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Original Research Article

Comparison of macular and peripapillary RNFL thickness between normal and abnormal eye in children with unilateral amblyopia

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Abstract

Aim: To compare macular and peripapillary RNFL thickness in amblyopic & fellow eye in unilateral amblyopia, using OPKOS SLO/OCT.

Material & Methods: This was an Institutional prospective analytical study conducted over a period of one year, after approval from Scientific and Ethical Committee. All the unilateral amblyopic 5 to 40 years of age, who gave consent for undergoing OCT were included in the study.

Results: During the study period, 100 eyes of 50 patients, who met the inclusion criteria were taken up for the study. Out of 50 patients, 30 were males and 20 were females with mean age of 20.7 ± 8.9 years. Patients were subdivided into types of amblyopia and anisometropia. The Mean Macular Thickness of amblyopic eye (273.61 ± 20.30) was statistically significantly increased in 50 patients (P=0.05) when compared to fellow non-amblyopic eye (262.81 ± 17.75).

Conclusion: There was a significant increase in mean macular thickness in all amblyopes, which was significant only in anisometropes, while RNFL thickness was significantly increased only in strabismic amblyopia, when compared with fellow eye. These results corroborate with findings of similar previous studies.

Keywords: Amblyopia, macular thickness, RNFL, SD-OCT

Introduction

Amblyopia is known as unilateral-or bilateral-reduced best-corrected visual acuity (BCVA) in response to abnormal visual stimulus throughout a critical period of development of the visual areas in the brain. Yet, some studies found a strong association between the amblyopic eye and cellular atrophy in the lateral geniculate nucleus (LGB) [1-3]. Modern advances in neuroanatomy and neurophysiology have reopened the possibility that there is some retinal dysfunction in amblyopia [4]. The retina is considered a motivating region for studying amblyopia and is still under investigation. The retinal alteration in the amblyopic eyes has not been clarified yet [5]. Amblyopia might affect the postnatal maturation process of the retinal ganglion cells (RGCs), resulting in RGC reduction and abnormalities [6].

During fetal development, there is a rapid decline in cell density in the retinal ganglion cell layer toward the end of gestation. At 16-17 weeks of gestation, the estimated number of axons are 3.7 million. The number of axons in the human adult optic nerve is 1.1 million [7]. It was hypothesized that amblyopia may affect the postnatal maturation of the retina including the postnatal reduction of retinal ganglion cells, hence the macular and RNFL thickness might be increased in amblyopic eyes.

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Optical coherence tomography (OCT) is a noninvasive technique, allowing high resolution, cross-sectional tomographic imaging of the retina and optic nerve with resolution of 10-17 µm. It is considered good for both macular and retinal nerve fiber layer assessment. The thickness measurement is not affected by refractive status or axial length of the eye, or by light changes in nuclear sclerotic cataract density (Schuman *et al*., 1996) [8].

Several techniques to evaluate the RNFLT, such as red-free ophthalmoscopy, scanning laser polarimetry (SLP) and optical coherence tomography (OCT) have been described. OCT is a noninvasive, noncontact technique that measures RNFLT [8-9]. The RNFLT measured by OCT corresponds to the RNFLT measured histologically [9]. Because OCT is based on near infrared interferometry, the thickness measurement is not affected by refractive status or axial length of the eye, or by light changes in nuclear sclerotic cataract density [8].

Thus, we aim to compare macular and peripapillary RNFL thickness in amblyopic & fellow eye in unilateral amblyopia, using OPKOS SLO/OCT.

Material & Methods

This was an Institutional Prospective analytical study conducted over a period of one year, after approval from Scientific and Ethical Committee. Written informed consent to participate in the study was obtained from all patients or from parents of minor subjects.

All the unilateral amblyopes 5 to 40 years of age, who gave consent for undergoing OCT were included in the study. Patients less than 5 yrs. of age and uncooperative children unable to maintain fixation in OCT were excluded as OCT was not possible in such patients. Patients having any ocular, neurological diseases or those who have undergone any intraocular surgery (cataract, glaucoma, vitreous or retinal surgery etc.) were not included however those with extraocular surgery were included in form deprivation amblyopia (for e.g. lid surgeries, ptosis surgery etc.). OCT signal less than 4/10 also excluded.

Amblyopia was defined as a best corrected visual acuity (BCVA) difference of at least 2 lines; causes for amblyopia included either strabismus, anisometropia or form deprivation. Anisometropia was defined as a cycloplegic spherical equivalent difference greater than 2 diopters between both eyes.

Complete ophthalmological examination including manual and automated refraction and orthoptic testing was done for all the patients.

SD-OCT (OPKOS SLO/OCT) was performed. 3D retinal topography and Peripapillary RNFL thickness mapping of both eyes of each patient was done. The mean of these values, as calculated by preloaded software was used to calculate the average macular thickness and RNFL thickness. Data was compiled at the end of 12 months and subjected to statistical analysis. A 95% of the confidence interval and 5% level of significance were adopted; therefore, results with a P value $6 \leq 0.05$ were considered as significant.

Results

During the study period, 100 eyes of 50 patients, who met the inclusion criteria were taken up for this study.

Out of 50 patients, 30 were males and 20 were females with mean age of 20.7 ± 8.9 years. Patients were subdivided into types of amblyopia and anisometropia. A total of 8 patients were having strabismic and 32 were having anisometropic amblyopia and 10 form deprivation amblyopia. Among patients with anisometropia, hyperopia was noted in 20 cases, myopia was noted in 11 cases and 4 were mixed. [Table 1]

The Mean Macular Thickness of amblyopic eye (273.61 ± 20.30) was statistically significantly increased in 50 patients (P=0.05) when compared to fellow non amblyopic eye (262.81 ± 17.75). [Table 2]

Table 3, there was no statistically significant difference in amblyopic (94.82 ± 12.73) and normal fellow eye (96.92 ± 11.41) in 50 patients in Peripapillary Rnfl Thickness in various subgroups. On subgroup analysis, strabismic amblyopic eyes (104.74 ± 14.99>> 95.81 ± 11.84) had statistically significant increase (P=0.05) in peripapillary RNFL thickness in amblyopic eye, but in anisometropic group or form deprivation, the difference was not

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significant. [Table 3]

Table 1: Demographic data

	Amblyopia	Anisometropia	Strabismic	Form deprivation
Total	50	32	8	10
Female: male	21:35	15:23	2:6	4:6
Mean age (±SD)	20.5 ± 8.7	19.48 ± 8.1	25.70 ± 8.8	18.49 ± 6.3
BCVA (Log MAR)	0.96	0.87	1.22	0.91

Table 2: Mean Macular Thickness

Characteristic (Mean Macular Thickness)	Amblyopic eye (Mean ± SD)	Non-Amblyopic Eye (Mean ± SD)	P Value
Total Amblyopes	273.61 ± 20.30	262.81 ± 17.75	0.05
In Strabismic	250.84 ± 24.29	257.94 ± 22.83	0.731
In Anisometropic	260.99 ± 18.51	252.62 ± 14.37	0.05
In form Deprivation	251.73 ± 21.64	251.83 ± 26.65	0.229

Table 3: Peripapillary Rnfl Thickness

Characteristic (Peripapillary Rnfl Thickness)	Amblyopic eye (Mean ± SD)	Non-Amblyopic Eye (Mean ± SD)	P Value
Total Amblyopes	94.82 ± 12.73	96.92 ± 11.41	0.937
In Strabismic	104.74 ± 14.99	95.81 ± 11.84	0.05
In Anisometropic	96.84 ± 10.62	95.69 ± 11.90	0.391
form Deprivation	97.90 ± 9.0	97.77 ± 10.27	0.110

Discussion

In the past, amblyopia was considered to be a disease with an abnormality of the retina; however, it has recently been reported that the cerebral anatomical alteration caused by amblyopia is primarily in the lateral geniculate body and the visual cortex [10]. Von Noorden *et al*. [1] have reported, in a histological study of patients with anisometric amblyopia, a decrease in cell sizes in the parvocellular layers enervated by the amblyopic eye, and this decrease was more pronounced in the lamina that received the crossed nerve fibers.

In normal individuals, the thickness of the fovea was reported to be 130 lm by the histopathological tests performed by Hogan *et al*. (1971) [11]. Kanai *et al*. (2002) [12] measured 47 eyes in 47 cases by performing OCT and reported the fovea thickness as 142 ±15 lm. Ling *et al*. (2000) [13] reported 146.34 ± 8.58 lm in 60 cases with 120 eyes, Gobel and Kretzchmar-Gross (2002) [14] reported 153±15 lm in 60 cases with 120 eyes and Hee *et al*. (1998) [15] have reported 174±18 lm in 41 cases with 73 eyes. Comparing the fovea thickness (186.31 Mm) of the 93 normal eyes in our study (mean age: 8.7 years) to these data, our result was thicker than the previous studies.

Concerning the visual deprivational amblyopia, there were few studies that reported the changes in this type. Kim *et al*. [16] did not find a considerable variance in deprivational amblyopic eyes compared to the normal eyes regarding the macular thickness, while they found thicker nasal RNFL in the amblyopic eyes. The present results were in contrast to this finding: there was a significant increase in the foveal thickness and the superior and inferior RNFLT. This difference in the results may be due to the measuring of the eccentric parafoveal area accidentally rather than the central foveal area [17].

SE might lead to statistically accurate results. This was in disagreement with Araki *et al*. [18] they reported a significant correlation between the AL and CMT changes, which might be owing to the relatively small sample size (21 subjects with less difference in the mean SE among the study subjects). By contrast, Kok *et al*. [19] concluded consistent results with our findings; they did not find an abnormal relation between the AL and CMT in amblyopic eyes.

Agarwal S *et al*. (2014) [20] found increased macular thickness in strabismic amblyopes. The

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mean age of patients and BCVA did not show significant correlation with the mean macular thickness or RNFL thickness of amblyopic eye, neither in any subgroups.

Conclusion

There was a significant increase in mean macular thickness in all amblyopes, which was significant only in anisometropes, while RNFL thickness was significantly increased only in strabismic amblyopia, when compared with fellow eye. These results corroborate with findings of similar previous studies.

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