Comparative study of retinal macular thickness changes in unilateral amblyopia with normal eye, using optical coherence tomography (OCT)

Hitesh Vyas

Associate Professor, Dept. of Ophthalmology, GMERS Medical College, Gandhinagar, Gujarat, India

***Corresponding Author:**
Email: drhjvyas@gmail.com

Abstract

Aim: To study the OCT images of macula in amblyopic eyes**.**

Materials and Methods: Patients attending eye department of our institution were selected. Unilateral amblyopia patients were completely evaluated. Patients were subjected to OCT (Optical Coherence Tomography) Spectral Domain 'Cirrus™' HD-OCT (Carl Zeiss Meditec. Inc. Dublin, CA, USA) for both eyes. 30 patients with unilateral amblyopia (other eye normal) and 60 eyes were studied with OCT of macular, foveal region, and all data was analyzed with 'Excel' sheets.

Results: 21 were males, 9 female. Types of Amblyopia included 10-myopia, 8-astigmatism, 9-hypermetropia, 3-strabismus. Mean Macular Thickness (MMT) in amblyopic eye was 286 µm and Normal eye – 284 µm. Mean Foveal Thickness (MFT) in amblyopic eye was 254 µm and normal eye – 242 µm.

Conclusions: OCT examination shows increased macular thickness compared to normal eye. Cause of increased macular thickness is not known. But if 'thickness modifier' is found out then it may be possible to 'treat' amblyopia in future.

Keywords: Amblyopia, Low Vision, Macular thickness, OCT.

Introduction

'Amblyopia' means 'lazy-eye' or permanent low vision without any obvious pathological changes in structure of eye. Usually unilateral but sometimes can be bilateral. Whenever there is visual difference of 2-lines on 'Snellen's Chart' compared to other eye, then that is labeled as 'Amblyopia'. Binocular vision is developing till 10 years of age. If any 'interference' develops during this period then Amblyopia develops. Treatment for Amblyopia is best correction of refractory errors, correction of strabismus and 'Occlusion' therapy of the affected eye. Treatment after 10 years of age is ineffective. Many patients develop amblyopia due to refractory errors, squint or idiopathic event.

1. Strabismic amblyopia: defocused image falling on deviated eye is gradually ignored by visual cortex to avoid diplopia. This adaptation gradually becomes permanent.
2. Anisometropic amblyopia: When 2 eyes have refractory error with difference more then 3.5 dioptres, unequal images or anisokonia occurs. This leads to difficulty in fusion of 2 images, which leads to suppression of one eye and amblyopia. [2]
3. Stimulus deprivation amblyopia: If one eye has media opacity like 'cataract', that eye is not able to generate good image of object for cerebral cortex, resulting into amblyopia.

If underlying event in children is not addressed, then permanent low vision develops, which cannot be rectified later on. Direct ophthalmoscope examination is normal in the affected eye. Recent advance like OCT shows 'live' anatomical cross-section of macula of retina.[1] This computerized scan is taken with light-beam and no hazard to the patient. We are using OCT to study many retinal macular diseases. OCT gives data about thickness of various parts of macula including central fovea.

Some studies have noted retinal thickening in amblyopic eyes.[2] Ganglion cell layer in macula mainly develops thickening changes. The aim of this study is to demonstrate retino-macular thickness in affected eye, as compared to normal eye in same patient.[1] This correlation is significant as it is studied in same patient. OCT gives cross-sectional picture of macular region, divided into 9-regions.[3] Fovea being central region.[4]

Normal eye: Eye having best-corrected vision of 6/6 on Snellen's Chart.

Amblyopic Eye: Eye with best-corrected visual activity 2 or more lines less on Snellen's Chart compared to 'Normal Eye'.

OCT (Optical Coherence Tomography) has opened up non-invasive modality to study cross sectional structure of retina-macula in living eye. We can define various retinal problems accurately using OCT images. Many surgical and medical management of macular problems is based on observation of OCT images. Spectral Domain OCT has refined analysis and can give 3-D images. Here 840 nm light beam scans tissues at 27000 A-scans per second, producing about 500 B-scans per second. This precisely defines the tissue thickness which was not possible with earlier 'Time Domain OCT' instruments.

Materials and Methods

Many patients with diverse eye problems attend OPD of our institution. Patients having one eye corrected normal vision (6/6), and other eye 'amblyopia' (corrected visual acuity 2 lines difference

on Snellen's chart.) were selected for this study. Any patient with previous history of any intra-ocular operations (cataract, glaucoma etc.) was excluded from the study. Complete ocular examination including Slit-lamp bio microscopy, Refraction, Intra-ocular pressure check up, dilated (Tropicamide + Phenylephrine) ophthalmoscopic examination with special emphasis on macular region. Patients were subjected to OCT (Optical Coherence Tomography) Spectral Domain 'Cirrus™' HD-OCT (Carl Zeiss Meditec. Inc. Dublin, CA, USA) for both eyes.[3] Macula was analyzed for both eyes. Nine macular regions covering 6mm area (defined by EDTRS) were studied with scans. This machine gives accurate thickness analysis of all regions including 'Foveal' region.

30- patients with unilateral 'amblyopia' (other eye normal vision) (60 eyes) were studied with OCT of macular region and all data was analyzed with 'Excel' sheets.

Inclusion Criteria: Age > 10 years, Visual Acuity as per the definition given above.

Exclusion Criteria: Patients with preexisting ocular diseases like iridocyclitis, Posterior capsule opacification, treatment of retinal diseases and systemic diseases like diabetes and Hypertension will be excluded. Patients with any type of ophthalmic surgery will be included only if no complication is seen. Unwilling or uncooperative patient.

Ethical Issues: This is non-invasive study. OCT is commonly performed procedure for various retinal disorders. Patient's informed written consent is taken. Total confidentiality of patient is kept. IEC clearance is obtained for this study.

Discussion

Amblyopia involves psycho-physical changes in neurons of LGB and visual cortex. Unequal visual input from both eyes results into imbalanced neural network development during critical period of binocular visual development. (within 10 years of age).[4] Spectral domain OCT takes 27000 scans per second and gives accurate 2D and 3D map of macula. Central 6mm region of macula (divided into 9 EDTRS areas.) was studied with 840 nm light beam. Data about amblyopic and normal eye was tabulated and analyzed.

Our study showed increased MMT and MFT in amblyopic eye compared to normal other eye of the same patient.

Pang et al showed increased macular thickness in myopic amblyopic eyes, which was reduced following amblyopia treatment in children below 10 years age.[5]

Li et al did meta analysis of various studies and showed increased MMT (Mean macular thickness) and MFT (Mean Foveal thickness), which correlates with our study.[6]

Yassin et al showed increased MMT on OCT.[7]

Results

Sex distribution-- 21 were males, 9 female. Age ranged from 18 to 70 years. Types of Amblyopia included 10-myopia, 8-astigmatism, 9-hypermetropia, 3-strabismus. Majority were 'anisometropic' type where there was difference of more than 4-diopters between two eyes. Mean Macular Thickness (MMT) in amblyopic eye was 285.97 +/- 21.36 µm and Normal eye – 283.67 +/- 23.14 µm. ($p<0.001$) Mean Foveal Thickness (MFT) in amblyopic eye was 254.23 +/- 33.06 µm and normal eye – 242.13 +/- 31.38 µm. ($p<0.001$) Both total macular and foveal thickness are more in amblyopic eye compared to normal eye.[8]

Fig. 1: Age distribution, this chart shows age distribution of all included patients

Fig. 2: Sex distribution, male-female distribution chart

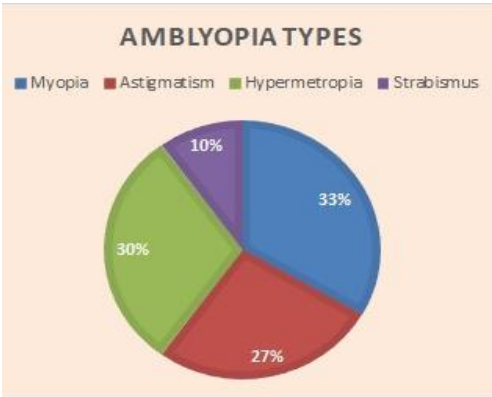

Fig. 3: Amblyopia types, various refractory error and strabismic types

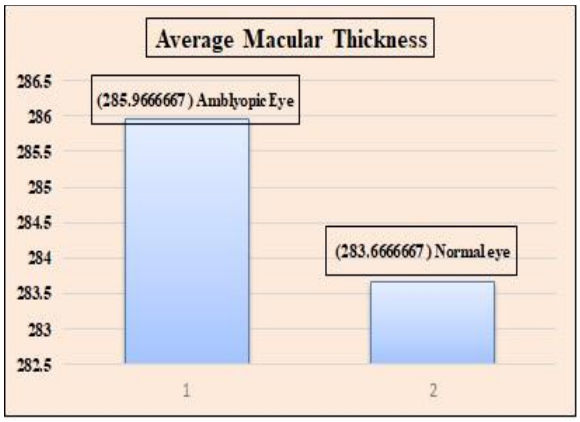

Fig. 4: Mean macular thickness, bar chart of MMT both amblyopic and normal eye

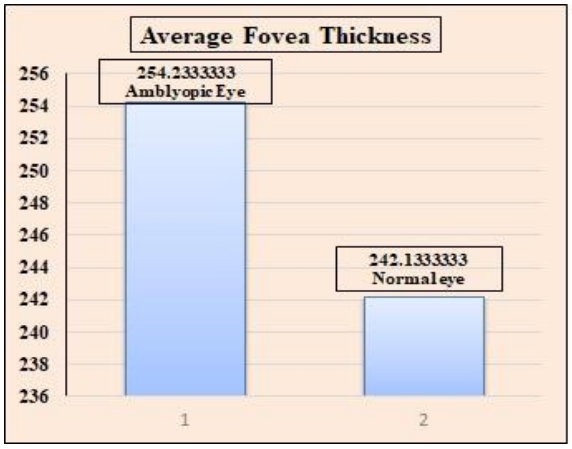

Fig. 5: Mean foveal thickness, both amblyopic and normal eye

Conclusion

OCT examination shows increased macular thickness compared to normal eye. Foveal thickness is also more in amblyopic eye compared to normal eye. This correlates with other similar studies. Cause of increased macular thickness is not known. But if 'thickness modifier' is found out then it may be possible to 'treat' amblyopia in future.

Conflict of Interest: None

References

1. Rajavi Z, Moghadasifar H, Feizi M, Haftabadi N, Hadavand R, Yaseri M, Sheibani K, Norouzi G, Macular thickness and amblyopia, J Ophthalmic Vis Res. 2014 Oct-Dec;9(4):478-83. doi: 10.4103/2008-322X.150827.
2. Tick S, Rossant F, Ghorbel I, Gaudric A, Sahel JA, Chaumet-Riffaud P, et al. Foveal shape and structure in a normal population. Invest Ophthalmol Vis Sci. 2011;52:5105–10. [PubMed: 21803966].
3. Drexler W, Sattmann H, Hermann B, Ko TH, Stur M, Unterhuber A, et al. Enhanced visualization of macular pathology with the use of ultrahigh-resolution optical coherence tomography. Arch Ophthalmol. 2003;121:695–706. [PubMed: 12742848].
4. Sang Won Yoon MD, Thicknesses of Macular Retinal Layer and Peripapillary Retinal Nerve Fiber Layer in Patients with Hyperopic Anisometropic Amblyopia, Korean J Ophthalmol Vol. 19:62-67, 2005.
5. Pang Y, Frantz KA, Block S, Goodfellow GW, Allison C, Effect of Amblyopia Treatment on Macular Thickness in Eyes With Myopic Anisometropic Amblyopia. Invest Ophthalmology Vis Sci. 2015 Apr;56(4):2677-83. doi: 10.1167/iovs.14-15532.
6. Li J(1), Ji P, Yu M., Eur J Ophthalmology. 2015 Sep-Oct;25(5):400-9. doi: 10.5301/ejo.5000583. Epub 2015 Mar 19. Meta-analysis of retinal changes in unilateral amblyopia using optical coherence tomography.
7. Yassin SA(1,)(2), Al-Tamimi ER(3,)(4), Al-Hassan S(5), Macular and retinal nerve fiber thickness in recovered and persistent amblyopia, Int. Ophthalmology. 2015 Dec;35(6):833-42. doi:10.1007/s10792-015-0055-9. Epub 2015 Feb 21.
8. Chen W(1), Chen J, Huang J, Xu J, Zhang F, Lu F, Comparison of macular and retinal nerve fiber layer thickness in untreated and treated binocular amblyopia, Current Eye Res. 2013 Dec;38(12):1248-54. doi: 10.3109/02713683.2013.805233. Epub 2013 Sep 27.