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Study of Macula by Spectral Domain Optical Coherence Tomography (SD-OCT) In Patients Of Unilateral Amblyopia

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Abstract

Purpose: To compare the macular changes in two eyes in patients with unilateral amblyopia by SD-OCT .

Methods: A prospective observational study was performed of 48 patients with amblyopia aged more than 5 years who had not received treatment for amblyopia from December 2017 to July 2019.

Results: The mean foveal thickness in amblyopic eyes (255±31.82µm) was significantly more than normal eyes (242.18±31.17µm). No statistical significant difference in macular thickness, mRNFL , GCL+, GCL++, macular and mRNFL volume between normal and amblyopic eyes and between the both amblyopic groups i.e. strabismic and anisometropic was noted. In our study, we found that the macular thickness in anisometropic eyes (266.88±22.16 µm) was more as compared to strabismic eyes(260.40±31.51µm)but it was not significant .

Conclusion: Cortical changes are the main pathophysiology behind amblyopia. The changes at the level of retina need to be studied more to confirm whether they are significant or incidental findings unmasked by the newer technologies.

Keywords: Amblyopia, Optical coherence tomography, SD-OCT {SPECTRAL/ FOURIER DOMAIN OCT} , Macular thickness, foveal thickness

Introduction

Amblyopia is known as unilateral or bilateral reduced best corrected visual acuity(BCVA) which is caused by abnormal visual stimulation throughout the critical period of development of visual areas in brain.[1]It may be due to abnormal binocular interaction in one or both eyes or pattern visual deprivation during the visual immaturity for which no obvious cause can be detected on physical examination.[2]

According to American Academy of Ophthalmology, it is defined as developmental disorder of central nervous system resulting from abnormal processing of visual images leading to reduction in visual acuity.[3]Visual significant conditions like monocular or binocular visual deprivation, strabismus, anisometropia or abnormal visual environment during critical period of vision development lead to various physiological and anatomical abnormalities in striate cortex and lateral geniculate body. The area found to be dysfunctional is area 6 which is confirmed by functional imaging.[4]It is one of most common cause of preventable monocular blindness and nearly all amblyopic visual loss is preventable with early detection and appropriate management.[5]

Advances in neuroanatomy and neurophysiology have reopened the possibility that there are some changes occurring at the level of retina. The changes that occur at the level of retina are not yet clarified. Amblyopia might affect the RGC (retinal ganglion cells) by affecting its postnatal maturation resulting in reduction of RGC and its abnormalities.[1]

With advent of optical coherence tomography (OCT) of the retina,it is possible to study and understand whether amblyopia is associated with changes at the

level of the retina. OCT means optical coherence tomography in which word optical is related to lights and optics, coherence is related to two light beams of same wavelength, Tomography means sectioning/cutting. [6] Hence OCT can be used to study the various layers of the tissue under study in vivo. Retina is a multilayered tissue with each layer having a different reflectance. Thus , by this principle OCT permits recognition of multiple retinal layers in *vivo* in a noninvasive manner.[6]

The purpose of our study is to compare the structure of the macula in the two eyes in patients with unilateral amblyopia by SD-OCT and detect any structural change occurring in the amblyopic eyes at the level of retina.

Materials And Methods

A prospective observational study was performed on 48 patients of amblyopia aged more than 5 years who have not received treatment for amblyopia attending MGM ophthalmology OPD.

Inclusion criteria werepatients of age > 5 years with untreated unilateral amblyopia (anisometropic,strasbismic, unilateral deprivational , meridional). We excluded cases who presented with bilateral deprivational amblyopia and ammetropic amblyopia and patients having any ocular disease and history of any intraocular surgery. Patient's demographic details, history, clinical ocular examination were documented as per a predefined proforma .

Detailed evaluation which included history, visual acuity testing,evaluation of near stereopsis by TNO test, ocular movements, detailed anterior segment examination using slit lamp, examination under mydriasis and fundus examination using ophthalmoscope. Type of Amblyopia was identified as Mild, moderate and severe.Macular study was performed by SD-OCT **{**SPECTRAL/ FOURIER DOMAIN OCT} [7]using the Radial Scan protocol.[3 D maestro -1 OCT (Topcon)- (Tokyo,Japan)].

Types of Amblyopia was considered as Mild when BCVA was 20/25 - 20/40 (0.2 – 0.3), Moderate when BCVA was 20/40 - 20/100 (0.3 – 0.8) and severe when BCVA was 20/100 - 20/400 (> 0.8).

The study protocol was approved by the Institutional ethical Committee and adhered to the tenets of Declaration of Helsinki.

Statistical Analysis:

Data was entered in Microsoft Excel and analyzed using SPSS version 24.0th Mean and SD was calculated for quantitative variables and proportions were calculated for categorical variables. Z- test was applied to check significant difference between two groups P- Value of <0.05 will be considered statistically significant. Unpaired 't' test was applied to check significant difference between symptomatic and asymptomatic group.

Results

48 patients were included in this study. The mean age of presentation was 26.73 ± 13.90 years. The maximum percentage of the patients were in the age group 11-20 years;(14 patients / 29.16%), followed by 41-50 years – 10 patients / 20.83%.Ourstudy had male preponderance with M:F ratio of 1.28:1; male accounting for 54 %.In our study of 48 amblyopic patients, maximum patients had severe amblyopia; 23 patients /47.91%.(Table 1)

In 48 amblyopic patients, most common refractive error was any type of astigmatism (52.08%) followed by hypermetropia (29.16%) and myopia(16.66%). (Table 2) Of the 24 amblyopic patients with astigmatism, 11 patients (45.83%) had hyperopic astigmatism followed by 8 patients (33.33%) who had myopic astigmatism followed by 5 patients (20.83%) who had mixed astigmatism.(Table 3)

The maximum patients showed anisometropicamblyopia; 38 patients (79.16%) followed by 10 patients (19.83%) who had strabismicamblyopia.(Table 4)

The mean macular thickness in normal eye was noted as 271.10±19.38 while that in amblyopic eye was 266.26 ±23.23. (Table no. 5) The mean Foveal thickness in normal eye was 242.18 ±31.17 and that in amblyopic eye was founded to be 255 .00±31.82.

Table 6 shows the average macular,foveal, RNFL , GCL +, GCL ++ thicknessin amblyopic eyes in patients with anisometropic and strabismicamblyopia. In our study, we found that the macular thickness in anisometropic eyes (266.88±22.16) was more as compared to strabismic eyes (263.90±28.14),while

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the foveal thickness (P=0.230 NS) , (RNFLP=0.809 NS) , GCL+ (P=0.849 NS) and GCL++(P=0.961 NS) was more in strabismic eyes compared to anisometropic eyes but not statistically significant.

Table no 1 : Grades of amblyopia

Grade of Amblyopia (Visual acuity on LogMar chart)	No of patients	Percentage
Mild (0.2 – 0.3)	9	18.75%
Moderate (0.3-0.8)	16	25.0%
Severe (> 0.8)	23	47.91%
Total	48	100.0%

Table no 2 : Distribution according to refractive error

Refractive Error	No of patients	Percentage
Myopia	9	18.75%
Hypermetropia	15	31.25%
Astigmatism	24	50.00%
Total	93	100.0%

Table no 3:Distribution according to type of astigmatism

Astigmatism	No of patients	Percentage
Simple Myopic	00	00
Simple Hypermetropic	00	00
Compound Myopic	08	33.33 %
Compound Hypermetropic	11	45.83 %
Mixed	05	20.83%
Total	24	100 %

Table no 4 : Type of amblyopia

Type of Amblyopia	No of patients	No of patients
Anisometropic	38	79.17%

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Strabismic	10	19.83%
Deprivational	0	0
Ametropic	0	0
Total	48	100%

Table no 5 : Average thickness(micrometer) in Normal & Amblyopic eyes

Average Thickness	Normal eyes Mean±SD	Amblyopic eyes Mean±SD	Z-value	P-value
Mean macular Thickness	271.10±19.38	266.26 ±23.23	1.11	P=0.267 NS
Mean Foveal Thickness	242.18 ±31.17	255 .00±31.82	1.99	P=0.04 S
RNFL	28.06 ±4.19	27.52 ±3.38	0.694	P=0.487 NS

Table no 6 : Thickness in Amblyopic eyes in patients with Anisometropic&Strabismic Amblyopia

Average thickness	Anisometropic Amblyopic eye Mean±SD	Strabismic Amblyopic eye Mean±SD	t-value	p-value
Macular thickness	266.88±22.16	263.90±28.14	0.320	P=0.720 NS
Foveal thickness	253.58±30.55	260.40±31.51	1.10	P=0.230 NS
RNFL	27.37±3.31	28.08±3.76	0.430	P=0.809 NS
GCL +	69.64±10.77	71.29±14.24	0.132	P=0.849 NS

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GCL ++	106.07±22.53	106.18±24.67	0.026	P=0.961 NS

Discussion

Our study of 48 patients was done to detect the structural changes occurring in patients of unilateral amblyopia at level of retina. In our study the maximum percentage of the patients were in the age group 11-20 years – 14 (29%), followed by 21-30 years – 10 (20%). The mean age group was 26.73±13.90 years. Similar results were found in another study carried out in 2018 , in which mean age of the children was found to be 13.5 years. About more than half of amblyopic children were above 11 years.[8]

Amblyopia occurs in approximately 2% of general population.[9]. American Academy of Ophthalmology in 2017 had stated prevalence according to the different age groups of children, which showed lower prevalence in 6 to 71 months which ranged from 0.7% to 1.9%, and higher rates (1% to 5.5%) in school based studies.[10]In a study done by Mishrikotkar et al(2018), the prevalence of amblyopia was found to be 1.85%.[5]

Our study had male preponderance with M: F ratio of 1.28:1, male accounting for 54 % . Others have reported similar ratios. [8],[11]In 48 amblyopic patients,most common refractive error was found to be astigmatism(52.08%) followed by hypermetropia (29.16%).Out of 24 amblyopic patients who had astigmatism, 11 patients(45.83%)had hyperopic astigmatism followed by 8 patients (33.33%) who had myopicastigmatism.

In our study, 23 patients(47.91%) had severe amblyopia(visual acuity->0.8) followed by 16 patients(25%) had moderate amblyopia (visual acuity- 0.3-0.8) and only 9 patients(18.75%) had mild amblyopia (visual acuity- 0.2- 0.3).

38 patients(79.1%) had anisometropic amblyopia followed by 10 patients(20.86%) who had strabismic amblyopia with no patient havingdeprivationalamblyopia.Other studies showed similar distribution of types of amblyopia.[12][13] [14][5]

The mean macular thickness in our study was 271.10±19.38 micrometer in the normal eyes, whereas it was 266.26±23.23 micrometer in the amblyopic eyes. This difference was not statistically significant. Alotaibi et al in their study of 93 patients[15] and Zhu Li et al[16]in their study ,had similar findings. But in the study carried out by Agrawal et al[16]and Kasemet al in [1], mean macular thickness was higher in amblyopic eyes than in normal eyes , which was statisticallysignificant .

The mean foveal thickness in amblyopic eyes (255±31.82 micrometer) was more as compared to normal eyes (242.18±31.17 micrometer) which was statistically significant (P=0.04) Others[17]also showed that the macular foveal thickness was significantly more in amblyopic eyes as compared to normal eyes.

In our study, Macular RNFL thickness in amblyopic eyes (27.52±3.38 micrometer) was slightly more as compared to normal eyes (28.06±4.19 micrometer) but this was not statistically significant. Similar findings were noted by Araki et al [mRNFL in amblyopic (27.7±2.9 micrometer) and normal (29.9±1.9 micrometer) eyes].[18]and others in separate studies[19][20][21].

In our study, we found that there is increase in foveal thickness, RNFL, GCL+,which was more in strabismic amblyopic patients (260.40±31.51, 28.08±3.76, 71.29±14.24 ,106.18 ±24.67micrometer) as compared to anisometropic amblyopia (253.58±30.55,27.37±3.31, 69.64±10.77 , 106.07±22.53 micrometer). Again this was not statistically significant. Similar to our study Alotaibi et al showed no statistical difference in macular and foveal thickness[15]and Firat et al in 2013 showed no statistical difference in GCL++ in both the groups.[22]Study carried out Araki et al and Mikki et al in 2017, there was no significant difference in mRNFL, GCL+,GCL++ in both the groups.[18]

Our study showed that, there was decrease in macular and GCL++ thickness in anisometropic (266.88±22.16 micrometer) and strabismic amblyopic patients (263.90±28.14micrometer) but was not significant . No statistical difference was found in macular and foveal thickness in

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anisometropic amblyopia and normal eyes in study performed by Yoon et al (2004) which was similar to our study [23].

Conclusion -

Our study showed that only few significant retinal changes are present in amblyopia which are detectable on OCT.The limitation of our study is that the study population is small and therefore we could not compare the findings between different grades of amblyopia.

Cortical changes are the main pathophysiology behind amblyopia.The changes at the level of retina need to be studied more to confirm whether they are significant or incidental findings unmasked by the newer technologies.

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