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Association between astigmatism and amblyopia.

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Purpose: The aim of this study was to determine the association between stigmatism and amblyopia.
Methods: It was a hospital based, cross-sectional retrospective study conducted in Nepal Eye Hospital. Medical record of amblyopic children aged 13 years or younger from were reviewed. Children with amblyopic eyes due to simple astigmatism were included. Relation between depth of amblyopia with magnitude and types of astigmatism, orientation of axis was determined. Out of 139 amblyopic eyes of 82 children, 93 were simple myopic astigmatism and remaining 42 were simple hyperopic astigmatism.
Results: Mean age of patients was 7.38±2.61 years. Visual acuity improved by at least one line in Snellen chart in 4/5th of eyes after astigmatic correction. Moderate amblyopia was found to be present in 45% eyes while severe amblyopia in 16% of eyes. With the rule astigmatism was found to be present in 88% eyes. Mean astigmatism was 2.47±0.98D and majority of eyes (67.7%) had high astigmatism. Depth of amblyopia was not associated with magnitude of astigmatism ($p > 0.05$) but number of lines improved with astigmatic correction was correlated with the magnitude of astigmatism ($p < 0.001$). Risk of amblyopia is more in high myopic astigmatism.
Conclusion: Presenting age of amblyopic children was late in Nepal. Depth of amblyopia was not associated with magnitude of astigmatism.

Key words: Amblyopia, High myopic astigmatism, Myopic children, Simple myopic astigmatism, With-the-rule astigmatism

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1. Introduction

Amblyopia is a disorder of the visual system that is characterized by decrease in the best corrected visual acuity (BCVA) in an eye with no organic pathology[1]. Amblyopia is common in patients with anisometropia and high refractive error[2]. Weakley conducted a study to determine the risk factors of amblyopia and found that risk of amblyopia is higher in astigmatism of more than 1.50D[3] . Xiao found that astigmatism is the most common type of refractive error in amblyopic patients[4] . Optical correction of astigmatism should be provided prior to age three to five years, to prevent development of amblyopia[5] . However, none of these studies answer that what type of astigmatism are more amblyogenic and how orientation, types and magnitude of astigmatism affect the amblyopia.

In this study, we determined association between astigmatism and amblyopia. Effect of different type and magnitude of astigmatism on amblyopia was evaluated. Only cases with simple astigmatism were included so that it gives the direct relationship between amblyopia and pure astigmatism. The findings of this study are thought to be helpful for the vision scientists and eye care practitioners to reduce the effect of this monocular blinding disease.

2. Methods and methodology

It was a hospital based retrospective and cross-sectional study. Medical record review of patients diagnosed with amblyopia in orthoptics department of Nepal Eye Hospital was done. All patients with simple astigmatism in amblyopic eyes and age 13 years or younger were included in this study. Patients with ocular pathology or manifest squint were excluded. Written informed consent according to protocol conforming to the Declaration of Helsinki was waived for this retrospective study thorough our investigational review board. Health Insurance Portability and Accountability Act 1996 regulations were followed for all patients involved in this study.

All the patients had a comprehensive eye examination including visual acuity [unaided visual acuity and best corrected visual acuity (BCVA)], ocular alignment, cycloplegic refraction and an indirect fundus examination. Visual acuity was measured using Snellen or HOTV chart depending on the age and cooperation of patients. Alternate cover test, prism cover test and/or synaptophore were performed for the evaluation of eye alignment. Cycloplegic refraction was performed in each patient after instilling cyclopentolate 1% in each eye. The refraction and comprehensive ophthalmology examination were performed by a pediatric optometrist.

Amblyopia was classified by the American Association for Pediatric Ophthalmology and Strabismus guidelines[6]. We included only refractive amblyopia (ametropic and anisometropic) with simple astigmatism in amblyopic eyes. This was done to determine the association between pure astigmatism and amblyopia. Depth of amblyopia was classified into three groups, mild (with BCVA 20/30 to 20/40), moderate (with BCVA 20/60 to 20/80) or severe (with BCVA less than 20/80)[7] . Astigmatism was classified as mild (<1.00D), moderate (1.00D to 1.75D) and high ($\geq$ 2.00D)[8] . The data were analysed with Statistical Package for Social Sciences (SPSS Inc. Chicago, IL, USA) software. Independent sample t test, Pearson correlation, one-way ANOVA with Post Hoc, Pearson chi-square test were done and p value of less than 0.05 was considered as statistically significant.

3. Results

One hundred and thirty-seven amblyopic eyes of 83 children were included in this study. Fifty-four children had bilateral amblyopia and remaining 29 had unilateral amblyopia. 52% (43) were females and 48% (40) were males. In the group of unilateral amblyopic eyes, 18 (62%) had amblyopia in left eyes and 11 (38%) had in right eyes.

Mean age of patients was 7.36±2.64 years. The mean age of children was 6.69±2.28 years in the group of bilateral amblyopia while it was 8.62±2.82 years in the group of unilateral amblyopia. There was not difference in the age of males and females (Independent sample t test, t = 0.221, p > 0.05). Out of 137 eyes with amblyopia, vision did not improve with astigmatic correction in 21.2% (29) eyes. Vision improved by 5 lines in 3.6% (5) eyes, 4 lines in 6.6% (9) eyes, 3 lines in 9.5% (13), 2 lines in 25.5% (35) and one line in 33.6% (46) eyes after refractive correction. Mean number of lines improved by correction was 1.58±1.31. There was not significant difference between males and females on the number of lines improved with correction (independent t test, t = -0.283, p > 0.05). There was no statistically significant correlation between age of patients and the number of lines improved by astigmatic correction (Pearson Correlation, p > 0.05).

Table 1 shows the BCVA of amblyopic eyes. Mild amblyopia was found in 38.9% of eyes while moderate in 45.3% of eyes. Depth of amblyopia was not associated with age (Oneway ANOVA, F = 0.982, P > 0.05) and gender of patients (Chi-Square test, X2 = 2.647, P > 0.05). Similarly, depth of the amblyopia was not related with the number of lines improved with the correction of astigmatism (One-way ANOVA, F = 1.868, p > 0.05).

Table 1. BCVA of amblyopic eyes.

BCVA	Number of eyes	Percent	Depth of amblyopia
6/9	0	0	Mild(54, 38.9%)
6/12	54	38.9	
6/18	47	33.8	Moderate(63, 45.3%)
6/24	16	11.5	
6/36	16	11.5	Severe(22, 15.8%)
6/60	3	2.2	
4/60	1	0.7	
3/60	2	1.4	
Total	139	100	

As shown in figure 1, myopic astigmatism was found in two thirds (97) of eyes. Type of astigmatism (myopic or hyperopic) was not associated with the age (independent t test, t = -1.091, p > 0.05) and gender of patients (Pearson Chi-Square test, X2 = 0.866, p > 0.05). Similarly, it was not associated with number of lines of improvement of vision by astigmatic correction (independent sample t test, t = 1.562, p > 0.05), depth of amblyopia (Pearson Chi-Square tests, X2 = 3.495, p > 0.05), and magnitude of astigmatism (independent sample t test, t = -0.246, p > 0.05).

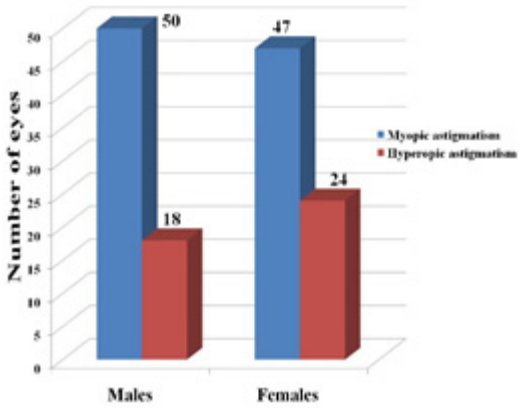

Figure 1. Types of astigmatism by gender.

With The Rule (WTR) astigmatism was found in majority of eyes [Figure 2]. Orientation of axis of astigmatism was not associated with age (one-way ANOVA, F = 0.598, p > 0.05), gender (Pearson chi-square test, X2 = 0.168, p > 0.05), number of lines of vision improvement after astigmatic correction (one-way ANOVA, F = 0.01, p > 0.05) and depth of amblyopia (Pearson chi-square test, X2 = 4.122, p > 0.05). Magnitude of astigmatism was significantly associated with the orientation of axis of astigmatism (one-way ANOVA, F = 4.623, p = 0.011). Patients with WTR astigmatism had high magnitude of astigmatism followed by with oblique astigmatism and least astigmatism in patients with against the rule (ATR) astigmatism. Orientation of astigmatic axis was not associated with the types of astigmatism, myopic or hyperopic (Pearson chi-square test, X2 = 0.311, p > 0.05).

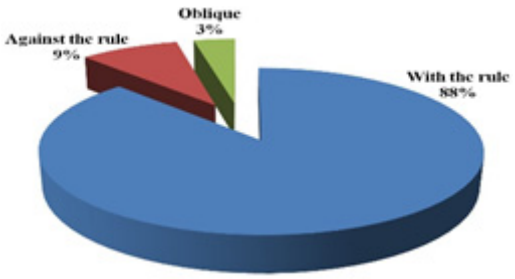

Figure 2. Types of astigmatism

depending upon orientation of the axis.

Mean astigmatism of eyes was 2.47±0.98D with range 0.75D to 5.50D. Majority of eyes (67.7%) had high astigmatism [Figure 3]. Age of patients and magnitude of astigmatism were positively correlated but statistically non-significant (p = 0.128). Magnitude of astigmatism was not associated with gender (independent sample t test, t = -0.572, p = 0.568) and depth of amblyopia (One-Way ANOVA, Post Hoc test, F = 0.819, p = 0.443). The number of lines improved with astigmatism correction was highly significantly correlated with the magnitude of the astigmatism (Pearson Correlation, p = 0.000).

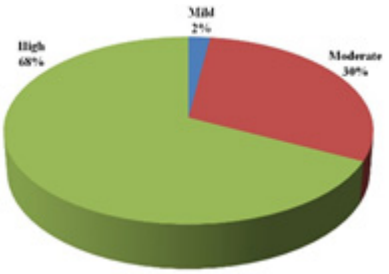

Figure 3. Severity of astigmatism.

4. Discussion

Mean age of patients was 7.38±2.61 years. This indicates that presentation age is higher in Nepalese amblyopic children. This may highlight the insufficient vision screening programs in the country. It may also be due to unawareness of parents to their children's visual problems. Presenting age of anisometropic amblyopic children was late in comparison to bilateral amblyopia due to ametropic in our study. Our finding was consistent with the study by Woodruff et al9) . They also found that presenting age of anisometropic amblyopic patients was late in comparison to strabismic and ametropic amblyopic patients. This might be due to the fact that in children with anisometropic amblyopia, fellow eye may be normal so that daily activities of children may not be bothered.

In our study, visual acuity improved by at least one line in 4/5th of eyes by astigmatic correction. Improvement by one line was most frequently observed and five lines improved in some eyes. Harvery et al. found that astigmatic children do not attain normal levels of visual function10) . Improvement of visual acuity with astigmatic correction was found not to be associated with

age and gender of patients and also with depth of amblyopia.

We found that moderate amblyopia is common in patients with astigmatism and severe amblyopia was found only in 16% of eyes. This might be due to the fact that astigmatic eyes have normal focus in one meridian so normal visual development occurs in that meridian reducing the chance of severe amblyopia. Not surprisingly, depth of amblyopia was found not to be associated with age and gender of patients.

Myopic astigmatism was found to be more common than hyperopic astigmatism. This might be due to the fact that eyes with hyperopic astigmatism can accommodate in some extent so that circle of least confusion lies on the retina. This was consistent with the results of Dobson et al.11). They found meridional amblyopia in myopic astigmatism but not in hyperopic astigmatism. However, type of astigmatism was found not to be associated with age, gender of patients and depth of amblyopia or magnitude of astigmatism.

WTR was the most common type of astigmatism. It was found to be present in more than 4/5th of the eyes. It was consistent with other studies. In a study by Cowen and Bobier, WTR astigmatism was the most frequent form (45%) followed by ATR (40%) and oblique (15%) 12). Similarly, in a study by Dobson and coworkers11) there was high prevalence of ATR astigmatism in infants and toddlers, which disappears by the time the children reach school age. Our findings showed that orientation of the axis of astigmatism was not associated with age and gender of patients. Abrahamsson and Sjostrand13)found that the angle of astigmatic axis strongly relates to the risk of developing amblyopia. Axes +/- 15 degrees from the main axes did not affect the risk of amblyopia but oblique astigmatism significantly increased the risk of developing amblyopia. Confounding to their study, Orientation of axis of astigmatism was found not to be associated with the depth of amblyopia. Our study also showed that patients with WTR astigmatism had high magnitude of astigmatism in comparison to ATR astigmatism. However, the number of other types of astigmatism was low in our study which may not give an exact figure.

5. Conclusions

In our study, majority of the eyes with astigmatism had high astigmatism. This indicates that the higher the amount of astigmatism, the higher the risk of amblyopia. Before this study, we had thought that higher the magnitude of astigmatism, the higher the chance of severe amblyopia. But this study showed that depth of amblyopia was not associated with the magnitude of astigmatism. Possible reason of this may be due to the fact that higher the astigmatism, greater the chance of early diagnosis and treatment. And our results also showed that magnitude of astigmatism is correlated with the number of lines improved with astigmatism correction.

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