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OCT Changes In Unilateral Amblyopia Patients, Using OPKOS SLO/OCT: A Cross Sectional Study

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Abstract

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

Method: *A prospective cross sectional study was conducted on 55 patients (37 anisometropia,10 strabismic & 7 form deprivation) of 5-40y of age(mean 20.2±8.4).Macular and RNFL thickness were measured using SD-OCT(OPKOS SLO/OCT) and compared.*

Result: *Mean macular thickness of all amblyopia patients showed statistically significant increase (P=0.05) in amblyopic eye(AE=262.27±19.29,Non AE=255.21±18.63).On subgroup analysis, increase was significant only in anisometropes (P=0.03)while RNFL thickness was increased in strabismic amblyopes (P=0.04).(AE=102.22±14.06 Non AE=93.55±12.24).No correlation was found with age of patient.*

Conclusion: *There was a significant increase in mean macular thickness in 55 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 the most frequent cause of unilateral poor visual acuity in children and young adults. It is often defined as a reduced best corrected visual acuity in one or both eyes, due to abnormal visual experience during the critical period of visual development.

Although it usually develops during the first 2-3 years of postnatal period, amblyopia can develop up to the age of 9.In India the incidence is around 1.1% [1] although its incidence could be higher in medical underserved populations.

This condition is secondary to visual deprivation or abnormal ocular interaction and is usually divided into three sub-types: strabismic, anisometropic/ ametropic and form deprivation (cataract, ptosis, nystagmus); [13] furthermore, these can co-exist. Anisometropic and/or strabismic amblyopia account for the majority, nearly over 90% of all amblyopia.

Functional changes are well documented in amblyopia, including loss of visual acuity and contrast sensitivity. As for structural changes, the deleterious effect of amblyopia on the cell growth of the lateral geniculate body (Baddini-Caramelli et al., (2001) [2] and visual cortex (Dyer D et al (1952) [3] has been well-established by quantitative histologic studies in several animal species and in human, but retinal involvement in amblyopia is still a topic of debate worldwide, with different studies showing conflicting results.

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 (Provis et al., 1965). [4] 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.

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 fibre 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).[5]

To date, the literature has shown conflicting results Yoon et al [6] and Yen et al [7]found a thicker RNFL in eyes with anisometropic amblyopia. AL Haddad et al [8] & Huynh et al [9] showed a thicker fovea in amblyopic children. Altintas et al [10], Repka et al [11] and Kee et al [12] found no difference in the thickness of the macula and RNFL in amblyopic children.

The purpose of our investigation is to use SD-OCT to measure macular and RNFL thickness in patients with unilateral amblyopia, and to compare the macular and RNFL thickness of the amblyopic eye and the normal eye in patients with amblyopia. This information may be useful in understanding the anatomical changes in amblyopia and in predicting treatment outcomes.

Material & Method

This was an Institutional Prospective Cross sectional study conducted at MGM Medical College, Indore, from November 2014 to June 2015, after approval from Scientific and Ethical Committee, DAVV University. 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 eg 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≤ 0.05 were considered as significant.

Result

During the study period, 110 eyes of 55 patients, who met the inclusion criteria were taken up for this cross-sectional analysis.

Out of 55 patients, 32(58.18%) were males and 23 (41.8%) were females with mean age of 20.2±8.4 years. Most of the patients (58%) were from 10-20 years of age._Patients were subdivided into types of amblyopia and anisometropia. A total of 10(18.1%) patients were having strabismic and 37(67.27%) were having anisometropic amblyopia and 8(14%) form deprivation amblyopia. Among patients with anisometropia, hyperopia was noted in 18 cases, myopia was noted in 15 cases and 4 were mixed.

Table 1: Demographic data

	Amblyopia	Anisometropia	Strabismic	Form deprivation
Total	55	37	10	8
Female:male	23:32	16:21	3:7	4:4
Mean age (±SD)	20.2±8.4	19.59±8.2	25.2±8.5	18.12±6.8
BCVA (Log MAR)	0.94	0.85	1.25	0.93

Table 2 shows the Mean Macular Thickness in various subgroups.

Table 2 : Mean Macular Thickness

Characteristic(MEAN MACULAR THICKNESS)	AMBLYOPIC EYE (mean±SD)	NON AMBLYOPIC EYE(mean±SD)	P VALUE
TOTAL AMBLYOPES	262.27±19.29	255.22±18.63	0.05
IN STRABISMIC	258.6 ±23.4	256.6 ±20.4	0.9
IN ANISOMETROPIC	264.10± 17.30	255.37± 16.77	0.03
IN FORM DEPRIVATION	258.37±23.83	250.25±25.48	0.5

Table 3 : Peripapillary Rnfl Thickness

Characteristic (PERIPAPILLARY RNFL THICKNESS)	AMBLYOPIC EYE (mean±SD)	NON AMBLYOPIC EYE(mean±SD)	P VALUE
Total Amblyopes	96.12±11.63	95.85±11.54	0.90
IN STRABISMIC	101.3 ±13.58	94.3 ±11.78	0.05
IN ANISOMETROPIC	94.27±11.21	95.93±11.96	0.53
FORM DEPRIVATION	98.25±9.9	97.37±10.35	0.8

Table 4 : Previous studies on optical coherence tomography (OCT) in amblyopia

S.no	OCT	Study first author (year)	No of Patient	Age group	Type of amblyopia	Retinal nerve fiber layer thickness	Central macular thickness
1	Stratus OCT	Huynh, 2009	4118	Children 6-12 years	Strabismus, anisometropia, controls	No difference	Increased foveal minimum Thickness
2	(Cirrus HD-OCT	Al Haddad (2011)	45	20 years	Strabismus, anisometropia	No difference	Increased mean macular thickness in overall amblyopes,esp in anisometropes
3	OCT 3000	Elvan Yalcin(2014)	60, 30	8-14 years	Hypermetropic, emmetropic controls	No difference	Increased mean macular thickness
4.	OCT??	Alotaibi AG (2011)	93	Children 5-12 years	Unilateral amblyopes	Increased thickness in amblyopic eye	No difference
5.	Cirrhus HD-OCT	Agarwal S (2014)	51	5-15 years	Strabismic ,anisometropic	Not studied	Increased mean macular thickness

The Mean Macular Thickness of amblyopic eye (262.27±19.29) was statistically significantly increased in 55 patients(P=0.05)when compared to fellow non amblyopic eye (255.22±18.63).

On subgroup analysis, the macular thickness is statistically significantly increased only in anisometropic amblyopic eyes (264.10± 17.30>>255.37± 16.77) (P=0.03) & not in strabismic or form deprivation subgroup.

As seen in Table 3, There was no statistically significant difference in amblyopic (96.12±11.63) and normal fellow eye (96.12±11.63) in 55 patients in Peripapillary Rnfl Thickness in various subgroups.

On subgroup analysis, strabismic amblyopic eyes (101.3 ±13.58 >>94.3 ±11.78) 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 significant.

The mean age of overall amblyopia patients (20.2±8.4) and subgroups (anisometropia= 19.59±8.2, strabismic=25.2±8.5, form deprivation 18.12±6.8) did not show significant correlation with the mean macular thickness or RNFL thickness of amblyopic eye.

Discussion

The mean macular thickness and peripapillary RNFL thickness has been extensively studied in amblyopia using TD-OCT, but data with the use of SD-OCT is rarely available.

To the best of our knowledge, it was first study of its kind using OPKOS SLO/OCT.

The macular thickness measured by both OCTs vary greatly as Time domain measures retinal thickness only upto IS/OS junction while spectral SLO/OCT(OPKOS),the spectral domain OCT used in the current study measures it upto second layer ie upto RPE[136].Moreover SD OCT is more accurate. To obtain an RNFL layer thickness measurement, the Stratus OCT uses the top of the ganglion cell layer as the outer boundary whereas the OPKO/OTI OCT uses the bottom of the fiber layer as the outer boundary [19]. However comparing the retinal thickness of amblyopic eye with the normal fellow eye can reproduce a fair outcome to corroborate with earlier studies.

In this study, the mean macular thickness is increased in amblyopic eye, while the RNFL thickness is not. Large clinical study The Sydney Childhood Eye Study by Huynh SC (2009) [9] (n=4118 patients) also found increased foveal minimum thickness in amblyopic eyes but not in peripapillary RNFL. Kyung-Ah Park (2011) [14] obtained notable increase in thickness of retinal layers including ganglion cell layer plus inner plexiform layer at macula.

On subgroup analysis,mean macular thickness was increased only in anisometropic amblyopic eyes, while strabismic eyes showed increased RNFL thickness.

In previous studies, Al-Haddad CE et al(2011)[8] and Elvan Yalcin et al (2014) [16] also found significant increase in mean macular thickness in anisometropic amblyopia using SD-OCT,but no significant relation in peripapillary RNFL thickness., while Yen et al (2004) [7] and Yoon et al (2005)[6] found significant increase in peripapillary RNFL in both strabismic and anisometropic amblyopia. However, Altintas [10], Walker [17] ,Kee [12] and Repka [11] found no differences between the sound and amblyopic eyes.

Agarwal S et al (2014) [15] found increased macular thickness in strabismic amblyopes.

The 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. Quoc EB et al [18] & Al Haddad et al [8] couldn't establish this correlation too, but Won KS et al (2010) [20] while assessing the relationship between macular retinal thickness and age with SD-OCT, found a negative correlation between retinal thickness and age.

The variations in results of these reports are probably due to different study populations, defining criteria and type of amblyopia, different instruments used to measure the macular thickness and co-existent factors like refractive errors.

Our findings support the hypothesis of thicker retina in amblyopic eyes, which may be attributed to an arrest of the normal postnatal reduction in the number of retinal neurons. (Yen et al (2004) [7]. Another possible hypothesis is that ageing affects the normal and amblyopic eyes differentially, with the former being affected more, producing a thinner macula on OCT, however in our study no correlation of retinal thickness with age was found.

The increased thickness of macula and peripapillary RNFL could have many clinical implications:

It could have a role in pathogenesis or alternatively be a result of the cortical changes;

it may also serve as a tool in monitoring response to treatment if future studies show changes in OCT with amblyopia therapy.

There were many limitations in the study like unequal distribution of patients in subgroups,no control of normal patients and less stable fixation and thus decentered scans on OCT.

Conclusion

The mean macular thickness is significantly increased in amblyopic eyes as compared to non amblyopic eyes .On subgroup analysis it is increased only in anisometropic amblyopes ,not in strabismic or form deprivation.

There is no significant increase in peripapillary RNFL thickness in amblyopic eyes.However,the difference was significant in strabismic subgroup.

There is no significant correlation of retinal layer thickness with age of the patient.

This opens the exciting discussion of a possible retinal origin to amblyopia.

However,more studies on the differences in thickness of the macula and the retinal nerve fiber layer between patients with anisometric amblyopia and strabismic amblyopia are required.

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