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ORIGINAL ARTICLE

Hearing Impairment in Children with Congenital Hypothyroidism

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Abstract

Background: *There is increased risk of hearing impairment in children with congenital hypothyroidism (CH). Only a few studies have explored the prevalence of hearing impairment in CH and their results vary widely. There is no data of hearing impairment in Bangladeshi children with CH.*

Objectives: *The aim of this study was to investigate the prevalence of hearing impairment in children with CH, and its relation with age of diagnosis and the dose of thyroxine (T4) they received.*

Methods: *This study was conducted in Paediatric Endocrinology & Metabolic Disorder Department of Dhaka Shishu (Children) Hospital from July 2014 to December 2018. Hearing evaluation of 55 children diagnosed with CH was performed with a battery of tools that included Middle ear analysis, Pure Tone Audiometry (PTA), Behavioral Observation Audiometry (BOA) and Oto Acoustic Emissions (OAE). The choice of assessment tool was based on patient's age.*

Results: *The mean age at diagnosis and at inclusion into the study was 2.0±1.7 years and 3.2±2.3 years respectively. The etiological diagnosis was thyroid agenesis in 40(72.7%), ectopia in 3(5.5%), dyshormonogenesis in 7(12.7%) and hypothyroidism with eutopic gland in 5(9.1%%) patients. Middle ear analysis, PTA, BOA and OAE was done in 35, 28, 32 and 37 patients respectively. Sensorineural hearing loss was detected in 1 out of 55(1.8%) patients while conductive hearing loss was found in 3(5.4%) patients.*

Conclusion: *Hearing loss was present in a small proportion of patients with permanent CH. Further larger studies are required to determine the exact prevalence of hearing impairment in Bangladeshi children with CH.*

Keywords*: Children, congenital hypothyroidism, hearing loss, prevalence.*

Introduction

Thyroid hormone is necessary for normal development of the auditory system[1,2] and the association between thyroid hormone and hearing development has long been recognized in patients with congenital hypothyroidism (CH), endemic cretinism and thyroid hormone resistance.[3,4] Recent genetic studies confirmed the relation between thyroid hormone and hearing system development.[5,6] So, CH, the most common endocrine disorder with an incidence rate of 1/4000-5000 live births also increase the risk of hearing impairment in children.[7]

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Although mental outcome of CH patients is improved if patients are treated early in infancy, during CH screening, but subtle neurological deficits such as fine motor coordination, attention deficient, speech delay, hearing impairment, and hearing problems may develop.[8,9] Many studies, both in animal models and human patients have identified auditory system dysfunction among cases with thyroid disorders.[10] The rate of hearing loss has been reported to be 20-36% in CH patients before Iranian national CH screening program, and reported hearing loss was bilateral and severe.[11] On the other hand, recent reports held after CH screening programs, indicate that mild hearing loss occurs in up to 20% of CH patients.[12,13]

Hearing loss, specially its mild form in children may result in delayed speech and difficulties in comprehension and problems in receptive language, auditory processing and reading, which may persist, especially in those with delayed treatment.[14,15] Therefore, considering the consequences of CH and its related hearing loss and also the fact that CH was more prevalent in our community,[16,17] the aim of this study was to investigate the rate of hearing impairment in CH patients, and its relation with factors such as CH severity and age at starting treatment.

Materials and Methods

Children aged 6 months to 6 years diagnosed as permanent CH and on replacement therapy were recruited from paediatric endocrinology department of Dhaka Shishu (Children) Hospital between July 2014 and December 2018. All patients were underwent audiological evaluation by trained audiologist at specialized centre for hearing (SHAHIK, Dhaka, Bangladesh).

The diagnosis of hypothyroidism was based on low serum free T4 and elevated serum thyroid stimulating hormone (TSH) levels according to reference ranges.[18] Etiological diagnosis was based on the findings of technetium‑99m pertechnetate thyroid scintiscan and thyroid ultrasonography performed routinely at the time of initial evaluation of CH.[19] Perchlorate discharge test was done in selected cases. Those having subclinical hypothyroidism, transient hypothyroidism, history of familial hearing loss, dysmorphism, especially craniofacial anomalies, past history of significant neurological insult (bacterial meningitis, head trauma, mental retardation), otitis media or any other ear disease, significant neonatal problems such as very low birth weight, hyperbilirubinemia, mechanical ventilation, use of ototoxic medications were excluded. Autoimmune thyroid disease was excluded by routinely performing antithyroid peroxidase antibodies in all patients.[20] Children who fulfilled the criteria were enrolled into the study after obtaining written informed consent from the parents/caretakers.

The clinical and biochemical data were recorded into a prestructured proforma. A detailed otorhinolaryngological examination was done to exclude conditions listed in the exclusion criteria. The audiological investigations were done on all the patients by the same audiologist and on same instruments. The choice of hearing assessment tool was based on the patient's age and the ability to cooperate.

After an otoscopic examination to ensure that there was no wax or perforation, Middle ear analysis was performed by inserting the probe of Immittance Meter (MAICO MI 34, MAICO Diagnostics, Berlin, Germany) into the ear canal. A tympanogram was obtained based on the pressure variance at 226 Hz.

Puretone hearing thresholds were estimated in the frequency range of 250 Hz to 8 kHz using Madsen Orbiter 922 Clinical Audiometer Version II (GN Otometrics, Taastrup, Denmark) which was calibrated according to ANSI standards. Air conduction and bone conduction pure tone threshold curves were obtained for each ear separately. High frequency audiometry measuring thresholds at 10, 12, and 16 kHz was performed with the same audiometer. The pure tone average thresholds at 500, 1000, and 2000 Hz were also recorded for each ear. Speech recognition thresholds test was done to determine the faintest level at which a person could hear and repeat words presented at a comfortable intensity (e.g., 30-40 dB above the pure tone audiometry [PTA] of 500, 1000, and 2000 Hz). Speech discrimination score was calculated as the percentage of correctly repeated words after presenting 25 phonetically balanced monosyllables to the test ear at an intensity of 40-50 decibel above the average air conduction threshold for 500, 1000, and 2000 Hz, with the non-test ear masked adequately.

Behavioral responses were recorded to a variety of nonverbal stimuli for children aged <3 years and those not cooperative for PTA. The behavior was analyzed by observing consistent age†appropriate responses.

Transient evoked otoacoustic emissions (TrOAE) and distortion product OAE (DPOAE) were performed on SmartOAE and SmartTrOAE instruments (Intelligent Hearing Systems, Miami, USA), respectively. Individuals with abnormal results on behavioral observation audiometry (BOA) and OAE testing were further considered for brain stem evoked response audiometry.

All data were coded and entered in SPSS for Windows (Version 20.0; IBM Corp., Armonk, NY, USA) for analysis. Descriptive statistics was reported as mean and standard deviation while the qualitative variables were recorded in proportions. Associations were evaluated using Pearson correlation test, Chi square test, and Fisher's exact test. Multiple regression analysis was used to access the relationship of hearing loss to factors such as age at diagnosis and dose of T4. A $p<0.05$ was considered statistically significant.

Results

The study population consisted of 55 children. The mean age at diagnosis was 2.0±1.7 years and their mean age at inclusion into the study was 3.2 ±2.3 years. The interval between diagnosis of CH and the date of enrolment into the study was <1, 1-3 years and >3 years in 15 (27%), 18 (33%) and 22 (40%) patients, respectively (Table I).

Table I
Interval between age at diagnosis and age at inclusion

Age interval	Number of patients (%)
< 1 year	15 (27)
1-3 year	18 (33)
>3 year	22 (40)
Mean age at diagnosis - 2.0±1.7 years	
Mean age at inclusion into the study - 3.2 ±2.3 years	

The etiology of CH based on the results of combined scanning and PDT was thyroid agenesis in 40(72.7%), ectopia in 3(5.5%), DH in 7(12.7%), and hypothyroidism with eutopic gland in 5(9.1%) (Table II).

Table II
Etiological diagnosis of hypothyroidism

Etiology	Number of patients (%)
Thyroid agenesis	40 (72.7)
Ectopia	3 (5.5)
Dyshormonogenesis	7 (12.7)
Eutopic	5 (9.1)
Total	55 (100)

The presenting features included constipation in 22(40%), developmental delay in 11(20%), lethargy in 8(14.5%), prolonged neonatal jaundice in 8(14.5%), growth retardation in 5(9%), and attention deficit in 1(1.8%). Eleven (20%) had nonspecific symptoms. None of the patients complained of hearing loss (Table III).

Table III
Distribution of presenting feature at diagnosis

Presenting feature	Number of patients (%)
Constipation	22(40)
Developmental delay	11(20)
Lethargicness	8(14.5)
Prolonged neonatal jaundice	8(14.5)
Growth retardation	5(9.0)
Attention deficit	1(1.8)
Non-specific symptoms	11(20)
Hearing loss	0(0)

Impedance audiometry was performed in 35 patients. Thirty-two (91.4%) patients had normal type A tympanogram and 3(8.6%) had type B tympanogram suggestive of conductive pathology of the left ears. On the right side, 34(97.2%) patients showed type Atympanogram and 1(2.8%) had type B tympanogram. PTA was done in 28 patients in both the ears and showed normal results. There was no relation between age, age at diagnosis, and dose of T4 and frequencies in both the ears. All the 43 patients who underwent BOA showed normal response in the right ear. In the left ear, response was absent in 1 patient suggestive of mild SNHL. Thirty-seven patients who underwent TrOAE and DPOAE showed normal results (Table IV).

Table IV
Results of audiological investigations

Method	Number of patients performed	Result			
		Normal		Abnormal	
		Left	Right	Left	Right
Impedance audiometry	35	32	34	3	1
Pure tone audiometry	28	28	28	0	0
Behavioral observation audiometry	43	42	43	1	0
Otoacoustic emissions (TrOAE & DPOAE)	37	37	37	0	0

Based on the results of all the hearing assessment tests, SNHL was detected in 1 out of 55 (1.8%) patients while conductive hearing loss was found in 3 (5.4%) (unilateral in 2) patients.

Discussion

All but one of our patients showed normal hearing and the prevalence of hearing impairment was 1.8%, which is close to the lowest (1.2%) reported so far from India.[21] A previous study from Iran estimated a prevalence of 3.2% in CH patients diagnosed by newborn screening and initiated on early treatment.[22] In all other studies, the prevalence of hearing impairment ranged between 20% and 50%.[23-25] However, François et al[26] documented normal hearing in all the 42 children of a cohort of CH. The differences in results can partly be attributed to small sample sizes. The number of patients assessed for hearing impairment ranged between 32 and 75 in the previous studies.[23-26] Other factors that may contribute to differences in prevalence are the methods of hearing assessment, age of hearing examination, or differences in genetic factors in different patient populations.[22] Genetic component in CH is indicated by an increased occurrence in down syndrome,[27] advanced maternal age,[28] and increased occurrence in families.[29] The only patient who was detected to have hearing impairment in our study had DH similar to previous observations.[23] The higher risk of hearing impairment in DH is probably due to the underlying genetic factors.[30]

The effect of treatment or the dose of T4 did not seem to have any relationship with hearing impairment in our patients. Treatment with T4 was shown to improve the minor abnormalities of hearing in a previous study.[31] The improvement was attributed to a better recruitment of neuronal pool of the generators of the auditory brainstem response waves in the brainstem and thalamocortical projections of the auditory pathways which are adversely affected in the hypothyroid state.[31] However, even with early treatment, specific auditory brainstem evoked potential abnormalities were found in 25% of patients in another study.[24] The conductive hearing loss observed in some of our patients is probably because of common occurrence of otitis media in this age group in our set up.[32]

Conclusion

Although a very lower rate of hearing loss found among our studied CH patients, the importance of early treatment of hearing loss in order to prevent speech and language development problems, physicians should look for hearing loss in any patient with CH. Further studies with larger sample size are required to delineate the exact burden of hearing loss in our children with CH.

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