The Prevalence of Refractive Errors and Binocular Anomalies in Students of Deaf Boys Schools in Tehran

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Abstract

***Purpose*:** The association between deafness and ocular abnormalities is well established; however the nature and prevalence of these problems are diverse across the globe.

***Methods*:** A team of optometrists and social worker visited one hundred fifty eight deaf boy students at their schools and those who needed more detailed evaluation were referred to the Farabi Eye Hospital's strabismus clinic. These students in selected schools underwent detailed visual acuity testing, refraction, binocular examination, color vision and fundoscopy.

***Results*:** The percentage of ocular abnormalities in the deaf boys included in this study was 52.8%. The frequency of refractive errors in the present study was 39.9%. Astigmatism was the leading refractive anomaly (31%). Hypermetropia was found in 13.2% of the children and myopia was found in 12.6%. Anisometropia was detected in thirty children (19%) and amblyopia was found in 22 children (13.9%). A disturbance of ocular motility was present in 18 cases (11.3%). In 44 (28%) cases stereopsis was reduced, and in six (3.8%) cases it was absent. Majority of the students (89.9%) had congenital hearing loss. 6.3% children had color vision deficiency. Seventy four deaf boys (46.8%) had a normal eye examination, while 84 (53.2%) cases had ocular problems, and 20 (12.65%) of them had more than one problem. The prevalence of refractive error, amblyopia, and strabismus was found to be significantly increased compared to the general population. In addition, the prevalence of ocular abnormalities generally increased with the severity of the hearing loss.

***Conclusion*:** We recommended that screening for ocular abnormalities should be made mandatory in hearing-impaired children and parents must be aware of high prevalence of ocular abnormalities in deaf children, as they need appropriate visual sense to compensate their poor auditory sense.

***Keywords*:** Deafness, Hearing Impairment, Ocular Abnormalities, Refractive Errors, Strabismus

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Introduction

Ophthalmologic screening of visual problems in deaf children is very important because the most of knowledge is obtained through the senses of sight and hearing. When one of these is seriously impaired, the other is used to compensate. As the degree of impairment increases, the role of the remaining sense becomes progressively more significant. Thus, the deaf population may compensate by making greater use of visual-perceptual cues than their hearing peers, and thus even a mild refractive error may reduce the visual cues available to the child.[1,2]

The prevalence of ocular abnormalities among deaf children has been reported to vary from 33 to 60%[3-6] and also many researchers have reported high incidences of ophthalmologic abnormalities among deaf children compared with the hearing population of the same age.[3,7]

Therefore, particular attention must be paid to ocular abnormalities in deaf children, as their early detection and proper treatment are the best assurances for the maximum possible social and professional performance of these students and routine ophthalmologic screening of the deaf school is necessary to reduce the needless deaf-blind population.[8]

This study was set up to determine the prevalence of visual abnormalities among Iranian deaf boys student with mild, moderate, severe and profound hearing impairment and to make recommendations for their ophthalmological assessment.

Methods

The study sample consisted of one hundred fifty eight deaf boys from Tehran deaf schools with moderate, severe and profound hearing impairment. The hearing loss was assessed from previous examination in the school. The etiology of the hearing impairment was categorized as congenital and acquired. Acquired hearing impairment was due to, for example, prematurity or perinatal complications, meningitis, and other acquired infections. In all cases the better ear average was used to categorize the degree of hearing impairment. The severity of hearing impairment was classified as mild (40-55 dBHL), moderate (56-70 dBHL), severe (70-90 dBHL) and profound (>90 dBHL) deafness as per World Health Organization norms.

A team of optometrists and social workers visited each deaf boy at their school. The children were examined with a sign language expert near them and they responded by sign and those who needed more detailed evaluations were referred to the Farabi Eye Hospital's strabismus clinic. The optometric work-up included visual acuity assessment, stereopsis and color vision evaluation, gross confrontational field testing, binocular examination, retinoscopy and fundus examination.

Visual acuity at six meters with Snellen's E-Chart examined if oral communication was available. The criteria for visual impairment were visual acuity of $<^{4}/_{10}$ Snellen's E-Chart.

Binocular vision assessment was made using the cover test, and Titmus stereoacuity tests. Stereoacuity of 100 seconds of arc or better was accepted to demonstrate fine depth perception and was considered normal. Stereoacuity of more than 100 seconds was recorded as reduced and, where stereoacuity was not demonstrable, absent stereopsis was recorded. Ocular motility was assessed in nine positions of gaze, testing both ductions and versions.

Refractive errors and keratometry examined with Topcon 8800 auto Refractokeratometer and Beta 200 Heine retinoscope. Myopia was defined as an error more than or equal to -0.50 diopter (D), hypermetropia more than or equal to +1.00 D, and astigmatism more than or equal to ±0.75 D. Anisometropia was defined when refractive errors between two eyes were differed more than 0.75 D.

Amblyopia was defined as a difference of two lines or more between the two eyes and a best corrected vision of $^{20}/_{30}$ or worse resulting from anisometropia, strabismus or large astigmatic error.

Statistical analysis was carried out on the data. The χ^2 test was employed for the analysis of specified groups within the hearing impaired sample and 95% confidence limits were applied when comparing the findings of the present study against existing data.

Results

A total of 158 deaf students were examined. Their age range was 8-24 years with mean age of 16.34 years ±3.41 SD. All cases were

male. Majority of the students (89.9%) had congenital hearing loss.

3.8% of these students had visual impairment for distance in the better eye. The percentage of ocular abnormalities in the deaf boys, included in this study, was 53.2. Seventy four deaf boys (46.8%) had a normal eye examination, while 64 cases had ocular problems and 20 of them had more than one problem.

The frequency of refractive errors in the present study was 39.9%. Astigmatism was the leading refractive anomaly (31%). Hypermetropia was found in 13.2% of the children and myopia was found in 12.6%. Anisometropia was detected in thirty children (19%) and amblyopia was found in 22 deaf boys (13.9%). Only 6.1% of mild and moderate hearing loss had amblyopia and the prevalence of amblyopia within severe hearing loss (32.1%) was more than other severity of deafness. 39.9% of cases, as to American Academy of Ophthalmology guidelines, were in need of wearing glasses and only 14.9% of them had worn appropriate correction. 11.4% of deaf boys student had changes on their refractive errors and their glasses must be changed. 13.3% of them had never been examined before and we prescribed glasses for them for the first time.

We found that a significant relationship between refractive errors and severity of the hearing loss ($p<0.001$) and when severity of hearing loss increased prevalence of hyperopia, astigmatism, anisometroipia and stereopsis defect increased and myopia decreased.

26.2% of ocular abnormalities were within mild and moderate of hearing loss but 73.8% of ocular abnormalities were within severe and profound hearing loss.

When severity of hearing loss increased the prevalence of anisometropia significantly increased. 60% of deaf boys with profound hearing loss had anisometropia (>0.75 D).

6.3% of children had color vision deficiency most of which were Red-Green color defects. One boy was one-eyed. Two (1.2%) students had iris Heterochromia. They also had white forelock hair and together with the deafness were presumed to have Waardenburg syndrome.

A disturbance of ocular motility was present in 18 cases (11.3%). Six cases (3.8%) had unilateral esotropia and four cases (2.5%) had alternate esotropia. Exotropia was detected in 14 cases (7.6%), eight (5.1%) had constant and six (3.8%) had alternate exotropia. Intermittent exotropia and exophropia were present in 32 cases (20.3%). Ninety children (57%) had normal stereopsis. In 44 (28%) cases stereopsis was reduced, and in six (3.8%) cases it was absent. In 18 (11.3%) children, we were unable to identify the degree of stereopsis due to the lack of cooperation. The cases in which stereopsis was reduced were the cases with strabismus or retinal pathology with or without refractive errors.

Anterior segment anomalies were found in four children (2.5%). Heterochromia iridum was found in two patients who were recorded as having Waardenburg syndrome type II (Heterochromia iridum, white forelock, deafness). Retinal abnormalities were detected in ninety (12%) patients. Table 1 shows all ocular abnormalities in deaf boys.

All types of ocular abnormalities such as refractive errors, amblyopia and strabismus were not associated with the type and severity of hearing loss.

Table 1. Ocular abnormalities in deaf boys

Type of defect	No (%) affected
Refractive errors	63 (39.9%)
Hypermetropia	21 (13.29%)
Myopia	20 (12.65)
Astigmatism	49 (31%)
Anisometropia	30 (19%)
Amblyopia	22 (13.9%)
Mild	8 (5.1%)
Moderate	10 (6.3%)
Sevier	4 (2.5%)
Vision impairment	6(3.8%)
Strabismus	
Unilateral esotropia	18 (11.3%)
Alt & Acc esotropia	6 (3.8%)
Unilateral exotropia	4 (2.5%)
Alternate exotropia	8 (5.1%)
Int. exotropia and exophoria	6 (3.8%) 32 (20.3%)
Stereopsis	
Normal	121 (76.1%)
Reduced	14 (8.8%)
Absent	16 (10.1%)
Unidentified	8 (5%)
Color vision deficiency	10 (6.3%)
Ocular pathology	
Cornea/lens anomalies	4 (2.5%)
Retinal abnormality	19 (12%)
Heterochromia	2 (1.26%)

Discussion

Previous studies have reported the frequency of visual impairment among the entire hearing impaired population,[3-7] but failure to specify the degree of hearing impairment and the differences in the definition of visual impairment made comparisons between these studies difficult.

The prevalence of ocular abnormalities in this study population was relatively high (53.2%) among deaf school students in Tehran compared to previous studies reported to vary from 33 to 60%.[3-6] The prevalence of ocular abnormalities among deaf children in studies around the globe included the Turkish School for the deaf, 40.4 percent[3]; Deaf School, Kathmandu, Nepal, 23 percent[9]; Oregon School for the deaf (USA), 48 percent[10]; Deaf school, Benin, Nigeri, 73.2% and 178 (33%) having minor ocular abnormalities in Australia.[11] This study is close to the Oregon deaf school study in USA. Findings in the developed countries are higher. The relatively high findings in some studies are most likely attributable to the investigative procedure employed (for example, all the children in the Oregon deaf school study had electroretinogram). This means that even more subtle abnormalities were detected, hence the higher incidence. Refractive errors (39.9%) were the most common ocular abnormality in this study. Among these, astigmatism was the commonest (31%) while myopia and hyperopia were 12.6 and 13.2%, respectively. There have been some reports that high cylinder corrections are characteristic of deaf children.[6,12] In a previous study in our country, in the normal school children were shown to have a prevalence of astigmatism (>0.75 D) of 9.8% to 18%.[13] In our study, the prevalence of astigmatism (>0.75) was 31% which was significantly higher than normal population. This finding is consistent with other reports.[6,12] But, the reason for this increase in astigmatism in deaf children is not known.[6]

In a review of 49% patients with sensorineural hearing loss in tertiary care, University of California, San Francisco, USA, the investigators found hypermetropia to be the most common abnormality[14] that was different to the findings of our study. Table 2 compares the finding of this study with other similar studies in published literature.

In our study anisometropia (>1.00) was present in 19%. Anisometropia has been reported to occur in 3.7% of normal children[15] and in our country has been reported at rate of 3% to 4.2%.[13] The prevalence of anisometropia in our study among deaf boys was significantly higher than normal population.

Amblyopia was present in 13.9% of patients. Amblyopia (best corrected visual acuity in either eye worse than $^{20}/_{30}$) has been reported in normal children at a rate of 1.2%[14] and in our country has been reported between 0.9% and 4.3%.[13]

Amblyopia prevalence was significantly higher than in the normal population. This is due to ocular pathologies such as strabismus and anisometropia and retinal pathologies. Another reason for this may be the delay of diagnosis due to low socioeconomic level of the families.

Table 2. Comparison of ocular abnormalities in hearing-impaired children

Name	Country	Year	Cases examined	Ocular problem	Refractive error	Fundus abnormalities	Strabismus
Guy et al	United Kingdom	2003	122	110 (90.1)	43 (39.1)		
Hanioğlu-Kargi Se	Turkey	2003	104	42 (40.4)	31 (29.3)	9 (8.6%)	19 (18.2%)
Gogate et al	India	2008	901	216 (24%)	167 (18.5%)	10 (1.1%)	12 (1.3%)
Elango et al	Malaysia	1994	165	95 (57.6)	23 (13.9%)		
Armitage et al	UK	1995	87	35 (45.8)	24 (28.9%)	12 (12%)	20 (24%)
Siatkowski et al	USA	1994	54	33 (61.1%)	24 (44.4%)	3 (5.5%)	
Ma et al	China	1989	279	100 (35.8)	50 (17.9)	80 (28.6)	
Osaiyuwu et al	Nigeria	2009	86	63 (73.2%)	63 (73.26%)		
Nicol et al	Australia	1988	78	26 (33%)			
Present study	Iran	2013	158	84 (53.2%)	63 (39.9%)	19 (12%)	18 (11.3%)

The next most common ocular abnormalities were found to be amblyopia and strabismus, which has been determined at different rates in previous studies. The incidence of manifest strabismus has been cited as 1.3% and 3.7% from overseas studies.[1,16] In our study, 18/158 (11.3%) of the children had strabismus, which was significantly greater than in the normal population. In previous studies, strabismus prevalence was between 3.6% and 24.0% among deaf children.[6,12,16] Higher prevalence of refractive errors and strabismus in the hearing-impaired population, who may be amenable to spectacle, surgical or orthoptic treatment, makes early diagnosis essential because this population is specially dependent upon vision for their maximal cognitive, psychological and emotional development. Refractive errors and amblyopia are easily treatable and it would be a shame if such a hearing-impaired child does not get proper eye care attention.

Our study show that ocular abnormalities such as refractive errors, amblyopia and strabismus were not associated with the type of hearing loss that is consistent with Armitage`s finding[12] but the prevalence of refractive errors, amblyopia, and strabismus was found to be significantly increased from the general population. In addition, the prevalence of some ocular abnormalities such as hyperopia, astigmatism and anisometropia generally increased with the severity of the hearing loss.

In our study severity of hearing loss in deaf boys with refractive errors was significantly higher than those without refractive errors, and also prevalence of refractive errors in various severity of hearing loss was significantly different. In this study prevalence of refractive errors in student with profound hearing loss was more than students with mild and moderate hearing loss. Leguire also reported that prevalence of refractive errors in individuals with more than 80 db hearing loss was more than those with less than 80 db hearing loss but this difference was not significant statistically.

In Sharma's study the prevalence of refractive errors and non-refractive conditions such as strabismus, amblyopia, Nystagmus and so on generally did not have significant difference in various severity of hearing loss. In Janson study, low severity of hearing loss among people with significant ocular problems and those without ocular problems, did not have significant differences. Janson concluded from Sharma's and his own study that the low severity of sensory neural hearing loss is not the predicting factor for having any ocular abnormalities.

Results of this study are different with Sharma and Janson's studies and most similar to Leguire's. Sharma and Janson's study were on people with sensory neural hearing loss but our study and Leguire's were on deaf people (sensory neural and conductive). Janson mentioned that the reason for the differences of his study and Leguire's is that in his study well-known risk factors for ocular and hearing defects were omitted, and this can be the reason for the difference between our results and Janson's and the similarity of our results with Leguire's because in our study we included people with hearing loss with different etiologies of hearing loss. One reason for differences between our results and Sharma's probably is that in his study 16.4% of people had low degree hearing loss whereas it was 0% in ours and also in his study 23% of people suffered from unilateral hearing loss whereas in our study all students had bilateral hearing loss.

For more accurate investigation, in this study the relationship between refractive errors and the severity of hearing loss is evaluated both generally and one by one, whereas in other studies it is investigated generally.

The results of this study strongly suggest that deaf children have an increased prevalence of refractive errors, strabismus, amblyopia and other ocular abnormalities which necessitates earlier and more c omplete ocular examination. 39.9% of cases, as to American Academy of ophthalmology guidelines, were in need of wearing glasses and only 14.9% of them had worn appropriate correction. 13.3% of them had never been examined before and we prescribed glasses for them for the first time.

Conclusion

Visual screening plays an important role in order to detect visual problems related to refractive errors, strabismus and amblyopia. Ophthalmologists and optometrists play an important role in organizing such screening

programs so that related diseases may be diagnosed and treated. It must be kept in mind that this first step may be the starting point for the establishment of the hearing impaired patients educational, social and psychological well-being in the future.

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