



(Original Research Article)

A Study on Hearing Profile in Hypothyroidism and Comparative Evaluation of Hearing in Hypothyroid Subjects before and After Treatment with Thyroxine – A Study of 100 Cases

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Abstract

Deafness is most common otolaryngological manifestation associated with thyroid dysfunction. So it was contemplated to study hearing profile in hypothyroid individuals and its response to thyroid hormone therapy.

Material Method- This original research study included 100 subjects divided into 2 groups. Case group included clinically and biochemically confirmed hypothyroid patients before treatment (n=50) Control group- included Euthyroid subjects (n=50)

Result: 41 out of 50 patients demonstrated hearing loss, 32 had Sensorineural hearing loss 9 had mixed hearing loss and 9 had normal hearing. Following treatment with levothyroxine hearing threshold improved by 5-10 db in 6 patients and more than 10 db in 33 patients while 2 patients had no improvement. BERA revealed reduced amplitude of wave I, II, III & V. After 6 months of treatment with levothyroxine wave V absolute amplitude improved significantly.

Conclusion: Hypothyroid patient had significant degree of hearing impairment. An improvement in hearing parameters occurred following levothyroxine replacement therapy over a period of 6 months.

Keywords – Hypothyroidism, BERA, thyroxine, Hearing loss, Audiometry.

Introduction

The thyroid hormones (T₃ and T₄) influence various metabolic activities in the body. It can be said that no tissue or organ system escapes the adverse effects of thyroid hormone insufficiency and the ear being no exception. Infact hearing loss may be the most common ENT manifestation of hypothyroidism.

Hypothyroidism both congenital and acquired has been associated with impaired hearing. It has been estimated that a significant hearing loss is found in 25% of patients with acquired hypothyroidism.¹ Hypothyroidism effect 2% of adult women and only 0.2% of men.²⁻³ The pathophysiological mechanisms of hearing loss in hypothyroidism is not clear but it is known that in this hormonal

disorder there is a reduction in cell energy production, compromising the microcirculation, oxygenation and metabolism of the involved organs including. Inner ear structures such as the stria vascularis and organ of Corti.⁴ Although literature does not yield many studies on hearing changes in hyperthyroid patients.¹²

The Objective of this study is to evaluate the prevalence of hearing impairment in hypothyroidism, correlation between severity of hearing impairment with serum TSH, T4 and T3 levels and to compare hearing thresholds before and after treatment with thyroxine.

Material and Methods

A prospective case control analytical type of study was conducted to evaluate hearing thresholds in hypothyroid patients and to compare these, before and after treatment with thyroxine hormone. The study was conducted in the Department of Otorhinolaryngology & Head and Neck Surgery and ENT Surgery Government Medical College, Rajindra Hospital, Patiala from 2012-2015 The study included 100 subjects, divided into two groups.

1. Case Group- Clinically and biochemically confirmed hypothyroid patients pre-treatment (n=50).
2. Control Group-Euthyroid subjects (n=50).

The Inclusion Criteria included age between 18 and 60 years and Proven cases of clinical hypothyroidism by history, clinical examination and hormone assays.

Exclusion Criteria included Age more than 60 years, patients with history of ear disease, Exposure to prolonged loud noise, family history of hearing impairment, history of intake of ototoxic drugs, history of head trauma and stroke and patients with diabetes mellitus. All the subjects on first reporting were tested for hearing impairment with puretone audiometry, impedance audiometry and BERA.

A comparison was performed between the hearing thresholds and brainstem evoked response audiometry parameters obtained from hypothyroid patients (Group-1) and normal subjects i.e. controls

(Group 2), randomly selected and matching in age and sex with hypothyroid patients. The average of right and left ear was taken and analyzed.

Furthermore within Group I (hypothyroid patients), a comparison was performed between the hearing thresholds and brainstem evoked response audiometry parameters in the hypothyroid state and in the euthyroid state and after 6 months of treatment with thyroxine (Group 1)

Evaluation of the data was carried out statistically by applying 'V test for comparisons. 'p' value was calculated. 'p' value less than 0.05 and 0.005 were considered significant and highly significant respectively. A written and informed consent of the subjects were taken for the study.

Results

Of the 50 patients with hypothyroidism, 44 were females and 6 were males. Their age ranged from 18-60 years (mean 42.2 ± 12.814). (Table 1)

82% of the patients i.e. 41 out of 50 patients demonstrated hearing loss: 32 had sensorineural hearing loss, 9 had mixed hearing loss and 9 had essentially normal hearing. (Table 2)

The relationship between severity of hearing impairment and thyroid profile was found to be statistically insignificant. ($p > 0.05$) (Table 3)

Following treatment with thyroxine, hearing thresholds improved by 5-10 dB in 6 patients and more than 10 dB in 33 patients at one or more of frequencies between 250-4000 Hz one or both of the ears while 2 patients had no improvement. A statistically significant improvement in hearing thresholds was observed by pure tone audiometry. (Table. 4)

Acoustic reflex tested at 1000 Hz at 105dB speech frequency was elicited in one or both ears in 21 hypothyroid patients only and no significant correlation could be made with post treatment results.

The Tympanogram was abnormal i.e. type B in 9 patients. Following treatment with thyroxine, Impedance audiometry curve i.e. tympanogram returned to type A in 7 out of 9 patients.

Brainstem electric response audiometry revealed delayed conduction along the brainstem indicated by prolonged absolute latency of wave V and interpeak latency IN and reduced amplitudes of waves I, II, III and V. (Table 5,6) Following treatment with thyroxine, brainstem auditory evoked response parameters did not show significant change towards normalcy following treatment except wave V absolute amplitude which improved significantly following 6 months of treatment with thyroxine.(Table 7,8)

Table 1 Age & Sex Distribution of Patients & Controls

Age groups in years	Study Group I		Control Group 2	
	Males	Females	Males	Females
18-29	1	8	1	8
30-39	1	9	1	9
40-49	1	11	1	11
50-60	3	16	3	16

Table 2 Pure Tone Audiometry

Frequency (Hz)	Hearing thresholds in dB		
	Controls	Pre – T/t hypothyroid	'p' value
	Mean ± S.D.	Mean ± S.D.	
250	17.3 ± 6.79	23.2 ± 8.91	0.000
500	17.3 ± 5.07	22.8 ± 10.16	0.001
1000	17.6 ± 5.34	23.5 ± 11.83	0.002
2000	17.6 ± 6.87	29.4 ± 12.37	0.000
4000	19.5 ± 6.81	32.0 ± 13.823	0.000

Table 3 Pure Tone Audiometry (Severity of hearing impairment)

	Severity of hearing impairment				'p' value
	Mild		Moderate		
	Mean (Median)	IQR	Mean (Median)	IQR	
S.T ₃	0.70 (0.79)	0.59-0.88	0.607 (0.70)	0.36-0.78	0.084
S.T ₃	5.07 (5.3)	4.8-5.7	4.49 (5.15)	2.99-5.73	0.554
S. TSH	19.77 (14.6)	9.8-27.08	27.18 (16.48)	10.6-27.8	0.645

Table 4 Pure Tone Audiometry

Frequency (Hz)	Hearing thresholds in dB		'p' value
	Pre-T/t Hypothyroid	Post – T/t Eu-thyroid	
	Mean ± S.D.	Mean ± S.D.	
250	23.2 ± 8.91	17.00 ± 8.049	0.000
500	22.8 ± 10.16	16.35 ± 8.83	0.000
1000	23.5 ± 11.83	14.81 ± 9.05	0.000
2000	29.4 ± 12.37	19.50 ± 11.03	0.000
4000	32.0 ± 13.82	23.05 ± 13.73	0.000

Table 5 –Absolute latencies

Waves	Absolute latencies in msec		'p' value
	Pre-T/t Hypothyroid	Post – T/t euthyroid	
	Mean ± S.D.	Mean ± S.D.	
I	1.6277 ± 0.17673	1.6600 ± 0.11416	0.216
II	2.7722±0.14341	2.7159±0.12006	0.60
III	3.6908±0.24796	3.7421±0.17732	0.118
IV	5.6846±0.30323	5.6626±0.23368	0.604

Table 6 – Inter – Peak latencies

Inter-peak latencies	Controls	Post – T/t hypothyroid	'p' value
	Mean ± S.D.	Mean ± S.D.	
I-II	1.9513±0.25928	2.0161±0.27229	0.216
III-IV	1.8505±0.27620	1.8935±0.18900	0.404
I-V	3.8030±0.30470	3.9619±0.23224	0.005

Table 7 Absolute wave amplitudes

Waves	Absolute wave amplitudes (µV)		'p' value
	Controls	Post – T/t hypothyroid	
	Mean ± S.D.	Mean ± S.D.	
I	0.3769 ± 0.13882	0.2675 ± 0.08994	0.000
II	0.3471 ± 0.20775	0.1875±0.11891	0.000
III	0.4419±0.19657	0.2803±0.13309	0.000
IV	0.5792±0.15492	0.3406±0.14061	0.000

Table 8 Absolute wave amplitudes

Waves	Absolute wave amplitudes (µV)		'p' value
	Pre=T/t hypothyroids	Post – T/t euthyroids	
	Mean ± S.D.	Mean ± S.D.	
I	0.2675±0.08994	0.2279±0.10046	0.042
II	0.1875±0.11891	0.2177±0.14736	0.180
III	0.2803±0.13309	0.3040±0.17972	0.339
IV	0.3406±0.14061	0.3912±0.15043	0.044

Discussion

IN the present studies hearing impairment in the hypothyroid patients was observed in 41 out of 50 patients (82 %). The nature of hearing loss was predominantly sensorineural (32 out of 41 patients). The remaining 9 patients exhibited mixed loss. The hearing loss was mild to moderate, with none of the patient exhibiting severe loss. Improvement in hearing thresholds following 6 months of replacement therapy was observed in 39 out of 41 patients.

The presence of a significant difference in the hearing thresholds of hypothyroid patients when compared to an age and sex matched control group was taken as reasonable evidence of a causal relationship between hypothyroidism and hearing loss. In addition, a significant difference in the hearing thresholds was found following replacement therapy with thyroxine, indicating an improvement in the hearing sensitivity with levothyroxine.

Our findings are thus in total agreement with those of Vant Hoff⁵ who had reported an incidence of 85 % hearing impairment in 48 myxoedematous patients and improvement in 73 % after treatment with levothyroxine. The results of our study also support previous studies by Howarth & Lyold⁶, Hilger⁷ with very limited number of patients. Our results are also in agreement with that of Anand et al⁸ who reported incidence of 80 % hearing impairment in 18 out of 20 hypothyroid patients and also reported an improvement in hearing sensitivity with levothyroxine. These findings are also in partial agreement with those of De Vos⁹ who reported 53% hearing loss by pure tone audiometry. However, no improvement was seen when retesting was done after treatment with thyroxine. Our results are also in agreement with that of Malik et al¹⁰ who conducted study on 45 patients of confirmed hypothyroidism, which revealed hearing impairment in 32 (71.11%) patients and improvement in hearing, after replacement therapy with thyroxine, in 20.28% of patients. Aggarwal et al¹¹ observed 39% hearing loss in a

study conducted on 100 patients with goitrous hypothyroidism. 15% cases had sensorineural hearing loss, 13% had mixed hearing loss and 8% had a conductive hearing loss and also reported a statistically significant hearing improvement by L-thyroxine treatment. This is consistent with our study.

Although the dominant lesion is sensorineural, a small additional mixed hearing loss was noted in 9 patients that normalized after treatment in 7 out of the 9 patients with narrowing of air-bone gap and return of the tympanogram to type A, while it remained unchanged in 2 patients. The acoustic reflex was elicited in one or both ears in 21 hypothyroid patients only and no significant correlation could be made with the post-treatment results.

Identical findings were reported by Howarth and Lloyd⁶, Hilger⁷, Anand et al⁸, Brucker- Davis F et al²² and Orhan et al²¹

No relationship was found between severity of hearing impairment and thyroid profile. This is in contrast to Malik et al¹⁰ who observed hearing impairment to increase with increasing serum TSH levels and decreasing T3 and T4 levels ($p > 0.05$).

The functional integrity of the auditory pathway depends on the intact anatomical pathway, functional relay stations, myelination and thickness of the tract and absence of any compression or pressure from outside. BAEP (Brainstem Auditory Evoked Potentials) have come into widespread use for the assessment of the clinical state of the middle portion of the brainstem. It allows evaluation of functional integrity of auditory pathway from hair cells to thalamic nuclei. Values of BAEP (particularly the absolute and interpeak latencies) represents the peripheral (from acoustic nerve and ponto-medullary portion) and central (ponto-mesencephalic) conduction time.

In our study, Brainstem electric response audiometry revealed delayed conduction along the brainstem indicated by prolonged absolute latency of wave V and interpeak latency I-V and reduced

amplitudes of waves I,II,III and V. Thus the brainstem electric response parameters in hypothyroidism were 'slow and low' as compared to those obtained from controls. Similar to this, Abbott et al.,¹³ reasoned that diminished myelin production and alteration in cerebral metabolism during acute hypothyroidism may be the possible explanations for the reduction of wave I, V Amplitudes. Huang et al¹⁴ reported increased absolute latency and interpeak latencies in a study conducted on 16 hypothyroid patients. Anand et al⁸, in a study on 20 hypothyroid subjects, observed prolonged absolute latency of wave V and prolonged interpeak latencies I-III and IN and reduced absolute amplitudes of waves I,II and V. Lorenzo et al¹⁵ reported in 25% of the hypothyroid patients, increase in wave V absolute latencies and that of inter-peak latencies III-IV and IN. Khedr et al¹⁶ in a study on 23 hypothyroid patients, reported prolongation of all wave latencies and interpeak latencies in some of the patients. Yunnan Anjana et al¹⁷, in a study on 30 patients, observed reduced amplitude of wave V which supports our result but reported prolongation of absolute latency of wave III and interpeak latencies I-III, which is in contrast to our study. Our results are also in partial agreement with that of Thornton and Jarvis¹⁸ who reported reduced absolute amplitudes of waves III and V and prolongation of interpeak latency I-V, suggesting retrocochlear defect. Chandrashekhar et al¹⁹ also observed prolonged absolute latencies in waves III and V and interpeak latency I-V and reduced absolute amplitude I and V.

The above observations probably indicate that the site of lesion in, hypothyroid hearing loss is at multiple levels in the auditory system; in the middle ear, cochlea and retrocochlear sites.

Although a definitive subjective improvement in hearing was documented in post-treatment audiograms but brainstem evoked response parameters did not show significant reversibility to normalcy except in wave V absolute amplitude which showed statistically significant improvement with 6 months of thyroxine therapy

.Similar to these, Anand et al⁸ and Di Lorenzo et al¹⁵ also reported no statistically significant improvement in these parameters after 6-12 months of treatment with thyroxine. Our result is in partial agreement with Abbott et al¹³, who reported decreased amplitudes of waves I and V and reasoned that diminished myelin production and alteration in cerebral metabolism during acute hypothyroidism may be the possible explanations for the reduction of wave I, V amplitudes, which can be reversed after treatment.

In contrast to our results, Chandrasekhar et al¹⁹ observed that there was a significant prolongation of wave III and V latency in hypothyroid patients without treatment and significant increase in wave III and V latency in hypothyroid patients with TH treatment. In the IPL of BAEP, there was a significant prolongation of IPL I-V in hypothyroid patients without treatment and significant increase in hypothyroid patients with TH treatment. Also, there was significant reduction in amplitudes I-Ia and V-Va in hypothyroid patients without treatment and significant increase in amplitudes I-Ia and V-Va in hypothyroid patients with treatment.

Neurotransmitter system and axonal transportation. Knipper et al²⁰ in his study discussed that the TH can accelerate gene expression not only in oligodendrocytes but also in schwann cells of the auditory tract, leading to an improved understanding of the role of TH in the process of myelin genesis. He also explained that the auditory system nerve conduction and impulse transmission from the cochlea to the brainstem can occur coincidentally with initial transduction of sound signals only in the presence of TH.

Normal levels of thyroid hormones are required for proper excitability of the peripheral auditory pathway, thalamo-cortical projections and auditory processing at the cortical level. So, the changes in BAEP could be multi etiological factors such as low body temperature, alteration in cerebral metabolism, myxoedematous infiltration, defective myelination and regulator proteins like

"otoferlin" and "prestin" which is entirely depend upon the metabolic action of thyroxine hormone. However, significant improvement in absolute amplitude of wave V may indicate that there is a better recruitment of neuronal pool of the generators of these waves of BERA in the brainstem which may further go in favour of hearing improvement.

Conclusions

The hypothyroid patients demonstrate a significant degree of hearing impairment when compared to age and sex matched normal subjects. The site of lesion in auditory system is probably at multiple levels; in the middle ear, cochlea and retrocochlear sites. As a significant improvement in hearing parameters occurred following levothyroxine replacement therapy, so conclude a relationship between hearing loss and hypothyroidism. As changes were noted in BERA parameters and significant improvement seen in absolute amplitude parameter of wave V. so there might be a slow conduction at the periphery and with treatment, there is a better recruitment of neuronal pool of the generators of the waves of BERA in brainstem. In conclusion, hypothyroidism may lead to alteration in auditory pathway in central nervous system as determined by BERA recordings. So brainstem auditory evoked potential could be useful to evaluate the effect of hypothyroidism on auditory pathway and central nervous system. The Tympanogram was abnormal i.e. type B in 9 patients. Following treatment with thyroxine, Impedance audiometry curve i.e. tympanogram returned to type A in 7 out of 9 patients.

Conflict of interest- None

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