



## Macular thickness and peripapillary nerve fiber layer thickness in children with anisometropic and strabismic amblyopia- A comparative study

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### Abstract

*To study and compare the macular thickness and peripapillary nerve fibre layer thickness in children with anisometropic amblyopia with those having strabismic amblyopia. A prospective non- randomised case series study was carried out. In all 50 children between the ages of 5 and 16 were selected. The anisometropic amblyopia group had 38 children (24 boys and 14 girls) and the strabismic amblyopia group had 12 children (7 boys and 5 girls) In both the groups the peripapillary retinal nerve fibre layer (RNFL) thickness and macular thickness was measured using optical coherence tomography (OCT) The RNFL thickness and macular layer thickness of the amblyopic eye was measured and compared to the normal eye of the same subject which served as a control. It was found that the macular thickness of the amblyopic eye was greater than that in the normal eye in the anisometropic amblyopia group, 247.8947 +/- 34.3926 in amblyopic eye versus 222.2386 +/- 31.1919 in the normal eye a p value = 0.00106. The RNFL thickness too was greater in the amblyopic eye when compared to the normal eye in this group 113.4060 +/- 34.8319 versus 109.4494 +/- 29.0185, p value = 0.5922 thus not reaching statistical significance. In the strabismic amblyopia group however it was found that though the macular thickness was increased in the amblyopic eye it did not reach statistical significance, mean macular thickness (in microns) 233.75 +/- 31.5224 in amblyopic eye versus 223.00 +/- 31.4266 in normal eye a p value = 0.4118. and surprisingly the RNFL layer thickness was actually lesser than that in normal eyes in this group, 116.86 +/- 48.2924 versus 117.7089 +/- 37.2872 in normal eyes. P value = 0.9261. Thus this study found that macular thickness was raised in both anisometropic as well as strabismic amblyopia but RNFL thickness was not.*

**Keywords:** OCT (optical coherence tomography) Strabismic amblyopia, anisometropic amblyopia, macular thickness, RNFL (retinal nerve fibre layer) thickness.

### Introduction

Amblyopia is defined as an unilateral or bilateral diminution of vision. Amblyopia results from abnormal binocular interaction or pattern vision deprivation or both. In amblyopia no organic disease of the media, fundus or visual pathway

can be found and which in certain cases can be reversed by therapeutic measures<sup>[2]</sup>. The word amblyopia is derived from a greek word meaning 'blunting of vision'<sup>[1]</sup>. Various forms of Amblyopia are encountered, amblyopia may be

strabismic, anisometropic, stimulus deprivation, bilateral ametropic and meridional.

The deleterious effect of amblyopia associated with any cause, during the neonatal period on cell growth of the LGB (lateral geniculate body) has been established by exhaustive quantitative histologic studies in several species<sup>[3-5]</sup>, including in human beings<sup>[6]</sup>. In spite of all these studies it is still unclear as to which is the exact site which determines visual deficit in amblyopia. Several studies have been designed and undertaken to examine the changes in the retina in amblyopes, the results of which have at best remained inconclusive.

Optical Coherence Tomography (OCT) is a non invasive non contact imaging system which provides high resolution cross-sectional images of the retina, vitreous and the optic nerve. Recent advanced instruments image anterior segments as well as perform intra operative angiography as well. OCT is analogous to B-scan ultrasonography but uses light instead of sound waves. Measurements are made directing a beam of light (laser) and measuring the echo time delay and magnitude of reflected or back scattering light using low-coherence interferometry. Cross sectional images are generated by scanning the optical beam in the transverse direction, thus yielding a two dimensional data set that can be displayed as a false colour or greyscale image. Using OCT we get resolutions down to 5- 10 microns<sup>[7]</sup>.

The retinal nerve fibre layer is formed by the expansion of the fibres of the optic nerve; It is thickest near the porous opticus, gradually diminishing towards the ora serrata. As the nerve passes through the lamina cribrosa it loses its myelin sheath and are continued through the choroid and over the retina as simple axis cylinders. RNFL layer is a sensitive structure and certain conditions can damage the RNFL, common amongst them are raised intraocular pressure as in glaucoma. Inflammation, vascular diseases and any kind of hypoxic insults. RNFL thickness also decreases with increasing age but

not with decreasing visual acuity. Petinitis pigmentosa patients also have much thinner RNFL. This study aims to find out changes if any, in the RNFL thickness and macular thickness in anisometropic and strabismic amblyopia in children attending a medical college hospital in eastern India. The study aims to compare the changes, if any, in the RNFL thickness and macular thickness between the two groups of amblyopes, viz, the anisometropic amblyopes and strabismic amblyopes.

### Material and Method

This prospective study enrolled 50 children between the ages of 5 and 16 years having anisometropic and strabismic amblyopia. 38 children (24 boys and 14 girls) had anisometropic amblyopia and 12 children (7 boys and 5 girls) had strabismic amblyopia. Children having bilateral amblyopia, glaucoma, nystagmus, prior strabismic surgery or any other retinal pathology contributing to altered RNFL thickness were excluded from the study. Similarly children having media opacity giving rise to divergent squint were excluded from the study. The enrolled children were submitted to a detailed ocular examination. Best corrected visual acuity (BCVA) was assessed using a snellen's chart from 6 meter distance. Manifest and cycloplegic refraction using 1% cyclopentolate was performed on every child. Alternate cover tests, ductions, versions and measurement of intra-ocular pressure (IOP) was done. A complete slit lamp and dilated fundus examination was done on the subjects. Anisometropia is a difference between the refractive states of both the eyes that occur in one or both the principal meridians. This becomes significant clinically when it reaches 1D in either or both the principal meridians.<sup>[8]</sup> In our study Anisometropia was said to be present when there was a difference of

- a) +1.00 Dioptre spherical or more between the two eyes
- b) - 2.00 Dioptre spherical or more between the two eyes

c) +/-1.50Dioptre cylindrical or more between the eyes.<sup>[9]</sup>

To calculate the mean visual acuity (VA), Snellen’s VA was converted to log of minimum angle of resolution (logMAR) scale and the mean logMAR VA was reconverted to Snellen’s VA. In this study, RNFL thickness and Macular thickness were assessed using OCT (Stratus OCT 3000, Carl Zeiss meditec, Dublin, CA, USA). Macular thickness was recorded using the ‘fast macular’ acquisition protocol. This uses 6 radial scans centred on the fovea each scan being 30° apart and 6 mm long. Peripapillary RNFL thickness was measured using the ‘fast RNFL’ acquisition protocol. This uses a circular scan 3.4 mm in diameter centred on the optic nerve head. Multiple images were recorded by one particular examiner and mean reading was recorded. Any reading that had a signal strength less than 4 were discarded. The distance between the vitreoretinal interface and the retinal pigment epithelium was taken as the retinal thickness. All scans were analysed using the software that came with the instrument. The results were statistically analysed using a two tailed student’s ‘t’ test.

Children enrolled in the tests were treated for their amblyopia using refractive correction and occlusion therapy as per the recommendations of the PEDIG guidelines,([www.pedig.net](http://www.pedig.net)). Part time total occlusion therapy was prescribed including occlusion of the amblyopic eye as per age of the child. Low allergy occlusive dressing was used for all children. Every child was followed up monthly to note for visual acuity and occlusion amblyopia if any.

**Observations**

This study included 50 children, 38 having anisometropic amblyopia and 12 having strabismic amblyopia. The mean age of the enrolled children in the study was 10.41 years. See table 1. These children were subjected to thorough ocular examination including fundus examination and anterior segment biomicroscopy, all of them were normal except for the presence of

anisometropia and strabismus. The mean visual acuity (BCVA) in the amblyopic eye in the anisometropic group was 20/78 and the mean visual acuity in the amblyopic eye in strabismic group was 20/86. (table 1) Macular thickness in the amblyopic eyes in anisometropic amblyopia group was 247.8947+/-34.3926 microns. The mean macular thickness in the fellow normal eye being 222.2386+/-31.1919 microns. The mean difference between the eyes being 25.6561 microns which has a p value = 0.00106 which is < 0.05 and hence is statistically significant. Thus macular thickness in anisometropic eyes is found to be increased in this study. See table 2. The mean RNFL thickness in the amblyopic eye in the anisometropic amblyopia group was 113.4060 +/- 34.8319. microns and the mean RNFL thickness in the fellow normal eye being 109.4494 +/- 29.0185 microns, the difference being 3.9566 microns which is not statistically significant since p value = 0.5922 which is > 0.05.( see table 2). Further Mean macular thickness in amblyopic eyes in strabismic amblyopia group was found to be 233.75 +/-31.5224 microns as compared to 223.00+/- 31.4266 microns in their fellow normal eyes, the difference being 10.75 microns, the p value of this difference is p= 0.4118 which is >0.05 and hence is not significant. The RNFL thickness in the strabismic amblyopia group is 116.86 +/- 48.2924 micron as compared to 117.7089 +/- 37.2872 micron in the fellow normal eyes. This is reverse to the trends seen thus far in the study, the RNFL thickness being actually lower in the affected eye, though this is not significant statistically as the difference has a p value =0.9261 which is much greater than 0.05. see table 3.

**Table 1** showing metrics of enrolled children and their mean best corrected visual acuity (BCVA).

Total no. of children enrolled	50
Mean age of enrolled subjects	10.41 years
No of males	31
No of females	19
Mean Visual acuity Amblyopic eye	20/80
Mean Visual acuity fellow eye	20/26

Sub groups	
No of Anisometropic amblyopes	38
No of Strabismic amblyopes	12
Mean Visual Acuity in Anisotropic amblyopes	20/78
Mean Visual acuity in fellow normal eyes	20/27
Mean Visual Acuity in strabismic amblyopes	20/86
Mean Visual acuity in fellow eye	20/26

**Table 2** showing mean macular thickness and RNFL thickness in the anisometropic amblyopic eye and normal fellow eye. SD = standard deviation

	Amblyopic eye	Fellow Eye(normal)	P Value
Macular thickness (in microns)+/- SD	247.8947 +/- 34.3926	222.2386 +/- 31.1919	0.00106
RNFL Thickness (in microns)+/- SD	113.4060 +/- 34.8319	109.4494 +/- 29.0185	0.59220

**Table 3** showing mean macular thickness and RNFL thickness in the strabismic amblyopic eye and fellow normal eye. SD = Standard deviation

	Amblyopic Eye	Fellow Eye (normal)	P Value
Macular thickness (in microns)+/- SD	233.75 +/- 31.5224	223.00 +/- 31.4266	0.4118
RNFL Thickness (in Microns)+/- SD	116.86 +/- 48.2924	117.7089 +/- 37.2872	0.9261

**Discussions**

Repka et al<sup>[9]</sup> compared the peripapillary RNFL thickness of amblyopic and normal fellow eyes in 37 patients in the age group of 7 -12 years. They found that the peipapillary RNFL thickness in amblyopic eyes is not significantly thinner than in normal eyes. This more or less agrees to our study of strabismic amblyopes. Yoon et al<sup>[10]</sup> studied the macular and peripapillary RNFL thickness by OCT in hyperopic anisometropic amblyopia<sup>[10]</sup> and they concluded that amblyopia is associated with increased peripapillary RNFL thickness though not statistically significant. This finding matches with ours regarding anisometropic amblyopia. However opposed to our findings there was no change in macular thickness in their studies. Huynh et al<sup>[11]</sup> in their studies examined the macular and peripapillary RNFL thickness in amblyopia and found that central macular thickness was increased in amblyopia in the age group of 6-12 years. There was no significant

changes in the thickness of the peripapillary RNFL. This finding is consistent with the findings of this study. Yen et al<sup>[12]</sup> hypothesised that amblyopes have thicker retina, the amblyopic process having effects at multiple levels in the visual pathway. Experiments have proved that retinal ganglion cells suffer changes with light deprivation from birth. These changes may include some or all of these- cell loss or apoptosis<sup>[13]</sup>, mean nucleolar volume diminution in ganglion cell layers, and inner plexiform layer thinning in rats and cats<sup>[14]</sup>. Changes also include reduction in optic nerve head area in mice<sup>[15]</sup>. Arden and wooding<sup>[16]</sup> showed that pattern ERG was reduced in various types of amblyopia in human. These results suggest that at least in humans amblyopia may be associated with changes that affect retinal function at the level of production of Pattern ERG deficit, which is assumed to be preganglionic, however other studies<sup>[17-18]</sup> have refuted this claim specially those in which fixation, and focus were pre adjusted. Dickman et al<sup>[19]</sup> compared the RNFL thickness, macular thickness and foveal volume in patients with unilateral amblyopia with the normal eye, their findings stated that no significant change was observed in the peripapillary RNFL thickness.

**Conclusion**

In conclusion it can be said that the results in this study were consistent with other similar studies undertaken elsewhere as far as the changes in macular thickness is concerned. Macular thickness increases in amblyopes specially in anisometropic amblyopes. In strabismic amblyopes too it increases albeit not significantly. However RNFL thickness does not show a consistent result with amblyopia being slightly raised in the anisometropic variety and actually being thinner in the strabismic amblyopes. This is markedly different in Indian children, most studies involving western and asian children have increased RNFL thickness. The reason behind this may be a racial factor or some yet unknown



factors. Studies involving autopsies may shed more light on the histopathological changes underlying the amblyopic eyes, both at the retinal level as well as higher centres in the visual pathway.

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