International Journal of Otorhinolaryngology and Head and Neck Surgery
Gupta V et al. Int J Otorhinolaryngol Head Neck Surg. 2020 Aug;6(8):1494-1499
http://www.ijorl.com
pISSN 2454-5929 | eISSN 2454-5937

Original Research Article

DOI: http://dx.doi.org/10.18203/issn.2454-5929.ijohns20203202

Hearing impairment in patients of hypothyroidism in sub Himalayan region

Vikasdeep Gupta[1]*, Sunder Singh Dogra[2], Pardeep Bansal[2], Kuldeep Thakur[3], Vidhu Sharma[4], Deepak Verma[5], Vandana[6]

[1]Department of Otolaryngology and Head Neck surgery, All India Institute of Medical Sciences, Bathinda, Punjab, India
[2]Department of Otolaryngology and Head Neck surgery, Dr. Rajendra Prasad Government Medical College, Kangra at Tanda, Himachal Pradesh, India
[3]Department of Otolaryngology and Head Neck surgery, All India Institute of Medical Sciences, New Delhi, India
[4]Department of Otolaryngology and Head Neck surgery, All India Institute of Medical Sciences, Jodhpur, Rajasthan, India
[5]Department of Otolaryngology and Head Neck surgery, Bhagat Phool Singh Government Medical College, Khanpur Kalan (Sonepat), Haryana, India
[6]Department of Ophthalmology, Post Graduate Institute of Medical sciences, Rohtak, Haryana, India

Received: 14 May 2020
Revised: 27 June 2020
Accepted: 04 July 2020

***Correspondence:**
Dr. Vikasdeep Gupta,
E-mail: vdgupta88@gmail.com

ABSTRACT

Background: The objective of the study was to assess the hearing impairment in patients of hypothyroidism.
Methods: A prospective clinical study has done at a referral centre included 33 diagnosed patients of hypothyroidism in the age group of 15 to 65 years, fulfilling the inclusion and exclusion criteria who attended the outpatient department. The diagnosis of hypothyroidism was confirmed by thyroid function tests i.e., serum T3, T4 and TSH levels while hearing assessment was done using tuning fork tests, pure tone audiometry, impedance audiometry and otoacoustic emissions. Hearing impairment was measured in decibels of hearing loss, or dB HL and graded as mild, moderate, moderately severe, severe, or profound.
Results: Percutaneous transluminal angioplasty showed 42.7% of the patients had high frequency sensorineural type of hearing loss. The air bone gap was not significant. On tympanometry, all the patients had type A graph and distortion product otoacoustic emissionss in all patients were pass.
Conclusions: Acquired hypothyroidism affects primarily high frequency hearing thresholds causing high frequency sensorineural hearing loss, with little or no effect on lower frequencies.

Keywords: Audiometry, Hearing impairment, Hypothyroidism, Impedance, Thyroid gland

INTRODUCTION

The thyroid gland is the primary endocrine regulator of the body. It produces two related hormones, thyroxine (T4) and triiodothyronine (T3) which act through thyroid hormone receptors alpha and beta and play a critical role in cell differentiation during development or growth of the body, central nervous system maturation and help to maintain thermogenic and metabolic homeostasis in the body.[1,2] Auditory function is particularly sensitive to the effects of the thyroid hormone, which is required for the complex development of auditory system and physiology of the cochlea.[3-7] An association has long been recognized between thyroid hormone levels and hearing development in patients with congenital hypothyroidism

(CH), endemic cretinism and thyroid hormone resistance.[8-10]

Autoimmune disorders of the thyroid gland can stimulate the excessive production of thyroid hormones (thyrotoxicosis) or cause glandular destruction and hormone deficiency (hypothyroidism). Normal serum value range of T3 is 77-135 ng/dl, T4 is 5.4-11.7 µg/dl and TSH 0.34-4.25 microIU/ml.[11] Hypothyroidism refers to a decrease in thyroid function due to structural or functional damage to the thyroid gland (thyroprivic, primary hypothyroidism), due to pituitary (secondary hypothyroidism) or due to hypothalamus (tertiary hypothyroidism). Values of T3 and T4 decreases in all of them but TSH is elevated only in primary hypothyroidism. It is low or absent in secondary or tertiary hypothyroidism. The latter two categories are differentiated by TSH response to TRH, being low in secondary and normal in tertiary hypothyroidism.[11]

Based on age factor different terms for Hypothyroidism are described i.e. cretinism refers to severe hypothyroidism in infancy; juvenile hypothyroidism refers to hypothyroidism in childhood; myxoedema is the full-blown picture of frank hypothyroidism in adults. Primary idiopathic hypothyroidism is the most common cause of thyroid failure in adults. The reason is unknown and is believed to represent the end stage of autoimmune thyroiditis.[11]

The impairment in hearing in patients suffering from goiter was first described by Bircher and was later confirmed by the Myxoedema Committee of Clinical Society of London.[12] Hypothyroidism is a cause of hearing impairment worldwide, probably accounting for at least 50000 hearing-impaired infants born each year.[13] The problem is particularly prevalent in those parts of the world where endemic goiter is common, as the use of iodized salt can prevent deafness due to hypothyroidism. In 1974, Ritter stressed that hearing loss can be the most common otological manifestation of congenital and acquired hypothyroidism and the auditory symptoms may occur alone or in association with vertigo and tinnitus.[14] The real incidence of hearing loss in patients with Hypothyroidism is still uncertain, and it may affect up to 25% of the patients with acquired hypothyroidism and 35-50% of the patients with congenital hypothyroidism. Thyroid hormones control synthesis and production of protein, myelin, enzymes and lipids in the CNS. Moreover T4 can act as a neurotransmitter. The pathophysiological mechanisms of hearing loss in Hypothyroidism is not entirely known but it is said that there is a reduction in cell energy production, compromising the microcirculation and consequently, oxygenation and metabolism of the involved organs including stria vascularis and organ of Corti.[15,16] Thus it is believed that hearing impairment in hypothyroidism maybe because of malfunction in the cochlea, in the central auditory pathways and/or in the retrocochlear region.[17]

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. Moreover, the results of the 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 resulting in improved hearing in hypothyroid patients, however there are few which have found no correlation between the two.[18-25] The results of hearing impairment in patients with hypothyroidism are conflicting, making it necessary to broaden the study in this line of research.[26-31] Thus the goal of the present study was to assess the hearing impairment in patients of hypothyroidism.

METHODS

A prospective observational study was done at Dr. Rajendra Prasad government Medical College, Kangra at Tanda (H.P.) from December 2012 to December 2013 included 33 diagnosed patients of hypothyroidism in the age group of 15 to 65 years of either sex while the patients with hereditary, noise or ototoxic drug induced hearing loss, purely conductive hearing loss, with previous ear surgery were excluded from the study.

A written informed consent was obtained from all patients before the study and Institutional ethics committee clearance was obtained for the same.

The diagnosis of hypothyroidism was confirmed by thyroid function tests which included serum T3, T4 and TSH. Those patients were included in the study who had the values as: T3<77 (normal 77-135 ng/dl) and/or; T4<5.4 ng/dl (normal 5.4-11.7 µg/dl) and/or; TSH>4.25 micro IU (normal 0.34-4.25).

After detailed ear, nose, and throat examination, hearing assessment was done by: tuning fork tests, pure tone audiometry, impedance audiometry, and otoacoustic emissions. Tuning fork tests (Rinne and Weber) were done using 256 Hz, 512 Hz and 1024 Hz tuning forks and the results were recorded. ALPS advanced digital audiometer AD2100 was used for percutaneous transluminal angioplasty (PTA) and hearing impairment was measured in decibels of hearing loss, or dB HL and graded as mild, moderate, moderately severe, severe or profound as defined below:[32]

Mild: for adults between 26-40 dB HL and between 20-40 dB HL for children; Moderate: between 41-54 dB HL; Moderately severe: between 55-70 dB HL; Severe: between 71-90 dB HL; Profound: >90 dB HL; Deaf: Having no hearing at all.

Impedance audiometer AT235 was used for performing tympanometry. Tympanometry was performed with the patient seated in a soundproof room, and results were recorded. It is based on the principle that when a sound

strikes the tympanic membrane, some of the sound energy is absorbed while the rest is reflected. A stiffer tympanic membrane would reflect more of sound energy than a compliant one. By changing pressure in the external auditory canal and then measuring the reflected sound energy, it is possible to find the compliance or stiffness of the tympano-ossicular system and thus find the diseased status of the middle ear.

Types of tympanograms

- *Type A*- normal tympanogram.
- *Type As*- compliance is lower at or near ambient air pressures, seen in fixation of ossicles.
- *Type Ad*- high compliance at or near ambient pressure; seen in ossicular discontinuity or thin and lax tympanic membrane.
- *Type B*- a flat or dome-shaped graph; seen in fluid collection in middle ear.
- *Type C*- maximum compliance occurs with negative pressure below 100 mm of H_2O, seen in retracted tympanic membrane.

Otoacoustic emission test (OAE) was done in all patients seated in a soundproof room, and results recorded as pass or refer. OAEs are acoustic signals emitted from the cochlea through the middle ear and into the external ear canal, where they are recorded by a sensitive microphone. OAEs are most probably generated by active mechanical contraction of the outer hair cells, spontaneously or in response to sound. There are four types of OAEs: spontaneous OAEs (SOAE), transient evoked OAEs (TOAE), distortion product OAEs (DPOAE), and stimulus frequency OAEs (SFOAE). Because of the low level of OAEs and the presence of other sounds in the ear canal, measures must be taken to secure reliable recordings.

RESULTS

In our study all patients ranged from 15-65 years of age with minimum age of 17 years and maximum 65 years with mean age 36.7 years. All of the 33 patients had high TSH levels ranging from 7.5 to 66.6 with a mean of 25.7 (±19.5). T3 values of the patients ranged from 2 to 107.9 with mean value of 53.9 (±37.9), out of which 23 (69.7%) of the patients had T3 level below normal while T3 level was normal in 10 (30.3%) patients. T4 level was below normal in 21 (63.6%) of the cases and normal in 12 (36.4%) of the cases.

PTA findings at 500, 1000, 2000, 4000 differ from those at 8000 Hz as there was moderately severe hearing loss in one patient at higher frequency whereas in others, there was mild hearing loss (Table 1).

The hearing loss didn't show much relationship with decrease in amount of T4 values below normal in frequency of 4000 Hz (Table 2).

Table 1: Pure tone audiometry at different frequency (symmetrical for both ear).

Frequency	Normal N (%)	Mild N (%)	Moderate N (%)	Moderately severe N (%)	Severe N (%)	Profound N (%)
500 Hz	31 (93.9%)	2 (6.1%)	0	0	0	0
1000 Hz	32 (97%)	1 (3%)	0	0	0	0
2000 Hz	31 (93.9%)	1 (3%)	1 (3%)	0	0	0
4000 Hz	29 (87.9%)	3 (9.1%)	1 (3%)	0	0	0
8000 Hz	18 (54.5%)	14 (42.4%)	0	1	0	0

Table 2: Relationship of pure tone thresholds at 4000 Hz with serum levels of T4.

PTA (4 KHz)	T4 Value		
Hearing	**Normal**	**Below normal**	**Total**
Normal	12	17	29
Mild	1	2	3
Moderately severe	0	1	1
Total	13	20	33

The relation between PTA values at 8000 Hz shows as the level of T4 value is more below normal, the hearing loss is affected more (Table 3).

Table 3: Relationship of pure tone thresholds at 8000 Hz with serum levels of T4.

PTA (8 KHz)	T4 value		
Hearing	**Normal**	**Below normal**	**Total**
Normal	7	11	18
Mild	6	8	14
Moderately severe	0	1	1
Total	13	20	33

Table 4: Relationship of pure tone thresholds at 4000 Hz with serum levels of T3.

PTA (4 KHz)	T3 value		
Hearing	**Normal**	**Below normal**	**Total**
Normal	9	20	29
Mild	1	2	3
Moderately severe	0	1	1
Total	10	23	33

Similarly T3 values didn't affect 4000 Hz frequency range (Table 4).

However the effect on lower values of T3 hormone affected the hearing thresholds at 8000 Hz (Table 5).

Table 5: Relationship of pure tone thresholds at 8000 Hz with serum levels of T3.

PTA (8 KHz)	T3 value		
Hearing	**Normal**	**Below normal**	**Total**
Normal	7	11	18
Mild	3	11	14
Moderately severe	0	1	1
Total	10	23	33

Otoacoustic emission: Distortion product otoacoustic emissions were pass in all of the 33 patients.

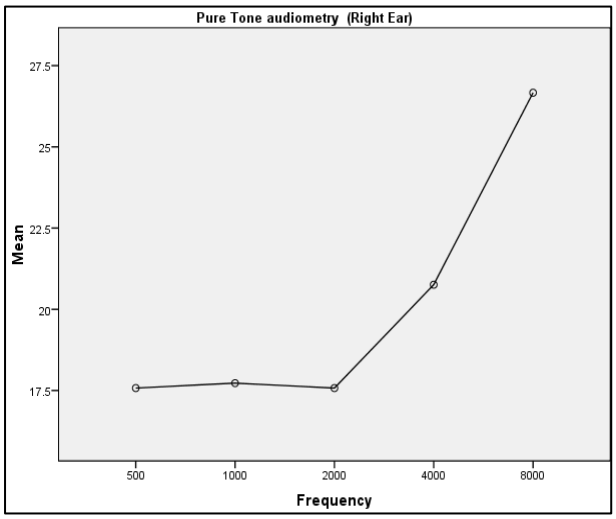

Figure 1: The mean of intensities at the high frequency ranges for the right ear show higher values as compared to the low frequency ranges.

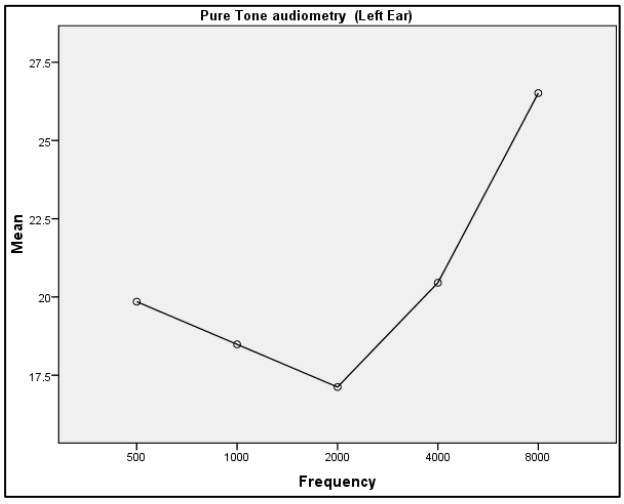

Figure 2: The plot formed between mean intensities at different frequencies for the left ear shows that the mean threshold of hearing increases as the frequency increases in hypothyroid patients.

DISCUSSION

In the present study, 42.4% of the cases had mild hearing loss in the frequency range of 4000 and 8000 Hz. All the patients had normal hearing or minimal hearing loss in the frequency range of 500Hz, 1000 Hz and 2000 Hz. The medical literature quotes a hearing loss of 25% for patients with acquired hypothyroidism and 35-50% for congenital hypothyroidism.[28,30]

As we analysed the patients with changed audiometric tests, we observed that all of them had TSH values between 4 and 30 mUI/ml. Changed audiometric tests were also seen in patients with proper free T4 levels. Thus, the audiometric thresholds do not seem to be associated with the serum levels of these hormones. These findings correlate with the study done by Khechinaschvili et al in 2007, in which by the PTA, sensorineural hearing loss was detected in 74.0% of cases.[23] The BTA revealed disturbances of temporal summation of excitation in cochlear receptors in 26.0% of inspected subjects. The data of the EOAE mostly corresponded to those of the PTA. In some patients, however, the PTA demonstrated normal thresholds, while the EOAEs, as well as the BTA, indicated abnormalities. The investigations have shown that the specific hormonal therapy hardly improves either peripheral or central hearing disorders associated with hypothyroidism. However, in our study DPOAEs were normal in all the patients.

Debruyne et al in 1983 also observed in their study that in 36 of their patients (80%), the auditory thresholds were normal; in the remaining nine patients (20%) a sensorineural hearing loss of different degrees was detected.[18] Thornton et al, in this study on auditory brainstem response findings in hypothyroid and hyperthyroid disease, found that the audiometric findings for the hypothyroid group (21 patients) showed that 36% of this group had a four frequency average threshold greater than 25 dB.[33] In the present study also, 42.7% of the patients had thresholds greater than 25 dB at 8000 Hz.

On the contrary, Vikas et al, found that nearly 48.83% and 40.62% of the hypothyroid patients had a moderate and mild degree of hearing impairment, respectively.[21] He suggested that the conductive hearing impairment in these patients may be the result of reduced compliance due to hypertrophy and edema of the mucosal lining of the Eustachian tube and middle ear and thickening of the tympanic membrane.

Meyerhoff based on his experimental study reasoned out that the conductive type of hearing loss may be due to partial or complete obliteration of oval or round window because of changes in ossicles and round or oval window, crystallized consistency of bone, fusion or distortion of incus and stapes.[17]

But out of the patients with thyroxine treatment, only 0.06% showed mild conductive hearing loss whereas 99.94% were normal, which is also correlated well with the findings of Anand et al, and Vikas et al, who reported conductive hearing impairment in hypothyroidism with improvement in air conduction after treatment.[13,21]

Similar findings were seen in the study by dos Santos et al who found high audiometric thresholds in 22 ears (36.67%) of the patients with hypothyroidism and in only seven ears (11.67%) from patients of the control group ($p<0.05$); there was a predominance of mild/moderate sensorineural hearing loss in both groups.[24]

Vanasse et al, in their study recorded brainstem auditory evoked potentials in 15 adult hypothyroid patients immediately before treatment.[25] All patients were women, ranging in age from 34 to 82 years. Fourteen also had an audiometric study. In five patients, both tests were repeated 20 to 22 months after treatment. Audiometry showed that hearing loss increased with age, suggesting that hearing loss in these patients could be secondary more to aging than to hypothyroidism. When compared to sex-matched controls of similar ages, the patients showed no statistically significant differences in brainstem auditory evoked potentials before treatment. Brainstem auditory evoked potential values were not modified in the five patients whose tests were repeated after treatment.

Our findings are in total agreement with those of Vant Hoff, who reported an incidence of 85% of hearing impairment in 48 myxedematous patients and improvement in 73% after replacement therapy.[16]

The results of our study are in contrast to those of Parving et al[19,20] They studied myxedema patients in two groups where patients in group I were below 60 years of age (median age 48 years), and those in group I1 were above 60 years (median age 78 years). No association was found between myxedema and hearing impairment and no improvement in hearing acuity following treatment in either of the groups. The discrepancy between this and our study may be partially explained by the older age of patients in Parving's study when the presbyacusis factor causes deterioration in hearing.

There are diverse views regarding improvement in hearing in hypothyroid patients with thyroxine treatment. Studies by Vant Hoff et al, Rubeinstein et al, Howarth AF et al and Anand VT et al have reported an improvement in hearing following thyroxine therapy.[16,21,28-30] On the other hand, studies by Post et al, DeVos et al, and Parving et al have not reported any significant improvement in hearing post treatment with thyroxine.[15,19,31]

In our study, otoacoustic emissions were normal, and children below 15 years of age were not taken in the study. Moreover, further testing, including BERA was not done to ascertain any retrocochlear pathology further.

CONCLUSION

Acquired hypothyroidism mainly affects high-frequency hearing thresholds causing high-frequency sensorineural hearing loss, with little or no effect on lower frequencies. The hearing loss is not affected by the level of thyroid hormone below normal.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. Cabello G, Wrutniak C. Thyroid hormone and growth: relationships with growth hormone effects and regulation. Reprod Nutr Dev. 1989;29:387-402.
2. Bernal J. Thyroid hormones and brain development. Vitam Horm. 2005;71:95-122.
3. Deol MS. The role of thyroxine in the differentiation of the organ of Corti. Acta Oto-laryngologica. 1976;81(5-6):429-35.
4. Mra Z, Wax MK. Effects of acute thyroxin depletion on hearing in humans. Laryngoscope. 1999;109(3):343-50.
5. Knipper M, Zinn C, Maier H, Praetorius M, Rohbock K, Köpschall I, et al. Thyroid hormone deficiency before the onset of hearing causes irreversible damage to peripheral and central auditory systems. J Neurophysiol. 2000;83(5):3101-12.
6. Uziel A, Gabrion J, Ohresser M, Legrand C. Effect of hypothyroidism on the structural development of the organ of Corti in the rat. ActaOtolaryngeol. 1981;92(5-6):469-80
7. Sohmer H, Freeman S. The importance of thyroid hormone for auditory development in the fetus and neonate. Audiol Neurootol. 1996;1:137-47.
8. DeLong GR, Stanbury JB, Fierro-Benitez R. Neurological signs in congenital iodine deficiency disorder (endemic cretinism). Dev Med Child Neurol. 1985;27(3):317-24
9. Refetoff S, De Wind IT, De Groot IJ. Familial syndrome combining deaf-mutism, stippled epiphyses, goiter and abnormally high PBI: possible target organ refractoriness to thyroid hormone. J Clin Endocrinol. 1967;27(2):279-94.
10. Brucker-Davis F, Skarulis MC, Pikus A, Ishizawar D, Mastroianni MA, Koby M, et al Prevalence and mechanisms of hearing loss in patients with resistance to thyroid hormone. J Clin Endocrinol Metab. 1996;81(8):2768-72.
11. Morgan JM McCaffrey T. Head and neck manifestations of endocrine diseases. In: Gleeson M, Clarke R. Scott-Brown's Otorhinolaryngology: Head and Neck Surgery 7Ed: 3 volume set. CRC Press; 2008:400.

12. Bircher HV. Der endemische Kropf und seine Beziehungen zur Taubstummheit und zur Kretinismus. Basel: Benno Schwabe. 1883.
13. Anand VT, Mann SB, Dash RJ, Mehra YN. Auditory investigations in hypothyroidism. Acta Oto-laryngologica. 1989;108(1-2):83-7.
14. Ritter FN. The effects of hypothyroidism upon the ear, nose, and throat. Laryngoscope. 1967;77:1427-79.
15. DeVos JA. Deafness in hypothyroidism. J Laryngol Otol.1963;77:390-414.
16. Hoff WV, Sturat D. Deafness in myxoedema. Quart J Med. 1979;48(2):361-7.
17. Meyerhoff WL. Hypothyroidism and the ear: Electrophysiological, morphological, and chemical considerations. Laryngoscope. 1979;89:1-25.
18. Debruyne F, Vanderschueren-Lodeweyckx M, Bastijns P. Hearing in congenital hypothyroidism. Audiology. 1983;22(4):404-9.
19. Parving A, Parving HH, Lyngsøe J. Hearing sensitivity in patients with myxoedema before and after treatment with L-thyroxine. Acta oto-laryngologica. 1983;95(1-4):315-21.
20. Parving A, Ostri B, Hansen JM, Bretlau P, Parving HH. Audiological and temporal bone findings in myxedema. Ann Otol Rhinol Laryngol. 1986;95(3):278-83.
21. Vikas M, Shukla GK, Naresh B. Hearing profile in hypothyroidism. Indian J Otolaryngol Head Neck Surg. 2002;54:285-90.
22. Ben-Tovim R, Zohar Y, Laurian N, Laurian L, Zohiar S. Auditory brain stem response in experimentally induced Hypothyroidism in albino rats. Laryngoscope. 1985;95:982-6
23. Khechinaschvili S, Metreveli D, Svanidze N, Knothe J, Kevanishvili Z. The hearing system under thyroid hypofunction. Georgia Med News. 2007;144:30-3
24. dos Santos KT, Dias NH, da Silva Mazeto GM, de Carvalho LR, Lapate RL, Martins RH. Audiologic evaluation in patients with acquired hypothyroidism. Brazilian J Otorhinolaryngol. 2010;76(4):478-84.
25. Vanasse M, Fisher C, Berthezene F, Roux Y, Volman G, Mornex R. Normal brainstem auditory evoked potentials in adult hypothyroidism. Laryngoscope. 1989;99:302-6.
26. Chandrasekhar M, Kowsalya V, Vijayalakshmi B. Electrophysiological changes on brainstem auditory evoked potentials in hypothyroid patients. J Pharm Res. 2011;4:2856-9.
27. Di Lorenzo L, Foggia L, Panza N, Calabrese MR, Motta G, Tranchino G, et al. Auditory brainstem responses in thyroid diseases before and after therapy. Hormone Res Paediatr. 1995;43(5):200-5.
28. Rubenstein M, Rubenstein C, Theodor R. Hearing dysfunction associated with congenital sporadic hypothyroidism. Ann Otol Rhinol Laryngol. 1974;83:814-9.
29. Rubinstein M, Perlstein TP, Hildesheimer M. Cochlear action potentials in experimentally induced Hypothyroidism in guinea pigs. Acta Otolaryngol. 1975;79(331):1-10.
30. Howarth F, Lloyd HE. Perceptive deafness in hypothyroidism. Br Med J. 1956;1:431-3.
31. Post JT. Hypothyroid deafness. Laryngoscope. 1964;74:221-32.
32. Clarke JG. Uses and abuses of Hearing loss classification. Asha. 1981;23:493-500.
33. Thornton AR, Jarvis SJ. Auditory brainstem response findings in hypothyroid and hyperthyroid disease. Clin Neurophysiol. 2008;119(4):786-90.

Cite this article as: Gupta V, Dogra SS, Bansal P, Thakur K, Sharma V, Verma D, et al. Hearing impairment in patients of hypothyroidism in sub Himalayan region. Int J Otorhinolaryngol Head Neck Surg 2020;6:1494-9.