ABSTRACT

Amblyopia is a common cause of visual impairment in children. The aim of this study was to assess the profile of amblyopia and the outcome of occlusion therapy in amblyopic children attending the eye department of a tertiary care hospital. This was a hospital based prospective interventional study. Sixty-five eyes of 47 patients fulfilling the inclusion criteria were included in the study. Occlusion therapy was started for the diagnosed amblyopic cases after refractive adaptation of 4 weeks. The mean age of presentation was 8.8 ±3.2 years. 29(61.7%) cases had unilateral amblyopia, 18(38.3%) cases had bilateral amblyopia. Ametropic amblyopia (52.3%) was the most common type of amblyopia followed by Anisometropia (23.1%). Refractive error was the most common cause of amblyopia with compound myopic astigmatism seen among 30.8% and hypermetropia among 29.2% of patients. There was no significant association between initial visual acuity with age of presentation and types of amblyopia respectively (P=0.1, P=0.5). The final visual outcome after therapy was better among patients with Ametropic amblyopia than other types (P=0.02). There was significant association between final visual outcome with age, initial visual acuity, type and severity of amblyopia respectively (P<0.001, P<0.001, P=0.02, P=0.02). In conclusion, Ametropia was the most common type of amblyopia. The mean age of presentation was 8.8 years, which was beyond the critical period affecting the outcome of treatment. Uncorrected refractive error was the most common amblyogenic factor. Age of presentation, types and severity of amblyopia are the important contributing factors for the outcome of occlusion therapy. Therefore, early detection and management of amblyopia is important to reduce visual impairment among children.

KEYWORDS
Amblyopia, Refractive error, occlusion therapy, Nepal

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INTRODUCTION

Amblyopia is defined as a unilateral or bilateral decrease in visual acuity caused by deprivation of pattern vision or abnormal binocular interaction without detectable cause.\(^1\) It is the most common cause of monocular blindness globally.\(^2-4\) In Nepal, prevalence has been reported to be 0.9 - 1.8%.\(^5-7\) The different causes of amblyopia include strabismus, anisometropia, bilateral high-refractive errors, form deprivation, high astigmatism or a combination of two or more etiologies in the same patient. Though the causes are different, the basic mechanisms of either abnormal binocular interactions between two eyes or form deprivation in one or both eyes remains same in all cases of amblyopia.\(^8-10\)

The mainstay of amblyopia treatment is occlusion therapy with patching of sound eye along with optical correction. Outcome of occlusion treatment depends on age at presentation, types and severity of amblyopia, initial visual acuity and treatment compliance.\(^11\)

In Nepal, few retrospective studies on clinical profile of amblyopia and outcome of occlusion therapy have been reported. This study analyzed the clinical profile of amblyopia and outcome of occlusion therapy in amblyopic children.

MATERIALS AND METHODS

This prospective, hospital based interventional study was done in outpatient department of Ophthalmology at Nepal Medical College Teaching Hospital (NMCTH) from January 2016 to July 2017. Ethical clearance was taken from Nepal Medical College- Institutional Review Committee (NMC-IRC). Informed consent was taken from the parents before enrolling children in the study. Consecutive sampling method was used in this study. All children below 18 years with the diagnosis of amblyopia were included in this study. Children with stimulus deprivation amblyopia were excluded from the study due to different modalities of treatment for them.

Detailed history regarding age of onset and past occlusion treatment was recorded. Ophthalmic examination included visual acuity by Snellen vision chart, cycloplegic refraction by streak retinoscope. Thorough anterior and posterior segment evaluation was done using Takaji Slit lamp biomicroscopy and indirect ophthalmoscopy. Ocular alignment was assessed by cover-uncover test and prism cover test. Binocularity was assessed by Worth four dot test and synaptophore.

Amblyopia was defined as a reduction of best-corrected Snellen acuity to less than 6/9 (20/30) in one eye or a two-line difference between the two eyes, with no visible signs of eye disease.\(^12\)

Amblyopia was classified into following different types.\(^13\)

**Ametropic:** If there is amblyopia in both the eyes with the spherical equivalence of refractive error of more than 1D.

**Anisometropic:** amblyopia in the presence of anisometropia of 1D of spherical equivalence or the 1.5D of astigmatism. Strabismic: amblyopia in presence of heterotropia at distance/near or history of strabismus surgery in past

**Combined:** amblyopia in the presence of both strabismus and anisometropia

**Stimulus deprivation:** patients with known documented cases of sensory deprivation (ptosis, cataract or other media opacities) with no primary heterotopias or refractive error that could be causally related to amblyopia.

Based on visual acuity, Amblyopia was also categorized into different severity: \(^14\) mild when visual acuity was 6/9 to 6/12, moderate when visual acuity was 6/18 to 6/24 and severe when visual acuity was 6/36 or less. The severity of refractive error was graded as mild, moderate and severe. Mild: when myopia and hyperopia of up to 2D spherical equivalence, astigmatism of 1D, moderate: when hyperopia and myopia of >2D to 5D spherical equivalence, and astigmatism > 1D to 3D and high refractive error when myopia and hyperopia of >5D spherical equivalence and the astigmatism more than 3D.

All the diagnosed cases of amblyopia were prescribed occlusion therapy along with 2hrs of near activities after refractive adaptation of 4weeks. Children with mild to moderate amblyopia were treated with 2hrs patching of sound eye. For severe amblyopia 6 hours of patching was advised. Cases with Ametropic amblyopia were prescribed patching of alternate eyes. Patching was done using Surgiclude Orthoptic Eye Patch. Follow up was done at 3weeks, 3months and 6months after instituting patching regime. To make sure that patient is adhering to treatment protocol, in every follow-up visit history was taken about the hours of patching being done and the hours of near activities done during patching time. Visual acuity of 6/9 or better in the amblyopic eye or acuity of no more than 1 line worse than sound eye or end of 6 month was considered as end point of treatment.
Data was collected in research proforma. Data entry and statistical analysis were done using SPSS version 16. Chi square test was used to find the association between categorical variables. P value <0.05 was considered significant.

**RESULTS**

A total of 65 amblyopic eyes of 47 patients were included in this study. Twenty (42.6%) of the cases were male while twenty-seven cases (57.4%) were females. The mean age of the patients was 8.8±3.2 years (range 5-16 years). Median age was 8 years. Among 47 amblyopic cases, twenty-nine cases (61.7%) had unilateral amblyopia, while eighteen cases (38.3%) had bilateral amblyopia. Among unilateral cases; in 18 (38.3%) cases left eyes were affected and in 11 (23.4%) right eyes were affected (Table 1).

Among 65 amblyopic eyes, the most common type of amblyopia was Ametropic amblyopia (52.3%, n=34), followed by Anisometric (23.1%, n=15), Strabismic (13.8%, n=9) and combined type (10.8%, n=7). Among 47 amblyopic cases, twenty-nine cases (61.7%) had unilateral amblyopia, while eighteen cases (38.3%) had bilateral amblyopia. Among unilateral cases; in 18 (38.3%) cases left eyes were affected and in 11 (23.4%) right eyes were affected (Table 1).

We found that there was no statistically significant association (P= 0.55) between types of amblyopia and visual acuity at presentation. Seventy three percent of cases with Ametropic amblyopia had an initial visual acuity between 6/18-6/36.

The type of refractive error associated with amblyopia was also analyzed (Table 3). Compound myopic astigmatism (n=20, 30.8%) was most frequently found in amblyopic eyes, followed by hyperopia (n=19, 29.2%). Most of them had moderate refractive error (63.1%, n=41), followed by severe refractive error (24.6%, n=16 cases). Compound myopic Astigmatism (38.2%) was significantly (P=0.022) higher among those with Ametropic Amblyopia.

### Table 1: Characteristics of Amblyopic Patient

| Variables        | n  | %   |
|------------------|----|-----|
| Gender           |    |     |
| Male             | 20 | 42.6|
| Female           | 27 | 57.4|
| Age              |    |     |
| 5-7 years        | 21 | 44.7|
| 8-10 years       | 16 | 34.0|
| 11-16 years      | 10 | 21.3|
| Binocularity     |    |     |
| Unilateral       | 29 | 61.7|
| Bilateral        | 18 | 38.3|
| Laterality       |    |     |
| Right eye        | 11 | 23.4|
| Left eye         | 18 | 38.3|

### Table 2: Types and Severity of Amblyopia

| Variables               | n  | %   |
|-------------------------|----|-----|
| Types of Amblyopia      |    |     |
| Ametropic               | 34 | 52.3|
| Anisometric             | 15 | 23.1|
| Strabismic              | 9  | 13.8|
| Combined                | 7  | 10.8|
| Severity of Amblyopia   |    |     |
| Mild                    | 5  | 7.7 |
| Moderate                | 15 | 23.1|
| Severe                  | 45 | 69.2|

### Table 3: Types of Refractive Error in Amblyopic eyes

| Types of refractive error | n  | %   |
|---------------------------|----|-----|
| No error                  | 1  | 1.5 |
| Simple Myopia             | 2  | 3.1 |
| Simple Myopic astigmatism | 7  | 10.8|
| Compound Myopic astigmatism | 20 | 30.8|
| Simple Hyperopia          | 19 | 29.2|
| Simple Hyperopic astigmatism | 1  | 1.5 |
| Compound Hyperopic astigmatism | 8  | 12.3|
| Mixed astigmatism         | 7  | 10.8|

Fig.1: Association between age of presentation and final visual acuity
There was statistically significant association between severity of refractive error and visual acuity at presentation (P=0.005). 68.3% of amblyopic eyes with moderate refractive error had visual acuity between 6/18-6/36 at presentation. Fifty six percent of patients with severe refractive error had a visual acuity of 6/60 or less at presentation.

The association between the age of presentation and the visual acuity at presentation was not statistically significant (P=0.15). However, the final visual acuity in relation to age of presentation was found to be significant. (P=0.00) (Table 4, Fig. 1)
There was statistically significant (P=0.00) association between visual acuity at presentation and visual acuity after treatment. All of the patients with initial visual acuity ranging from 6/9-6/12 had final visual acuity better than 6/12. About 70.7% of amblyopic eyes with initial Visual acuity between 6/18-6/36, had final vision better than 6/12. Only 10.5% of amblyopic eyes with initial vision 6/60 or less had 6/12 or better vision at the end. About 36.8% of them had a final visual acuity of 6/60 or less (Table 5, Fig. 2).

There was a significant association between severity of refractive error and final visual acuity (P=0.019). Almost 71% of amblyopic eyes with moderate refractive error had final visual acuity of 6/12 and better. About 44% of the patients with severe refractive error had final visual acuity ranging from 6/18-6/36 at the end of treatment (Table 6, Fig. 3).

This study showed statistically significant association between types of amblyopia and treatment outcome in terms of lines of visual acuity improvement (P=0.005). Among children with Ametropic amblyopia, 29.4% had 2 lines of improvement, 23.5% had 4 lines of improvement, 17.6% had complete resolution and 5.9% had no improvement. In Anisometric amblyopia 40% had 3 lines of improvement, 13.3% had 2 lines and 1 line improvement respectively. There was no improvement in 13.3% of eyes with Anisometropia. In Strabismic amblyopia 55.6% had no improvement and 11.1% had complete resolution. In combined type of amblyopia 57.1% had no visual improvement and none of the cases had complete resolution. In terms of final visual acuity, 70.6% of Ametropic and 60.0% of Anisometric amblyopia had final visual acuity of 6/12 or better. About 43% of combined and 33.3% of Strabismic amblyopia had significantly lower final visual acuity of 6/60 or less at the end of study. (P=0.002) (Table 7, Fig. 4).

The association between the severity of amblyopia and outcome of treatment in terms of lines of visual acuity improvement was also studied. 80% of mild amblyopic eye had complete resolution and 20% had 1 line improvement. In moderate amblyopia only 12.2% had complete resolution and 31.7% had 2 lines improvement and 14.6% had no improvement. None of the eyes with severe amblyopia had complete resolution. This was statistically significant (P=0.000). There was statistically significant association between severity of amblyopia and final visual acuity (P=0.02). All of those with mild, 80% with moderate and 42.2% with severe amblyopia had a final vision equal or better than 6/12. Almost 16% with severe amblyopia had vision 6/60 or less at the end of 6 months.

**DISCUSSION**

Amblyopia is the most common cause of visual impairment in both children and adults. It is an important public health problem as the visual impairment caused by amblyopia is profound and life long if left untreated.15-17

### Table 6: Association of Final Visual acuity with severity of Refractive Error

| Severity of Refractive error | 6/6-6/12 n (%) | 6/18-6/36 n (%) | 6/60 or less n (%) | Total n (%) |
|-----------------------------|----------------|-----------------|-------------------|-------------|
| None                        | 1 (100)        | 2 (28.6)        | 5 (42.9)          | 1 (100)     |
| Mild                        | 3 (42.9)       | 11 (26.8)       | 4 (25.0)          | 16 (100)    |
| Moderate                    | 29 (70.7)      | 1 (2.4)         | 41 (100)          |             |
| Severe                      | 5 (31.3)       | 7 (43.8)        | 1 (0.0)           |             |

**P value = 0.019**

### Table 7: Association of Final Visual acuity with Types of Amblyopia

| Types of Amblyopia | 6/6-6/12 n (%) | 6/18-6/36 n (%) | 6/60 or less n (%) | Total n (%) |
|--------------------|----------------|-----------------|--------------------|-------------|
| Anisometric        | 9 (60.0)       | 5 (33.3)        | 1 (6.7)            | 15 (100)    |
| Ametropic          | 24 (70.6)      | 10 (29.4)       | 34 (100)           |             |
| Strabismic         | 2 (22.2)       | 4 (44.4)        | 9 (100)            |             |
| Combined           | 1 (14.3)       | 3 (42.9)        | 7 (100)            |             |

**P Value = 0.02**
The prevalence of amblyopia is reported to be 1.3% to 3.6% in developed countries. In Nepal there is no population-based studies on prevalence of amblyopia. However, few studies done in school, hospital and clinical setting in Nepal has reported it be 0.9-1.8%.\textsuperscript{5, 7} Amblyopia is the unilateral or less commonly bilateral loss of vision caused by abnormal visual inputs during a critical period of visual development. The critical period is seen as the period of time during which abnormal visual inputs can result in amblyopia, but it is also the time during which eliminating the abnormal visual inputs and, usually occluding eyes for some period of time can reverse amblyopia. The critical period for developing amblyopia extends up to 8 years.\textsuperscript{4} Therefore, the age of presentation is important for amblyopia diagnosis and management. In our study the mean age of presentation was 8.8 years, ranging from 5-16 years. This shows that there is lack of awareness among people. Therefore, implementing preschool vision screening is very important for diagnosis of amblyopia.

In our study, among 47 amblyopic cases, 42.6% were males and 57.4% were females. Unilateral (61.7%, n=29) cases were more common than bilateral (38.3%, n=18). Among unilateral cases, left eye (38.3%, n=18) were more frequently affected than Right eye (23.4%, n=11). Similarly, studies done in Nepal by Sapkota et al\textsuperscript{19} and in Korea by Chung et al\textsuperscript{20} have reported that unilateral cases more common than bilateral. However, studies done in India by Menon et al\textsuperscript{21} and Gupta et al\textsuperscript{22} and a study done in Ethiopia by Destaye et al\textsuperscript{23} have found that bilateral cases more than unilateral.

In our study Ametropic amblyopia (52.3%, n=34) was the most common type of amblyopia followed by Anisometropic (23.1%, n=17) and mild amblyopia (7.7%, n=5) which is similar to a study by Bhandari et al.\textsuperscript{7} This may be due to the fact that in Nepal cases are usually presented late and there is lack of willingness among people to initiate treatment.

Refractive error was the most common risk factor for the development of amblyopia in this study; with Compound myopic astigmatism (30.8%, n=20) being the most common type followed by hypermetropia (29.2%, n=19). Compound myopic Astigmatism (38.2%) was the most common refractive error among patients with Ametropic Amblyopia, which was statistically significant (P=0.022). This was similar to a study done by Sapkota et al\textsuperscript{19}, who reported astigmatism to be the most common type of error accounting for 59.2%. Gupta et al\textsuperscript{22} and Xiao et al\textsuperscript{28} also found astigmatism to be the most common type of refractive error. However, studies done by Menon et al\textsuperscript{21}, Adhikari et al\textsuperscript{24} and Marthala et al\textsuperscript{25} reported hypermetropia as the most common type of refractive error in children with amblyopia. The association between type and severity of refractive error with final visual acuity was also statistically significant in our study (P= 0.036, P=0.019 respectively), which was similar to studies done by Menon et al\textsuperscript{29} and Awan et al.\textsuperscript{30}

Around 60% of Ametropic amblyopia presented among those aged between 5-7 years, whereas 50% of Anisometropic cases presented among aged between 11-16 years. This was statistically not significant (P=0.09). This is comparable to a study done by Menon et al\textsuperscript{21} and in contrast to study by Pediatric Eye Disease Investigator Group (PEDIG)\textsuperscript{13} where children were of younger age group in strabismus. This suggested that Ametropic amblyopia gets early attention as they experience blurring of vision, whereas Anisometropic cases may go unnoticed.

The association between the types of amblyopia and the initial visual acuity was not significant statistically (P = 0.55). But the association between types of amblyopia and final visual acuity was significant statistically (P=0.002). Final visual outcome was better among Ametropic amblyopia. About 71% had final visual acuity equal or better than 6/12, whereas visual acuity of 6/60 and less was seen more commonly among children with Strabismic and Combined amblyopia (33.3% and 42.9% respectively). This was similar to the study done by Adhikari et al\textsuperscript{24} but was in contrary to other studies done by Arikany et al\textsuperscript{26}, Lee et al\textsuperscript{21} and Mohan et al.\textsuperscript{32}

In this study most of the cases had severe amblyopia (69.2%, n=45), followed by moderate (23.1%, n=17) and mild amblyopia (7.7%, n=5) which is similar to a study by Bhandari et al.\textsuperscript{7}
significant (P=0.000). Studies done by Beardsell et al and Woodruff et al did not find any association, however Arikan et al found the association between the age and the final visual outcome. We also found a statistically significant association between the initial and the final visual acuity. Children having less initial visual acuity showed lower improvement in the final visual acuity. Similarly, other studies done by Adhikari et al, Beardell et al, Woodruff et al and Flynn et al have also reported the same.

In our study 78.5% had VA 6/18 or better after 6 month of occlusion therapy. This is similar to studies done by Arikan et al, Beardsell et al, Woodruff et al and Flynn et al. Therefore, we can conclude that occlusion therapy is effective in the treatment of amblyopia. Factors like age at presentation, types and severity of refractive error, types of amblyopia and initial visual acuity at presentation are very important contributing factors for the final visual outcome. The limitations of this study was that the assessment of the compliance of patching therapy was not done, as we prescribed only part time patching in accordance to recommendation by PEDIG studies. Even the follow up period was of 6 months only.

In conclusion, amblyopia is an important cause of visual impairment among children. The most common amblyogenic factor still remains uncorrected refractive error. The occlusion therapy for treatment of amblyopia is effective if instituted early. So early diagnosis and treatment of amblyopia is of utmost importance to avoid visual impairment in children, which can be profound and life long if left untreated. Preschool and school vision screening program should be brought in focus to avoid the socioeconomic burden caused by amblyopia.

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