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Assessment and evaluation of hearing, tinnitus, and vertigo in children with endocrine disorders

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ABSTRACT

Background: Metabolic and endocrine disorders are related to a significant proportion of mortality and morbidity seen in the child population globally. The disorders and associated comorbidities affecting various body organs including inner ear functions include diabetes mellitus, growth hormone deficiency, childhood obesity, precocious puberty, etc.

Aims: The present clinical trial was carried out to assess high-frequency hearing, associated tinnitus and vertigo in children with endocrine disorders including growth hormone deficiency, precocious puberty, type 1 diabetes mellitus, obesity and idiopathic short stature.

Materials and Methods: 120 subjects having a growth hormone deficiency, precocious puberty, type 1 diabetes mellitus, obesity and/or idiopathic short stature, and 32 healthy children were evaluated with a complete otolaryngologic examination followed by otoscopic ear examination, tympanometry, vertigo, and tinnitus. The collected data were subjected to statistical evaluation and results were formulated.

Results: PTA>20dB was seen in 2.5% (n=3) subjects, HFA >20dB was seen in 5% (n=6), PTA and HFA >20dB in 5% (n=6) subjects (p= 1.000, 0.465, and 1.000). 18.6% (n=19) had tinnitus, and 8.82% (n=9) had vertigo. Presence of vertigo and tinnitus in study subjects with ISS seen in 22.7% (p=0.04). Vertigo with PTA and HFA value >20dB was seen in 3.84% (n=1) subject with GHD, 5.88% (n=2) with Type1 DM, 4% (n=1) with obesity, and 3.06% (n=3) subjects in whole experimental group.

Conclusion: Within its limitations, the present study concludes that endocrine diseases manifested in childhood can lead to alterations in the inner ear with poorly understood aetiology. However, the study suggests a balance examination and thorough hearing examination be done in all children visiting endocrinology clinics to detect and treat any associated abnormality at an early stage.

Keywords: Hearing pattern, endocrine disorders, metabolic disorders, pediatric, tinnitus, vertigo

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INTRODUCTION

Metabolic and endocrine disorders are related to a significant proportion of mortality and morbidity seen in the child population globally. These disorders affect people not only by themselves but also comorbidities associated with metabolic and endocrine disorders contribute to mortalities and morbidities as diseases themselves. These disorders and associated comorbidities affect various body organs and systems including inner ear functions. These disorders include diabetes mellitus, growth hormone deficiency, childhood obesity, and precocious puberty, etc.[1] Diabetes Mellitus is a metabolic disorder with a genetic component identified by persistent hyperglycaemia and is associated with various neuropathic and vascular complications. Among children, approximately 90% are seen having insulin-dependent Diabetes Mellitus (type-I DM) and is usually diagnosed in adolescent age. Various literature data defines clearly the effect and damage in retro cochlear and cochlear pathways associated with the auditory system caused by Type 1 Diabetes Mellitus.[2]

Another disorder presenting, treated, and diagnosed in childhood is Growth hormone deficiency (GHD) which affects approximately 1 in 4-10 thousand live births, and presents as short stature. Idiopathic Short stature (ISS) is the most common reason in children visit the Pediatrician. The effect of growth hormone deficiency on hearing is established by various researchers. It was shown that in humans, functions and development of the auditory system are affected by the deficiency of growth hormone.[3] Also, obesity is increasing in children to adolescents globally, and approximately 1/3rd of children with obesity have one or more metabolic disorders. Obesity and associated comorbidities are shown to increase in hearing loss risk.[4]

Precocious puberty is another disorder seen in both genders, but, more in females, and is presented as testicular enlargement in males before 9 years of age, and budding of the breast in females of less than 8 years. Most child patients seen in child endocrinology departments are of precocious puberty and idiopathic short stature. These metabolic disorders and associated comorbidities affect normal hearing and inner ear functions in children.[5] Hence, the present clinical trial was carried out to assess the hearing including high-frequency hearing, and associated tinnitus and vertigo in children with endocrine disorders including growth hormone deficiency, precocious puberty, type 1 diabetes mellitus, obesity, and idiopathic short stature (ISS).

MATERIALS AND METHODS

The present study was carried out after obtaining clearance from the concerned Ethical committee. The study included a total of 120 subjects having both males and females within the age group of 6 years to 17 years and the mean age of 9.29 years. The subjects were recruited from the children visiting the Outpatient Department, Department Of **Otorhinolaryngology,** Shyam Shah Medical College And Sanjay Gandhi Memorial Hospital, Rewa, Madhya Pradesh for treatment of growth hormone deficiency, precocious puberty, type 1 diabetes mellitus, obesity, and/or idiopathic short stature. The study controls were contributed by 32 healthy children including 17 males and 15 females with no chronic disease and mean age of 9.28 years and age range of 6-16 years.

The inclusion criteria for the study were children having one of the following disorders: growth hormone deficiency, precocious puberty, type 1 diabetes mellitus, obesity, and idiopathic short stature, and children in the age range of 6-16 years. The subjects having the following conditions were excluded from the study: current respiratory tract infection, ear wax, thyroid disease, chronic disease history, mentally retarded subjects, active ear effusion/inflammation, history of Adenotonsillectomy/ear surgery, and/or syndrome associated with the vestibule-cochlear system. After final inclusion, the subjects were

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explained about the study design. Informed consent was then taken from the parents of the included children.

Following inclusion, the complete otolaryngologic examination was carried out for all subjects followed by an otoscopic ear examination in both ears. The tympanic device was used for tympanometry by an experienced audiologist followed by hearing examination in anechoic space with air conduction hearing test in the frequency range of 250-20,000 Hz, HFA (High-frequency average) with frequencies of 8, 10, 12, 16, and 20 thousand Hz, PTA (Pure tone average) with frequencies of 500, 1000, 2000, and 4000 Hz, bone conduction hearing test in the frequency range of 500-4000 Hz, and acoustic reflex recording. Subjects assessed with Type B and C on tympanogram, and with hearing loss in audiometry tests were also not included in the study. The results were depicted as for single-ear owing to the negligible difference assessed in frequencies for two years (<10dB). The normal hearing range was taken between 0-20dB, whereas, hearing loss was considered at >20dB.

Concerning vertigo assessment, the Pediatric Vestibular symptom questionnaire[6] was used having 10 questions scores of 3, 2, 1, and 0 for mostly, sometimes, rarely, and never. The additional option of I don't know was discarded and added with no scores. Scores of 0-15were considered normal, whereas, 15-30 scores were taken as a symptom of vertigo. For tinnitus ringing/humming sound if perceived by subjects was recorded on the same scale and scoring criteria as vertigo. Subjects with scores of 2 or 3 were considered having tinnitus.

The collected data were subjected to the statistical evaluation using SPSS software version 21.0, 2012, Armonk, NY, ANOVA, and t-test. The results were formulated keeping the level of significance at $p<0.05$.

RESULTS

The study included a total of 120 subjects having both males and females within the age group of 6 years to 17 years and the mean age of 9.29 years. The study controls were contributed by 32 healthy children including 17 males and 15 females with no chronic disease and mean age of 9.28 years and age range of 6-16 years. The demographic and disease characteristics of the study subjects are summarized in Table 1.

Table 1: Demographic and disease characteristics of the study subjects

Characteristics	**Controls**		**Growth Hormone Deficiency**		**Precocious Puberty**		**Type 1 DM**		**Obesity**		**Idiopathic Short Stature**	
	(n)	**(%)**	**(n)**	**(%)**	**(n)**	**(%)**	**(n)**	**(%)**	**(n)**	**(%)**	**(n)**	**(%)**
Number (n)	32	100	26	21.66	13	10.83	34	28.33	25	20.83	22	18.33
Mean age (years)	9.28		9.27		8.44		9.24		9.86		9.65	
Gender												
Females (64)	17	53.12	13	50	10	76.92	18	52.94	12	48	11	50
Males (56)	15	46.87	13	50	3	23.07	16	47.05	13	52	11	50
High-Frequency Average (Mean±S.D)	4.37±6.46		5.59±7.53		4.57±7.62		7.31±9.33		6.74±10.24		4.05±2.99	
Pure Tone Average (Mean ± S.D)	3.13±4.56		4.06±5.11		3.71±3.11		5.35±5.99		5.07±6.04		3.60±3.67	

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There were 64 females and 56 males in the children examined and 17females and 15 males in controls. Among examined children 28.33% (n=34) subjects had Type-1 diabetes mellitus, 21.66% (n=26) had GHD, 20.83% (n=25) had obesity, 18.33% (n=220 had idiopathic short stature, and 10.83% (n=13) had precocious puberty. HFA and PTA in controls were 4.37±6.46 and 3.13±4.56 Hz respectively. In children with GHD, precocious puberty, Type-1 DM, obesity, and ISS, HFA was 5.59±7.53, 4.57±7.62, 7.31±9.33, 6.74±10.24, and 4.05±2.99 respectively, and PTA values respectively were 4.06±5.11, 3.71±3.11, 5.35±5.99, 5.07±5.99, and 3.60±3.67.

The normal hearing range was taken between 0-20dB, whereas, hearing loss was considered at HFA and PTA of >20dB. In total study subjects, PTA value of more than 20dB was seen in 2.5% (n=3) subjects, HFA value of >20dB was seen in 5% (n=6) subjects, and both PTA and HFA values of >20dB were also seen in 5% (n=6) subjects. These differences were statistically non-significant with respective p-values of 1.000, 0.465, and 1.000. Concerning comparison of the control group to GHD, precocious puberty, Type1 DM, obesity, and Idiopathic short stature for >20dB, the difference was found to be non-significant statistically (p>0.05). Individual values of these parameters are described in Table 2.

Table 2: HFA, PTA, and HFA and PTA values of more than 20dB in the study subjects

Characteristics	Controls (32)		Growth Hormone Deficiency (26)		Precocious Puberty (13)		Type 1 DM (34)		Obesity (25)		Idiopathic Short Stature (22)	
	n%	p	n%	p	n%	p	n%	p	n%	P	n%	p
HFA <20dB	1(3.125)	-	2(7.69)	0.326	0	1.0	3(8.82)	0.363	2(8)	0.314	0	1.0
PTA <20dB	1(3.125	-	1(3.84)	1.0	0	1.0	1(2.94)	1.0	1(4)	0.578	0	1.0
HFA and PT< 20dB	1(3.125	-	1(3.84)	1.0	0	1.0	1(2.94)	1.0	1(4)	1.000	0	1.0

Among 102 children studied, 18.6% (n=19) had tinnitus, and 8.82% (n=9) had vertigo. Concerning the individual parameter assessment for the presence of vertigo and tinnitus in study subjects, no statistically significant difference was seen for GHD, precocious puberty, Type1 DM, obesity, and Idiopathic short stature, as well as the whole study population, except for children with ISS where 22.7% (n=5) subjects reported tinnitus symptoms (p=0.04). In subjects with precocious puberty and ISS, no subject with PTA and HFA value >20dB had tinnitus/vertigo. Vertigo with PTA and HFA value >20dB was seen in 3.84% (n=1) subject with GHD, 5.88% (n=2) with Type1 DM, 4% (n=1) with obesity, and 3.06% (n=3) subjects in whole experimental group. Similarly, PTA and HFA value >20dB with tinnitus and vertigo was seen in 3.84% (n=1), 2.94% (n=1), 4% (n=1), and 2.04% (n=2) subjects with GHD, Type1 DM, obesity, and overall experimental group respectively (Table 3).

Table 3: Tinnitus and Vertigo in the study subjects

Parameter with scores	Controls (32)	Growth Hormone Deficiency (26)		Precocious Puberty (13)		Type 1 DM (34)		Obesity (25)		Idiopathic Short Stature (22)		Total (102)	
	n%	n%	p	n%	p	n%	p	n%	p	n%	P	n%	P
Tinnitus symptom 0/1	29(90.6)	22(84.6)		11(84.6)		27(82.35)		20(80)		17(77.2)		83(81.3)	

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Tinnitus symptom 2/3	3(9.37)	4(15.3)	0.341	2(15.3)	0.265	7(20.5)	0.14	5(20)	0.094	5(22.7)	0.044	19(18.6)	0.074
Pediatric vestibular symptom questionnaire 0/1	31 96.8%	24(92.3)		12(92.3)		30(88.2)		21(84)		21(95.4)		93(91.1)	
Pediatric vestibular symptom questionnaire 2/3	1(4)	2(7.69)	0.655	1(7.69)	0.572	4(11.7)	0.272	4(16)	0.131	1(4.54)	1.0	9(8.82)	0.263
HFA and PTA >20dB with Vertigo	0	1(3.84)	0.203	0	-	2(5.88)	0.242	1(4)	0.437	0	-	3(3.06)	0.347
HFA and PTA >20dB with Tinnitus and vertigo	0	1(3.84)	0.453	0	-	1(2.94)	0.494	1(4)	0.437	0	-	2(2.04)	0.580

DISCUSSION

The present study assessed 64 females and 56 males in the children examined and 17females and 15 males in controls. Among examined children 28.33% (n=34) subjects had Type-1 diabetes mellitus, 21.66% (n=26) had GHD, 20.83% (n=25) had obesity, 18.33% (n=220 had idiopathic short stature, and 10.83% (n=13) had precocious puberty. HFA and PTA in controls were 4.37±6.46 and 3.13±4.56 Hz respectively. In children with GHD, precocious puberty, Type-1 DM, obesity, and ISS, HFA was 5.59±7.53, 4.57±7.62, 7.31±9.33, 6.74±10.24, and 4.05±2.99 respectively, and PTA values respectively were 4.06±5.11, 3.71±3.11, 5.35±5.99, 5.07±5.99, and 3.60±3.67. These findings were similar to the studies by Kılıç K et al[7] in 2018 and McGaughran JM et al[8] in 2001where the values were comparable to those seen in the present study.

The normal hearing range in the present study was taken between 0-20dB, whereas, hearing loss was considered at HFA and PTA of >20dB. In total study subjects, PTA value of more than 20dB was seen in 2.5% (n=3) subjects, HFA value of >20dB was seen in 5% (n=6) subjects, and both PTA and HFA values of >20dB were also seen in 5% (n=6) subjects. These differences were statistically non-significant with respective p-values of 1.000, 0.465, and 1.000. Concerning comparison of the control group to GHD, precocious puberty, Type1 DM, obesity, and Idiopathic short stature for >20dB, the difference was found to be non-significant statistically (p>0.05). These findings were in agreement with the findings of Hwang JH et al[9] in 2009 and Allen DB et al[10] in 2013 where they reported similar hearing patterns in their examined population.

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study subjects, no statistically significant difference was seen for GHD, precocious puberty, Type1 DM, obesity, and Idiopathic short stature, as well as the whole study population, except for children with ISS where 22.7% (n=5) subjects reported tinnitus symptoms (p=0.04). In subjects with precocious puberty and ISS, no subject with PTA and HFA value >20dB had tinnitus/vertigo. Vertigo with PTA and HFA value >20dB was seen in 3.84% (n=1) subject with GHD, 5.88% (n=2) with Type1 DM, 4% (n=1) with obesity, and 3.06% (n=3) subjects in whole experimental group. Similarly, PTA and HFA value >20dB with tinnitus and vertigo was seen in 3.84% (n=1), 2.94% (n=1), 4% (n=1), and 2.04% (n=2) subjects with GHD, Type1 DM, obesity, and overall experimental group respectively. The relationship of tinnitus and vertigo in subjects with hearing loss and endocrine disorders is studied by few authors and has scarce data. However, these findings were comparable to the study of Kocyigit M et al[11] in 2020 where authors reported similar findings concerning vertigo and tinnitus in subjects with endocrine and metabolic diseases.

CONCLUSION

Within its limitations, the present study concludes that endocrine diseases manifested in childhood can lead to alterations in the inner ear with poorly understood etiology. However, the study suggests a balance examination and thorough hearing examination be done in all children visiting endocrinology clinics to detect and treat any associated abnormality at an early stage. However, the present study had few limitations including a smaller small size, shorter monitoring period, geographical area biases, and single-institutional nature. Hence, further longitudinal studies with a larger sample size and longer monitoring period are required to reach a definitive conclusion.

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