

Hypothyroidism and Deafness/ Outcome of L-thyroxine Therapy on Hearing loss in Hypothyroidism Patients

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Abstract

Background: Hearing loss is one of the most neglected otolaryngological manifestations associated with thyroid dysfunction. Studies have reported that hypothyroidism is one of the risk factors. Hence, the study is taken up. The objective is to determine the effect of L-thyroxine treatment on patients with hypothyroidism and hearing loss. **Material and Methods:** It is a prospective cohort study, after obtaining ethical clearance and informed consent, based on TSH values and audiogram reports. We recruited 70 hypothyroid cases. After clinical Examination, L-thyroxine was administered to the recruited individuals, and they were called for follow-up at the 2nd, 4th, and 6th months, respectively. During follow-up visits, cases were assessed based on their audiograms and thyroid profiles. All data were noted and analyzed using the Statistical Package for the Social Sciences software. **Results:** The mean age of the study population was 38±14 years. All patients had bilateral hearing impairment. The percentage of conductive hearing loss was higher than that of sensorineural and mixed hearing loss. Statistically significant (at $p < 0.05$) results were obtained in the case of TSH, T3, T4 levels, PTA, and percentage of hearing loss based on repeated measures, analysis of variance, and post hoc test. **Conclusion:** Our study results indicate that after 4 months of levothyroxine therapy, hearing parameters improved, suggesting that early clinical diagnosis and adequate treatment may reverse hearing loss in hypothyroid patients.

Keywords: T3, T4, TSH, PTA, hearing loss.

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INTRODUCTION

Hypothyroidism is a metabolic disorder known since 1500 BC, characterized by absent or reduced function of the thyroid gland. Clinically, it manifests as bradycardia, weight gain, fatigue, constipation, and cold intolerance. People from high altitudes suffer more from this hormonal imbalance, resulting in hypothyroidism and subclinical hypothyroidism. It can cause hearing loss. The types and degrees of hearing disturbances, the pathophysiology, and the progression of the disease process still require a better understanding. The effects of thyroid hormone have been correlated with human auditory function. Dynamic changes in hearing have been recorded during the development of hypo- and hyperfunctioning thyroid disorders.

Experimental studies reveal that the ear disease in thyroid disorders shows normal perilymph sodium and potassium levels. But increased auditory thresholds on BERA.

Thyroid hormone is essential for the physiological development of the cochlear nerve, and reduced thyroid hormone levels in the mother adversely affect the newborn with clinical conditions like Endemic Cretinism, congenital hypothyroidism, and thyroid hormone resistance. About 35% of deafness is reported in cretins¹, but the association with adults is unclear.

All the cells of the body are critically dependent on thyroid hormones, which act like a catalyst for Homeostasis. Reduced thyroid hormone levels in the mother of the newborn with clinical conditions like Endemic cretinism,

congenital hypothyroidism, and Thyroid Hormone resistance are all well-known; however, the adult association is not clear.

Histopathological findings of the cochlea show crystallized consistency, large dark stains of lipid accumulations in Hensen's cells, large vacuole spaces in stria vascularis, debris in the cochlear duct and tectorial membrane, ossicles, oval window, and round window abnormalities.

Even though India is improving its health indices, hearing disability remains high. According to Verma et.al, the prevalence of hearing loss is 6-26.9 % in the Indian population. The main risk factors were aging, intrauterine infections, loud and occupational noise, ototoxic drugs, and genetic disorders. However, the exact frequencies of hearing in patients with hypothyroidism are still unclear. In 1907, hearing loss in acquired hypothyroidism was reported for the first time, after many studies were conducted.

Some studies failed to elucidate the association between hypothyroidism and deafness. The hearing loss can be reversed

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in patients with hypothyroidism, and a few showed no improvement even after adequate thyroid management; therefore, the results are disputed.

Therefore, in this study, we shall determine the efficacy and association of L-thyroxine hormone therapy in hypothyroid patients with hearing loss.

Hypothyroidism with middle ear changes: Edema and Hypertrophy of the mucosa of the middle ear cleft due to chronic catarrh and retracted tympanic membrane with variations in middle ear pressures resulting in negative pressure and reduced compliance.^[11,12]

Mc. Mohan (1956) reported increased hearing thresholds and absent acoustic reflexes in 33.33% of cases due to accumulation of Myxedematous middle ear mucosa and the eustachian tube.

Schatzak & Haubrich (1967) demonstrated mucopolysaccharides in the scala of the cochlear nerve from Hypothyroid guinea pigs.

Hypothyroidism with inner Ear changes: Tectorial membrane is involved first in these cases. Thickening of the basilar membrane, Enlargement of intracellular space in stria vascularis, degeneration of marginal & intermediate cells, inner and outer air cell degeneration, tectorial membrane irregularity & accumulation of debris in the cochlear duct.

Hypothyroidism with Biochemical Changes: Thyroid hormone Beta receptors by myelinogenesis of the eighth cranial nerve “Prestin”, a cochlear protein, acts on outer air cells, regulates functions, and is reduced in conditions of hypothyroidism. Lower temperature, reduced cerebral metabolism, faulty myelin development, and nervous tissue dysfunction are associated with prolonged nerve conduction time. Calcium absorption is reduced in individuals with hypothyroidism. These ions are involved in synaptic transmission. Hypertension, Hyperlipidemia, Electrolyte imbalance & autoimmunity of the thyroid may contribute to the problem.

Table 1: Clinical symptoms

1	Thyroid Swelling
2	Pitting edema
3	Obesity
4	Menstrual irregularities
5	Hair fall
6	Skin changes & cold tolerance
7	Excess sleepiness and lethargy
8	Tinnitus
9	Menier’s syndrome like symptoms
10	constipation
11	Voice change
12	Weight gain
13	Hearing loss

confirmed by blood T3, T4, and TSH values. Among the three, TSH is the most stable parameter. Normal values are shown in [Table 1]. The prevalence of hypothyroidism varies

from one geographical area to another, and it is associated with conductive, sensorineural, and mixed types of deafness. Therefore, thyroid gland dysfunction affects cochlear integrity in the auditory system. However, the exact frequencies of hearing loss in patients with hypothyroidism are still unclear.

Thyroid hormones are essential for the physiological development of the cochlea,^[9] therefore, thyroid gland dysfunction affects cochlear integrity of the auditory system. However, the exact frequencies of hearing loss in patients with hypothyroidism are still unclear. In 1907, acquired hearing loss in hypothyroidism was reported for the first time, and subsequent studies found that some failed to elucidate the association between hypothyroidism and deafness,^[10-14] while others reported an association.^[15-24] Therefore, in this study, we determined the efficiency and association of L-thyroxine hormone therapy in hypothyroid patients with hearing loss.

MATERIALS AND METHODS

Based on Thyroid profile and pure-tone audiometry reports, 70 confirmed hypothyroidism cases with hearing impairment who visited our ENT department at McGann teaching District Hospital from June 2020 to October 2021 were included after obtaining institutional ethical committee clearance. Patient demographic data, history noted in a proforma. Each individual clinically examined was to rule out other pathologies. Hearing threshold level for each patient was plotted on a graph as 500, 1K, 2K, 4K, 6K, 8K Hz frequencies respectively.

The standard air-conduction and bone-conduction curves are obtained using a standard audiometer in a soundproof chamber. Air-bone gap (ABG) was assessed.

We follow the standard classification of hearing loss, such as A. sensorineural deafness (SNHL), B. mixed, and C. conductive deafness. The degree of hearing loss is 1. minimal (15–25 dB), 2. mild (26–40 dB), 3. moderate (41–55 dB), 4. moderately severe (56–70 dB), 5. severe (71–90 dB), and 6. profound (>90 dB).

Thyroxine was administered to selected cases based on TSH values, and each case was followed up at 2 and 4 months. During follow-up visits, each case was assessed audiologically with PTA reassessment, and thyroid profiles were obtained. All data were recorded and analyzed using SPSS (Statistical Package for the Social Sciences).

RESULTS

Of the 70 patients in our study, 68 (97.1%) were female, and 2 (2.9%) were male. The patient age ranged from 13 to 84 years, with a mean of 38±14 years. In our study, the majority of patients were in the 21–40 age group, followed by 41–60, <20, and ≥60 years, respectively. All patients had bilateral hearing impairment. The percentage of conducting hearing loss was higher in our study population, followed by sensorineural and mixed types of hearing loss [Table 2]

Table 2: Basic characteristics of cases

	N	%
Gender		
Female	68	97.1
Male	2	2.9

Age		
Less than 20 years	7	10
21-40	36	51.4
41-60	23	32.9
More than 60 years	4	5.7
Type of hearing loss		
Right Ear		
Conducting	30	42.9
Sensorineural	20	28.6
Mixed	20	28.6
Left Ear		
Conducting	36	51.4
Sensorineural	19	27.1
Mixed	15	21.4

We recruited the cases based on TSH and audiogram report for the study. After 4 months of treatment with levothyroxine the levels of T3 and T4 attained normal and the levels of TSH gradually reduced to normal limits. The percentage of hypothyroidism cases according to the levels of T3, T4 and

TSH before treatment was found to be 55.7%, 64.3% and 100%. After treatment with L-thyroxin the percentage of hypothyroidism reduced and the percentage of euthyroid state was attained in our study population [Table 3]

Table 3: Thyroid and audiogram profile

	1 st visit (N,%)	2 nd visit (N,%)	3 rd visit (N,%)
Thyroid Profile			
T3			
Hypothyroidism	39(55.7)	1(1.4)	0
Euthyroid	31(44.3)	67(95.7)	68(97.1)
Hyperthyroidism	0	2(2.9)	2(2.9)
T4			
Hypothyroidism	45(64.3)	2(2.9)	1(1.4)
Euthyroid	25(35.7)	68(97.1)	69(98.6)
TSH			
Hypothyroidism	70(100)	46(65.7)	24(34.3)
Euthyroid	0	24(34.3)	46(65.7)
PTA of Right Ear			
Normal	0	2(2.9)	6(8.6)
Minimal	5(7.1)	50(71.4)	51(72.9)
Mild	55(78.6)	15(21.4)	10(14.3)
Moderate	7(10)	3(4.3)	3(4.3)
Moderately Severe	3(4.3)	0	0
Severe	0	0	0
Profound	0	0	0
PTA of Left Ear			
Normal	0	3(4.3)	7(10)
Minimal	2(2.9)	48(68.6)	53(75.7)
Mild	55(78.6)	11(15.7)	4(5.7)
Moderate	7(10)	3(4.3)	4(5.7)
Moderately Severe	2(2.9)	4(5.7)	2(2.9)
Severe	3(4.3)	1(1.4)	0
Profound	1(1.4)	0	0

Before treatment, according to the audiogram (PTA) reports of the right ear, it was found that 78.6% had a mild type of hearing loss, followed by moderate (10%), minimal (7.1%), and moderately severe (4.3%) types of hearing loss. After treatment, 8.6 % of cases were completely cured from hearing loss, and 72.9% of cases had minimal hearing loss, followed by mild (14.3%) and moderate (4.3%) types of hearing loss [Table 2].

Similarly, for the left ear, before treatment, it was found that 78.6% had a mild type of hearing loss, followed by moderate

(10%), severe (4.3%), minimal (2.9%), moderately severe(2.9%), and profound (1.4%) type of hearing loss. After treatment, 10% of cases were completely cured of hearing loss, and 75.7% had minimal hearing loss, followed by mild (5.7%), moderate (5.7%), and moderately severe (2.9%) types of hearing loss [Table 2].

However, based on the percentage of hearing loss calculation after 4 months of treatment, only 13 (right ear) and 10 (left ear) cases had hearing loss [Table 2].

Table 4: Thyroid and hearing loss profile on repeated measurement at different visits

Variables	I		II		III		Greenhouse-Geisser Analysis		
	Mean	SD	Mean	SD	Mean	SD	F(df)	n2(Partial eta squared)	
Thyroid profile									
T3	0.8703	0.25	2.27	9.01	1.4	0.24	1.287 (1.002,69.141)	0.018	0.261NS
T4	4.66	2.1	8.15	1.8	9.81	2.11	165.5 (1.7, 73.7)	0.706	0.0001*

TSH	31.96	28.6	9.98	7.1	4.85	2.5	57.34 (1.1, 73.7)	0.454	0.0001*
PTA									
Right Ear	32.2	9.6	25.4	7.1	22.15	6.8	181.33 (1.25,86.01)	0.724	0.0001*
Left Ear	35.1	14.3	27.14	12.14	22.7	10.14	103.63 (1.4, 95.1)	0.6	0.0001*

According to the repeated measure analysis of variance with a Greenhouse–Geisser correction, the mean T4 and TSH levels differed statistically significantly between different visits [F(1.7, 120) = 165.5, p < 0.001 and F(1.1, 73.7) = 57.34, p < 0.001]. However, there was no statistically significant difference between different visits for T3 levels

(Table 3). Similarly, the mean of PTA and percentage of hearing loss for right and left ear levels differed statistically significantly between different visits during treatment [F(1.25,86.01) = 181.33, p < 0.001, F(1.4, 95.1) = 103.63, p < 0.001, F(1.24, 85.5) = 207.2, p < 0.001 and F(1.41, 97.21) = 126.4, p < 0.001 respectively [Table 5].

Table 5: Least significant difference (LSD) POST HOC TEST

Difference between visit	Mean difference	St. Error	Sig b	95% confidence interval for difference	
				Lower bound	Upper bound
T3					
1-2	-1.399	1.079	0.199NS	-3.551	0.754
2-3	0.863	1.075	0.425NS	-1.281	3.008
1-3	-.535*	0.04	0*	-0.615	-0.455
T4: 3(4.3)					
1-2	-3.492*	0.275	0*	-4.039	-2.994
2-3	-1.658*	0.246	0*	-2.148	-1.167
1-3	-5.150*	0.339	0*	-5.825	-4.474
TSH					
1-2	21.975*	3.067	0*	15.857	28.093
2-3	5.125*	0.774	0*	3.58	6.669
1-3	27.100*	3.416	0*	20.285	33.915
Right Ear PTA					
1-2	6.844*	0.602	0*	5.643	8.044
2-3	3.199*	0.263	0*	2.675	3.724
1-3	10.043*	0.663	0*	8.72	11.366
Left Ear PTA					
1-2	7.936*	0.814	0*	6.312	9.559
2-3	4.480*	0.615	0*	3.253	5.707
1-3	12.416*	1.117	0*	10.187	14.645

Post hoc test using the least significant difference (LSD) revealed that the initial rise of T3 from 1 visit to 2nd visit and two visits to 3rd visit was not statistically significant; however, a statistically significant difference when compared to T3 level between 1st visit to 3rd visit. The levels of T4 and TSH levels were compared between visits and found to be statistically significant [Table 4].

Similarly, PTA and the percentage of hearing loss in the right and left ears between visits were compared, and these differences were found to be statistically significant [Table 5].

DISCUSSION

Thyroid hormones are essential for the proper development and function of the auditory system, and thyroid gland dysfunction can significantly impact auditory health. It is important to maintain healthy thyroid hormone levels through appropriate medical management to ensure the integrity of the auditory system. Based on the studies, pure tone audiometry has revealed that between 11.5 and 95% of the subjects examined had hearing loss 26-29. There are conflicting accounts of the link between hypothyroidism and hearing loss. According to a study by Means et al.,^[30] it occurs in 66.7% of cases. Contrarily, according to Post et al.'s study 26, there were no complaints of hearing impairment in any of the cases. Similarly, some studies reported that thyroid hormone improved hearing impairment, while others found

no improvement in hearing loss despite thyroid hormone treatment.^[26-29,31] In the present study, we have attempted to evaluate the association between hypothyroidism and hearing loss.

In our study, out of 70 patients, females were more common than males, and the majority of the people came under the age group 21–40 years, which was similar to the studies of Singh R et al. and Hussein et al.^[32,33]

In the present study, the assigned patients should adhere to a period of at least 4 months of continuous replacement therapy to achieve a euthyroid state. The proportion of hypothyroidism was reduced, and the percentage of euthyroidism increased in our study population after 4 months of L-thyroxin administration. This was comparable to research by Hussein et al. and Singh et al.^[32,33]

According to the repeated-measures analysis of variance, the mean T3, T4, and TSH levels, and PTA differed significantly across visits during treatment. Before treatment, the mean audiometric threshold was found to be higher; however, after treatment, the mean audiometric threshold was significantly reduced in our study population, as in Singh et al.'s study.^[32]

Thyroid hormone insufficiency reduces cellular energy output. This reduces microcirculation and, as a result, metabolism and oxygenation in the implicated organ. It also affects the structures of the ear.^[34,35] Hypothyroidism has been linked to problems in the neurological and morphological development of the organ of Corti,^[36] suggesting that thyroid hormones have a direct

influence on the cochlea. These findings point to several areas of involvement in the ear in hypothyroid individuals with conductive, sensorineural, or mixed hearing loss.

According to Vinita et al. (2020) and Anil et al. (2017, the percentage of SNHL is higher than that of conducting and mixed types of hearing loss. However, in our study, the rate of conductive hearing loss was higher, followed by sensorineural and mixed types of hearing loss.^[37,38]

According to Singh et al. (2019, thyroxine substitute PTA noted a statistically significant improvement (46.42% of the ear) in hearing threshold. Only the amplitude of wave Va in the BERA showed a substantial improvement after thyroxine replacement.^[32] Our study also confirms and supports the notion that hypothyroidism-related hearing loss can be treated and reversed with L-thyroxine medication, as shown in studies by Harpuneet et al. (2016), Hussein et al. (2017), and Bhat et al. (2022).^[33,39,40]

Limitation:

1. The sample size is small, and further follow-up (after 4 months) was not done.
2. Multiple parameters, such as OAE, ABR, Impedance audiometry, and high frequency audiometry, would have given still better results and outcome.
3. Blood parameters preferably obtained from a standard laboratory with periodic calibrations.
4. Subject bias and instrument bias during PYA assessment.

CONCLUSION

Hearing loss in hypothyroidism is often overlooked and unreported due to its high frequency. The current study was conducted to investigate the effect of hypothyroidism on hearing acuity. As a result, a clinical approach to monitoring hearing in hypothyroid individuals is critical. Early detection and action to avoid worsening hypothyroidism will slow the progression of hearing loss.

Recommendations:

1. Periodic evaluation of hearing by an ENT surgeon and an audiologist is recommended.
2. Hearing loss was mostly bilateral (90%), mild to moderate (96%), SNHL (70%), and compromised in higher frequencies.
3. Declare 3 times more hearing loss. 17% patients require hearing support in adulthood.

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Conflicts of interest

There are no conflicts of interest.

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