

# VISUAL FUNCTIONS AMONG AMBLYOPIC PATIENTS

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## ABSTRACT

Apart from decreased visual acuity, amblyopia may be associated with alteration in color vision, contrast sensitivity and stereopsis. The study was conducted to assess visual functions among amblyopic patients. Cross sectional observational study was done with appropriate examination. Best corrected visual acuity, color vision, contrast sensitivity and stereopsis were done among 31 amblyopic patients of age 5-18 years, visiting Department of Ophthalmology in Kathmandu Medical College from October 2021 to March 2022. Among thirty-one patients, male is to female ratio was 1.81:1. Mean age of participants was  $9.45 \pm 3.49$  years. Among patients with stimulus deprivation amblyopia, visual acuity was  $<6/60$ , color vision and contrast sensitivity were decreased in 100% and moderate stereopsis (80-200 seconds of arc) was present. Among patients with strabismic amblyopia, visual acuity was decreased (6/12-6/18), color vision and contrast sensitivity were normal in 100% and good stereopsis ( $<60$  seconds of arc) was seen. Among those with refractive amblyopia, visual acuity was 6/6-6/9 in 34.5%, 6/12-6/18 in 44.8% and 6/24-6/60 in 20.7%. Color vision was decreased in 27.3% in ametropic, 9.1% in meridional and normal in anisometropic type. Contrast sensitivity was decreased in 27.3% each in ametropic and anisometropic, and in 63.6% in meridional amblyopia. Good and poor ( $>200$  seconds of arc) stereopsis was found in 24.1% each and moderate in 51.7% of refractive amblyopia. Contrast sensitivity was seen to be decreased with decrease in vision (40.0%, 42.8%, 50.0% and 100.0% in visual acuity 6/6-6/9, 6/12-6/18, 6/24-6/60 and  $<6/60$  respectively). To conclude, visual functions are affected in different types of amblyopia.

## KEYWORDS

Amblyopia, color vision, contrast sensitivity, stereopsis, visual acuity

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## INTRODUCTION

Amblyopia is clinically defined as reduction of visual acuity in one or both eyes, caused by abnormal binocular interaction during the critical period of visual development.<sup>1</sup> American Academy of Ophthalmology considers amblyopia as an interocular difference of 2 lines or more in a visual acuity table (without specifying any), or visual acuity worse than or equal to 20/30 with the best optical correction.<sup>2</sup>

Amblyopic patients tend to have many problems owing to visual sub-normality. As amblyopia is a preventable condition, timely diagnosis and assessment of these aspects of visual function with appropriate management may uplift the quality of vision in these patients.

## MATERIALS AND METHODS

It was a cross sectional observational study conducted among amblyopic children visiting Department of Ophthalmology in Kathmandu Medical College, during the study period of 6 months October 2021 to March 2022. Sample size was 31 and the study was approved by the Institutional Review Committee of Kathmandu Medical College, Kathmandu. Amblyopic children falling on the age range of 5-18 years of age visiting the department during the study period was enrolled.

Detailed relevant history was taken from patients and/or parents. Comprehensive ophthalmological examination of anterior segment and posterior segment was done.

Visual acuity was checked by self-illuminating Snellen box, illiterate E optotype or Lea symbol chart whichever applicable. Best corrected

visual acuity determined by retinoscopy and subjective refraction were noted. Cycloplegic refraction was done in all the cases.

Color vision was examined by pseudo-isochromatic Ishihara color vision chart (38 plates edition) and contrast sensitivity were measured by Lea contrast with 10m flip chart. Similarly, stereopsis was measured using Titmus fly test.

Data were entered in a specially designed proforma and were analyzed using SPSS-20 and p value <0.05 was considered statistically significant.

## RESULTS

Among thirty-one enrolled participants, male to female ratio was 1.81:1 and age ranged from 5-17 years with mean age of 9.45 years ± 3.49 SD.

According to types, refractive amblyopia was present in 93.6%, whereas strabismic and stimulus deprivation amblyopia was seen in 3.2% each.

Refractive amblyopia was present in 70%, while stimulus deprivation and strabismic amblyopia was present in (3.2%) each. Among the refractive amblyopia, anisometric amblyopia was present in 22.6% (n=7) and ametropic and meridional amblyopia in 35.5% (n=11) each.

Best corrected visual acuity was reduced in all forms of amblyopia. Best corrected visual acuity was 6/6-6/9 in 32.3% (n=10), 6/12-6/18 in 45.2% (n=14), 6/24-6/60 in 19.4% (n=6) and <6/60 in 3.2% (n=1).

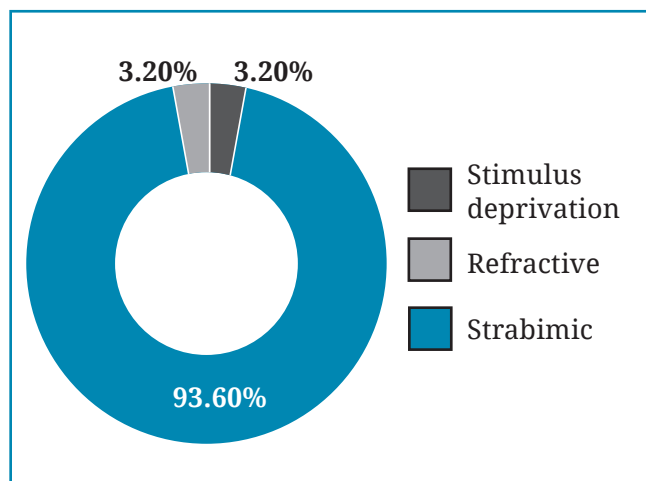


Fig. 1: Distribution of patients according to types of amblyopia

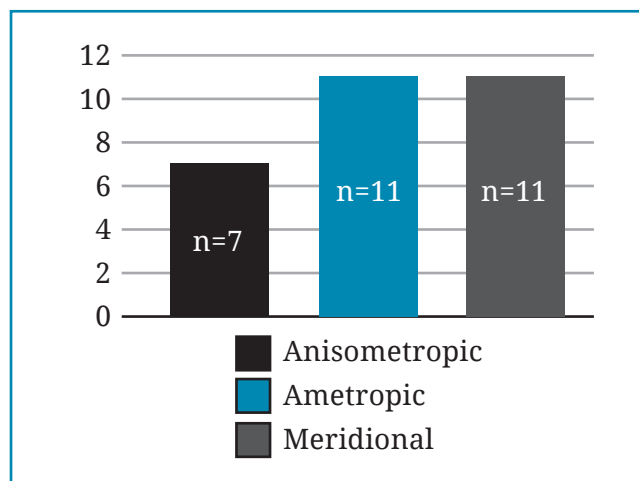


Fig. 2: Distribution of types of refractive amblyopia

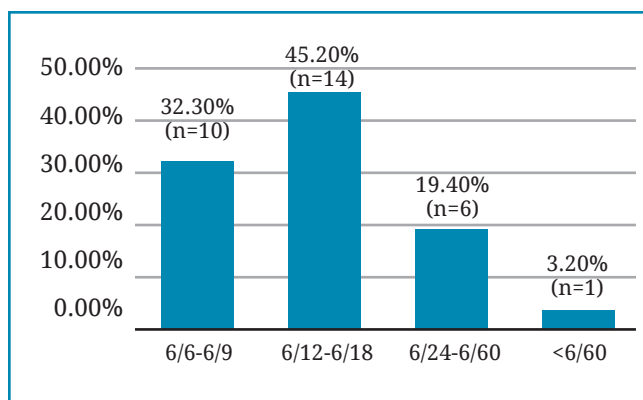


Fig. 3: Distribution of status of BCVA

Color vision was decreased in stimulus deprivation, ametropic and meridional amblyopia, and it was not affected in strabismic and anisometropic amblyopia. Color vision was decreased 100.0% (n=1) in stimulus deprivation, 27.3% (n=3) in ametropic and 9.1% (n=1) in meridional amblyopia.

Contrast sensitivity was decreased in stimulus deprivation, ametropic, anisometropic and meridional amblyopia, while it was not affected in strabismic amblyopia. Contrast sensitivity was decreased 100.0% (n=1) in stimulus deprivation, 27.3% (n=3) each in ametropic

Table 1: Distribution of status of color vision

Type of amblyopia	Color vision		Total
	Normal	Decreased	
Stimulus deprivation amblyopia	0	100.0% (1)	1
Strabismic amblyopia	100.0% (1)	0	1
Anisometropic amblyopia	100.0% (7)	0	7
Ametropic amblyopia	72.7% (8)	27.3% (3)	11
Meridional amblyopia	90.9% (10)	9.1% (1)	11

Table 2: Distribution of status of contrast sensitivity

Type of amblyopia	Contrast sensitivity		Total
	Normal	Decreased	
Stimulus deprivation amblyopia	0	100.0% (1)	1
Strabismic amblyopia	100.0% (1)	0	1
Anisometropic amblyopia	57.1% (4)	42.9% (3)	7
Ametropic amblyopia	72.7% (8)	27.3% (3)	11
Meridional amblyopia	36.4% (4)	63.6% (7)	11

Table 3: Distribution of status of stereopsis

Type of amblyopia	Grading of stereopsis			Total
	Good (<60 seconds of arc)	Moderate (80-200 seconds of arc)	Poor (>200 seconds of arc)	
Stimulus deprivation amblyopia	0	100.0% (1)	0	1
Strabismic amblyopia	100.0% (1)	0	0	1
Anisometropic amblyopia	14.3% (1)	42.9% (3)	42.9% (3)	7
Ametropic amblyopia	36.4% (4)	36.4% (4)	27.3% (3)	11
Meridional amblyopia	18.2% (2)	72.7% (8)	9.1% (1)	11

and anisometropic type and 63.6% (n=7) in meridional amblyopia.

Patients with stimulus deprivation amblyopia and strabismic amblyopia had moderate (80-200 seconds of arc) and good (<60 seconds of arc) grade of stereopsis respectively. Majority of patients with anisometropic amblyopia had moderate and poor grade of stereopsis. Stereopsis was poor in 42.9% anisometropic amblyopia, 27.3% ametropic amblyopia and 9.1% meridional amblyopia, while stereopsis was moderate in 100.0% stimulus deprivation amblyopia and 42.9% anisometropic amblyopia.

## DISCUSSION

Reduced best corrected vision in one or both eyes by abnormal visual development early in life results in amblyopia. Conditions like uncorrected refractive error, strabismus, media opacities like corneal scar, cataract and ptosis can cause amblyopia or it can even be idiopathic. Different studies identified strabismic amblyopia is more common than anisometropic combined or stimulus deprivation amblyopia.<sup>3,4</sup> Abnormal visual processing of the primary visual cortex in amblyopia can result in decreased visual acuity and contrast sensitivity.<sup>5</sup>

The extent of abnormalities of other visual functions and the involvement of the peripheral visual field in amblyopic eyes are less well understood, as the central visual field is affected preferentially. The most commonly recognized visual disturbance associated with amblyopia is decreased Snellen visual acuity.<sup>6</sup>

Although decreased vision is the prominent sign of amblyopia, there are certain associated microscopic anatomical and structural abnormalities in the retina, lateral geniculate body and in area V1 of the visual cortex.<sup>6-11</sup> Deficiency in other visual functions including contrast sensitivity, color vision, and stereopsis has also been observed in patients with amblyopia according to different studies.<sup>12-15</sup>

Contrast Sensitivity is a measure of the ability to distinguish the visual markers under different levels of contrast. This is more adaptively used in daily life.<sup>16</sup> Strabismic and anisometropic amblyopic eyes have marked losses of threshold contrast sensitivity, especially at higher spatial frequencies; this loss increases with the severity of amblyopia.<sup>17</sup>

Contrast sensitivity is depressed for only a limited band of high spatial frequencies in strabismic amblyopia while in anisometropic amblyopia, depression of contrast sensitivity was found over the whole frequency range.<sup>18</sup>

Severe degree of amblyopia and larger amount of strabismus are associated with reduced stereoacuity.<sup>19</sup> Patients with stereo-deficiency have a substantial impact on visuomotor tasks, difficulties in playing sports in children and locomoting safely in old age. It is known that they may also have limited career options.<sup>15</sup> Stereopsis will never be obtained unless amblyopia is treated, the eyes are aligned, and binocular fusion and function are achieved before the critical period for stereopsis ends.<sup>17</sup> Recovery of stereoacuity can occur during refractive adaptation and occlusion phases of treatment. The optical treatment phase can give a better stereoacuity for individuals with not only anisometropia, but also with all three types of amblyopia. Improvement in stereoacuity is more likely to occur in the refractive adaptation phase than in the occlusion phase.<sup>19</sup> Color perception arises from signals generated by three cone photoreceptors with different spectral sensitivity functions. Signals from the retina which pass through the Lateral Geniculate Body are eventually transmitted to the cerebral cortex. Transmission of color and motion information predominantly occurs by two major parallel pathways to the brain, where visual signals are reintegrated in the visual cortex. Retinal cells in the parvocellular pathway are responsible for fine and chromatic stimuli, while cells of the magnocellular pathway are responsible for moving and achromatic stimuli. Some studies have revealed that monocular visual deprivation affects the size of parvocellular and magnocellular cells in the LGB which is more significant with long-term involvement of the eye, and may affect color vision.<sup>20-22</sup>

Although traditionally treatment for amblyopia is recommended until 8-9 years of age, recent studies suggested successful treatment in older individual as the plasticity of visual system may extend into adulthood.<sup>23</sup>

Kocak *et al*<sup>4</sup> investigated color vision and its relation with the type of amblyopia and visual acuity of amblyopic eyes and found out that deficient color vision in the amblyopic eyes was not related to the visual acuity and type of amblyopia. However, in our study, patient with stimulus deprivation amblyopia had decreased color vision.

Almog *et al*<sup>5</sup> studied the correlation between visual acuity (VA) and color vision and to establish a guide for the diagnosis of the cause of visual loss divided into optic neuropathies, macular diseases, media opacities and amblyopia. The result showed for the same degree of VA loss, patients with optic neuropathy are most likely and patients with amblyopia are the least expected to have a significant color vision loss.



In our study, color vision was decreased in 100% patients with BCVA 6/60, 16.67% in VA 6/24-6/60, 21.42% in VA 6/12-6/18 group.

Wang *et al*<sup>7</sup> showed that the contrast sensitivity of the patients with ametropic and anisometropic amblyopia was lower than that of the normal control group.

Contrast sensitivity was seen to be decreased in 27.3% (n=3) each in patients with ametropic and anisometropic amblyopia and in 63.63% (n=7) in meridional amblyopia.

Apart from decreased visual acuity, color vision was impaired in 16%, contrast sensitivity was

decreased in 45% and stereopsis was poor in 22.6% amblyopic patients.

**LIMITATION:** As the sample size of study was small and it was a descriptive study, P value could not be determined in this study. Thus, only the mean values and frequencies of the data were calculated. Therefore, we recommend study with larger sample size and longer study period so that we have similar number of patients in each type of amblyopia.

**Conflict of interest:** None

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