Original Research Article

Evaluation of Sensory Neural Hearing Loss in Hypothyroid Children At Tertiary Care Centre

Rakesh Maran[1], Ankush Jain[2], Garima Namdev[3],Mritunjay Shringirishi[4*]

[1]Associate Professor, Department of ENT, Chirayu Medical College and Hospital, Bhopal,India

[2]Assistant Professor, Department of Pediatrics, Mahaveer Institute of Medical Science and Research Centre, Bhopal,India

[3]Associate Professor, Department of Community Medicine, Mahaveer Institute of Medical Science and Research Centre, Bhopal,India

[4]Assistant Professor, Department of ENT, Mahaveer Institute of Medical Science and Research Centre, Bhopal,India

Received: 01-12-2021 / Revised: 12-12-2021 / Accepted: 26-12-2021

Abstract

Aim : To evaluate sensory neural hearing loss in hypothyroid children.**Material and methods**:We undertook this prospective observational study which includes patients presented with hypothyroidism to the department of ENT and Paediatrics in Mahaveer Institute of Medical Sciences and Research Centre. All children were planned for hearing evaluation during period of June 2020 to November 2021, total 32 patients of age group 1 to 18 years were taken for the study.**Results**: All subject showed type A graph in impedance audiometry and elevated acoustic reflex threshold in ipsilateral and contralateral ear as compared to control group. TEOAEs in otoacoustic emission showed decreased SNR as compared to control group. High significance difference was found for absolute latency of wave I and significant for wave III and V as compared to control group.**Conclusion:** The severity and prevalence of hearing loss is more if duration of hypothyroidism is more and if delay in starting treatment in hypothyroid child.SNHL is bilateral and mostly mild in early stage.

Keywords: Hypothyroidism; Pure Tone Audiometry; Sensory Neural Hearing Loss(SNHL), ABR(Auditory Brain Response), Distortion Product Otaacoustic Emission(DPOE), Transitory Evoked Hota Acoustic Emission (TEOAE), Signal to Noise Ratio(SNR)

Introduction

It has long been recognized relation between thyroid hormone and hearing sensitivity, it dates back to last century when hearing loss and deaf-mutism were reported in resident of endemic goiter areas which was confirmed by many recent studies by demonstrating a relationship between iodine intake and auditory functions in children who are living in iodine deficiency areas. Tetraiodothyronine, (T4) and triiodothyronine (T3) is synthesized and secreted by a butterfly-shaped thyroid gland located in front of the trachea. [1]

Hypothyroidism is one of most important dysfunction of thyroid gland, hypothyroidism may be congenital or acquired resulting in generalized decrease in metabolism of all systemic organs. Thyroid hormone is essential not only for regulating metabolism but also for coordinated development of nervous system. Hearing loss if not noticed if treated early.In late cases it may result in delayed language and difficulties in comprehension, auditory processing and reading. The pathophysiology of hearing loss in hypothyroidism may be due to decrease in cell energy production which leads to reduction in microcirculation resulting low oxygenation and metabolism of evolved organ. Neurological disturbances were reported in children with congenital hypothyroidism. [2,3]

Hypothyroidism occurs in about 1 in 4000 new born. Thyroid hormone involves in synthesis of protein, lipid, myelin and enzymes.

**Correspondence*

Dr. Mritunjay Shringirishi

Assistant Professor, Department of ENT, Mahaveer Institute of Medical Science and Research Centre, Bhopal, MP,India

E-mail: mritunjay90p@ymail.com

Moreover, T4 work as neurotransmitter so studies have proven the role of thyroid hormone receptor in development of cochlea and retro cochlear region and hearing function. It has long been recognized that hearing loss is associated with congenital hypothyroidism, endemic cretinism, thyroid hormone resistance and in Pendred's syndrome, autosomal recessive disorder present with sensory neural hearing loss and goiter. [4-8]Hearing loss remains a significant problem, particularly in patients with severe congenital hypothyroidism. Auditory symptoms may be single or associated with vertigo and tinnitus. Aim of our study was early diagnosis and intervention in form of thyroxin replacement therapy and hearing rehabilitation. Because early diagnosis and intervention could improve the long-term prognosis in these patients. [9]

Materials & Methods

Study design: prospective observational study

Study setting: children diagnosed as hypothyroidism in pediatric and ENT department of Mahaveer Institute of Medical Science and Research Centre, Bhopal.

Duration of study: June 2020 to November 2021

Inclusion criteria: Total 32 hypothyroid children (diagnosed by standard criteria) of age group 1 to 18 years were taken for the study and similar age control were taken.This study was conducted in patients, subjected to detailed history, ENT examination, and audiological evaluation.

Exclusion criteria: Those patients who showed hearing defects in the family, intrauterine infections, perinatal hypoxia, patient with external and middle ear pathology,long term therapy with amino glycosides, acoustic trauma in the past, previous ear surgery.

Methodology

Patients who were diagnosed with hypothyroidism underwent pure tone audiometry or free field audiometry and in selected cases ABR Study to assess the hearing status of patient. 21 patients above age group 10 years were screened with pure tone audiometry and rest 11 patients below 10 years were planned for ABR. All these investigations were routine and noninvasive and ethical approval has been taken from concerning institutional ethical committee. In our study detailed audiological assessment done in patients which were clinically proven hypothyroid to evaluate degree and nature of hearing loss.Prior selection for the study impedance audiometry done in all subject. All congenital hypothyroid patients were treated with thyroxin replacement therapy during and after study. Follow up audiometry is done in hearing impaired patients after 3 months and 6 month of attaining of euthyroid level. Hypothyroid patients who showed hearing impairment even after 6 month of attaining of euthyroid level was treated with hearing aids, audio-verbal and speech therapy.Pure tone audiometry done after obtaining normal values in 32 healthy children of age 10 to 18. Normal hearing was taken as threshold level of below 2 5 dBHL at all frequency from 500 to 8000Hz. ABRs recorded by using Intra Acoustic Sensor System with click stimuli of 90 dB hearing level presented at 20 click/s and alternating polarity through Standard TDH39 headphones. Average of 1024 sweeps was taken and latencies of wave one and five were analyzed.

Analysis and Statistical aspects: Statistical analysis done for two groups (control and hypothyroid group). In our study total 32 patient of age group 1 to 18 years were taken. The mean age of control and hypothyroid group was 10 years and 8.8 years. Out of 32 cases 16 were female and 16 males. On clinical assessment otoscopy was normal in all children. The mean value of freeT3, freeT4, TSH hormones in hypothyroid group were 2.72pg/ml, 1.61ng/dl and 31uIU/L respectively, and mean of control group was 2.51ng/ml, 1.29micrgram/dl, 3.63uIU/ml respectively.

Terms and Definitions

Impedance Audiometry The mean ear canal volume in control group was 1.18 ml in left ear and 1.15ml in right on other hand in hypothyroid children ear canal volume was 0.90 ml in left and 0.86 ml in right. The Mean static compliance was 0.49 ml and 0.50 ml in control and hypothyroid group it was 0.65 and 0.66 in left ear respectively. Mean middle ear pressure was 7.84 daPa and 1.53 daPa in control and hypothyroid group respectively

Ipsilateral Acoustic Reflex Acoustic reflex was present in 30 subject in control group and 3 subject in hypothyroid group in right ear and was elevated in 2 and 29 respectively in both groups whereas in left ear acoustic reflex was present in 29 subject and 3 in both groups respectively and was elevated in 3 and 29 subject.

Contralateral Acoustic reflex Acoustic reflex in right ear was present in 31 in control and 5 hypothyroid whereas elevated in 1 and 27 subject respectively.

In left ear acoustic reflex was present in 29 subject and 4 and elevated in 3 and 28 respectively.There was a significant difference.

Otoacoustic Emission In right ear TEOAEs were found to be present in 27 control group and 17 hypothyroid group subject and were absent in 5 and 15 subject respectively. In left ear TEOAEs were present in 30 control group subject in 14 subject in hypothyroid group and absent in 2 and 18 respectively. There was highly significance difference.In right ear DPAOEs were present in 28 subject in control group 22 in hypothyroid group and absent in 4 and 10 respectively. In left ear DPOAEs were present in 30 and 23 subject in hypothyroid group and absent in 2 and 9 respectively. No significant differences.

Pure Tone Audiometry Average Air conduction threshold at frequencies 500Hz, 1000Hz and 2000Hz was calculated. The mean air conduction threshold in right ear of control group was 11.14 dB and hypothyroid group was 17.49 dB in left ear it was 10.79 dB and 18.30 dB respectively Significance differences between two.

Bone conduction threshold: Mean bone conduction in right ear was 11.14 dB and 14.43 dB and left ear was 7.19 dB and 14.90 dB in control and hypothyroid group respectively.

Statistically highly significant difference between two.

Auditory Brainstem Evoked Responses. Three subjects showed mild sensorineural hearing loss in bilateral ear. Inter-peak latency and latencies for wave I, III, V were compared among two group. Result showed significant difference in latency for wave I, III for both ear and wave V for right ear. No significant differences seen in inter-peak latency.

Hearing loss In comparison group all subject had hearing within normal limit on the other hand in hypothyroidism group 5 subject had mild hearing loss in pure tone audiometry and 3 subject in BERA. 6 subject in hypothyroid group had bilateral hearing loss. Result shows high significant difference.

Observation Table:

Table 1: Comparison Of Pta (Air Conduction And Bone Conduction) Among Control Group And Hypothyroid Group

Test	Ear	Control Group (n=21)		Hypothyroid Group (n=21)		P value
		Mean	SD	Mean	SD	
PTA (Air conduction in dB)	Right	11.14	1.65	17.49	9.43	0.001
	Left	10.79	1.45	18.30	9.98	0.004
Bone Conduction (dB)	Right	11.14	1.19	14.43	7.59	<0.001
	Left	7.19	1.72	14.89	7.91	<0.001

p-value<0.05= significant; Not significant (p>0.05).

Table 2: Comparison Of Abr Among Control Group And Hypothyroid Group

Wave	Ear	Control Group(n=11)		Hypothyroid Group (n=11)		P value
		Mean	SD	Mean	SD	
I	Right	1.21	0.01	1.41	0.06	<0.01
	Left	1.32	0.01	1.44	0.01	<0.01
III	Right	3.36	0.01	3.49	0.04	<0.01
	Left	3.41	0.02	3.54	0.05	<0.01
V	Right	5.19	0.03	5.39	0.06	<0.01
	Left	5.16	0.03	5.32	0.02	<0.01
I-V	Right	3.97	0.04	3.98	0.08	0.228
	Left	3.68	0.53	3.87	0.01	0.629
I-III	Right	2.15	0.01	2.08	0.07	0.399
	Left	2.08	0.01	2.10	0.04	0.006
III-V	Right	1.83	0.03	1.90	0.09	0.148
	Left	1.75	0.03	1.78	0.04	0.016

Significant ($p<0.05$); Not significant ($p>0.05$).

Result

In our study total 32 patient of age group 1 to 18 years were taken. The mean age of control and hypothyroid group was 10 years and 8.8 years. Out of 32 cases 16 were female and 16 males. On clinical assessment otoscopy was normal in all children. The mean value of freeT3, freeT4, TSH hormones in hypothyroid group were 2.72pg / ml, 1.61ng/dl and 31uIU/L respectively, and mean of control group was 2.51ng/ml, 1.29micrgram/dl, 3.63uIU/ml respectively.

Statistical Analysis

Statistical analysis done for two groups (control and hypothyroid group). Data was compiled using MS excel 2007 and analysis was done with the help of Epi-Info 7 software. Frequency and percentage were calculated & statistical test (Chi Square) was applied wherever applicable; $p<0.05$ was taken as statistically significant.

Discussion

In this study detailed audiological assessment done in patient having hypothyroidism to find out degree and nature of hearing loss. Patient with normal serum level of free T4 and elevated level of serum TSH is consider hypothyroid. External ear and middle ear pathologies were ruled out before selecting subject for study, so middle ear pressure and compliance were in normal range in all subjects. However, in study of Dokianakis et al observed out of 23 hypothyroid patients 4 showed reduced middle ear pressure (less than- 100daPa) and compliance which improved on treatment [10].

A relationship between hypothyroidism and hearing has been mentioned in various literature. Thyroid hormone plays an important role in various physiological activity in our body, auditory system is one of these .Pure tone audiometry was normal in 77% patients whereas SNHL in both ears was recorded in 23% patients. In study of Nedunchezhian et al PTA shows SNHL in 38 percent cases of thyroid disorder. Anand et al found decreased in hearing thresholds and brainstem auditory evoked potential changes in 16 patients out of 20 having hypothyroidism without thyroid hormone treatment and hormone replacement therapy for period of 3.7 months they reported a improvements in auditory functions, there was also decrease in the absolute latency amplitude on wave I, III and V and increase in the absolute latency in wave V and inter peaks L I-III and L I-V. [11-13]

Acoustic reflex testing done in both hypothyroid and control groups and results showed highly significance difference ($p<0.01$) between two groups in both ears in ipsilateral and contralateral ears. The result showed that mean acoustic reflex test for ipsilateral and contralateral of hypothyroid group were elevated then control group in all frequencies tested. In our study TEOEs were present in 43.75% in left ear and 53.13% in right ear of all subjects in hypothyroid group however absent in 56.25% and 46.88% in respective ear in same group. Similar findings were found in study of Khechinschvili et al. due to decreased activity of cells in organ of corti. Findings showed 25% of subject had mild hearing loss in both ears whereas in study of Khechinschvili et al shows 74% of subject had hearing loss. [14].In the study of Thornton and Jarvis comparison done between hypothyroidism and hyperthyroidism and they found average threshold was more than 25dB in hypothyroidism and hypothesized that this may be because of change in metabolism and pathophysiological change of auditory system. They also assume that involvement of retrocochlear region in hypothyroidism may be associated with body temperature of patient which may affect absolute latency and inter peak latencies of ABR waves. [15]François M et al in their study on role of congenital hypothyroidism in hearing loss in children found out that there is no significant difference for the auditory thresholds at conversational and high frequencies between 42 children with congenital hypothyroidism treated with l-thyroxine and an age-matched control group, regardless of the cause of the thyroid failure or hormone level and the age at the start of treatment.[16]

The aim of study by Bruno R, Aversa T et al was to ascertain whether an early and adequate replacement treatment may be able to prevent sensorineural hearing loss in 32 screened children with CH and no associated risk factors for neuro-otologic alterations. These patients were recruited according to highly selective criteria aiming to preliminarily exclude the negative interference of both treatment variables and other underlying risk factors. Authors concluded that: a) 25% of CH patients detected by CH screening may show, at a median age of 15.4 years, a mild and subclinical hearing impairment, despite early and adequate replacement treatment; b) the risk of hearing loss is higher in CH young patients than in age-matched control subjects without CH; c) the risk of hearing loss is closely associated with the severity of CH; d) this risk is particularly relevant in the children with pre-natal onset of hypothyroidism.[17]A national population-based study was done by Lichtenberger-Geslin L et al showing factors associated with hearing impairment in patients with congenital hypothyroidism treated since the neonatal periodThe purpose of this study was to assess hearing and its determinants in a population-based registry of young adult patients with CH. Hearing loss was associated with the type of CH (patients with athyreosis and gland in situ were more frequently affected than those with an ectopic gland A trend for association with serum free T_4 concentration at diagnosis was also observed (RR = 1.47; 95% CI, 0.96–2.23). Hearing loss was mostly bilateral (90%), mild to moderate (96%), of the sensorineural type (76%), and concerned high or very high frequencies. Conclusion was that despite major improvements in prognosis, hearing loss remains a significant problem, particularly in patients with severe CH. Parents and primary care providers should be aware of this risk, because early diagnosis and intervention could improve the long-term prognosis in these patients.[18]Chari DA et al in their otorhinolaryngology reports on diagnosis and treatment of congenital sensorineural hearing loss reviewed current literature regarding the work-up and management of congenital sensorineural hearing loss and found that diagnostic evaluation of a newborn with sensorineural hearing loss begins with a complete audiologic evaluation and comprehensive history and physical exam. This review presents a diagnostic algorithm for the work-up of congenital hearing loss, focusing on the three following modalities: cytomegalovirus testing, genetic evaluation, and imaging.[19]Hashemipour M et al in a similar study like us on hearing impairment in congenitally hypothyroid patients found out that the rate of hearing loss was low among our studied CH patients. It may be due to proper management of CH patients. In view of the fact that all CH neonates were dyshormonogentic and considering the relation between certain gene mutations and hearing impairment in CH patients, further studies with larger sample size, with regard to different etiologies of CH should be investigated to indicate the possible gene mutations related to hearing loss in CH. [20]

Conclusion

The severity and prevalence of hearing loss is more if duration of hypothyroidism is more and if delay in starting treatment in hypothyroid child. SNHL is bilateral and mostly mild in early stage.

References

1. Stanfield C. Principles of Human physiology. Third ed. San Francisco, CA: Pearson Benjamin Cummings, 2008.
2. Mac Faul R, Dorners, Brett EM, Grant DB. Neurological abnormalities in patient treated for hypothyroidism form early life Arch Dis Child. 1978; 53:611-9
3. Wolter R, Noel P, De cock P et al. Neurophysiological study in treated thyroid dysgenesis. Acta Paedaltr Scand [Suppl]. 1979; 277:41-6.
4. Ng L, Goodyear RJ, Woods CA, Schneider MJ, Diamond E, Richardson GP, Kelly MW, Germain DL, Galton VA, Forrest D. Hearing loss and retarded cochlear development in mice lacking type 2 iodothyronine deiodinase. Proceedings of the National Academy of Sciences of the United States of America. 2004; 100(10):3474-3479.

5. Ng L, Hernandez A, He W, Ren T, Srinivas M, Ma M, Galton VA, St Germain DL, Forrest D. A protective role for type 3 deiodinase, a thyroid hormoneinactivating enzyme, in cochlear development and auditory function. Endocrinology. 2009; 150(4):1952-1960
6. Forrest D, Erway LC, Ng L, Altschuler R, Curran T. Thyroid hormone receptor beta is essential for development of auditory function. Nature genetics. 1996; 13(3):354-357.
7. Fraser GR. Association of congenital deafness with goiter (Pendred's syndrome) A study of 207 families. Ann Hum Genet. 1965; 28:201-49.
8. Meyer Holl WL. The thyroid and audition. Laryngoscope. 1975; 85:483-9
9. Lichtenberger-Geslin L, Dos Santos S, Hassani Y, Ecosse E, Van Den Abbeele T, Leger J. J Clin Endocrinol Metab. 2013; 98(9):3644-52
10. Dokianakis G, Ferekidis E, Pantazopoulos P. Hearing loss and hyperthyroidism, Arch Otorhinolaryngol. 219(2):351-353.
11. Savatore D, Davis TF, Schlumberger J, Hay ID, Larsen PR. Thyroid physiology and diagnostic evaluation of patient with thyroid disorders. In: Melmed S, Polonsky KS, Larsen PR, Kronenberg HN(eds) Williams Textbook of endocrinology, 12th edition. Elsevier Saundet, Philadelphia, pp327-361.
12. Ponrajkumar Nedunchezian, Gowri Shankar Murugesan, Sursh Vadivel, Vevek Mariappan. A Study on association between thyroid disorders and sensorineural hearing loss, Int J Otorhinolaryngol Head Neck Surg. 2019; 5(5):1315-1319.
13. Anand VT, Mann SBS, Dash RJ, Mehara YN. Auditory investigations in hypothyroidism. Acta Otolaryngol. 1989; 108:83-87
14. Khechinaschvili S, Metreveli D. The hearing system under thyroid hypofunction. Georgian Med News. 2007; 144:30-33.
15. Thornton AR, Jarvis SJ. Auditory brainstem response findings in hypothyroid and hyperthyroid disease. Clin Neurophysiol. 2008; 119(4):786-790.
16. François M, Bonfils P, Leger J, Czernichow P, Narcy P. Role of congenital hypothyroidism inhearing loss in children. The Journal of pediatrics. 1994; 124(3):444-6.
17. Bruno R, Aversa T, Catena M, Valenzise M, Lombardo F, De Luca F, Wasniewska M. Even in the era of congenital hypothyroidism screening mild and subclinical sensorineural hearing loss remains a relatively common complication of severe congenital hypothyroidism. Hearing research. 2015; 327:43-7.
18. Lichtenberger-Geslin L, Dos Santos S, Hassani Y, Ecosse E, Van Den Abbeele T, Léger J. Factors associated with hearing impairment in patients with congenital hypothyroidism treated since the neonatal period: a national population-based study. The Journal of Clinical Endocrinology & Metabolism. 2013; 98(9):3644-52.
19. Chari DA, Chan DK. Diagnosis and treatment of congenital sensorineural hearing loss. Current otorhinolaryngology reports. 2017; 5(4):251-8.
20. Hashemipour M, Hovsepian S, Hashemi M, Amini M, Kelishadi R, Sadeghi S. Hearing impairment in congenitally hypothyroid patients. Iranian journal of pediatrics. 2012; 22(1):92.

Conflict of Interest: Nil
Source of support:Nil