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A study on association between thyroid disorders and sensorineural hearing loss

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ABSTRACT

Background: Thyroid hormones are important for overall growth and maturation. They play a significant role in the development of cochlea. Hearing loss is commonly seen in thyroid disorders. This study attempts at understanding the association between thyroid disorders and sensorineural hearing loss.
Methods: 106 subjects with thyroid disorders were evaluated for hearing loss. They were classified according to their thyroid status and pure tone audiometry was done. The cases were compared with age and sex matched controls.
Results: SNHL was the common type of hearing loss seen. The prevalence of SNHL found to be 32.1% in cases. SNHL is bilateral and commonly high frequency type in the early stage of the disease. The severity and prevalence of hearing loss is more with longer duration of the disease state. 29.4% of the cases showed improvement in hearing with therapy for three months.
Conclusions: In patients with thyroid disorders, hearing evaluation helps in the detection of hearing loss earlier and thus treatment could be started.

Keywords: Pure tone audiometry, Sensorineural hearing loss, Conductive hearing loss, Hypothyroidism, Hyperthyroidism, Thyroid receptors

INTRODUCTION

Thyroid disorders are a common clinical problem in the general population. They can be hyperthyroid or hypothyroid with clinical manifestations involving all systems. It can affect the middle ear and cochlea. The audiological manifestations are hearing loss and tinnitus. Hearing loss is the principal symptom and it can be sensorineural, conductive or mixed hearing loss.[1,2] The importance of screening for hearing loss in patients with thyroid disorders can be understood if the prevalence of hearing loss in patients with thyroid disorders are well established. This leads to increased quality of life in patients with thyroid disorders.

The objective of the present study is to determine the prevalence of sensorineural hearing loss in patients with thyroid disorders and to evaluate the hearing loss and the effect of treatment of thyroid disorders on hearing loss.

METHODS

This study was a case control study and was conducted in Upgraded Institute of Otorhinolaryngology, Madras Medical College, Chennai during the period between June 2015 and November 2016. Patients attending endocrinology OPD in Madras Medical College formed the sample of this study. Institutional ethical clearance was obtained. Study was explained in detail to the prospective subjects. A detailed questionnaire was prepared. After obtaining their informed consent

subjects were included in the study. The subjects were male and female patients of all ages, patients with either hypothyroidism or hyperthyroidism or euthyroid patients with thyroid swelling on treatment. The exclusion criteria for this study were patients with other otological conditions, patients with family history of deafness, patients with other medical ailments contributing to hearing loss, patients with history of noise exposure, patients on ototoxic drugs and patients with other congenital ear anomalies.

Thyroid profile of the patients was evaluated clinically, biochemically, radiologically by ultrasound and by FNAC. Their diagnosis established and grouped into hypothyroid, hyperthyroid and euthyroid with swelling. About 106 of those patients selected randomly satisfying the above criteria were allotted into the case group. The criteria for the duration of the disease taken in this study were the date of first visit of the patients to the Endocrinology Clinic. Most of the patients in this study were from the lower socioeconomic group. The duration of the disease of the patients ranges from 4 months to 15 years.

Then the patients were brought to Neurotology Department. These patients are evaluated otologically and by pure tone audiogram. Pure tone audiogram is again repeated after 3 months of medical management and assessed for improvement. None of them were surgically intervened.

Equal number of controls was selected with normal thyroid status and without any history of ear disorders. They were age and sex matched. Pure tone audiogram was done for them. The results were analyzed statistically using the software-IBM SPSS version 22 and Chi-square test. The p values less than 0.05 were considered as significant.

RESULTS

Age distribution

Age of the patients in case group ranged from 15 to 70 years; mean age being 33.73 years. Age of the patients in control group ranged from 13 to 63 yrs; mean age being 32.92 years.

Cases were divided into 3 groups: hypothyroid, hyperthyroid, euthyroid with goitre. Hypothyroid patients constituted bulk of the cases with 87.7% of the cases. Hyperthyroid patients constituted about 7.5% and euthyroid with goitre group 4.7% of the cases. Hypothyroid disorders seemed to be the most common thyroid disorder (Table 1).

Distribution of hearing loss

In the case group, pure tone audiometry (PTA) showed hearing loss in 41 patients i.e., 38.7% of the cases. Of these SNHL is seen in 34 patients, CHL in 4 patients, MHL in 3 patients. In control group, PTA showed hearing loss in 18 patients i.e, 16.4% of the cases. 13 patients had SNHL and 5 patients had CHL; remaining was normal.

Table 1: Division of cases into hypothyroid, hyperthyroid, euthyroid with goitre.

Status	Control		Case		Total
	Count	%	Count	%	
Euthyroid	0	0	5	4.7	5
Hyper-thyroid	0	0	8	7.5	8
Hypo-thyroid	0	0	93	87.7	93
Normal	110	100	0	0	110
Total	110	100	106	100	216

So the prevalence of SNHL is 32.1% in case group compared to the 11.8% prevalence of SNHL in the control group. This difference is statistically significant and it showed that SNHL is more prevalent in patients with thyroid disorders than the normal population. SNHL is also the most common type of hearing loss in thyroid patients (Table 2 and Figure 1).

Table 2: Distribution of hearing loss in cases and controls.

Pure tone audiogram	Control		Case		Total
	Count	%	Count	%	
Normal	92	83.6	65	61.3	157
SNHL	13	11.8	34	32.1	47
CHL	5	4.5	4	3.8	9
MHL	0	0.0	3	2.8	3
Total	110	100	106	100	216

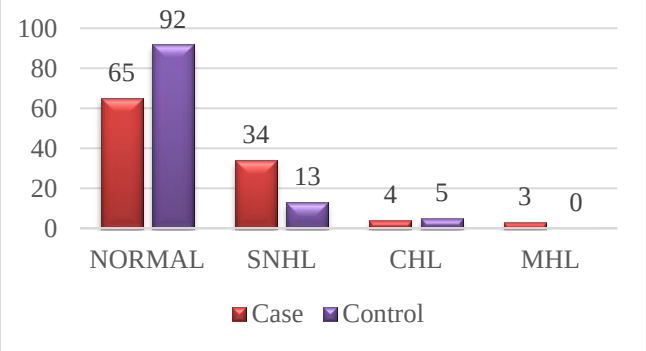

Figure 1: Types of hearing loss.

Hearing loss severity distribution

Of the patients who had SNHL in the case group, mild loss is seen in 14 patients, moderate loss seen in 5, severe loss seen in 2 patients. High frequency hearing loss (HFSNHL) is seen in 14 patients. The prevalence of HFSNHL is greater in the control group (61.5%)

compared to the case group (41.2%). The degree of severity in SNHL is same in both the groups and it is not statistically significant (Table 3).

Hearing loss in thyroid patients

In hypothyroidism the prevalence of SNHL is 30.1%, CHL 4.3%, MHL 3.2%. Three of eight hyperthyroid and three of five euthyroid patients with thyroid swelling in the study showed SNHL. So SNHL is the most common hearing loss in all the three thyroid disorders. SNHL is bilateral and commonly mild and high frequency type in the early stage of the disease. The severity and prevalence of hearing loss is more with longer duration of the disease state (Table 4 and 5), (Figure 2).

Repeat PTA after 3 months

The 34 SNHL patients were assessed for their hearing again by pure tone audiometry after 3 months of therapy. 10 patients showed improvement in their hearing level. All the 10 patients were hypothyroid. Again 6 were having mild SNHL and 4 were having HFSNHL previously. All the 10 patients were in early stage of the disease i.e. about 4-12 months of history of thyroid symptoms.

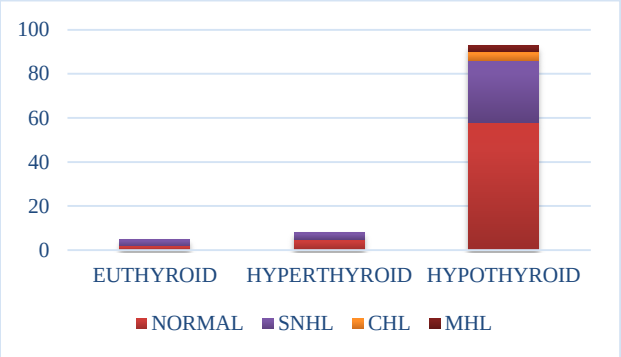

Figure 2: Distribution of hearing loss in thyroid disorders.

Table 3: Distribution of hearing loss severity in cases and controls.

SNHL severity	Control		Case		Total
	Count	%	Count	%	
HFSNHL	8	61.5	14	41.2	22
Mild	4	30.8	13	38.2	17
Moderate	1	7.7	5	14.7	6
Severe	0	0.0	2	5.9	2
Total	13	100	34	100	47

Table 4: Distribution of hearing loss in thyroid disorders.

PTA	Euthyroid		Hyperthyroid		Hypothyroid		Total
	Count	%	Count	%	Count	%	
CHL	0	0	0	0	4	4.3	4
MHL	0	0	0	0	3	3.2	3
Normal	2	40	5	62.5	58	62.4	65
SNHL	3	60	3	37.5	28	30.1	34
Total	5	100	8	100	93	100.0	106

Table 5: Distribution of severity of SNHL in thyroid disorders.

PTA	Euthyroid		Hyperthyroid		Hypothyroid		Total
	Count	%	Count	%	Count	%	
CHL	0	0	0	0	7	7.5	7
HFSNHL	2	40	1	12.5	11	11.8	14
Mild SNHL	1	20	1	12.5	11	11.8	13
Moderate SNHL	0	0	1	12.5	4	4.3	5
Normal	2	40	5	62.5	58	62.4	65
Severe SNHL	0	0	0	0	2	2.2	2
Total	5	100	8	100	93	100.0	106

DISCUSSION

Mechanism underlying sensorineural hearing loss in thyroid disorders is poorly understood.

Thyroid receptors

In humans there are two TR genes α and β located on chromosomes 17 and 3 respectively.[3,4] The active proteins

are TRα and TR β1, β2, β3. There are tissue specific preferences in expression of various TRs suggesting that they sub serve different functions in different tissues. In cochlea TRβ2 is expressed.

Experimental models

Many mouse models have been used in an effort to identify the underlying molecular mechanism. The absence of thyroid hormones during late gestation and early infancy can cause irreparable deafness in both humans and rodents.[5] Maturation of the organ of corti in late prenatal period in humans is highly sensitive to thyroid hormone.

Auditory system physiology, histology and anatomy studies reveal novel defects of hormone deficiency related to deafness.[3,5]

1. Defects in expression of potasssium channel genes.[3,6,7]
    a. KCNQ4 gene, a potassium channel gene in OHC, when abnormally expressed lead to chronic depolarization of OHCs and ultimately OHC loss.
    b. KCNJ10 gene in strial membrane, when abnormally expressed results in ionic balance defects that likely contribute to the reduced endocochlear potential, OHC dysfunction and sporadic OHC death.[7]
2. Tectorial membrane abnormalities- a prominent Hensen's stripe, elevated beta tectorin composition and disrupted striated sheet matrix.
3. Strial membrane abnormalities- deterioration of intermediate cells.[8]

Pendred syndrome

It is a genetic disorder leading to congenital bilateral sensorineural hearing loss and goitre with occasional hypothyroidism.[9] There is no specific treatment, other than supportive measures for the hearing loss and thyroid hormone supplementation in case of hypothyroidism. It accounts for 7.5% of all cases of congenital deafness.

Role of SLC26A4/pendrin gene

SLC26A4 encodes pendrin, an anion exchanger located in the cochlea, thyroid, and kidney.[10] Wangemann et al study showed cochlear hypothyroidism contribute to failure to develop hearing in mice lacking SLC26A4/ pendrin expression.[11]

Mutations of SLC26A4 cause an enlarged vestibular aqueduct, non-syndromic deafness and deafness as part of Pendred syndrome. Cochlear development, including tunnel opening, arrival of efferent innervation at outer hair cells, endochondral and intramembranous ossification were affected.

Resistance to thyroid hormone

This is an autosomal dominant syndrome in which patients have elevated thyroid hormone (TH) levels and decreased sensitivity to its action.[4,12,13] Features include attention deficit hyperactivity disorder, growth delay, tachycardia, goiter, frequent ear nose and throat infections, hearing deficit, and decreased bone mass.[9] Most patients with resistance to thyroid hormone (RTH) have mutations in the TRß gene.

Anand et al in 1989 reported an incidence of 80% hearing loss in 20 patients with hypothyroidism when compared with randomly selected age and sex matched controls. Out of 16 hearing loss patients 12 showed SNHL and 4 showed mixed hearing loss.[14] In the present study, prevalence of deafness is 38.7%, SNHL is 32.1%.

Van't Hoff reported an incidence of 85% deafness in a consecutive series of 48 patients with myxedema. The more severe the disease, the higher was the incidence of deafness; there was no difference between the effect on the high or low frequencies and in some cases the loss was unilateral. Severity of myxedema was associated with a higher incidence of deafness. The deafness was sensorineural.[15] In the present study, prevalence of deafness is 38.7%, SNHL is 32.1%. SNHL is bilateral. Here also severity of the disease is associated with a higher incidence of hearing loss.

Hall et al reported a prospective study undertaken to compare the auditory acuity in hypothyroid patients and to assess the effect of thyroxine on these thresholds, for the mean period of 5.7months (range 2-24 months). Auditory thresholds were reduced over all frequencies but the difference being significant only at 2000 and 4000 Hz.[16] In the present study**,** sensorineural hearing loss was the commoner hearing loss. High frequency hearing loss is seen in 41.2% of the affected SNHL patients.

Dokianakis et al did a study on 23 patients with hypothyroidism for a minimum of 4 months to a maximum of 20 years. Audiometric tests, including acoustic impedance measurements (tympanometry, stapedius reflex) were performed on all patients before and after an adequate substitution therapy. In 12 patients there was a definite impairment of hearing before the substitution therapy. Eight of them have shown a mild to moderate sensory-neural deafness. Four subjects showed mixed deafness. The audiometric measurements after an adequate substitution therapy of minimum 4 months has shown a definite improvement of hearing loss.[17] In the present study also similar observations were obtained. SNHL is seen in 30.1% of the hypothyroid patients- more common type of hearing loss. In the early stage of the disease, milder forms are commoner. PTA repeated after 3 months of treatment showed improvement in hearing in 10 of the 34 SNHL patients.

Karakus et al did a study on 62 patients (31 patients are hyperthyroid and other 31 patients are hypothyroid). Hearing thresholds were measured before therapy and after therapy. Sensorineural hearing loss was seen in patients with hypothyroidism. Low frequencies are affected most. After medical therapy hearing loss was improved. In hyperthyroid group the prevalence of sensorineural hearing loss is less.[18] In the present study also SNHL was seen in hypothyroid patients, but higher frequencies are affected more. After treatment hearing loss improvement was seen in this study also.

CONCLUSION

This study is presented to highlight the prevalence of hearing loss in patients with thyroid disorders. SNHL seems to be the more common hearing loss in thyroid patients. The severity and prevalence of hearing loss is more with longer duration of the disease state. SNHL is bilateral and mostly mild and high frequency type in the early stage of the disease. Pure tone audiogram as an investigation if included in the evaluation of thyroid patient any subtle hearing loss can be detected early. Early therapy may reverse the progression of hearing loss. This study is aimed at creating awareness among the public and physician community about the prevalence, early diagnosis and prevention of hearing loss in patients with thyroid disorders.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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