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Audiological Evaluation in Goitrous Hypotyhroidism

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ABSTRACT

Objective: To determine the incidence of deafness in patients suffering from goiterous hypothyroidism exclusively and to evaluate the role of L-thyroxine therapy in improving the hearing in this group of patients. **Study Design:** A prospective cohort study. **Materials and Methods:** Hearing status was evaluated in a sample size of 100 consecutive patients reporting to the ENT/Endocrinology department of Institute of Medical Sciences, Banaras Hindu University, Varanasi, UP with the diagnosis of goitrous hypothyroidism. The study group included patients in the age group of 5 to 65 years belonging to either sex. Patients with detected hearing loss were categorized into group A, and all other patients were designated group B. L-Thyroxine treatment for goitrous hypothyroidism was initiated in all the cases. At the end of 6 months, a repeat audiogram was done in all the patients in order to evaluate the efficacy of the said treatment protocol on the hearing in these patients. The data were tabulated and statistically analysed using Paired Students "*t*" test. **Results:** An overall 39% hearing loss was observed in patients with goitrous hypothyroidism. 15% cases had sensorineural hearing loss, 13% had mixed hearing loss and 8% had a conductive hearing loss. A statistically significant hearing improvement was recorded in this study by L-thyroxine treatment in group-A, and no deterioration of hearing was recorded in group-B. **Conclusions:** The incidence of sensorineural hearing is less in patients with goitrous hypothyroidism (15%) as compared with the overall incidence of sensorineural hearing loss reported for hypothyroidism (30% - 40%). Further, there is a definitive improvement in hearing with the use of L-thyroxine treatment of goitrous hypothyroidism.

Keywords: Hypothyroidism; Goitre; Hearing Loss; L-Thyroxine Treatment

1. Introduction

Hearing loss was first reported in acquired hypothyroidism in 1907 [1]. Over a period of time, a distinct association between hypothyroidism and auditory system dysfunction has been reported in medical text [2], though there are studies which have failed to elucidate a definitive relationship between hypothyroidism and deafness [3-5]. The medical literature now mentions vertigo, hearing loss, tinnitus and pruritic external auditory canal as important vestibular and audiological symptoms of hyvpothyroidism [2].

Hypothyroidism is associated with all types of deafness: sensorineural, mixed and conductive, however, the real incidence and pathophysiology of this hearing loss in these patients is still uncertain. This is attributed to the marked paucity of literature on the cited subject. The incidence of hearing loss varies from 25% to 50% with a higher incidence in congenital hypothyroidism [6,7]. Moreover, the results of audiological evaluation of patients with hypothyroidism under treatment with L-Thyroxine [LT] are conflicting. There are studies which have highlighted the importance of this modality of treatment in improving hearing in hypothyroid patients [8-12], but literature is also replete with studies which have found no correlation between the two [3-5,13,14]. Considering this, in order to broaden the studies in this line of research a prospective study was initiated exclusively in goitrous hypothyroid patients with the aim to:

1) Determine the incidence of hearing loss in these patients;

2) Evaluate the effect of LT therapy on this hearing loss in these patients.

To our knowledge, the current study is unique, in that audiological evaluation of goitrous hypothyroidism has not been previously reported in medical literature.

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2. Materials & Methods

A prospective outcome analysis study was carried out in the departments of Otorhinolaryngology & Endocrinology, Institute of Medical Sciences, Banaras Hindu University, Varanasi, UP, India from September 2002 to September 2005. For the purpose of this study 100 consecutive patients of either sex suffering from goitre with hypothyroidism were recruited in the study design. The study was approved by the University Board of Studies & Ethics committee, and an informed consent was mandatory for recruitment in the study design. Paediatric patients were also recruited in the study design.

All the patients of goitre reporting either to the otorhinolaryngology department or endocrinology department were subjected to detailed history taking and clinical examination. A FNAC (fine needle aspiration cytology), USG (ultrasound) of the enlarged thyroid and screening for thyroid function was done in all the cases to confirm the nature of the goitre and the hypothyroidism. The patients were specifically screened for thyroid dysfunction by T_4 and TSH levels. Thyroid function test were done by RIA [Radio Immune Assay], the kit for which was supplied by Bhabha Atomic Research Centre, Mumbai, India. Only patients with proven hypothyroid status were enrolled in the study:

- Serum thyroxine level (T_4): normal range 4 to 13 micrograms/dl;
- Serum thyrotropin (TSH): normal range 0.3 to 6 micro IU/ml.

Their particulars, detailed history of thyroid swelling and disease along with clinical examination were entered in a Performa. Tests to diagnose aetiology of hypothyroidism and goitre were also done. A special note of deafness, vertigo, and tinnitus was also made. The patients of deafness were further evaluated by tuning fork test and pure tone audiogram [PTA]. Alps advanced diagnostic audiometer AD100 with the following standards was used for PTA testing:

- Tone audiometer: EN60645-1/ANSI S3.6, Type 2;
- Speech audiometer: EN60645-2/ANSI S3.6, Type B or B-E.

It would be prudent to note that hypothyroid patients with deafness due to any other causes like:

- Chronic suppurative otitis media;
- Meningitis;
- Head Injury;
- Presbyacusis (patients above 60 years were not recruited in this study);
- Ototoxic drugs etc were excluded from the study design.

Finally, these patients with audiogram proven deafness were categorized in a designated special group-A, all other patients were enrolled in group-B. Patients in both the groups continued to receive thyroxine treatment under the supervision of endocrinology department and a regular monthly follow-up was maintained. At the end of 6 months a repeat audiogram was done and the hearing status was once again evaluated. A 10 db improvement in two consecutive frequencies was regarded as an audiological improvement [15,16]. The data was tabulated and statistically analysed by paired students "*t*" test.

In this study patient with Hashimoto's thyroiditis, iodine deficiency, thyroid malignancy, irradiated thyroid malignancy, Pendred's Syndrome and hyperthyroid patients treated with drugs/radioiodine etc were all included in the study design. Distinguishing congenital hearing loss due to "Pendred's Syndrome" and other causes of congenital hearing loss was difficult as "Perchlorate Test" was not available in our institution. Thus all the cases of congenital hearing loss with hypothyroidism and goitre were clinically regarded as "Pendred Syndrome". Although we recruited cases with diagnosis of hypothyroidism with goitre which reported for the first time to ENT/endocrinology department OPD of our institution, however during the course of study it was revealed that some of these patients had taken replacement in the past for short duration. This was probably due to the rural background, poor socio-economic status and illiteracy of our patient profile.

3. Results

Out of a total of 100 patients with goitre and hypothyroidism, 70 were females and 30 were males. The age group of patients ranged from 5 years to 64 years. There were 12 paediatric patients. The age distribution of these patients is given in **Table 1**.

A total of 39 patients had an audiological proven deafness. However over a period of time 3 patients were lost in follow-up, thus for statistical interpretation and discussion in this study the results in 36 patients were taken into consideration. Out of these 36 patients 8 patients had conductive hearing loss, 15 patients had sensorineural hearing loss and 13 patients had a mixed hearing loss. The distribution of these cases in accordance with WHO classification is shown in **Table 2**. The relationship of this hearing loss with the levels of T_4 is also given in **Table 2**. The mean T_4 levels which were associated with normal hearing are 2.7 micrograms. From the table it is clearly evident that the severity of the hearing loss is directly proportional to the decreasing value of T_4 levels.

The hearing thresholds were again measured 6 months later in euthyroid state post thyroxine therapy. The **Table 3** shows the audiological gains after L-thyroxine therapy in each ear separately and the overall gain in all the 36 patients. The analysis of the data revealed:

1) The 10 db hearing improvement or more is seen in 9

Table 1. Age distribution.

No of Pt's	AGE GROUPS [Yrs]						
	5 - 14	15 - 24	25 - 34	35 - 44	45 - 54	55 - 60	Total
Group-A	3	7	10	12	6	1	39
Group-B	9	23	9	12	5	3	61
Total	12	30	19	24	11	4	100

*No of Pt's: Number of patients; *Group-A: Goitrous hypothyroid patients with hearing loss; *Group-B: Goitrous hypothyroid patients with normal hearing.

Table 2. Hearing loss (with correlation to mean T4 levels).

Hearing Loss	Number of Cases [100]	Mean T4 (micrograms/dl)
Normal	61	2.7
Mild (25 - 40 db)	11	2.6
Moderate (41 - 55 db)	10	2.4
Moderately severe (56 - 70 db)	14	2.3
Severe (71 - 90 db)	04	1.8
Profound (>90 db)	nil	N/A

Table 3. Overall response to l-thyroxine treatment.

Imp [db]	−7	−6	−5	−4	−3	−2	−1	0	1	2	3	4	5	6	7	8	9	10	11	12
No of Ears	1	0	0	0	2	1	0	4	0	10	9	0	16	0	13	7	0	7	0	2
No of Pts	1	0	0	0	0	0	0	0	0	4	7	0	8	0	5	6	0	4	0	1

*Imp (db): improvement in Pure tone audiometry [average] in decibels; *No of ears: total number of ears *i.e.* 36 × 2 = 72; *No of pts: total number of patients in study design = 36.

ears only;

2) The 10 db hearing improvement or more in totality is seen only in 5 patients;

3) A decrease in hearing was recorded in 4 ears across various frequencies;

4) One case recorded a significant decrease in hearing by 7 db;

5) A hearing improvement was recorded in 64 ears, ranging from 2 db to 12 db;

6) A hearing improvement was recorded in 35 of the 36 patients.

The **Table 4** highlights the improvement in hearing following thyroxine treatment in each specific frequency *i.e.* 500 Hz, 1000 Hz, 2000 Hz and 4000 Hz. The study of the data indicates that:

1) A gain of 10db or more was recorded in 24, 31, 22, and 25 ears at 500 Hz, 1000 Hz, 2000 Hz and 4000 Hz respectively;

Table 4. Response to l-thyroxine treatment (frequency specific/each ear).

Frequency (Hz)	Improvement in hearing (db) (36 × 2 = 72 ears)						
	−10	−5	0	5	10	15	Total
500	2	13	13	20	13	11	72
1000	0	08	16	17	16	15	72
2000	0	10	20	20	14	08	72
4000	0	07	18	22	14	11	72

2) Maximum significant gain of 10 db or more was seen at 1000 Hz (31 ears);

3) A decrease in hearing threshold varying from −1 to −10 db was seen maximally at 500 Hz (15 ears). Other frequencies showed a miniscule upto −5 db decrease in hearing only.

The overall audiological improvement after thyroxine treatment was statistically analysed using paired students "*t*" test by comparing the average hearing threshold by pure tone audiometry for each patient at 500, 1000, 2000, 3000, 4000 Hz before and after thyroxine therapy (**Table 5**). In this study the value of "*P*" was found to be highly significant (**Table 5**). Thus, indicating that thyroxine therapy benefits hearing in goitrous hypothyroid patients. In addition, it would be prudent to note that no significant deterioration in hearing was detected in any patient of group-B at the end of 6 months.

In this study 17 patients also had tinnitus. And a history of vertigo was recorded in 39 of the 100 patients.

4. Discussion

Goitre is defined as an enlargement of thyroid gland. Worldwide about 90% of cases are due to iodine deficiency. In countries that use iodized salt, Hashimoto's thyroiditis is the most common cause [17]. Further it is important to note that over a period of time, patients of goitre due to lack of iodine can develop hypothyroidism [17]. Hence, the evaluation of hearing in goitrous hypothyroidism assumes clinical importance.

In our study group of goitrous hypothyroid we found that 39% of patients had some hearing loss. Out of these 15% cases had sensorineural hearing loss; a conductive hearing loss was seen in only 8% cases, the remaining 13% recorded a mixed hearing loss. The medical literature quotes a hearing loss of 25% for patients with acquired hypothyroidism and 35% - 50% for congenital hypothyroidism [6,7]. Moreover an incidence of 30% - 40% for sensorineural hearing loss has been reported for myxoedema in medical text [2]. From the above account it is clearly evident that patients with goitrous hypothyroidism have a comparable hearing loss (39%), but the incidence of sensorineural loss is less. Nevertheless, a

Table 5. Statistical analyses of hearing improvement with l-thyroxine treatment.

S. NO (Patients with deafness)	Average hearing threshold in db (pure tone audiometry)	
	Group-A1 (Pre treatment)	Group-A2 (Post treatment)
1.	71.33	68.33
2.	40	36.66
3.	30	28.33
4.	60	51.66
5.	53.33	45
6.	68.33	61.66
7.	35	31.66
8.	68.33	65
9.	70	60
10.	56.67	53.33
11.	46.67	36.66
12.	46.67	41.66
13.	45	43.33
14.	80	75
15.	78.33	73.33
16.	66.67	55
17.	41.66	36.66
18.	41.67	36.66
19.	41.67	38.33
20.	50	43.33
21.	85	80
22.	45	38.33
23.	48.33	38.33
24.	76.66	75
25.	38.33	36.66
26.	40	36.66
27.	55	46.66
28.	68.33	60
29.	60	55
30.	65	61.66
31.	61.67	53.33
32.	58.33	51.66
33.	30	36.66
34.	58.33	51.66
35.	65	56.66
36.	40	30
Statistical Calculations		
Mean	55.2308	49.7183
Standard Deviation [SD]	14.7682	14.0448
Standard Error of mean [SEM]	2.4614	2.3408

[*]**Confidence Interval:** The mean group-A1 minus Group-A2 = 5.5125; 95% confidence interval: 4.3466 to 6.6784; [*]**Intermediate values used in calculations:** t = 9.5986, df = 35, standard error of difference = 0.574; [*]***P* value and statistical significance:** Two tailed ***P value* = <0.0001**, which is ***extremely significant***.

sensorineural element tends to predominate (28%) in these cases of goitrous hypothyroidism too. Also most of the patients had a moderate or moderately severe hearing loss (**Table 2**).

In this study we recorded an overall statistically significant hearing improvement after thyroxine treatment (**Table 5**). But the author's would like to highlight that a significant 10 db improvement was observed in only 5 cases *i.e.* only about 13% cases had an objective audiological improvement (**Table 3**), though many cases claimed a subjective improvement in hearing. And one case also had deterioration in hearing. Further it was observed that the thyroxine treatment influences the hearing maximally at 1000 Hz, the frequency at which 31 ears had a significant gain of 10 db or more (**Table 4**). There are diverse views regarding improvement in hearing in hypothyroid patients with thyroxine treatment. Studies by Vent Hoff W (1979) [9], Rubeinstein M *et al.* (1974) [10], Howarth AF *et al.* (1956) [11] and Anand VT *et al.* (1989) [12] have reported an improvement in hearing following thyroxine therapy. On the other hand studies by Post JT (1964) [13], DeVos JA (1963) [14], Parving A *et al.* (1973) [3] and yet another study by Parving A *et al.* (1983) [4] have not reported any significant improvement in hearing post treatment with thyroxine. A recent study which analyses Meniere's disease and thyroid dysfunction also found no statistically significant difference between prevalence, pattern and severity of hearing loss between patients of Meniere's disease taking thyroxine supplements and patients who were not [5].

The exact Pathophysiological changes leading to hearing loss in hypothyroidism have not yet been unveiled. It is believed that hypothyroidism leads to decrease in cell energy production, compromising the microcirculation and consequently the metabolism and oxygenation of the involved organ. In the case of hearing loss this affects the inner ear structures: stria vascularis and organ of corti [18,19]. Thyroid hormone also controls protein synthesis, myelin production and enzymes and the level of lipids in the central nervous system. In addition, T_4 also acts as a neurotransmitter. Thus it is speculated that in hypothyroidism hearing impairment can originate in the cochlea, central auditory pathway and/or in the retrocochlear region [20]. Moreover, in most of the studies brainstem electric response does not show significant reversal following L-thyroxine therapy [4,12,14]. Thus it is widely accepted that improvement in hearing following levothyroxine therapy is attributed to improved general condition of the patient resulting in improved co-operation in psycho-acoustic testing, the so called functional improvement in central deafness [4,12,14]. The histological examination of temporal bones in these patients has also failed to show accumulations of glycoaminoglycans [4, 21,22]. It would however be imperative to note that con-

ductive hearing loss in hypothyroidism is secondary to Eustachian tube mucosal oedema [23].

Although it was not the endeavour of this study to analyse the vestibular changes in goitrous hypothyroidism, the authors would like to highlight that almost 39% cases had a history of vertigo, out of which 26 patients had an subjective improvement after levothyroxine therapy at the end of 6 months. In this context it would be important to note that the medical text mentions that almost 66% of patients of hypothyroidism suffer from vertigo [2]. Tinnitus too was present in 17 cases. Nine of these cases recorded a subjective improvement in form of decrease in the duration and intensity of the tinnitus. Thus a joint involvement of cochlear and vestibular system is also seen in goitrous hypothyroidism as has been reported for other metabolic disorders [24]. The authors would also like to highlight that no case of Meniere's disease *i.e.* the classical triad of vertigo, deafness with tinnitus was recorded in this case series, though the literature reports an intrinsic relationship between hypothyroidism and Meniere's disease (a recent study quotes a prevalence of 32%) [5].

Interpretations of these results must take into consideration the limitations of our analysis. As data from a single tertiary health care centre was used, it reflects the experience of our geographical area and may not be generalized. Information from observational studies can be subject to potential biases (e.g. selection bias) and confounding. Critics may contend that 6 months follow-up period is short. Furthermore, the results were not ascertained blindly. Last but not the least; we were unable to discern the reason for this decreased sensorineural hearing loss in goitrous hypothyroidism. This could be due to the demographic profile of our patients. But then the authors would like to emphasise that the very cause of hearing loss in hypothyroidism is debatable and controversial. Nevertheless, the strength of this study lies in its prospective character and independent statistical validation, which allowed for accurate assessment of data without depending upon recalled information in accordance with evidence based medicine. The authors would like to highlight that this study represents the largest series of patients on hypothyroidism. The true value of this study in context of existing literature lies in the audiological evaluation of patients belonging to the subgroup of goitrous hypothyroid, hitherto unreported in medical literature.

5. Conclusion

In conclusion, the patients of goitrous hypothyroidism have a lower rate of sensorineural hearing loss as compared with other patients of hypothyroidism. Further, this study delineates a definitive role of L-thyroxine therapy in improvement of hearing in patients suffering from goitrous hypothyroidism. We believe that conclusions of this study can serve as a guide for future research on the cited subject.

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