**Original article:**

# Study of retinal nerve fibre layer thickness (RNFL) by Optical Coherence Tomography in emmetropic, myopic and hypermetropic eyes in adult patients at Rural Tertiary Care Hospital

**Priyanka Boramani[1], *Shubhangi Nigwekar[2]**

[1]Postgraduate student, [2]Professor

Department of Ophthalmology, Rural Medical College, Pravara Institute of Medical Sciences ( DU) , Loni

Corresponding Author*

## ABSTRACT

**Purpose**: Study of retinal nerve fibre layer thickness (RNFL) by Optical Coherence Tomography(OCT) in emmetropic, myopic and hypermetropic eyes in adult patients at RTCH (Rural Tertiary Care Hospital).

**Materials and Methods**: It was a hospital based, descriptive, cross sectional study consisting of 140 eyes of 70 consecutive patients between 20-40 yrs, visiting ophthalmology outpatient department and fulfilling the inclusion and exclusion criteria and who underwent RNFL analysis using the OCT (Ziess Primus 200). The topic was approved by IEC. The said work was conducted at Rural Medical College in Department of ophthalmology.

**Result:** Out of 70 study cases, 27(39%) patients were emmetropics, 36(51%) patients were myopics and 7(10%) patients were hypermetropics. The average RNFL thickness in emmetropics, myopics and hypermetropics was 94.87±7.24µm, 85.47±3.95µm and 100.4±3.76µm respectively.

**Conclusion:** With the help of OCT, we can differentiate the changes in RNFL thickness in various refractive errors. So, the refractive status of the eye should be kept in mind before making any ocular diagnosis in which the RNFL is a diagnostic criteria.

**Keywords:** Optical Coherence Tomography (OCT), Retinal Nerve Fibre Layer (RNFL) thickness, Refractive errors (RE)

## Introduction-

Affection of the retinal nerve fibre layer (RNFL) is the most sensitive indicator of retinal and optic nerve damage as it precedes visual field loss[1]. Although red free fundus ophthalmoscopy and photography allow direct visualisation of the RNFL, these techniques are subjective, qualitative and not quantitative or reproducible.

OCT is a new, non- invasive technique which uses light waves to take cross sectional pictures of the retina with high resolution of 10 microns. With OCT, each distinctive layer of the retina can be seen and thickness of the RNFL can be measured as well as visualized. Retinal tissue, particularly the unmyelinated axons of the ganglion cells that make up the retinal nerve fibre layer can be imaged as well as measured with OCT. These measurements help in diagnosis and treatment guidance for many ocular conditions such as Age Related Macular Degenaration, glaucoma and retinal diseases, macular hole, etc.

Previous studies have found that white race, low birth weight, longer axial length, and myopia have been associated with a thinner RNFL[2,3]. Recently it has been reported that the mean peripapillary RNFL thickness varies with increasing or decreasing axial length and various refractive errors [4,5.] Significant correlations have been found between RNFL measurements and axial length and refractive status of the eye [6,7]. Without considerations of the refractive errors, one may not get the actual corrected values of RNFL thickness in ocular conditions where RNFL thickness is a diagnostic criteria. This could lead to under diagnosis or over diagnosis of some ocular conditions like glaucoma.

As few studies have been carried out in the Indian population, our purpose is to study the RNFL thickness in emmetropia, myopia and hypermetropia and their sub-groups. Our aim was to study the RNFL thickness in emmetropes, myopes and hypermetropes in adult patients at Rural Tertiary Care Hospital and to study the axial length in emmetropes, myopes and hypermetropes in adult patients at Rural Tertiary Care Hospital.

**Materials and Methods-**

This was a hospital based descriptive cross sectional study consisting of 140 eyes of 70 consecutive patients between 20 -40 yrs, visiting ophthalmology OPD between September 2016 to December 2017. Ethical Committee approval was obtained before starting the study. A written informed consent was obtained from all patients included in the study. All patients underwent a complete ophthalmic evaluation with visual acuity testing, slit lamp biomicroscopy, cycloplegic retinoscopy under tropicamide 1% ophthalmic solution and acceptance, axial length measurement, keratometry and non contact tonometry. RNFL thickness was measured with the help of OCT (Zeiss Primus 200). Scans were centred on the optic disc with a scanning diameter of 3.4mm. Scans with signal strength quality < 6 or poor centration were excluded. The RNFL thickness was recorded in micrometres. The patients were grouped as emmetropics, myopics and hypermetropics on the basis of cycloplegic refraction.Patients were further sub-grouped as emmetropics (-0.25 to +0.25D), low myopics (-0.50D to -3D), moderate myopics (-3.25D to -6D), high myopics (-6.25D and above), low hypermetropics (+0.50D to +2D), moderate hypermetropics (+2.25D to +5D) and high hypermetropics (+5.25D and above). The inclusion criteria were patients coming to the Ophthalmology OPD between 20 to 40yrs of age, patients having a clear optical media and willing to participate in the study. We excluded the patients having any anterior segment or posterior segment pathology. Patients having an astigmatism of more than ±1D were excluded.

Statistical analysis software namely SYSTAT version 12 (By Cranes software, Bangalore) was used to analyze the data.

**Results-**

**Table no.1 Age and gender wise distribution of cases in our study:**

| AGE GROUP (IN YEARS) | MALE | FEMALE | TOTAL |
|---|---|---|---|
| 21-25 | 14 | 15 | 29(42%) |
| 26-30 | 8 | 13 | 21(30%) |
| 31-35 | 3 | 4 | 7(10%) |
| 36-40 | 10 | 3 | 13(18%) |
| TOTAL | 35(50%) | 35(50%) | 70 (100%) |

**Table no.2 Age and gender wise distribution of refractive errors:**

| | EMMETROPIA | | MYOPIA | | HYPERMETROPIA | | |
|---|---|---|---|---|---|---|---|
| **Age group in (Yrs.)** | **Male** | **Female** | **Male** | **Female** | **Male** | **Female** | **Total cases in each age group** |
| 21-25 | 8 | 4 | 7 | 10 | - | - | 29 (42%) |
| 26-30 | 2 | 3 | 5 | 8 | 1 | 2 | 21 (32%) |
| 31-35 | 2 | 2 | 1 | 2 | - | - | 7(8%) |
| 35-40 | 4 | 2 | 2 | 1 | 3 | 1 | 13(18%) |
| **Total** | **16 (59.2%)** | **11(40.8%)** | **15 (41%)** | **21 (59%)** | **4(57%)** | **3(43%)** | **70(100%)** |
| Total of refractive errors | **27 (39%)** | | **36 (51%)** | | **7 (10%)** | | 70 (100%) |

**Table no. 3 Distribution of cases depending on refractive errors (RE) and their sub- groups:**

| **RE and their sub-groups** | **No. of cases** | **Percentage (%)** |
|---|---|---|
| **EMMETROPIA** | **27** | **39%** |
| **MYOPIA** | | |
| Low | 20 | 28.5% |
| Moderate | 13 | 18.5% |
| High | 3 | 4% |
| **Total Myopia** | **36** | **51%** |
| **HYPERMETROPIA** | | |
| Low | 3 | 4.2% |
| Moderate | 2 | 2.8% |
| High | 2 | 2.8% |
| **Total hypermetropia** | **7** | **10%** |
| **TOTAL** | **70** | **100%** |



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**Table no.4 Mean Average RNFL thickness in refractive errors and their sub-group:**

| Refractive error and their sub- groups (in dioptres) | Mean Avg. RNFL thickness ± SD (in µm) |
|---|---|
| **EMMETROPIA** | **94.87 ± 7.24** |
| **MYOPIA** | **85.47±3.95** |
| Low Myopia | 90.68 ± 8.74 |
| Moderate Myopia | 84.60 ± 9.46 |
| High Myopia | 81.14 ± 6.07 |
| **HYPERMETROPIA** | **100.4±3.76** |
| Low Hypermetropia | 96.5 ± 3.02 |
| Moderate Hypermetropia | 99.68 ± 2.39 |
| High Hypermetropia | 105.34 ± 9.21 |

**Table no.5 Mean Axial Length in refractive errors and their sub-groups:**

| Refractive error and their sub-groups (in dioptres) | Mean Axial length ± SD (in mm) |
|---|---|
| **EMMETROPIA** | **23.97 ± 0.33** |
| **MYOPIA** | **24.5±0.55** |
| Low Myopia | 24.14 ± 0.34 |
| Moderate Myopia | 24.56 ± 0.48 |
| High Myopia | 25.44 ± 0.41 |
| **HYPERMETROPIA** | **22.30± 0.97** |
| Low Hypermetropia | 23.36 ± 0.55 |
| Moderate Hypermetropia | 22.55 ± 0.35 |
| High Hypermetropia | 21.03 ± 0.62 |



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**Table no.6 Quadrantic assessment of RNFL thickness in refractive errors and their sub-groups:**

| Refractive errors and their sub-groups | Mean RNFL thickness in 4 quadrants in (µm) ± SD | | | |
|---|---|---|---|---|
| | **Inferior** | **Superior** | **Nasal** | **Temporal** |
| Emmetropia | 123 ± 14.56 | 121 ± 14.31 | 72.07 ± 13 | 59.87 ± 7.76 |
| Low myopia | 112.33 ± 13.38 | 84.65 ± 31.78 | 71.03 ± 13.36 | 59.13 ± 8.65 |
| Moderate myopia | 103.96 ± 15.21 | 101.98 ± 24.02 | 61.56 ± 9.62 | 58.40 ± 15.62 |
| High myopia | 108.11 ± 10.71 | 102.25 ± 8.93 | 62.25 ± 8.97 | 54.13 ± 14.78 |
| Low hypermetropia | 123.37 ± 22.05 | 115.69 ± 20.51 | 70.31 ± 8.03 | 58.56 ± 10.72 |
| Moderate hypermetropia | 126.16 ± 3.65 | 116.83 ± 3.67 | 74.67 ± 10.86 | 62.82 ± 3.29 |
| High hypermetropia | 126.7 ± 18 | 119.83 ± 11.28 | 83.17 ± 7.78 | 66.17 ± 9.56 |

In our study, Table no.1, shows that there were 35 males (50%) and 35 females (50%). Maximum number of cases belonged to the age group of 21-25 years, followed by the age group of 26-30yrs. i.e. 3rd decade of life.

Table no.2, shows that out of 70 cases, 27 (39%) were emmetropic, 36(51%) were myopic and 7 (10%) were hypermetropic. There were a total of 27 cases of emmetropia of which males were 16 (59.2%) and females were 11(40.8%).In 36 cases of myopia, there were 15(41%) males and 21(59%) females.

In a total of 7 cases of hypermetropia, there were 4 (57%), males and females were 3(43%). Maximum cases of emmetropia and myopia were seen in the age group of 21-25 years.Maximum cases of hypermetropia were seen in the age group of 36-40 years.

Table no.3 shows the distribution of eyes depending on refractive errors and their sub-groups.Maximum number of cases are low myopic (28.5%).

Table no.4 shows the Mean Average RNFL thickness in refractive errors and their sub-groups.

We found that as the myopia increases or decreases, RNFL thickness decreases or increases respectively. As the hypermetropia increases or decreases, the RNFL thickness increases or decreases respectively.

Table no.5 shows the Mean Axial Length in refractive errors and their subgroups. We found that as the myopia increased or decreased, axial length increased or decreased respectively. As the hypermetropia increased or decreased, the axial decreased or increased respectively.

Table no.6 shows the mean RNFL thickness in the inferior, superior, nasal and temporal quadrants. The RNFL has decreased progressively from the inferior, superior, nasal and temporal quadrant. i.e. (ISNT rule is followed).

By applying Karl Pearson's correlation co-efficient and by applying Student's 't' test, we found a negative correlation between axial length and RNFL thickness ($p<0.001$).There is a statistically significant decrease in the RNFL thickness as the axial length increased and increase in the thickness as the axial length decreased.

**Discussion-**

OCT is a sensitive, quantitative, reliable and reproducible method by which the retinal nerve fibre layer can be assessed. OCT was first reported by Huang et al. in 1991 and since then has been evolving rapidly. The ocular application of this technology provides quantitative measurements of the macular retinal thickness, peripapillary



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nerve fibre layer (NFL) thickness, and topographical measurements of the optic nerve head (ONH). Previous studies have shown that the RNFL thickness is affected by changes in the axial length and refractive errors.

Our study has been conducted in a rural population. We have studied the peripapillary RNFL thickness in various refractive errors in the adult population in this geographic area. In the past, many OCT based studies correlating the Retinal Nerve Fiber Layer and refractive errors have been done in the paediatric population. There are very few similar studies in adult population group.

We studied the variables like age, gender, types of refractive errors, subgroups of refractive errors, Axial length and Retinal Nerve Fiber Thickness. In our study majority of the cases belonged to the age group of 21-25 years and 26-30 years. Thus showing the maximum patients belonging to the 3rd decade of life (21-30 years). (Table no.1)Sowmya et. Al[8] also found maximum number of patients belonging to the 3rd decade in their study.Nadia et.al[9], found to have a mean age of 30.45±7.86 years (Range:17-47 years) of the cases in their study.There was no male or female preponderance in our study. (table no.1) Similar results were seen by Budenz DL et al[10] which had 52% females and 48% males in their study.

In the current study, maximum cases belonged to the group of myopia (51%) followed by emmetropia (39%) and then hypermetropia (10%). (table no.2) Though one study was conducted by Jong-Hwa Jun et.al[11] in the paediatric age group, similar results were found. However, the study conducted by Ramakrishnan R et.al[12] in adult population, showed maximum number of cases of emmetropia (45%) followed by myopia (28%) and then hypermetropia (26.3%). In our study, the distribution of cases as per these subgroups of refractive errors as shown in table no.3, were not comparable with other studies by Sung Won Choi et.al[13] and Tas M et,al[14] due to the different method of sub-grouping of refractive errors.

We found that the mean average RNFL thickness in emmetropes was 94.86±7.24µm. Similar RNFL thickness was found in emmetropes by Singh, Divya et al[15]. We found that as the degree of myopia increased the Mean Avg. RNFL thickness decreased. (Table no.4)Similar results of Mean Avg. RNFL thickness in moderate and high myopes were shown by Singh Divya et al[15]. The high myopic group in our study showed lesser average RNFL thickness as compared to the high myopic groups in Parvaresh et al[16] , Sowmya V et al[8], Sung-Won Choi et al.[13] and Malakar, Mousumi et al.[17] In the present study,as the degree of hypermetropia increased the Mean Avg. RNFL thickness has increased. (Table no. 4) Sowmya V et al[8] and *Parvaresh et al*[10] had a higher average RNFL thickness in hypermetropics as compared to our study. These variations seen in myopic as well as hypermetropic cases could be due to non uniformity in grouping the refractive errors. In the current study, we found the Mean Axial Length in emmetropia as 23.98 ± 0.33. (Table no. 5)*Parvaresh et al*[16]and Sowmya V et al[8] had similar values of emmetropia in their study, as against Singh, Divya et al[15] and Nadia et al.[9] who had slightly lower values of axial length than our study.

We found that, as the dergree of myopia increased in, the AL decreased.Sowmya V et al[8], *Parvaresh et al*[10] and Singh, Divya et al[9] showed similar results in low, moderate and high myopic cases. It was found that as the degree of hypermetropia increased, the AL decreased.*Parvaresh et al*[10], Singh, Divya et al[9] and Sowmya V et al[8] had similar results in high hypermetropes. Ramakrishnan R et al.[12], found that RNFL thickness did not follow the ISNT rule in their study. He mentioned that these changes were because of geographically different population and also proposed to consider further studies in the Indian population.

Nadia et al.[9] and Sowmya V et al[8] found RNFL thickness followed ISNT rule in their study.



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We also found that the ISNT rule was followed by all groups in our study. The inferior quadrant showed the greatest RNFL thickness followed by superior, nasal and then the temporal quadrant. (Table no.6)

We found a negative correlation between the axial length and RNFL thickness in the emmetropia, low, moderate and high myopia as well as hypermetropia by applying Student's 't' test which is significant. (i.e. $p<0.0001$) This means that if the axial length increases or decreases then RNFL decreases or increases.Nadia et al.[9] found significant correlations between RNFL measurements and axial length. Leung CK et al.[2] and Budenz, Donald L et al[10] concluded that RNFL measurement varies with the axial length/refractive error of the eye which is consistent with our study.

**Conclusion-**

With OCT, we can differentiate the changes in The RNFL thickness in various refractive errors. Correlation between the refractive errors and RNFL may help for better evaluation of ocular conditions, in which RNFL is a diagnostic criteria.

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