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Original Research Article

Retinal nerve fibre thickness measurement before and after cataract surgery using optic coherence tomography

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Abstract

Background: Cataract and glaucoma are the commonest causes of visual loss in elderly population and are often found to coexist. The association of glaucoma with cataract has become more frequent with the increase in life expectancy. Glaucoma is characterized by progressive optic neuropathy and optic disc and visual field damage. Structural changes can be imaged with OCT. As the cataract progress, the quality of scanned images get worsens. Hence the measured thickness of the retinal nerve fiber layer may not correspond to actual and this should be taken into account while making diagnosis and analysis.
Objectives: To measure retinal nerve fibre layer thickness before and after cataract surgery using OCT.
Material and methods: A prospective observational study was conducted at Sardar Patel Medical College, Bikaner from 1st August 2019 to 31st December 2020 on 100 patients, with cataractous lens changes undergoing cataract surgery. Pre- and postoperative RNFL scans were performed by the OCT.
Results: The average RNFL thickness measurement increased from 85.42 ± 10.15 µm to 91.08 ± 10.77µm after cataract surgery. An increase of 5% ($P < 0.001$) was found. The signal strength improved from 4.55 ± 0.62 to 8.0 ± 0.54, an increase by 75.7% ($P < 0.001$)
Conclusion: There was an increase in signal strength after cataract surgery in our study. Measurement of RNFL thickness parameters by SD- OCT is significantly altered following cataract surgery. Post the cataract surgery; a new baseline needs to be established for assessing the longitudinal follow-up of a glaucoma patient.
Keywords: Cataract, Glaucoma, RNFL, OCT.

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1. Introduction

Cataract and glaucoma are the commonest causes of visual loss in elderly population, and are often found to coexist.[1,2] The association of glaucoma with cataract has become more frequent with the increase in life expectancy. Glaucoma, the "silent thief of sight" is the second major cause of blindness and more importantly the most common cause of irreversible blindness all over the world.[3] It is estimated that, 4.5 million people go blind due to glaucoma globally and at least 12 million people are affected in India out of which 1.2 million people are blind from the disease. In India, one out of every 8 individual aged 40 years or above affected by glaucoma or is at risk of developing it.[4]

Glaucoma is a group of eye diseases is characterized by progressive optic neuropathy and a recognizable pattern of optic disc and visual field damage, leading to loss of peripheral vision followed by central vision loss. As the structural damage precedes functional damage and damage to the retinal ganglion cells cannot be directly detected in a clinical setting, clinicians have to rely on indirect methods of retinal ganglion cell evaluation by measuring retinal nerve fiber layer (RNFL) thickness. Confocal scanning laser ophthalmoscopy, scanning laser polarimetry, and optical coherence tomography (OCT) have been used to quantitatively and objectively measure optic disc topography and RNFL thickness. These are used to predict glaucoma development and have the potential to detect and measure structural progression.

However, the quality of imaging may be influenced by the non transparency of optic media. The most common cause of deteriorated optical media is cataract. As cataract is one of the most commonly encountered pathological conditions in ophthalmology, it is important to understand the effect of cataract on RNFL thickness measurements and ONH changes by OCT.

The more the cataract progression, the worse is the quality of scanned image. Hence the measured thickness of the retinal nerve fiber layer may not correspond to actual and this should be taken into account while making diagnosis and analyzing progression of glaucoma in cataract patients. Thus after the cataract surgery, a new baseline needs to be established for follow up of glaucoma patients. In our study, we aimed to thickness of evaluate the effect of cataract and its removal on measurement of average peripapillary retinal nerve fibre layer using the SD-OCT and relationship of subtypes of cataract with changes in RNFL thickness measurement.

2. Method and materials

A prospective observational study was conducted at Sardar Patel Medical College, Bikaner from 1st August 2019 to 31st December 2020. 100 patients, 61 males and 39 females of age ranging from 50 to 78 years with cataractous lens changes undergoing cataract surgery with intra ocular lens (IOL) implantation were included in the study.

Our study included patients with age > 50 years, age related nuclear, cortical and subcapular cataract with best corrected visual acuity > 20/ 200 and IOP < 21mmHg.

Patients with the following preexisting retinal or optic nerve pathologies, which may influence the RNFL thickness, were excluded

- Glaucoma
- History of ocular trauma
- High myopia with peripapillary atrophy
- Other media opacities such as corneal or vitreous opacities.

Relevant history was elicited in all patients. Complete general and ocular examination was carried out. Preoperative uncorrected visual acuity, refraction, best corrected visual acuity, tonometry, dilated fundoscopy, biomicroscopy with 90D lens, keratometry and biometry were performed in all the patients. Cross-sectional imaging of the peripapillary area was performed with the CIRRUS-HD™ OCT, Carl-Zeiss Meditec Cirrus SD-OCT model 400 (Zeiss Instruments, Dublin. CA, USA, software version 6.0), and the optic disc cube protocol used after pupillary dilation with 1% tropicamide and 2.5% phenylephrine hydrochloride. One eye of each patient scanned three times using the optic disc cube 200 × 200 protocol. OCT scans of signal strength <5 were excluded from the study. The scans were performed one week before surgery and repeated 14 days after surgery. All pre- and postoperative scans were performed by the same investigators. The average of three qualified circular scans was used to calculate the overall mean and quadrant RNFL thickness measurement.

Cataract surgery was performed under topical anesthesia by a single surgeon in all cases. The surgery involved a standard phacoemulsification with an in-the-bag monofocal foldable IOLs implantation through a clear corneal incision. Patients were followed up after 2 weeks of phacoemulsification cataract surgery. SD-OCT was repeated by the same examiner using the same protocol. The parameters evaluated at baseline and 14 days after phacoemulsification cataract surgery were RNFL thickness (360°, 4 quadrants), signal strength, and ONH parameters (optic rim area, optic disc area, average cup–disc ratio, and vertical cup–disc ratio).

2.2 Statistical analysis:

Descriptive statistics was analyzed with SPSS version 17.0 software. Continuous variables were presented as mean±SD. Categorical variables were expressed as frequencies and percentages. Paired sample T test was used for comparison of continuous variables from pre- and post-intervention. P<0.05 was considered as statistically significant.

3. Results

A total of 100 eyes of 100 patients undergoing cataract surgery at Sardar Patel Medical College from 1stAugust 2019 to 31th December 2020 were enrolled for the study. The mean age of the patients was 63.1 ± 7.32 years. 61% of the patients were males and 39% were females.

The average RNFL thickness measurement increased from 85.42 ± 10.15 µm to 91.08 ± 10.77µm after cataract surgery, An increase of 5% ($P < 0.001$) was found. The signal strength improved from 4.55 ± 0.62 to 8.0 ± 0.54, an increase by 75.7% ($P < 0.001$).

Table 1: Mean values of RNFL thickness

	Mean ± SD	Mean difference	SD	p value
Preop average RNFL thickness	85.42 ± 10.15	-5.658	4.203	<0.001
Post op average RNFL thickness	91.08 ± 10.77			

Table 2: Mean values of Pre-operative and Post-operative signal strength.

	Mean ± SD	Mean difference	SD	p value
Pre op signal strength	4.55 ± 0.62	-3.447	0.773	<0.001
Post op signal strength	8.00 ± 0.54			

Quadrant-wise RNFL thickness increased significantly after cataract surgery for all quadrants (inferior, superior, nasal, and temporal quadrants).

Table 3: Mean values of Pre-operative and Post-operative inferior RNFL thickness measurement

	Mean ± SD	Mean difference	SD	p value
Pre op inferior RNFL thickness	110.45 ± 11.47	-4.368	5.487	<0.001
Post op inferior RNFL thickness	114.82 ± 12.67			

Table 4: Mean values of Pre-operative and Post-operative superior RNFL thickness measurement

	Mean ± SD	Mean difference	SD	p value
Pre op superior RNFL thickness	101.31 ± 13.21	-3.84	2.836	<0.001
Post op superior RNFL thickness	105.15 ± 13.44			

Table 5: Mean values of Pre-operative and Post-operative nasal RNFL thickness measurement

	Mean ± SD	Mean difference	SD	p value
Pre op nasal RNFL thickness	67.78 ± 11.97	-3.01	9.050	0.002
Post op nasal RNFL thickness	70.79 ± 8.95			

Table 6: Mean values of Pre-operative and Post-operative temporal RNFL thickness

	Mean ± SD	Mean difference	SD	p value
Pre op temporal RNFL thickness	60.19 ± 9.09	-3.80	3.875	<0.001
Pre op temporal RNFL thickness	63.99 ± 9.19			

Table 7: Mean values of Pre-operative and Post-operative rim area

There was an increase in the measured values of Rim area and disc area post cataract surgery.

	Mean ± SD	Mean difference	SD	p value
Pre op rim area	1.46 ± 0.23	-0.018	0.078	0.048
Post op rim area	1.28 ± 0.24			

Table 8: Mean values of Pre-operative and Post-operative disc area

	Mean ± SD	Mean difference	SD	p value
Pre op disc area	2.03 ± 0.43	-0.04	0.086	0.042
Post op disc area	2.07 ± 0.40			

The average cup-disc ratio and vertical cup disc ratio showed no significant change.

Table 9: Preoperative and postoperative mean value of average C: D ratio and vertical C: D ratio

	Mean ± SD	Mean difference	SD	p value
Pre op average C:D ratio	0.48 ± 0.27	0.02	0.167	0.580
Post op average C:D ratio	0.50 ± 0.19			

	Mean ± SD	Mean difference	SD	p value
Pre op vertical C:D ratio	0.52 ± 0.27	0.01	0.168	0.782
Post op vertical C:D ratio	0.51 ± 0.19			

4. Conclusion

We found a significant increase in RNFL thickness measurement in all the four quadrants. This was similar to study by Kim *et al.*[5] Chang *et al*[6] however found a significant increase in average thickness, in all quadrants except temporal and all clock hours except 4–6 h.[7]

There was an increase in signal strength after cataract surgery in our study. The change in RNFL thickness measurement and signal strength can be explained by the fact that cataract impedes signal transmission to and reflection from the retina. The delayed time-of-flight information, in turn, affects the spatial delineation of RNFL layer leading to a falsely low measurement.

Measurement of RNFL thickness parameters by SD- OCT is significantly altered following cataract surgery. Post the cataract surgery; a new baseline needs to be established for assessing the longitudinal follow-up of a glaucoma patient. The presence of cataract may lead to an underestimation of the RNFL thickness, and this should be taken into account when analyzing progression in a glaucoma patient.

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