



Original article

Prevalence of amblyopia and patterns of refractive error in the amblyopic children of a tertiary eye care center of Nepal

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Abstract

Introduction: Refractive error is a common cause of amblyopia. **Objective:** To determine prevalence of amblyopia and the pattern and the types of refractive error in children with amblyopia in a tertiary eye hospital of Nepal. **Materials and methods:** A retrospective chart review of children diagnosed with amblyopia in the Nepal Eye Hospital (NEH) from July 2006 to June 2011 was conducted. Children of age 13+ or who had any ocular pathology were excluded. Cycloplegic refraction and an ophthalmological examination was performed for all children. The pattern of refractive error and the association between types of refractive error and types of amblyopia were determined. **Results:** Amblyopia was found in 0.7 % (440) of 62,633 children examined in NEH during this period. All the amblyopic eyes of the subjects had refractive error. Fifty-six percent (248) of the patients were male and the mean age was 7.74 ± 2.97 years. Anisometropia was the most common cause of amblyopia ($p < 0.001$). One third (29 %) of the subjects had bilateral amblyopia due to high ametropia. Forty percent of eyes had severe amblyopia with visual acuity of 20/120 or worse. About two-thirds (59.2 %) of the eyes had astigmatism. **Conclusion:** The prevalence of amblyopia in the Nepal Eye Hospital is 0.7%. Anisometropia is the most common cause of amblyopia. Astigmatism is the most common types of refractive error in amblyopic eyes.

Key-words: anisometric amblyopia, astigmatism, cycloplegic refraction, Nepal

Introduction

Amblyopia is defined as a disorder of visual system characterized by a reduction in the best-corrected visual acuity with no organic pathology (von Noorden, 2001). Amblyopia is the most common cause of monocular visual impairment in both children and adults and it is commonly associated with refractive errors and or strabismus (Wu et al,

2006; Attebo et al, 1998). The current literature shows that amblyopia is common in patients with bilateral high ametropia and/or anisometropia in Nepal (Karki, 2006). However, none of the previously published articles on this subject have evaluated the pattern of refractive error in the amblyopic children of different age groups in this region. It has already been established that the type and amount of refractive error as well as the difference in refractive power between the two eyes are significant risk factors in the treatment failure of amblyopia (Hussein et al, 2004).

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The objective of this study was to determine the prevalence of amblyopia and the types as well as frequency of refractive error in the amblyopic children in a general eye hospital of Nepal. We also evaluated the data to see if there were any associations among age, sex and type of refractive error with the depth and type of amblyopia. The magnitude of refractive error in different types of amblyopia has also been determined.

Materials and methods

A retrospective medical record review was conducted on all children diagnosed with amblyopia in the Nepal Eye Hospital (NEH) from July 2006 to June 2011. Written informed consent was waived for this retrospective study through our investigational review board and the Health Insurance Portability and Accountability Act 1996 regulations were followed for all patients involved in this study. All children of age 13 or younger without any ocular pathology were included as amblyopia treatment is provided for this age group in the NEH.

All patients had a comprehensive eye examination including stereoacuity, ocular alignment, visual acuity (with and without correction), cycloplegic refraction and an indirect fundus examination. Visual acuity was measured by using a Snellen, Sheridan-Gardiner, Lea or HOTV chart depending on the age and the cooperation of children. Alignment was measured using either alternate prism cover testing, Krimsky test or synoptophore. Cycloplegic refraction was performed in each patient after instilling cyclopentolate 1% into each eye followed by tropicamide 1%. Cycloplegia was considered complete if the neutralizing power was effectively the same when a child looked at a distance or a near target. Children prescribed glasses were seen again in one month and an ocular examination was repeated. If the best corrected visual acuity (BCVA) was 20/30 or worse and the exam was otherwise normal they were diagnosed with amblyopia and included in the analysis.

The American Association for Pediatric Ophthalmology and Strabismus (AAPOS) guidelines were followed to classify the amblyopia (Donahue, 2003). We included all the types of amblyopia: strabismic (if manifest deviation present), refractive (anisometropic and ametropic) and stimulus deprivation. We further classified amblyopia as mild (with BCVA of 20/30 to 20/40), moderate (with BCVA 20/60 – 20/80) or severe (with BCVA of less than 20/80) (Singh et al, 2008).

Refractive errors were classified as myopia, hyperopia and/or astigmatism. Myopia was further classified as low ($< -3.00D$), moderate ($-3.00D$ to $-6.00D$) or high ($> -6.00D$); hyperopia as low ($< +3.00D$), moderate ($+3.00D$ to $+6.00D$), or high ($\geq +6.00D$); and astigmatism was further classified as low ($< 1.00D$), moderate ($1.00D$ to $1.75D$) and high ($\geq 2.00D$) (Pokharel et al, 2010). Astigmatism was additionally classified as simple hyperopic, simple myopic, compound hyperopic, compound myopic and mixed and further subclassified into with the rule, against the rule and/or oblique astigmatism. **Statistics:** The statistical analysis was done using SPSS 13 software and a p value of < 0.05 was considered statistically significant.

Results

Four hundred forty children were identified with amblyopia. In this five-year period, 62,633 children had been seen at the Nepal Eye Hospital, making the prevalence of amblyopia 0.7% in this tertiary eye care center.

All the 440 patients had significant refractive error in the amblyopic eye, based on the AAPOS referral criteria. The mean age of the subjects was 7.74 ± 2.97 years (3 - 13 years). There was no significant difference in the age between males and females presenting with amblyopia (Independent t test, $p > 0.05$). Fifty six percent (248) children were male. There was a statistically significant difference in the number of males and females (NPar, chi-square test, $p = 0.008$). However, the gender distribution varied

with age. In the five-year old age group, the number of males was more than double that of the females (44 versus 20) but in the nine-year old age group, the number of males was less than that of the females (15 versus 19) [Figure 1].

Anisometropia was found to be the main cause of amblyopia (Npar, Chi-square test, $p < 0.001$). The cause of amblyopia was anisometropia in 53% (233) and ametropia in 29% (125) of the subjects [Figure 2].

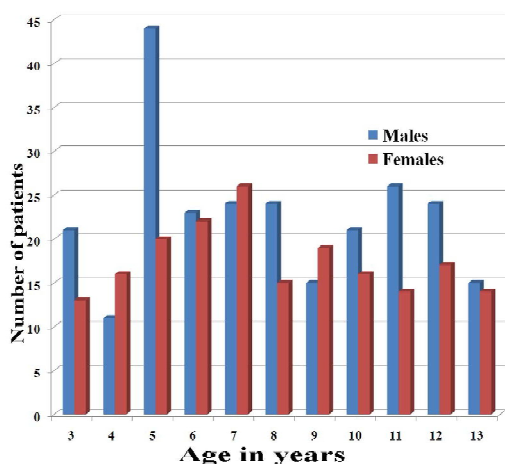


Figure 1: Age and gender distribution of the subjects at the time of their first hospital visit.

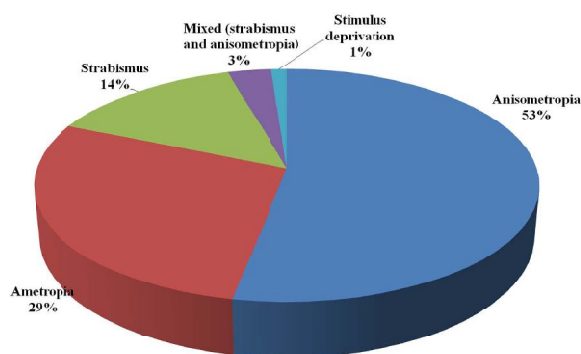


Figure 2: Causes of amblyopia.

Out of the 440 amblyopic subjects, 71% (315) had unilateral amblyopia and 29% (125) had bilateral amblyopia. There was a significant difference in the age of children with unilateral and bilateral amblyopia (independent t test, $p = 0.001$). Children with bilateral amblyopia were younger (mean age = 7.1 ± 2.7 years) compared to unilateral cases (mean age = 8.1 ± 3.1 years).

Among the patients with unilateral amblyopia, 59% (186) of the cases had the left eye involved. Amblyopia was found more common in the left eye (N Par, Chi-square test, $p = 0.001$).

In total, there were 565 eyes with amblyopia. The best-corrected visual acuity of the amblyopic eyes is shown in table 1. Forty-five percent of patients were classified as having moderate amblyopia and 40% with severe amblyopia. The depth of amblyopia was not associated with the age (one way ANOVA, $p > 0.05$) and gender (X^2 test, $p > 0.05$) of the subjects. One hundred and ten eyes (19.5%) had visual acuity of 20/200 or worse.

Astigmatism was the most common type of refractive error in amblyopic eyes (Npar, Chi-square test, $p < 0.001$). Out of 565 amblyopic eyes, astigmatism was found in 59.2% (335), simple hypermetropia in 33.5% (189) and simple myopia in 7.3% (41) of the eyes. In the group of astigmatic eyes, 24.8% (83) had mild, 39.7% (133) had moderate and 35.5% (119) had severe astigmatism.

Among the eyes with simple hyperopia, 25.9% (49) had mild, 54.5% (103) had moderate and 19.6% (37) had severe hyperopia. Similarly, in myopic eyes, 19.5% (8) had mild, 31.7% (13) had moderate and 48.8% (20) had severe myopia. The depth of amblyopia was not associated with the type of refractive error (Chi-square test, $p > 0.05$) [Table 2].

Table 1. Best corrected visual acuity (BCVA) of the amblyopic eyes.

BCVA	Number of eyes	Depth of amblyopia
20/2400	7 (1.2%)	Severe amblyopia (n = 226, 40%)
20/1200	6 (1.1%)	
20/600	8 (1.4%)	
20/400	7 (1.2%)	
20/300	8 (1.4%)	
20/240	11 (1.9%)	
20/200	63 (11.3%)	Moderate amblyopia (n = 254, 45%)
20/120	116 (20.5%)	
20/80	128 (22.7%)	
20/60	126 (22.3%)	Mild amblyopia (n = 85, 15%)
20/40	85 (15%)	
20/30	0 (0%)	
Total	565 (100%)	

Table 2: Relation between type of refractive error and type of amblyopia. [D- diopter, SD- standard deviation]

Types of refractive error ▶ Types of amblyopia ▼	Astigmatism Number of eyes (Percentage) (Mean astigmatism ±SD)	Simple hyperopia Number of eyes (Percentage) (Mean hyperopia ±SD)	Simple myopia Number of eyes (Percentage) (Mean myopia ±SD)	Total Number of eyes (Percentage)
Ametropic	152 (60.8%) (-1.86D±1.15D)	72 (28.8%) (+6.86D±2.58D)	26 (10.4%) (-8.63D±2.83D)	250 (100%)
Anisometropic	147 (63.1%) (-1.65D±1.15D)	77 (33%) (+3.95D±1.78D)	9 (3.9%) (-6.69D±4.55D)	233 (100%)
Strabismic	27 (42.9%) (-0.82D±0.81D)	30 (47.6%) (+2.06D±2.24D)	6 (9.5%) (-0.92D±0.90D)	63 (100%)
Mixed	6 (42.9%) (-0.83D±0.26D)	8 (57.1%) (+4.12D±1.69D)	0 (0%)	14 (100%)
Stimulus deprivation	3 (60%) (-2.25D±2.82D)	2 (40%) (+1.50D±0.71D)	0 (0%)	5 (100%)
Total	335 (59.3%) (-1.67D±1.17D)	189 (33.4%) (+4.74D±2.82D)	41 (7.3%) (-7.07D±3.88D)	565 (100%)

Table 3: Types of astigmatism in different types of amblyopia. [CHA- compound hyperopic astigmatism, CMA- compound myopic astigmatism, MA- mixed astigmatism, SMA- simple hyperopic astigmatism, SHA- simple hyperopic astigmatism]

Type of amblyopia	CHA	CMA	MA	SMA	SHA	Total
Ametropic	80 (52.6%)	55 (36.2%)	12 (7.9%)	3 (2%)	2 (1.3%)	152 (100%)
Anisometropic	88 (59.9%)	27 (18.4%)	17 (11.5%)	12 (8.2%)	3 (2%)	147 (100%)
Strabismic	14 (51.9%)	5 (18.5%)	1 (3.7%)	3 (11.1%)	4 (14.8%)	27 (100%)
Mixed	5 (83.3%)	1 (16.7%)	0 (0%)	0 (0%)	0 (0%)	6 (100%)
Stimulus deprivation	2 (66.7%)	0 (0%)	0 (0%)	0 (0%)	1 (33.3%)	3 (100%)
Total	189 (56.4%)	88 (26.3%)	30 (8.9%)	18 (5.4%)	10 (3%)	335 (100%)

Table 4: Types of astigmatism in different types of amblyopic eyes [WTR- with the rule, ATR- against the rule]

	WTR	ATR	Oblique	Total
Ametropic	125 (82.2%)	24 (15.8%)	3 (2%)	152 (100%)
Anisometropic	116 (78.9%)	23 (15.7%)	8 (5.4%)	147 (100%)
Strabismic	20 (74.1%)	7 (25.9%)	0 (0%)	27 (100%)
Mixed	4 (66.6%)	1 (16.7%)	1 (16.7%)	6 (100%)
Stimulus deprivation	2 (66.7%)	1 (33.3%)	0 (0%)	3 (100%)
Total	267 (79.7%)	56 (16.7%)	12 (3.6%)	335 (100%)

Among the astigmatic eyes, compound hyperopic astigmatism was found in 56.4% (189), compound myopic astigmatism in 26.3% (88), mixed astigmatism in 8.9% (30), simple myopic astigmatism in 5.4% (18) and simple hyperopic astigmatism in 3% (10) eyes. In another classification, 79.7% (267) had with the rule, 16.7% (56) had against the rule and 3.6% (12) had oblique astigmatism (Table 3, Table 4)

Discussion

Prior to the completion of this study, we believed that the prevalence of amblyopia would be higher in a hospital-based setting. However, through this chart review study in the Nepal Eye Hospital, we determined that the prevalence of amblyopia was only 1% of the general pediatric population in this tertiary eye care center. This is a lower incidence in comparison to the 2-3% found in other studies of the general population (Howel et al, 1983). One of the possible reasons for this low prevalence may be because parents are unaware of visual problems in their children and do not visit their eye physicians as a result. Another possibility is that vision screening for children in Nepal is inadequate. This highlights the insufficient availability and access of vision screening programs to the children in our country. Another factor may be due to the high threshold level of primary care givers for referring



children with visual problems to a specialist as well as parents not following through with appropriate referral for re-examination with an optometrist. Further study and analysis needs to be done to appropriately determine the factors contributing to this low prevalence of amblyopia in children.

In our study, the number of males with amblyopia was significantly higher. Lee et al (2010) also found similar gender difference among the amblyopic children. However, contrary to our findings, the number of female children with amblyopia was higher in the studies by Park et al (2011), Chua et al (2004), and Simons et al (1999). An explanation for this discrepancy may be due to the bias that fewer girls are seen in our hospital-based setting compared to the boys in our patriarchal society.

Anisometropia was the most common cause of amblyopia found in our study, presenting in 53% of subjects. In contrary to our study, in a study of Menon et al (2005), the most common subtype of amblyopia was strabismic amblyopia comprising 37% of the total 733 eyes. But in our study, strabismic amblyopia was found in only 14% of the subjects. The low prevalence of strabismic amblyopia in this study was unclear.

Ametropic amblyopia was found as the second most common cause of amblyopia. We identified 29% of the subjects with bilateral amblyopia. Our findings are consistent with those of Chung et al (2008), where about half (49%) of the amblyopic patients were found to have bilateral amblyopia. However, in the literature, bilateral amblyopia was very uncommon. Bilateral amblyopia was found in 7% of the 783 amblyopic patients in a study conducted in India (Menon et al, 2005). The higher proportion of subjects with bilateral amblyopia in our study may be because many children who visited this hospital had high ametropia. This also reflects the unawareness of Nepalese parents about the poor sight of their offspring.

In unilateral cases, we found amblyopia to be more common in the left eye. Similar findings have been reported in other studies as well (Repka et al, 2010;

Woodruff et al, 1994). However, no clear explanation could be given to justify this unique laterality.

Overall, 60% of the eyes had mild to moderate amblyopia and 40% had severe amblyopia. This may be because one-third of the subjects had bilateral amblyopia due to high ametropia and visual acuity was better in eyes with bilateral amblyopia than the eyes with unilateral amblyopia (Lesueur et al, 1998). Visual acuity of 20/80 was found in the highest number of amblyopic eyes. We determined that the depth of amblyopia was not associated with the age and gender of the subjects.

Significant refractive error was found in all of the amblyopic eyes. The majority of the amblyopic eyes (59.2%) were astigmatic. In a recent Chinese study (Xiao et al, 2011), 92% of amblyopic eyes were found to have clinically significant astigmatism. In another study by Lam et al (1991), 50% of the eyes had astigmatism. In Nepal, astigmatism was found in only 35% of the cases in the general population (Pant et al, 2010). This shows that the prevalence of astigmatism is higher in amblyopic children. Only one-third of the amblyopic eyes had simple hyperopia and less than one-tenth of the eyes had simple myopia.

The type of refractive error was found to be associated with the type of amblyopia. Astigmatism was the most common type of refractive error in ametropic and anisometropic amblyopia. In ametropic amblyopia, the mean hyperopia was $+6.86D \pm 2.58D$. This indicates that high ametropia is the risk factor for bilateral amblyopia. The magnitude of myopia was more than that of hyperopia (mean myopia was $-8.63D \pm 2.83D$) in this group. This may be due to the fact that children with myopia can see near objects better than children with similar magnitude of hyperopic refractive error. However, the mean astigmatism was $-1.86 DC$ in ametropic amblyopia. This apparent low astigmatism might be due to the higher spherical components in the astigmatic eyes. The mean myopia was higher in the anisometropic



amblyopic eyes also. In strabismic amblyopic eyes, the mean hyperopia was $+ 2.06 D \pm 2.24 D$ but both myopia and astigmatism were less than one diopter. This is because; the cause of strabismic amblyopia was strabismus not the refractive error.

Consistent with other studies, compound hyperopic astigmatism was found as the most common type of astigmatism in our study, comprising 43% of the astigmatic errors in our subjects. In a study of amblyopic children by Gupta et al (1973), 79% of the participants were found to have compound hyperopic astigmatism. In the Chinese study (Xiao et al, 2011), compound hyperopic astigmatism was determined to be the most common type of astigmatism (39%). In another classification of astigmatism, with the rule astigmatism was found as the most common types of astigmatism, as in another study by Xiao et al (2011).

By determining and defining the patterns and prevalence of amblyopia in Nepal, we will now be more likely be able to design more effective treatment plans to reduce and or eliminate this preventable disease in children. Referring the children with anisometropia, strabismus, high ametropia, and astigmatism to the pediatric ophthalmology clinic will definitely help the timely diagnosis and management of the amblyopia.

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