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RESEARCH ARTICLE

Audiological assessment in adults with hypothyroidism

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ABSTRACT

Background: Hypothyroidism, deficiency of thyroid hormone, is associated with many symptom complexes, one of them being hearing loss. Hearing loss in hypothyroidism may be the result of decreased cellular energy production, which compromises the microcirculation and thereby the metabolism and oxygenation of the middle ear and inner ear structures. **Aims and Objectives:** In this study, we evaluated the hearing loss in hypothyroid patients of age group of 18–45 years and compared them with that in healthy people. Furthermore, we compared the severity of hearing loss with the extent of thyroid hormone deficiency in the hypothyroid group. **Materials and Methods:** A case–control study was conducted in subjects aged between 18 and 45 years, in which 80 hypothyroid cases were selected after proper exclusion and informed consent and 80 age- and sex-matched healthy controls were studied. Hearing loss was assessed by pure tone audiometry, impedance audiometry, and distortion product otoacoustic emission tests. Statistical Package for the Social Sciences version 18 was used for statistical analysis. **Results:** About 66.3% of hypothyroid adults had mild hearing loss affecting the higher frequencies which were characteristically bilateral and mostly sensorineural. A decrease in thyroid hormones was closely related to the severity of hearing loss. **Conclusion:** Hypothyroid patients were more prone to sensorineural hearing loss. In patients with thyroid disorders, hearing evaluation helps in the detection of hearing loss earlier, and thus, treatment could be started.

KEY WORDS: Adult Hypothyroidism; Hearing; Audiometry; Tympanometry; Otoacoustic Emission; Tympanic Reflex

INTRODUCTION

Hypothyroidism is defined as a deficiency of thyroid activity. It has a broad clinical spectrum ranging from an asymptomatic or sub-clinical condition to an overt state of myxedema with end-organ effects and multisystem failure. The clinical manifestations of hypothyroidism have been greatly studied ever for 15th century BC. There are many symptom complexes associated with hypothyroidism, and one such area is the influence of the thyroid gland on hearing.

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Hearing loss was first reported in acquired hypothyroidism, in 1907.[1] Hearing loss can be defined as the pure tone average of air conduction hearing thresholds >25 decibels hearing level (dB) for the four frequencies (0.5, 1.0, 2.0, and 4.0 kHz) in the better ear. The real incidence of hearing loss in patients with hypothyroidism is still not clear, and it may affect nearly 25% of the patients with acquired hypothyroidism and 35–50% of the patients with congenital hypothyroidism.[2,3]

Thyroid hormones are essential for the physiological development of the cochlea;[4] therefore, thyroid gland dysfunction affects the integrity of the auditory system. Based on pure tone audiometry, hearing loss has been reported to

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vary from 11.5 to 95% of the investigated cases.[5-8] There are contradictory reports on the association of hypothyroidism and deafness. A study done by Means *et al*.[9] found its occurrence in 66.7% of cases. On the contrary, none of the cases complained of hearing impairment, as studied by Post.[5] Hearing impairment improved with thyroid hormones in some studies,[6,8,10] while no improvement was observed in others.[5,7] Hence, the relationship between hypothyroidism and hearing impairment has been controversial.

In the present study, an attempt was made to determine the association between hypothyroidism and hearing impairment.

MATERIALS AND METHODS

Eighty patients suffering from hypothyroidism and 80 age- and sex-matched normal subjects taken from the Medicine Outpatient Department, hospital staff, and the patient bystanders were studied at Government Medical College, Kozhikode. The age of patients varied from 18 to 45 years (mean age–33.86), with females outnumbering the males. Hypothyroidism was confirmed by estimating serum thyroid-stimulating hormone (TSH) (above 4.5 μU/ml) and free T_4 (below 0.8 ng/dl).

These patients were worked on in the audiology laboratory in the Department of Otorhinolaryngology, Government Medical College, Kozhikode. A thorough clinical assessment (detailed history, systemic, and audiological examination) followed by audiological investigations (pure tone audiometry, impedance audiometry, and distortion product otoacoustic emission [OAE] test) was done to determine the effect of hypothyroidism on hearing.

Audiological data in the hypothyroid state were compared with those of the euthyroid state.

Statistical Analysis

The present study is a case–control study. The data were analyzed using Statistical Package for the Social Sciences version 18 software of Windows. For all statistical tests, $P \leq 0.05$ was taken as the level of significance.

RESULTS

Hearing loss with tinnitus and dizziness was the most common cochleovestibular symptom among the hypothyroid group [Figure 1]. Pure tone audiometry was done, which revealed a mild hearing loss in 53 cases (66.3%), moderate hearing loss in cases (20%), and moderately severe hearing loss in two cases (2.5%) [Figure 2]. Fifty-three cases (66.3%) hypothyroid adults had sensorineural deafness, four cases (5%) had conductive hearing loss, and five cases (6.3%) had mixed hearing loss [Figure 3]. Hearing loss was characteristically bilateral, mild, and predominantly sensorineural, more so affecting the higher frequencies. There was a significant relationship between the severity of audiological impairment and the elevation of TSH and/or reduction in free T_4 [Figures 4 and 5].

There were 53 (66.3%) hypothyroid adults with Type A tympanogram, 14 (17.5%) with Type AD tympanogram, 12 (15%) with Type B tympanogram, and 1 (1.3%) with Type C tympanogram [Figure 6]. Acoustic reflex was present in 52 (65%) hypothyroid adults and absent in 28 (35%) [Figure 7].

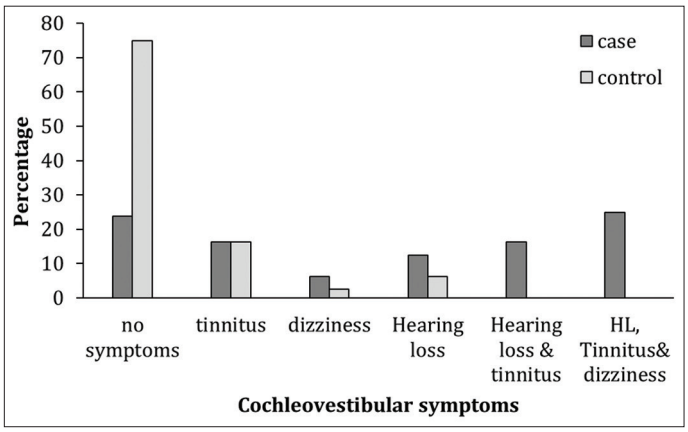

Figure 1: Otoneurological symptoms in hypothyroid cases and healthy controls

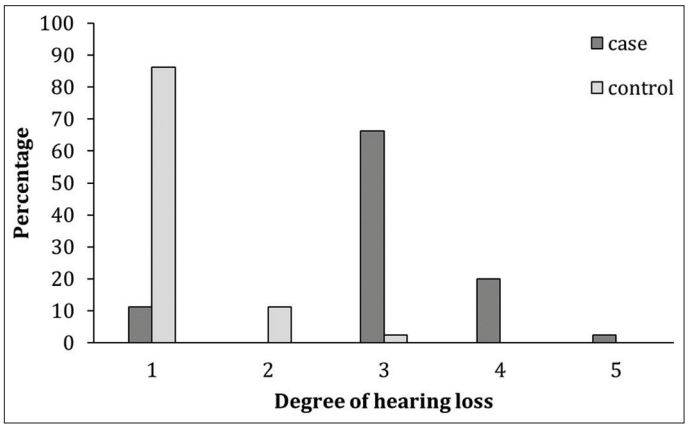

Figure 2: Hearing impairment in hypothyroid cases and healthy controls through pure tone audiometry

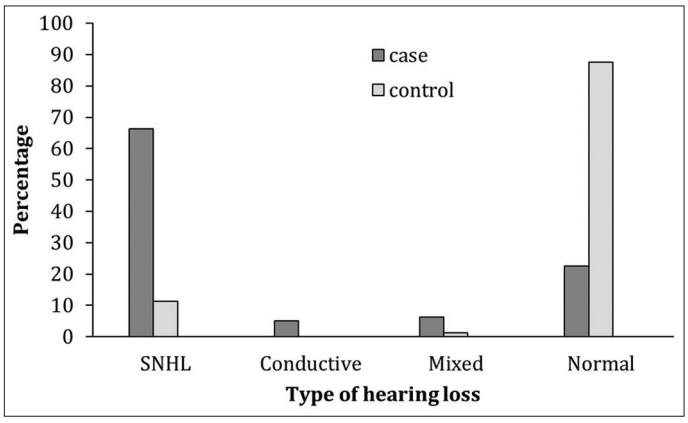

Figure 3: Type of hearing loss in hypothyroid and control groups

The OAE was a pass (present) in 48 (60%) hypothyroid adults when compared to 69 (86.3%) adults in the control [Figure 8]. It was a referral (absent) in 32 (40%) hypothyroid adults compared to 11 (13.8%) adults in the control group.

DISCUSSION

In our study, on compiling the audiological investigations, it is observed that hypothyroid adults have a higher proportion of bilateral mild sensorineural hearing loss affecting the higher frequencies associated with cochlear or retrocochlear pathology when compared to the healthy subjects.

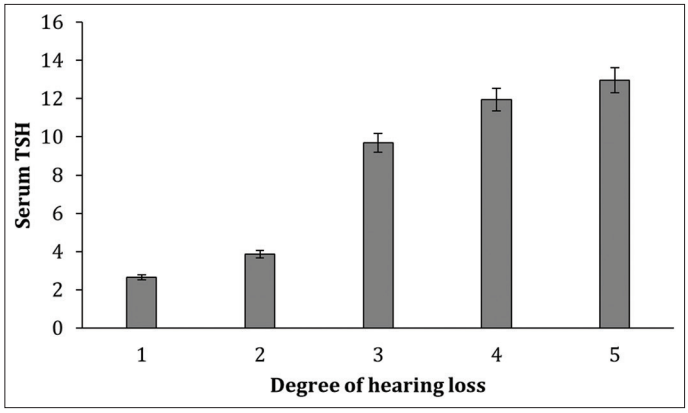

Figure 4: Serum thyroid-stimulating hormone with the degree of hearing loss in the study groups

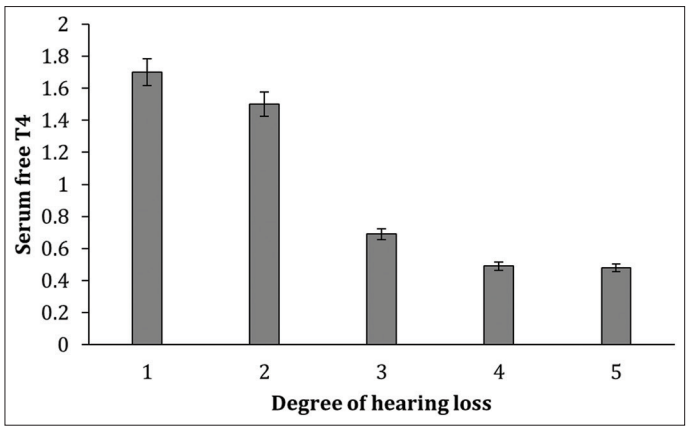

Figure 5: Serum free T_4 and degree of hearing loss in both the groups

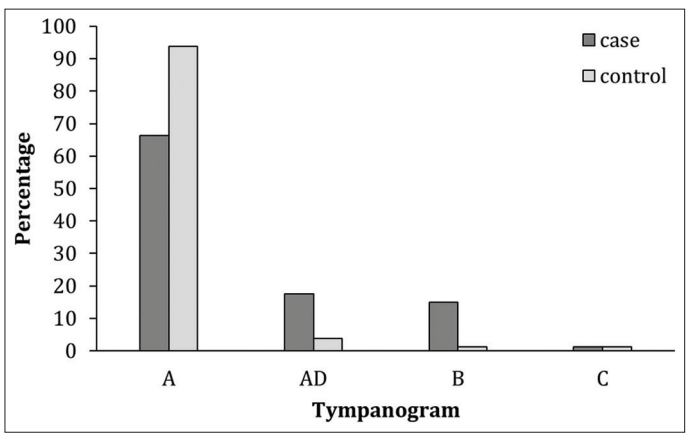

Figure 6: Tympanograms in both the study groups

Most of the patients (68.8%) in the present study were in the age group of 21–40 years. About 97.5% of hypothyroid patients were female. This was in accordance with the report by myxedema Committee of the Clinical Society of London (1888) that hypothyroidism affects women more than men and most of the middle age. It agrees with the findings of Wayne ET (1960) who found that 825 of the hypothyroid patients were female.

About 53.8% of patients had subjective hearing loss that was bilateral. This corresponds with the findings of Anand *et al.* (1989)[11] who found subjective hearing loss in 45% of hypothyroid patients. McMahon (1947)[12] suggested that the subjective hearing loss could have been due to actual conductive or sensorineural hearing loss or slowed mentation during the hypothyroid state that could have been interpreted by the patients as subjective hearing loss.

Tinnitus was present in around 20% of patients. This could be attributed to eustachian tube edema as most of them had retracted tympanic membranes, and a few had revealed

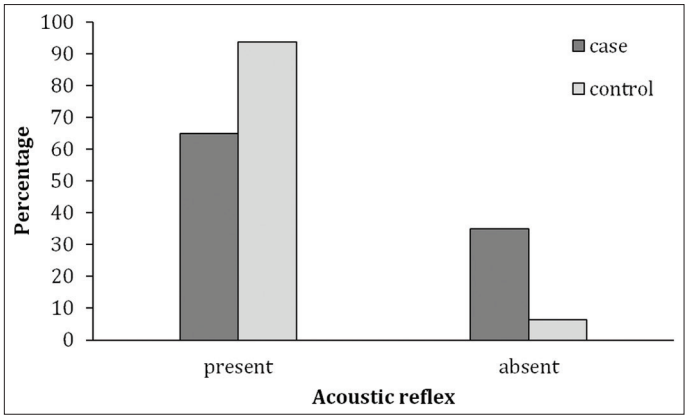

Figure 7: Acoustic reflex in both the study groups

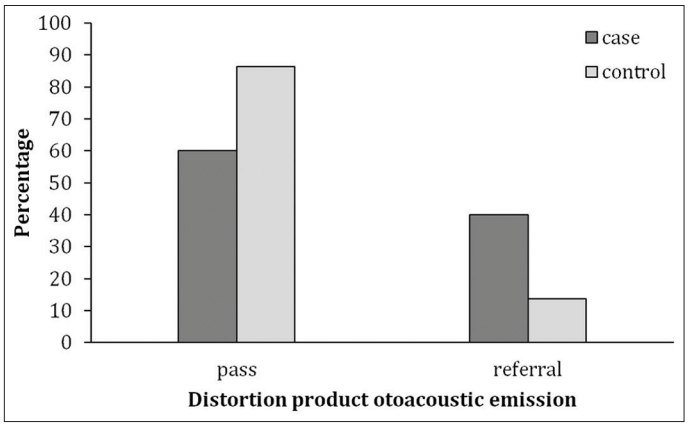

Figure 8: Distortion product otoacoustic emission test in both the study groups

abnormally reduced compliance. This finding is similar to that found by Anand *et al*.[11] who reported tinnitus in 15% of hypothyroid patients.

On pure tone audiometry, 66.3% had mild hearing loss and were bilaterally symmetrical. This is similar to the findings in studies done by Anand *et al*. (1989),[11] where he found 75% incidence of symmetrical or near symmetrical hearing impairment. Moderate hearing loss was found in 20%, whereas severe or profound hearing impairment was not found in any case. De Vos (1963),[7] Bhatia *et al*. (1977),[13] and Stephens (1970)[9] have reported similar findings.

About 66.3% had sensorineural deafness, 5% had conductive hearing loss, and 6.3% had mixed hearing loss. This was similar to the observations of Aggarwal *et al*.,[14] where he found 39% of hypothyroid adults having hearing loss. About 15% of cases had sensorineural, 8% conductive, and 13% mixed, and most of them had mild-to-moderate hearing loss.

Adults with hypothyroidism with hearing loss were found to be sensorineural, conductive, or mixed type. In patients having sensorineural or mixed hearing loss, the neural involvement could be explained by biochemical, metabolic, or morphological changes in the nervous system, thereby altering the nerve conduction. The low levels of thyroid hormones affect the different components of the cochlea and thus produce sensory deafness. The conductive impairment may be the result of decreased compliance due to hypertrophy and edema of the eustachian tube and middle ear mucosa leading to eustachian tube catarrh.

Meyerhoff (1979),[15] based on the experimental study, mentioned changes in ossicles and round or oval windows, such as crystallized consistency of bone, fusion or distortion of incus and stapes, and partial or complete obliteration of oval or round windows as other possible explanations for conductive hearing impairment.

Thyroid hormone is essential for normal development of the auditory system.[16] The deficiency of this hormone leads to a reduction in cell energy production. This will reduce the microcirculation and consequently the metabolism and oxygenation of the involved organ. Furthermore, it affects the structures within the ear.[17,18]

In this study, on performing tympanometry, Type A tympanogram was observed in 66.3%, Type AD tympanogram was observed in 17.5%, and Type B tympanogram was observed in 15% of the cases. The hypothyroid group showed a predominance of Type A tympanogram, which implies normalcy or ossicular chain pathology. Type AD implying flaccid tympanic membrane and Type B implying middle ear pathology were seen more among the cases when compared to the controls, and this difference with the controls was significant. This was similar to studies done by Anand *et al*.[11] on 20 hypothyroid patients, where the tympanogram curve was of Type B in one ear of each of the four patients. This shows a higher probability of middle ear pathology among the hypothyroid adults.

In this study, on testing acoustic reflex, 35% of cases had no reflex, while 6.3% among the controls had no reflex. The absence of acoustic reflex could be attributed to an increased hearing threshold or myxomatous infiltration of the middle ear. McMahon (1947)[12] also reported myxoedematous middle ear infiltration of the middle ear mucosa and eustachian tube.

In this study, on testing distortion product OAE, OAE was absent in 40% of cases. There was a significant relationship between the absence of OAE and hypothyroidism. This implies that the outer hair cell damage among the hypothyroid group outnumbered the healthy subjects. This was in accordance with studies done by Rawish *et al*., who found an increased absence of distortion product OAE in the hypothyroid group compared to the controls.[4]

Bhatia *et al*. (1977)[13] established cochlea to be the site of lesion in 34.72% of patients having sensorineural impairment in a study. The cochlea has been found to be the site of lesion in hypothyroidism experimentally too. Schaitzale and Haubrich (1967)[19] demonstrated acid mucopolysaccharides in the scalae of cochleas in hypothyroid guinea pigs. Anniko and Rosenkvist (1982)[20] reported the tectorial membrane being the first structure to show changes in hypothyroidism. Alterations in the normal structure were found in addition to the thickening of the basilar membrane. Furthermore, enlargement of the intercellular spaces in stria vascularis with degeneration of marginal and intermediate cells, inner and outer hair cell degeneration, tectorial membrane irregularities, and debris in the cochlear duct has been reported in a few studies.[21] Studies examining the effect of hypothyroidism on the cochlear function have suggested that abnormal thyroid hormone levels lead to defects in the neurological and morphological development of the organ of Corti [22] suggesting that thyroid hormones exert a direct effect on the cochlea.

These observations suggest multiple sites of involvement in the ear in patients of hypothyroidism manifesting as conductive, sensorineural, or mixed hearing impairment.

In studies conducted by Ben-Tovim *et al*.[3] on rats and Himelfarb *et al*.[23] on people, there was a significant relationship between the decrease of T_4 level and the changes in audiometric measurements and brainstem auditory evoked potential (BAEP) results. Hearing loss was found to be much greater in hypothyroid patients with higher TSH and lower free T_4 implying the relationship between poor thyroid control and hearing loss.

Studies by Vent Hoff and Stuart,[6] Rubenstein *et al*.,[8] and Anand *et al*.[11] have reported improvements in hearing

following thyroxine therapy. Hearing loss in hypothyroidism was found treatable and reversible after proper replacement therapy. In a study done by Di Lorenzo *et al*.,[24] a dramatic improvement in the hearing condition in hypothyroid patients was reported after 6–12 months of L-thyroxine replacement therapy. Anand *et al*.[11] claimed that audiometric changes seen in hypothyroidism might improve with treatment, but BAEP would be permanent in spite of the treatment. However, Di Lorenzo *et al*.[24] proved that the hearing loss in the hypothyroid patient improved after hormone replacement therapy by BAEP.

In my study, I have included three of the major audiological investigations which are essential to diagnose the type of hearing loss and the probable sites of damage involved. However, brainstem evoked response audiometry would be needed for confirmation of retrocochlear pathology which is not done in this study, hence being a limitation.

CONCLUSION

The hypothyroid subjects had significant mild, bilateral sensorineural hearing impairment compared to the normal healthy control group. The hearing impairment was noted maximally with higher frequencies. Poor thyroid hormonal control plays a significant role in reducing the auditory acuity of the hypothyroid subjects.

Even though the relationship between adult hypothyroidism and hearing loss has raised many controversies, it is now clear that adult hypothyroidism is closely linked to hearing loss. Due to the high-frequency nature of hearing loss in hypothyroidism, it commonly goes undetected and unreported. The present study was undertaken to study the influence of hypothyroidism on hearing acuity. A clinical approach to monitor hearing in hypothyroid patients is therefore important. Early diagnosis and interventions to prevent the worsening of hypothyroidism will, thereby, reduce the deterioration of hearing loss.

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