometric studies in adults with rheumatoid arthritis showed significantly greater hearing loss in patients with rheumatoid nodules than in those without nodules.¹¹

The results of this study suggest that a pathological stiffening of the middle ear occurs mainly in patients with severe polyarthritis of long duration.

In conclusion, the high incidence of type As tympanograms and the presence of acoustic reflex in our patients strongly indicate that juvenile chronic arthritis changes middle ear function but that such changes are not sufficient to cause conductive hearing loss. As with rheumatoid arthritis in adults, (clinically mild) dysfunction of conductive hearing seems to be common in juvenile chronic arthritis, but follow up studies are necessary to observe the clinical course of juvenile chronic arthritis, particularly with regard to the pattern of joint disease.

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