



8-1-2020

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How to Cite This Article

Tantawy, Mostafa; Ali, Ali; Mahmoud, Ahmed; and Hussein, Mohammed (2020) "Hearing Profile in Thyroid Dysfunction," *Al-Azhar International Medical Journal*: Vol. 1: Iss. 8, Article 9.

DOI: <https://doi.org/10.21608/aimj.2020.33445.1260>

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Hearing Profile in Thyroid Dysfunction

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Received for publication July 7, 2020; Accepted September 3, 2020; Published online September 3, 2020

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doi: 10.21608/aimj.2020.33445.1260

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ABSTRACT

Background: The etiology of hearing loss may be of endocrine or metabolic abnormalities with varying degrees.

Objective: Define how changes in thyroid hormone levels could affect the hearing system and characterize the audiological or electrophysiological findings of hearing assessment in individuals with acquired thyroid dysfunction.

Material and Methods: Between Dec 2018 - Feb 2020, twenty healthy control subjects, twenty hyperthyroidism, and twenty hypothyroidism patients who are diagnosed in the Department of Endocrinology and Metabolism at Al-Azhar University Hospitals between the ages of 18-50 years old. Pure tone audiometry, speech audiometry, and ABR measurements were performed for each patient.

Results: When audiometric findings of hypothyroid patients were studied, sensorineural hearing loss was detected mainly at high frequencies. When ABR measurements of the hypothyroid group compared to the control group, revealed that wave V. latency was longer in the hypothyroid group.

Conclusion: These changes in ABR waves suggest that there are retro-cochlear problems in hypothyroid patients.

Keywords: Hypothyroid; Hyperthyroid; Audiometry; ABR; Hearing loss

Disclosure: The authors have no financial interest to declare in relation to the content of this article. The Article Processing Charge was paid for by the authors.

Authorship: All authors have a substantial contribution to the article

INTRODUCTION

Multiple factors can affect hearing loss like genetic or environmental. Also several endocrine and metabolic abnormalities may lead to different degrees of hearing loss. The neurophysiology of hearing and anatomical structure of the auditory pathway is affected by changes in the hormonal and metabolic systems.¹

Before the very onset of hearing thyroid hormones act through thyroid hormone β receptors to influence hearing by initiating myelinogenesis of the vestibulocochlear nerve (VIII cranial nerve).² In addition to the expression of prestin (cochlear protein), that regulates functions of outer hair cells, has been proved to reduce in thyroid hormone deficiency.³

Hypothyroidism is considered a cause of the diminution of hearing. About twenty-five percent of patients with acquired hypothyroidism complain hearing loss, with partial reversibility after thyroid hormone replacement treatment.⁴

PATIENTS AND METHODS

Subjects:

A control group of 20 healthy volunteers (Group A) with normal thyroid function test were hearing-assessed in the Department of Audiology and Vestibular Medicine at Al-Azhar University Hospitals, the group included 10 males and 10 females with a mean age of 32.5 years and hearing threshold better than 25 dBHTL concerning frequency range 250-8000 Hz.

The hyperthyroid group (Group B) comprised 20 patients with acquired hyperthyroidism of mean age 35.4; 13 were males and 7 were females. While the hypothyroid group (Group C) comprised 20 patients with acquired hypothyroidism of mean age 37.95; 10 were males and 10 were females; both groups were diagnosed in the Department of Endocrinology and Metabolism at Al-Azhar University Hospitals. Any other causes of hearing loss were excluded as so any neurological disorders or systemic diseases that may interrupt with electrophysiological measures.

Based on findings of a previous paper Thornton and Jarvis,⁵ regarding pure tone thresholds of the average 2-4 kHz, the difference between hypothyroid (24.3±11) and control (11.7±5) was significant ($p<0.005$); so based on that with the power of 80.0% and confidence level of 95% the minimum sample size calculated to be fifteen in each group and with the non-responder rate we took twenty.

Equipments:

Two-channel Audiometer Inter-acoustics model AC40 with headphones TDH 39 and bone vibrator B71, Acoustic Immittancemeter Inter-acoustics model AZ26 with 220 Hz probe tone and Evoked potential system (ABR) Smart Intelligent.

Procedures:

All subjects were submitted to carefully taken full history, thyroid function test, otological examination, and hearing assessment including immittancemetry with ipsilateral acoustic reflexes, pure tone audiometry (PTA), speech audiometry, and auditory brain stem response (ABR) at a low repetition rate 21.1 clicks/sec and high repetition rate 71.1 clicks/sec.

Statistical Analysis:

Data obtained through history taking, clinical assessment, and laboratory tests were analyzed using Microsoft Excel software. The data were then imported into Statistical Package for the Social Sciences (SPSS version 20.0) software for analysis. Based on the form of data; qualitative data expressed as number and percentage while quantitative data for the continuous group is represented by mean ± SD. The following measures

were used to assess significant differences in the qualitative variable by the Chi-square test (X^2). Differences between quantitative independent multiple groups by ANOVA.

Ethical considerations: The study was approved by the ethical committee of Al-Azhar University, Egypt. Verbal and written consent was taken from all participants and they were free to leave the study at any time.

RESULTS

Table (1) shows age and gender distribution among studied groups. Mean age was 32.5±8.55, 35.4±9.17, and 37.95±8.1 years old among control, hyperthyroid and hypothyroid groups respectively with no significant difference among studied groups $P>0.05$.

Pure tone audiogram thresholds among three studied groups are shown in **Table (2)** showing that there is no significant difference between the three groups as regard frequency range 250 Hz – 2000 Hz. While the hypothyroid group was significantly higher than the other two groups regarding 4000 Hz and 8000 Hz on both right and left ears.

Table (3) shows the distribution of low and high-frequency audiogram thresholds among studied groups showing that the hypothyroid group was significantly higher than the other two groups regarding high-frequency thresholds.

Distribution of right and left word discrimination scores among studied groups are shown in **Table (4)** showing no significant difference between the three studied groups.

Acoustic reflexes of the studied groups are distributed and tabulated in **Table (5)** showing that the hypothyroid group was significantly higher than the other two groups regarding 1000 Hz and 2000 Hz on the right ear and 500 Hz, 1000 Hz, and 2000 Hz on the left ear.

Low and High repetition rate ABR among studied groups was compared in **Table (6)** showing that ABR results as regarding wave V latencies were significantly higher among the hypothyroid group on both right and left ears.

			Group A	Group B	Group C	F	P
Mean age in years			32.5±8.55	35.4±9.17	37.95±8.1	1.987	0.147
Gender	Female	N	10	7	10	1.21	0.54
		%	50.0%	35.0%	50.0%		
	Male	N	10	13	10		
		%	50.0%	65.0%	50.0%		
Total		N	20	20	20		
		%	100.0%	100.0%	100.0%		

Table (1): Age and gender distribution among studied groups.

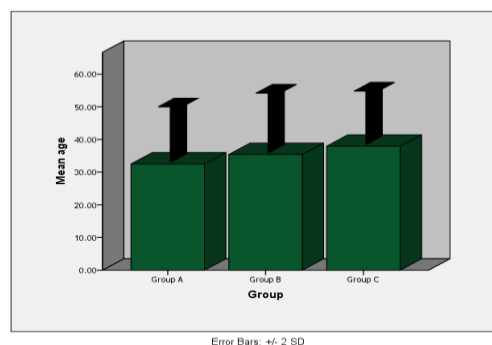


Figure (1): Mean age distribution among the three studied groups showing no significant difference.

		Thresholds in dBHL			F	P
Frequency in Hz		Group A	Group B	Group C		
Right ear	250	11.0±3.47	10.5±4.55	12.0±4.1	0.704	0.499
	500	12.75±3.43	13.5±4.1	13.25±3.35	0.186	0.831
	1K	15.0±3.62	15.5±3.94	17.0±3.76	1.515	0.228
	2K	17.0±4.1	18.0±4.41	19.5±3.59	1.930	0.154
	4K	19.75±4.43	20.75±4.06	24.5±4.55*	6.604	0.003*
	8K	21.5±4.61	22.25±3.43	25.5±6.04*	3.893	0.026*
Left ear	250	10.5±3.94	10.5±4.55	11.75±4.06	0.592	0.557
	500	11.5±2.85	13.25±4.66	13.25±3.35	1.487	0.235
	1K	14.75±3.02	15.25±3.79	17.25±3.43	2.972	0.059
	2K	17.7±3.4	18.25±4.66	19.5±2.76	3.105	0.052
	4K	19.75±3.79	21.5±4.0	24.25±3.72*	6.963	0.002*
	8K	21.75±4.66	21.77±3.72	27.0±7.32*	6.170	0.004*

Table (2): right and left pure tone audiogram thresholds distribution among the three studied groups.

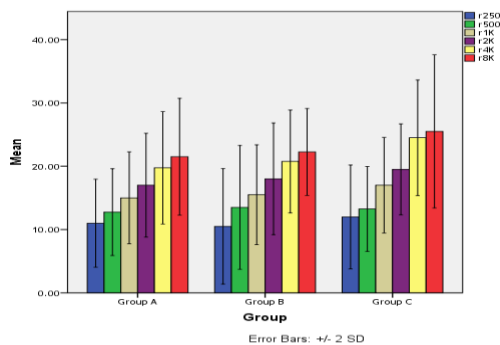


Figure (2a): Right ear pure tone thresholds of the three studied groups showing that Group C was significantly higher than the other two groups regarding 4kHz and 8kHz.

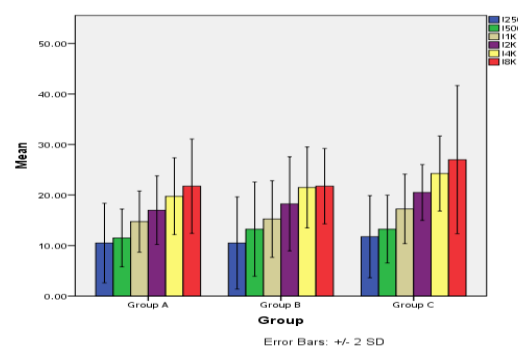


Figure (2b): left ear pure tone thresholds of the three studied groups showing that Group C was significantly higher than the other two groups regarding 4kHz and 8kHz.

		Mean thresholds in dBHL			F	P
		Group A	Group B	Group C		
Right	Low	12.91±3.19	13.16±4.11	14.08±3.35	0.590	0.558
	High	19.41±3.94	20.33±3.44	23.16±3.7*	5.571	0.006*
Left	Low	12.25±2.87	13.0±3.95	14.08±3.12	1.511	0.229
	High	19.5±3.63	20.5±3.5	23.91±3.75*	8.123	0.001**

Table (3): Low and high-frequency pure tone thresholds of both right and left ears among studied groups.

		Word discrimination score			F	P
		Group A	Group B	Group C		
Right Ear		0.97±0.03	0.98±0.04	0.97±0.021	2.452	0.071
Left Ear		0.97±0.03	0.98±0.05	0.97±0.04	2.534	0.064

Table (4): right and left distribution of word discrimination score among studied groups

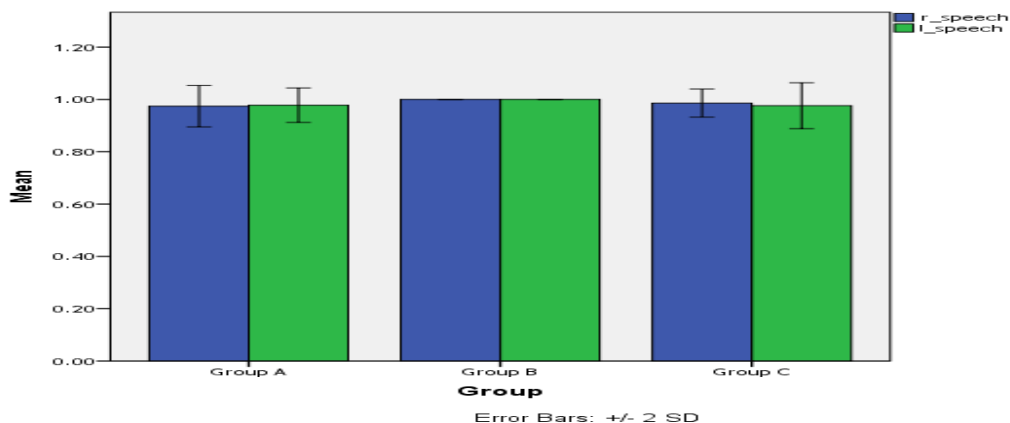


Figure (3): Distribution of right and left word discrimination score among the three groups showing no significant difference.

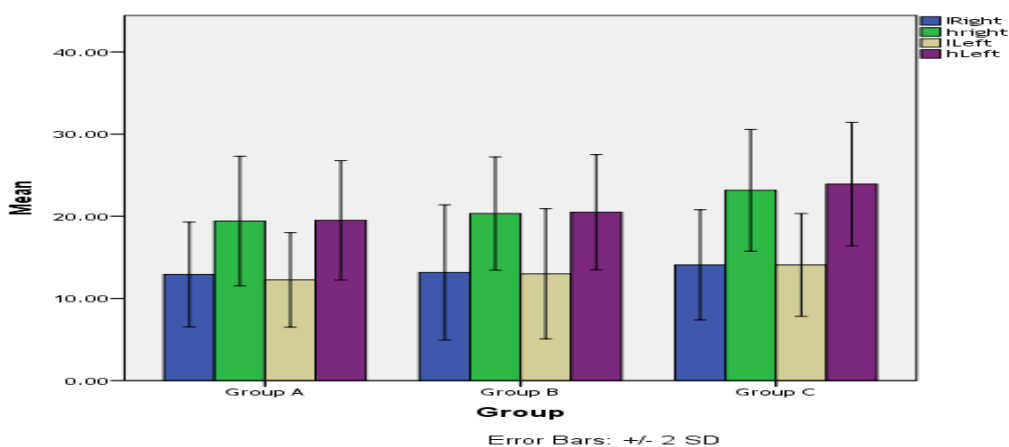


Figure (4): Low and high-frequency pure tone thresholds on both ears among the three studied groups showing that Group C was significantly higher than the other two groups regarding high frequency.

		Acoustic reflexes thresholds in dBHL			F	P
Frequency in Hz		Group A	Group B	Group C		
Right	500	86.5±4.89	86.25±5.09	88.12±3.72	0.453	0.639
	1K	89.0±4.75	88.5±4.61	96.5±6.25*	9.558	0.00**
	2K	93.25±4.37	91.75±3.35	101.0±6.58*	14.586	0.00**
	4K	97.35±3.99	96.0±3.07	96.11±3.33	0.766	0.471
Left	500	86.75±4.06	86.25±3.93	93.0±10.36	3.851	0.029*
	1K	90.5±4.55	89.0±4.75	97.85±8.09	7.480	0.002*
	2K	94.25±3.35	92.25±3.02	97.5±4.18	6.076	0.005*
	4K	97.05±4.35	95.0±3.62	96.25±2.5	1.306	0.283

Table (5): right and left ipsilateral reflexes thresholds distribution among the studied groups.

		Wave V Latencies in millisecond			F	P
Repetition rate		Group A	Group B	Group C		
Right	Low	5.45±0.16	5.41±0.16	5.89±0.11*	29.437	0.00**
	High	6.21±0.13	6.17±0.39	6.89±0.26*	48.703	0.00**
Left	Low	5.34±0.33	5.43±0.17	6.08±0.08*	32.789	0.00**
	High	6.33±0.17	6.22±0.34	7.06±0.18*	88.753	0.00**

Table (6): low and high repetition rate ABR wave V latencies in msec. of both right and left ears among studied groups. Group C was significantly higher than the other two groups regarding low and high repetition rates.

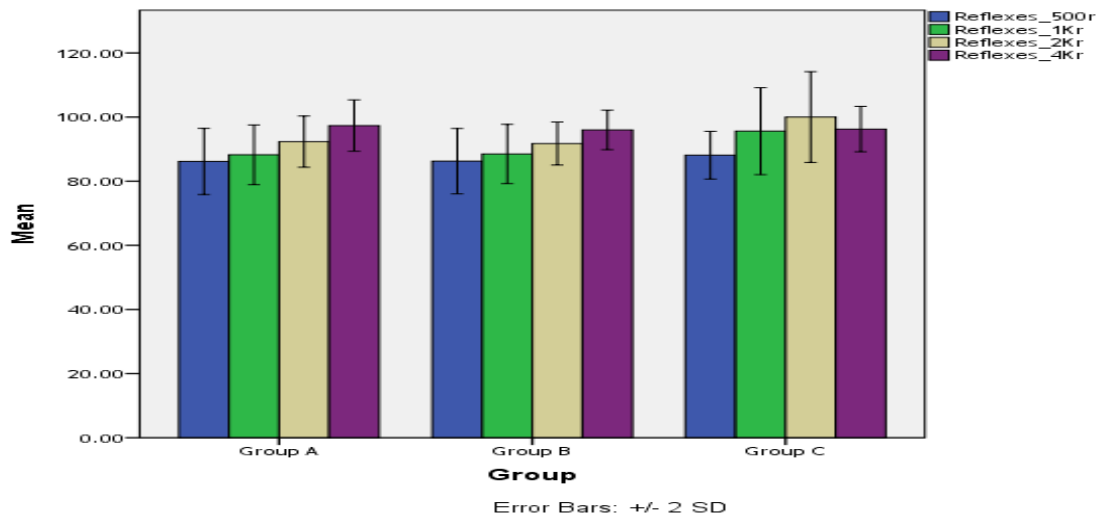


Figure (5a): Right ear ipsilateral reflexes distribution among studied groups showing that Group C was significantly higher than the other two groups regarding 1kHz and 2kHz.

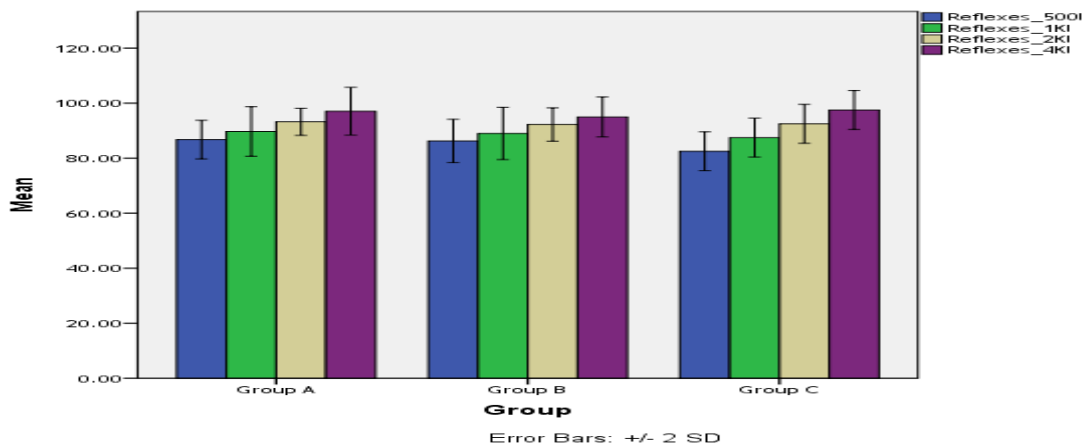


Figure (5b): Left ear ipsilateral reflexes distribution among studied groups showing that Group C was significantly higher than the other two groups regarding 500Hz, 1kHz, and 2kHz.

DISCUSSION

Hypothyroidism is defined as a decrease in serum concentration of thyroid hormones that leads to elevated serum TSH concentration and hyperthyroidism is described by a low serum level of TSH and increased thyroid hormones serum concentration. The normal range of FT3, FT4 and TSH serum levels is 0.2-0.5 ng/dL, 0.7-2.5 ng/dL and 0.4-4.2 mU/L respectively.⁶

In the current study, the assessment of patients with acquired hypothyroidism and hyperthyroidism was studied in detail when compared to the control group to define the degree of hearing loss. Results showed that there was no significant difference between the three groups regarding frequency range 250 Hz – 2000 Hz in both ears, but when high frequencies were recorded; subjects of group C were significantly higher than the other two groups at 4000 HZ and 8000 HZ. This is an

agreement with Thornton and Jarvis,⁵ compared between hypothyroid and hyperthyroid patients; found that the average threshold was above twenty-five dB in hypothyroid patients results while no significant difference between control and hyperthyroid patients results. They supposed that the significant alteration may be due to variation in the hormonal level which leads to changes in the metabolism and physiological criteria within cells in the retro-cochlear auditory pathway.

Also Karali and Guclu,⁷ Studied twenty-five hypothyroid patients and reported that comparison of the airway threshold values obtained by audiometry revealed that the hypothyroid group was found higher at high frequencies when compared to the control group. However there was no significant difference at 500 Hz - 4000 Hz, they found a statistically significant difference at 8000 Hz. In a study conducted on 30 hypothyroid

patients, Santos et al.⁸ detected a moderate sensorineural hearing loss in twenty-two of the sixty ears and reported that there were bilateral hearing losses.

On the other hand, Berker et al.⁹ examined twenty-two cases of Grave's disease and documented sensorineural hearing loss particularly at high frequencies in most cases.

Acoustic reflexes in the 3 groups; control, hyperthyroid and hypothyroid patients were measured and results showed a highly significant difference ($p < 0.05$) in ipsilateral acoustic reflexes among group C when compared to group A and group B specifically at 1000 Hz and 2000 Hz on the right ear and at 500 Hz, 1000 Hz and 2000 Hz on the left ear. Results match up with Bruschini et al.¹⁰ who stated elevated acoustic reflexes in patients with hypothyroidism when compared with the normal group. On the other hand, also stated elevated acoustic reflexes in hyperthyroid patients and mentioned that acoustic reflexes of both groups were elevated when compared with the control group.

There was no significant variation between the 3 studied groups when word discrimination score was measured, that might be due to the fact of discrimination score is more strongly correlated with the average of frequencies 500 Hz, 1000 Hz, 2000 Hz, and 4000 Hz.¹¹ Regarding this average of frequencies; discrimination does not depend only on 4000 Hz which was earlier proved to be affected by low thyroid hormones in group C of hypothyroid patients.

It is known that electrophysiological changes are seen in thyroid diseases. Calcium absorption decreases in hypothyroidism. Calcium is effective on synaptic transmission in the nervous system, so that hearing loss due to brain stem pathologies may occur in hypothyroidism.⁵

In the current study regarding the ABR test with a low repetition rate at a rate of 21.1 clicks/sec or high repetition rate at a rate of 71.1 clicks/sec when results of hyperthyroid patients are compared to the control group, no statistically significant difference was found about wave V absolute latency. Although a statistically significant prolongation in absolute wave V latency could be detected in patients with hypothyroidism.

Those findings were following Santos et al.⁸ who believed there may be some sluggish peripheral conduction in hypothyroidism. Also, Figueiredo et al.¹² who found a marked increase in absolute wave III and V latencies and interpeak I – III or I – V latencies in hypothyroid patients.

In addition to Karali and Guclu,⁷ found that the difference between wave III and V latencies or interpeak I - III latency was statistically significant ($p < 0.05$). Ismail et al.¹³ found a statistically significant delay in absolute wave III and V latencies of ABR in recently diagnosed patients.

The same as Chandrasekhar et al.¹⁴ who also have reported an increase in absolute wave latencies in hypothyroid patients may be due to reduced tissue metabolism which may contribute to impaired recruitment of neuronal pools at brainstem wave generators and slow peripheral conduction. Results revealed there was no dramatic difference ($p > 0.05$) between the control group and hyperthyroidism. Kumar et al.¹⁵ detected significant difference for waves I and III absolute latencies of both ears and wave V in right.

Khedr et al.¹⁶ also confirmed elongation of all absolute and inter-peak wave latencies affecting both central and peripheral conduction time suggesting that dysfunction in the nervous system is diffuse. Low temperature, decreased myelin development and cerebral metabolism alteration may be the potential exploration for the prolongation of the conduction time. Thornton and Jarvis,⁵ found no key difference ($p > 0.05$) in hyperthyroidism for absolute or inter-peak latencies of waves by evaluating the audiometry and ABR results of twelve hyperthyroid patients as compared to control.

On the other hand, Anjana et al.¹⁷ have found a significant decrease in latency to wave V. with no critical difference in inter-peak latencies for hypothyroid patients, as well as Vanasse et al.¹⁸ who compared hypothyroid patients to the control group but did not detect a big difference in ABR outcomes. The same as Ozata et al.¹⁹ who found no abnormalities in ABR of patients with hypothyroidism.

CONCLUSION

1. Patients with hypothyroidism have poorer pure tone thresholds than age-matched hyperthyroid patients at 4-8 kHz.
2. Vestibulocochlear symptoms like diminution of hearing were more frequent in patients with hypothyroidism.
3. The hearing loss was sensorineural, detected especially at high frequencies in the audiometric findings of hypothyroid patients.
4. Findings that support retro-cochlear hearing loss were found in patients with hypothyroidism, suggesting that ABR results were due to brain stem pathology when compared with the control group.

RECOMMENDATIONS

1. Furthermore, studies on a large sample size of patients to study with other variables like the duration of disease and the effect of medical intervention.
2. Full awareness plans targeting people complaining diminution of hearing to assess thyroid function.
3. Physicians should be aware of the impact of thyroid dysfunction on hearing to apply the ABR test and detect to what extent the auditory pathway is involved.
4. Widespread public health education programs are needed to increase awareness about the impact of thyroid dysfunction on hearing and post warning labels in health care units.

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