

Study of retinal nerve fiber layer and foveal thickness in amblyopia

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Abstract

Aim: To measure and compare the retinal nerve fiber layer (RNFL) and foveal thickness of normal and amblyopic eyes in unilateral amblyopia.

Material and Methods: This was a prospective, observational cross-sectional study conducted over a period of one year, after approval from the Institutional ethical committee. Children presenting to the pediatric ophthalmology clinic with a diagnosis of unilateral amblyopia due to anisometropia or strabismus or both were included. All children underwent clinical examination including BCVA, anterior and posterior segment examination and squint workup in cases of strabismus. Retinal nerve fiber layer (RNFL) and foveal thickness were measured in amblyopic as well as normal eye by Optovue RTvue 100 Fourier domain OCT.

Statistics: The Student t-test was used to compare the RNFL and foveal thickness in the normal and amblyopic eye.

Results: The study included 31 children out of which 16 (51.62%) were male and 15 (48.38%) female. Mean age of presentation was 11.29±3.06 years. There were 58.06% with anisometropic, 22.58% with strabismic and 19.36% subjects with mixed amblyopia. The mean foveal thickness of normal eyes was 254.64±35.57 μm whereas that of corresponding fellow amblyopic eyes was 271.29±28.08 μm with a p-value of 0.045. The mean RNFL was thicker in the normal eyes (111.06±17.63 μm) than the fellow amblyopic eye (108.80±23.50 μm) but this difference was not statistically significant (p=0.670).

Conclusion: Foveal thickness was found significantly more in the amblyopic eye than fellow normal eye whereas the RNFL thickness showed no statistically significant difference between the two groups.

Keywords: Retinal Nerve Fiber Layer, Foveal Thickness, Amblyopia, OCT

Introduction

Amblyopia is defined as a decrease of visual acuity in one or both eyes caused by abnormal visual experience during visual maturation and which in appropriate cases is reversible by therapeutic measures. It is usually found in patients with strabismus, anisometropia, or pattern vision deprivation.⁽¹⁾ It occurs usually during the development of a neuronal network between the retina and the cerebral cortex. The first 2–3 years of the life are the most common age for development, but it may develop up to the age of 8–9 years.⁽²⁾

Earlier it was thought that functional and morphologic effects on the visual cortex and lateral geniculate nucleus result in amblyopia. Changes have been seen in the lateral geniculate nucleus of the humans following visual deprivation amblyopia.⁽³⁾ Recently, it has been hypothesized that postnatal maturation of retina is affected by amblyopia, which may alter the foveal thickness and retinal nerve fiber layer (RNFL) thickness in amblyopic eyes.⁽⁴⁾

Ocular coherent tomography(OCT) is a non-invasive test used for quantification of the retinal structures. Time domain OCT have been used to study RNFL and macular thickness in amblyopic eyes. More recently, spectral-domain OCT (SD-OCT) has been used as it scans more data points. Keeping this in mind the present study was undertaken to assess the mean RNFL and mean foveal thickness in amblyopic eyes of children using Fourier-domain OCT in cases of

unilateral amblyopia and comparison was made with the fellow normal eyes.

Ethics: The study was conducted after prior approval from the ethical committee of university and was in correspondence with the Helsinki Declaration of 1975, as revised in 2000. Written and informed consent was taken from parents/ guardians of the children who participated in the study.

Materials and Methods

This was a hospital based observational cross-sectional study conducted in a tertiary care hospital in north India over a period of 1 year. Children presenting to the pediatric ophthalmology clinic with a diagnosis of unilateral amblyopia due to anisometropia or strabismus or both were included.

Amblyopia in the present study was defined by a difference in the BCVA between both eyes of two or more Snellen lines/equivalent measure on the Lea symbol chart in the absence of any organic lesion that could result in decreased vision. Children who could not read Lea / Snellen chart were diagnosed to have amblyopia by central, steady, maintained (CSM) method.

Strabismic amblyopia was defined as amblyopia in presence of heterotropia at distance or near fixation in the absence of any anisometropia. Anisometropic amblyopia included patients who had amblyopia in the presence of anisometropia that was 1 D or greater in the spherical equivalent in the absence of measurable

heterotropia at distance or near. Mixed amblyopia included patients with either a heterotropia at distance or near along with anisometropia of 1D or more in the spherical equivalent in both the eyes.

Patients with any intraocular disorder, nystagmus, laser treatment, intraocular surgery, neurological disorder, uncooperative children and unilateral amblyopia not due to anisometropia or strabismus or both were excluded from the study. Clinical examination included uncorrected visual acuity (UCVA) and best-corrected visual acuity (BCVA), Hirschberg test and cover/ uncover testing with and without glasses. Alternate prism cover test or krimsky test was done if strabismus was present during cover/uncover testing. Extraocular movements, anterior segment and pupillary evaluations, intraocular pressure, fundus examination, keratometry and A-scan for axial length were also done.

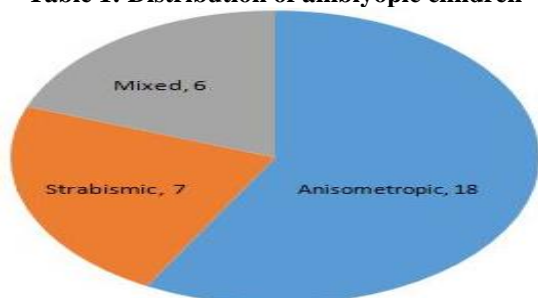
Optovue RTvue 100 Fourier domain OCT was used to test retinal thickness in both the normal and corresponding fellow amblyopic eyes. Comparison of amblyopic eye with the fellow normal eye can avoid age, gender and genetic influence on the study. Enhanced Macular Map 5 Scan (EMM5) was used to measure the mean foveal thickness and the mean parafoveal thickness in superior, inferior, nasal and temporal quadrants. Mean RNFL thickness was measured using the optic nerve head (ONH) scan. Mean RNFL thickness of all 8 quadrants was also calculated using the ONH scan.

Statistics: The Student t-test was used to compare the RNFL and foveal thickness in the normal and amblyopic eye. *P* value of <0.05 was considered significant.

Results

Thirty-one children were included out of which 16 (51.62%) were male and 15 (48.38%) female. Mean age of presentation was 11.29±3.06 years. Out of 31 patients, 58.06% patients were from the rural community. Eighteen subjects (58.06%) presented with anisometropic, 7 (22.58%) with strabismic and 6 (19.36%) subjects presented with mixed amblyopia. (Table 1)

Table 1: Distribution of amblyopic children



Hypermetropia was the most common refractive error seen in 24 (77.41%) children. In anisometropia amblyopia group, 83.33% patients were hypermetropic with a mean spherical equivalent (SE) of +4.4±2.09 D and 16.67% were myopic with a mean SE of -7.33±4.84 D whereas in the strabismic group 71.42% were hypermetropic with a mean SE of +2±0.55 D and 28.58% had myopia with a mean SE of -0.375±0.53 D. In the mixed type 66.67% had hypermetropia and 33.33% had myopia with a mean SE of +7.19±4.33 D and -6.43±3.62 D respectively.

On comparison of the mean RNFL thickness of normal eyes with the fellow amblyopic eyes, it was found that mean RNFL was thicker in the normal eyes than the fellow amblyopic eye but this difference was not statistically significant. (*p*=0.670) whereas the mean central foveal thickness was significantly thinner in the normal eyes as compared to the fellow amblyopic eyes (*p*=0.045)(Table 2).

Table 2: Comparison of mean RNFL and mean foveal thickness (in μ) in the study group (n=31)

| | Normal Eye (n=31) | Amblyopic Eye (n=31) | P value |
|-----------------------|-------------------|----------------------|---------|
| Mean RNFL thickness | 111.06±17.63 | 108.80±23.50 | 0.670 |
| Mean foveal thickness | 254.64±35.57 | 271.29±28.08 | 0.045 |

Comparing the subgroups it was seen that the mean RNFL thickness in the amblyopic eye of anisometropic group was thicker as compared to the strabismic group and thinner than the mixed group but this difference was not statistically significant. (*p*=0.172, *k*=3.518) The mean central foveal thickness in amblyopic eye of anisometropic group was thinner than the mixed type but thicker than the strabismic subtype. This difference was also not statistically significant (*p*=0.151, *k*=3.786) (Table 3)

Table 3: Comparison of mean RNFL and mean foveal thickness (in μ) in different types of amblyopia in children (n=31)

| | Anisometropic Amblyopia (n=18) | Strabismic Amblyopia (n=7) | Mixed Amblyopia (n=6) |
|-----------------------|--------------------------------|----------------------------|-----------------------|
| Mean RNFL Thickness | 111.91±19.63 | 96.01±16.28 | 114.39±37.22 |
| Mean foveal thickness | 268.05±30.58 | 262±27.31 | 291.83±16.89 |

Discussion

Amblyopia is known to affect lateral geniculate body causing its shrinkage in monkeys as well as

humans, where the reason is still unclear.⁽³⁾ Evidence of retinal changes has been controversial. Such changes affect the foveal thickness and RNFL which can be reliably studied on OCT.

Our study showed that the mean foveal thickness was significantly thicker in amblyopic eyes as compared to the normal corresponding eye. Few studies^(5,6) have reported similar results and this is assumed that visual deprivation and binocular competing role led to a decrease in foveal cone diameter and movement of Henle's fiber layer away from the fovea. This affected normal maturation of macula leads to increased foveal thickness.⁽⁷⁾

In a study by Alotaibi, mean RNFL thickness is reported to be thicker in amblyopic eyes as compared to normal eyes.⁽²⁾ However, the present study had thinner RNFL in the amblyopic eye as compared to the normal corresponding eye, but the difference was not significant. Other international studies also reported no significant difference in mean RNFL thickness in amblyopic eyes from normal eyes.^(8,9,10,11) Net RNFL thickness in amblyopic eyes may be a result of a decrease in the postnatal reduction of ganglion cells which causes an increase in RNFL thickness and decrease in number and size of axons which causes thinning of RNFL.^(2,12)

The present study showed that the mean RNFL thickness in anisometric amblyopia was greater than the strabismic amblyopia and less than the mixed type although this difference was not statistically significant. Contrasting results were seen in another study in which anisometric group had thinner RNFL than the strabismic but this difference was also not statistically significant.⁽¹⁰⁾

The foveal thickness in the anisometric group was slightly thicker than the strabismic group in our study but was not statistically significant. Atakan also found increased, but not significant, macular thickness in anisometric group than the strabismic group.⁽¹⁰⁾

Conclusion

The present study concludes that Fovea may be involved, but RNFL appears unaffected, in amblyopia. To the best of our knowledge, this study is one of the few studies done by Spectral domain OCT. However small sample size, a lack of follow up for long periods and lack of a normative database for children in Fourier domain OCT remain the most important limitations of the current study. A study with a larger sample size and a more prolonged follow-up period is required to establish these facts.

References

1. Van Noorden GK, Campos EC. Binocular vision and ocular motility. 6th edition. Mosby: Philadelphia; 2002.
2. Alotaibi AG, Al Enazi B. Unilateral amblyopia: Optical coherence tomography findings. Saudi J Ophthalmol. 2011 Oct; 25(4):405-9.

3. Von Noorden GK, Middleditch PR. Histology of the monkey lateral geniculate nucleus after unilateral lid closure and experimental strabismus: further observations. Invest Ophthalmol Vis Sci. 1975;14(9):674-83.
4. Yen MY, Cheng CY, Wang AG. Retinal nerve fiber layer thickness in unilateral amblyopia. Invest Ophthalmol Vis Sci. 2004 Jul;45(7):2224-30.
5. Pang Y, Goodfellow GW, Allison C, Block S, Frantz KA. A prospective study of macular thickness in amblyopic children with unilateral high myopia. Invest Ophthalmol Vis Sci. 2011 Apr 14;52(5):2444-9.
6. Al-Haddad CE, Mollayess GM, Cherfan CG, Jaafar DF, Bashshur ZF. Retinal nerve fibre layer and macular thickness in amblyopia as measured by spectral-domain optical coherence tomography. British Journal of Ophthalmology. 2011 Dec 1;95(12):1696-9.
7. Wu SQ, Zhu LW, Xu QB, Xu JL, Zhang Y. Macular and peripapillary retinal nerve fiber layer thickness in children with hyperopic anisometric amblyopia. International journal of ophthalmology. 2013;6(1):85.
8. Andalib D, Javadzadeh A, Nabai R, Amizadeh Y. Macular and retinal nerve fiber layer thickness in unilateral anisometric or strabismic amblyopia. Journal of Pediatric Ophthalmology & Strabismus. 2013;50(4):218-21.
9. Dickmann A, Petroni S, Salerni A, Dell'Omo R, Balestrazzi E. Unilateral amblyopia: An optical coherence tomography study. J AAPOS. 2009 Apr;13(2):148-50.
10. Atakan M, Çulfa S, Çalli U, Penbe AD, Atakan TG, Özertürk Y. Evaluation of Retinal Nerve Fiber Layer and Macular Thickness in Amblyopia. J Clin Exp Ophthalmol. 2015;6:437.
11. Repka MX, Kraker RT, Tamkins SM, Suh DW, Sala NA, Beck RW et al. Retinal nerve fiber layer thickness in amblyopic eyes. Am J Ophthalmol. 2009 Jul;148(1):143-7.
12. Yalcin E, Balci O. Peripapillary retinal nerve fiber layer and foveal thickness in hypermetropic anisometric amblyopia. Clin Ophthalmol. 2014;8:749-753.