

## ORIGINAL ARTICLE

## MEASUREMENT OF RETINAL NERVE FIBER LAYER THICKNESS IN PATIENTS OF UNILATERAL AMBLYOPIA USING OPTICAL COHERENCE TOMOGRAPHY

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**Background:** The retinal changes that develop in the eyes during amblyopia are still unclear. It has been proven that thickness of the nerve fiber layer of the retina is positively correlated with refractive error. The objective of the present study was to measure the Retinal Nerve Fiber Layer Thickness (RNFLT) using Optical Coherence Tomography (OCT) in patients of amblyopia.

**Method:** A descriptive study was conducted in the Department of LRBT Free Eye Hospital, Lahore for 6 months. After meeting the inclusion criteria, 80 patients (40 amblyopic and 40 normal) were taken and grouped as A and B. Socio-demographic details of all the patients were recorded. They then underwent a complete ophthalmologic evaluation that included BCVA, slit lamp biomicroscopy, OCT examination was carried by TOPCON OCT. Each examination was done using the “fast retinal thickness” protocol for each test eye. Mean RNFLT was calculated for each eye. **Results:** The mean age of patients was 12.58±4.44 years. There were 20 (50%) males and 20 (50%) females. In amblyopic eyes, the mean RNFLT was 125.82±13.06mm while in normal eyes, the mean RNFLT was 94.82±1.11mm. The overall mean RNFLT was significantly higher in amblyopic eyes as compared to normal eyes ( $p<0.01$ ), as well as significant when data was stratified for age and gender. **Conclusion:** There was significant difference observed in RNFLT in amblyopic eyes as compared to normal eyes. So, these results can help us to enhance our knowledge and understand the causes of amblyopia hence improving diagnosis and management of disease.

**Keywords:** Amblyopia; Retinal Nerve Fiber Layer Thickness; Optical Coherence Tomography; Unilateral; Normal eyes

**Citation:** Munim A, Abbas S, Ahmed A, Sarfaraz S, Ikram R. Measurement of retinal nerve fiber layer thickness in patients of unilateral amblyopia using optical coherence tomography. J Ayub Med Coll Abbottabad 2022;34(1).141–4.

## INTRODUCTION

Amblyopia is a disorder of the eye. It is defined as the difference in the best corrected visual acuity (BCVA) of  $\geq 2$  lines on Snellen’s chart in both eyes, in absence of any organic disease. It is mostly unilateral, but in rare cases bilateral amblyopia is also observed. It causes a noteworthy reduction in BCVA caused by scarcity in image formation or irregular binocular interface, in absence of any identifiable pathology in eye or vision.<sup>1</sup>

There are many forms of amblyopia which are grouped according to causal factor like strabismus, astigmatism, stimulus deprivation, anisometropia and ametropia.<sup>2</sup> Prevalence of amblyopia ranges from 1.19%–1.5% in different studies.<sup>3,4</sup>

Treatment strategies for amblyopia consists of removal of the obstacle to vision such as cataract, refractive error correction, alignment of both eyes by strabismus surgery and forced use of the poorer eye by occlusion therapy, pharmacologic penalization and optical degradation using fogging and diffusing filters.<sup>5</sup>

Since patients of amblyopia have decreased vision in the absence of any organic disease despite normal ocular structure of the optic nerve. The visual signal to the brain needs to be assessed also; thus, the RNFLT studies need to be piloted. The physical damages in RNFLT can be examined by using techniques like OCT, which offers quantitative RNFLT data by assessing the difference in sequential delay of back-scattered light from retinal layer and reference mirror.<sup>6</sup>

In a study conducted in Saudi Arabia, 93 children (5–12 years old) of unilateral amblyopia were included. The RNFLT was assessed by using OCT. The mean RNFLT was 112.16  $\mu\text{m}$  for amblyopic eyes and 106  $\mu\text{m}$  for normal eyes. Assessment of RNFLT on OCT exposed a significantly thicker layer in the amblyopic eyes ( $p<0.0001$ ).<sup>7</sup>

The rationale of the study was to detect the structural changes in the nerve fiber layer of the retina in patients with amblyopic eye in Pakistani population, so as to determine that the cause of reduced visual acuity in an amblyopic eye is thicker nerve fiber layer of the retina. As there has been no

study cited in literature locally, so this study will help determine relationship between RNFL and amblyopia in our population. Also, it will help in better understanding of the causes of amblyopia hence improving diagnosis and management of disease.

**MATERIAL METHODS**

It was a descriptive case series carried out in Outdoor patient department of LRBT (“Layton Rahmatullah Benevolent Trust”) Free Eye Hospital, Lahore for six months, i.e., December 2016 to June 2017. Sample size of 50 eyes, 40 in each group was calculated with 95% confidence level, 80% power of test. Non-probability purposive sampling was done. The following patients were included in the inclusion criteria; Patients aged 7–20 years, both genders, with amblyopia (defined as decrease in the BCVA 2 or more lines on Snellen’s chart without any existing ocular pathology or any organic cause as assessed on the basis of history and slit lamp fundus examination).

Patients with systemic disease, any co-existent ocular pathology other than amblyopia, unable to maintain follow up or h/o previous ocular trauma, systemic or ocular disease as confirmed by slit lamp examination respectively were excluded.

After meeting the inclusion criteria, 80 eyes (40 amblyopic and 40 normal) were taken. Patients were grouped as A and B containing amblyopic and normal eyes respectively. After taking informed consent and recording socio-demographic details, all the patients underwent a complete ophthalmologic evaluation that included best corrected visual acuity, slit lamp biomicroscopy for the anterior and posterior segment examination, IOP measurement by means of applanation Goldmann tonometry. OCT examination was then carried out in mydriasis by TOPCON OCT. Each examination was done using the “fast retinal thickness” protocol for each test eye. The OCT data from each test location was computed to obtain the retinal nerve fiber layer thickness in micrometers of the following four parapapillary sectors: nasal, temporal, superior and inferior. Mean retinal nerve fiber layer thickness was calculated for each eye. All the tests were performed by single experienced ophthalmologist to avoid bias. All the data was recorded in proforma. The study was approved from the institutional review board.

Collected data was analyzed in SPSS 20. Quantitative variables like age, retinal nerve fiber layer thickness was expressed as mean and standard deviation. Qualitative variables like gender were expressed as frequency and percentage. Statistical significance was assumed at P-value ≤0.05.

Confounding factors like age, sex, race were controlled through stratification.

**RESULTS**

As shown in Table-1 the mean age of patients was 12.58±4.44 years. There were 20 (50%) males and 20 (50%) females with male to female ratio of 1:1. In normal eyes, BCVA was 6/6 in all eyes (100%). In amblyopic eyes, 1 (2.5%) patient with BCVA 6/12, 1 (2.5%) with BCVA 6/18, 10 (25%) with BCVA 6/24, 1 (2.5%) with BCVA 6/30, 20 (50%) with BCVA 6/36 and 7 (17.5%) patients with BCVA 6/60.

According to Table-2 in amblyopic eyes, the mean RNFLT was 125.82±13.06mm. On the other side in normal eyes, the mean RNFLT was 94.82±1.11mm. The mean RNFLT was significantly different in both the eyes (p-value=0.000).

**Table 1: Demographics of patients\* Visual acuity of amblyopic eyes, while 6/6 visual acuity was observed in 40 (100%) normal eyes**

<b>N</b>	<b>40</b>
<b>Age (years)</b>	12.58±4.44
<b>Gender</b>	
<b>Male</b>	20 (50%)
<b>Female</b>	20 (50%)
<b>Best Corrected Visual Acuity</b>	
<b>6/6</b>	0*
<b>6/12</b>	1 (2.5%)
<b>6/18</b>	1 (2.5%)
<b>6/24</b>	10 (25%)
<b>6/30</b>	1 (2.5%)
<b>6/36</b>	20 (50%)
<b>6/60</b>	7 (17.5%)

**Table-2: Comparison for retinal nerve fiber layer thickness in both eyes. p-value = 0.000 (Significant)**

	<b>Amblyopic Eye</b>	<b>Normal Eye</b>
<b>n</b>	40	40
<b>Mean</b>	125.82±13.06	94.82±1.11
<b>SD</b>	13.06	1.11

**DISCUSSION**

Around 2–6% of the general population suffers from amblyopia which is a significant cause of reduced visual acuity.<sup>8,9</sup> Typical causes include: anisometropia, strabismus, or form deprivation or combination of all.<sup>10</sup> Unilateral amblyopia is defined as the decreased BCVA, secondary to the unusual visual experience through the critical time of visual improvement. The data regarding the direct retinal changes in the amblyopic eyes is still indecisive and contentious. Yen *et al.*, hypothesized a study that the amblyopia may disturb the post-natal growth of retina, also post-natal decrease of ganglion cells in retina, which can cause the significant growth of RNFLT in the amblyopic eyes.<sup>11</sup> If this certainly happen, it is likely that the detention of normal post-

natal modifications would result not only in higher RNFLT but may also upset the normal development of macula, and also cause high thickness of fovea.<sup>11</sup>

Many tools are available to assess RNFLT, like red - free ophthalmoscopy, scanning laser polarimetry & OCT. OCT is the non-invasive, non-contact tool that assess the RNFLT. The findings of OCT for RNFLT also strongly agrees with the histological findings.<sup>12, 13</sup> As the OCT is based on near infrared inter-ferometry, the thickness assessment is not exaggerated by refractive status or axial length, or by light variations in nuclear sclerotic cataract density.<sup>12, 13</sup>

As per findings of this study mean RNFLT in patient with amblyopia was higher as that of controls. i.e.,  $125.82 \pm 13.06$ mm vs.  $94.82 \pm 1.11$ mm. In age group 7–15 and 16–20 years mean RNFLT in patient with amblyopic eyes was significantly higher as that of normal eyes. Among male and female patients with amblyopia mean RNFLT was significantly higher when compared with controls mean RNFLT.

A very few studies conducted before which designed the evaluation of structural changes in retina of amblyopic eyes. Enoch *et al.*, suggested the specific cause for organic anomaly disturbing the retina in amblyopic eyes.<sup>14</sup> Colen *et al.*, assessed the RNFLT on third - generation nerve fiber analyzer (GDx, Laser Diagnostic Technologies, San Diego, CA), in strabismic amblyopia and found insignificant difference in amblyopic and normal eyes.<sup>15</sup>

Altintas *et al.*, conducted a study on 14 unilateral strabismic amblyopic eyes by using OCT and observed insignificant difference in macular & Circumpapillary RNFLT or macular volume.<sup>16</sup> Kee *et al.*, registered 26 children with unilateral amblyopia (6 were strabismic, 15 had anisometropic, 5 had both amblyopes), and insignificant difference was observed in 4 quadrants of Circumpapillary RNFLT and foveal thickness between amblyopic and normal eyes.<sup>17</sup>

There was significant difference observed in the mean RNFLT and mean foveal thickness of amblyopic eyes in children with aniso-metropic amblyopia & strabismic amblyopia.<sup>17</sup> Results of the present study were inconsistent with the results of Altintas *et al.*, but were similar to the results of study by Kee *et al.* As in this study a significant & higher difference was observed in RNFLT in amblyopic patients.

Repka *et al.*, completed two studies and evaluated RNFLT in 17 patients and found no difference in Circumpapillary RNFLT between amblyopic and normal eyes on OCT.<sup>18</sup> Similarly, Walker *et al.*, examined 30 adult candidates with amblyopia on OCT. They observed insignificant

difference in the mean RNFLT of any peri-papillary quadrants and macular thickness in any structural place.<sup>19</sup>

Yen *et al.*, assessed Circumpapillary RNFLT in 38 candidates of unilateral amblyopia (strabismic & refractive amblyopia) by using the 2<sup>nd</sup> generation OCT. The mean age of candidates was 26.4 years. They observed insignificant difference in strabismic amblyopic & normal eyes. But, the Circumpapillary RNFLT was significantly thicker in refractive amblyopia eyes than normal eye.<sup>11</sup> Yoon *et al.*, also reported similar results. They conducted the study on 31 hyperopic aniso-metropic eyes for assessment of Circumpapillary RNFLT which was significantly higher in amblyopic eyes, but the mean macular thickness was insignificant ( $252.5$  vs.  $249.7$  mm).<sup>20</sup>

Alotaibi *et al.*, examined around 93 unilateral amblyopic eyes (36 had strabismic eyes, 33 had anisometropic eyes, 24 cases had both). The mean RNFLT was significantly more thick ( $259.3$  vs.  $255.6$ mm,  $p < 0.0001$ ), while insignificant difference was observed for mean macular & foveal thickness.<sup>7</sup> A marginally higher mean macular & foveal thickness was observed in anisometropic amblyopic eyes (macular thickness:  $256.76$  vs.  $246.61$  mm  $p = 0.050$ ; & foveal thickness:  $187.12$  vs.  $177.61$  mm,  $p = 0.039$ ). Leone *et al.*, suggested that the higher macular thickness is mostly because of unintentional assessment of the para-foveal peculiar point in amblyopic eyes.<sup>21</sup>

## CONCLUSION

Findings of this study showed that there is a significant difference/change in the RNFLT in amblyopic eyes. So, these results can help us to better understand causes of amblyopia hence improving diagnosis and management of disease. Result of the current study proposed that while the progression of amblyopia may not affect significantly on macula, it may employ a major effect on peri-papillary RNFLT.

## AUTHORS' CONTRIBUTION

AM, SA: Idea and protocol. AA, SS: literature Search, data collection, entry. RI: Analysis. All authors contributed in manuscript writing and gave final approval.

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Submitted: November 2, 2021

Revised: --

Accepted: December 22, 2021

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