

Research Article



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ABSTRACT

Background: The thickness of the retinal nerve fiber layer is measured 3.5 mm from the center of the optic nerve. The presence of this thickness shift even in the absence of visual loss justifies ongoing observation of the afflicted eyes. Changes in the thickness of the retinal nerve fiber layer are highly correlated with vision loss, making it possible to accurately gauge how glaucoma is progressing.

Aim: The purpose of this study was to evaluate changes in intraocular pressure and the thickness of the retinal nerve fiber layer (RNFL) after glaucoma filtration surgery.

Methods: A total of 36 subjects, spanning both sexes and falling within the age range of 37-64 years, were assessed, with a mean age of 53.82 ± 12.94 years. Tonometry, gonioscopy, fundus examination, and slit-lamp examination were performed for the ocular examination. This was followed by filtration surgery (trabeculectomy), in which an aperture was created at 0-4 months prior to and 2-4 months after glaucoma filtration surgery combined with intraocular pressure modification. The procedure involved removing a tissue component from the drainage angle of the eye. The gathered information was examined statistically.

Findings: All individual quadrants and the overall quadrant had a significant increase in RNFL thickness ($p < 0.05$). With $p = 0.067$, the RNFL thickness rose for the temporal quadrant, going from 43.45 ± 14.07 to 46.73 ± 16.69 . It went from 53.39 ± 25.77 in the inferior quadrant to 60.92 ± 30.70 ($p = 0.002$) in the nasal quadrant, and from 47.91 ± 19.30 to 54.47 ± 20.11 ($p = 0.007$) in the nasal quadrant. RNFL thickness rose from 52.58 ± 17.38 to 58.50 ± 20.18 for the entire quadrant ($p = 0.0001$). For individuals over 50 and under 50, RNFL

Intraocular pressure dramatically dropped and thickness significantly increased for all age groups. In the current investigation, there was a substantial ($p < 0.05$) increase in RNFL thickness for both males and females with lower intraocular pressure.

The current study comes to the conclusion that after glaucoma filtration surgery, RNFL thickness increases in tandem with a drop in intraocular pressure. Age and gender were likewise associated with this rise in thickness.

Keywords: retinal nerve fiber layer thickness, optic nerve head, optical coherence tomography, glaucoma, and glaucomatous optic neuropathy

INTRODUCTION

Glaucoma is one of the primary causes of blindness in India, accounting for about 8% of cases of blindness after the disease. Worldwide, the incidence of blindness after glaucoma is estimated to be 12%. Optic neuropathy, or glaucoma, is a progressive condition characterized by an unusual pattern of vision field defects and a distinct optic disc appearance. Elevated intraocular pressure is often linked to glaucoma disease. Because the loss of vision caused by glaucoma is silent, prolonged, and symptomless, most affected individuals do not receive a diagnosis

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Primary open-angle glaucoma typically presents with an adult illness onset and a bilateral disease pattern. Along with visual field loss, glaucomatous optic nerve head alterations, and an open angle of normal appearance, it is

also characterized by intraocular pressure more than 21 mm. Raised intraocular pressure, a positive family history, corneal thickness, black racial background, myopia, and advanced age are risk factors for glaucoma.²

Loss of retinal ganglion cells and their axons is a hallmark of glaucoma. About 60% of glaucoma-affected eyes show signs of visual field impairment and abnormalities in the optic nerve head six years before any vision loss is apparent in glaucoma sufferers. Therefore, evaluation of retinal nerve fiber layer damage and changes to the optic nerve head are essential for early glaucoma detection and therapy.³

Optical coherence tomography is a regularly used non-invasive method for detecting damage to the retinal nerve fiber layer and abnormalities to the optic nerve head in glaucoma patients. This aids in separating ill individuals from healthy individuals who do not have glaucoma. The thickness of the retinal nerve fiber layer is measured 3.5 mm from the optic nerve head center. The presence of this thickness shift even in the absence of visual loss justifies ongoing observation of the afflicted eyes. Changes in the thickness of the retinal nerve fiber layer are highly correlated with vision loss, making it possible to accurately gauge how glaucoma is progressing.⁴

By performing operations to lower intraocular pressure while improving vision, these changes can be limited. Filtration surgery is one such appropriate procedure that depends on the severity of the condition. Retinal nerve fiber thickness is one measure of glaucoma progression that appears to be stable and dependable over an extended period of time.⁵ Nevertheless, there is a paucity of information in the literature about the validity of changes in retinal nerve fiber thickness measured by optical coherence tomography prior to and during glaucoma filtration surgery. Therefore, the purpose of this study was to evaluate the changes in intraocular pressure and the thickness of the retinal nerve fiber layer (RNFL) after glaucoma filtration surgery.

MATERIALS AND METHODS

With approval from the relevant ethical committee, the current prospective clinical investigation was carried out to evaluate changes in intraocular pressure and the thickness of the retinal nerve fiber layer (RNFL) after glaucoma filtration surgery. The subjects who visited the institute's Department of Ophthalmology made up the study population. Prior to enrollment, each participant received a thorough explanation of the study design. A total of 36 subjects, ranging in age from 37 to 64 years, with a mean age of 53.82 ± 12.94 years, were evaluated. The subjects were of both genders.

Prior to the eye examination, a thorough history and interviews were performed to evaluate family history, medical history, and related risk factors. The study included participants who met the following requirements: they had to be fit for surgery, have a confirmed diagnosis of glaucoma, have undergone glaucoma filtration surgery, and be willing to participate in the study. Patients who were unwilling to take part in the trial, individuals with end-stage disorders, macular dystrophy, cystoid macular edema, diabetic retinopathy, advanced cataract, and ocular pathology were all excluded. Visual field loss and abnormalities of the optic nerve head were used to diagnose glaucoma. Optical coherence tomography was carried out 2-4 months prior to and following glaucoma filtration surgery.

The eye examination included tonometry, gonioscopy, fundus examination, and slit-lamp examination. Following the filtering treatment (trabeculectomy), a tissue fragment that had caused an opening in the eye's drainage angle was removed. A visual field examination was required when there was an intraocular pressure of more than 21 mm Hg, a VCDR difference of more than 0.2 between two eyes, or a VCDR difference of 0.7 in any eye. The macular program was used for patients with more severe problems. Optical coherence tomography was used to determine the thickness of the retinal nerve fibers.

During the procedure, the following variables were measured: visual field, intraocular pressure both before and after the procedure, and the thickness of the retinal nerve fiber layer 0-4 months before and 2-4 months after the glaucoma filtration procedure.

The paired t-test and SPSS software version 21 (Chicago, IL, USA) were used to statistically evaluate the gathered data. The information was presented as a mean with standard deviations, a percentage, and a number. At $p < 0.05$, the significance threshold was maintained.

RESULTS

This study evaluated 36 patients and 44 eyes to determine how changes in RNFL (Retinal Nerve Fiber Layer) thickness and intraocular pressure occurred after glaucoma filtration surgery. With a mean age of 53.82 ± 12.94 years, the individuals were analyzed from both genders and within the age range of 37-64 years. In the current study, there were 54% (n=19) females and 46% (n=17) males. According to the current study, nerve fibers from

all quadrants are injured in advanced glaucoma, however only arcuate nerve fibers are harmed in early glaucoma. Following surgery, the thickness of the retinal nerve fiber layer rose dramatically, rising from 52.58 ± 17.38 to 58.46 ± 20.22 .

After glaucoma filtration surgery, the thickness of the retinal nerve fiber layer (RNFL) was measured in each quadrant. The results showed a substantial increase in RNFL thickness for both the entire quadrant and each individual quadrant ($p < 0.05$) (Table 1). With $p = 0.067$, the RNFL thickness rose for the temporal quadrant, going from 43.45 ± 14.07 to 46.73 ± 16.69 . It went from 53.39 ± 25.77 in the inferior quadrant to 60.92 ± 30.70 ($p = 0.002$) in the nasal quadrant, and from 47.91 ± 19.30 to 54.47 ± 20.11 ($p = 0.007$) in the nasal quadrant. RNFL thickness rose from 65.71 ± 27.76 to 70.16 ± 29.06 for the superior quadrant and from 52.58 ± 17.38 to 58.50 ± 20.18 for the overall quadrant ($p = 0.0001$).

The age-related change in RNFL thickness was also assessed in this study (Table 2). The study's findings demonstrated that, for individuals over 50, the average RNFL increased from 55.72 ± 19.62 to 63.53 ± 20.85 ($p < 0.0001$), the cusp disc ratio decreased significantly from 0.85 ± 0.11 to 0.79 ± 0.12 ($p = 0.0006$), and the intraocular pressure also decreased from 25.85 ± 6.51 to 10.78 ± 3.21 ($p = 0.053$). Age > 50 years showed non-significant decreases in visual field (dB) from 6.91 ± 3.61 to 6.44 ± 3.12 ($p < 0.312$), significant decreases in cusp disc ratio from 0.87 ± 0.12 to 0.83 ± 0.17 ($p = 0.03$), increases in average RNFL from 49.98 ± 15.19 to 53.37 ± 19.01 ($p = 0.023$), and intraocular pressure from 27.81 ± 4.22 to 14.52 ± 5.71 ($p < 0.0001$). For every age group, there was a considerable rise in the RNFL thickness and a significant decrease in intraocular pressure.

In the current study, both males and females with lower intraocular pressure had considerably thicker RNFLs. Gender-wise, the visual field grew non-significantly ($p = 0.8407$) for females and the cusp disc ratio dropped ($p = 0.0948$) for females, going from 0.86 ± 0.12 to 0.73 ± 2.59 . The intraocular pressure considerably dropped from 27.27 ± 6.88 to 14.19 ± 6.11 mm Hg ($p < 0.0001$), while the average RNFL rose from 49.53 ± 14.71 μm to 54.23 ± 17.15 μm ($p = 0.0052$). In men, there was a substantial drop in the visual field from 7.19 ± 2.92 to 6.25 ± 2.85 ($p = 0.01$), and a significant decrease in the cusp field ratio from 0.86 ± 0.11 to 0.78 ± 0.16 ($p < 0.0001$).

Table 3 displays a considerable increase in average RNFL from 52.29 ± 19.33 μm to 62.31 ± 22.17 μm ($p = 0.001$) and a significant decrease in intraocular pressure from 26.61 ± 5.98 to 11.65 ± 3.62 mm Hg ($p < 0.0001$).

DISCUSSION

The current study's findings demonstrated that there was a significant increase in retinal nerve fiber layer (RNFL) thickness in each quadrant after glaucoma filtration surgery, both for the entire quadrant and for each individual quadrant ($p < 0.05$). With $p = 0.067$, the RNFL thickness rose for the temporal quadrant, going from 43.45 ± 14.07 to 46.73 ± 16.69 . It went from 53.39 ± 25.77 in the inferior quadrant to 60.92 ± 30.70 ($p = 0.002$) in the nasal quadrant, and from 47.91 ± 19.30 to 54.47 ± 20.11 ($p = 0.007$) in the nasal quadrant. RNFL thickness rose from 65.71 ± 27.76 to 70.16 ± 29.06 for the superior quadrant and from 52.58 ± 17.38 to 58.50 ± 20.18 for the overall quadrant ($p = 0.0001$).

These findings aligned with those of studies conducted in 2006 by Keltner JL et al. and in 2013 by Wessel JM et al., whose authors found comparable quadrant-wise changes after glaucoma filtration surgery. The age-related change in RNFL thickness was also assessed in this study. The study's findings demonstrated that, for individuals over 50, the average RNFL increased from 55.72 ± 19.62 to 63.53 ± 20.85 ($p < 0.0001$), the cusp disc ratio decreased significantly from 0.85 ± 0.11 to 0.79 ± 0.12 ($p = 0.0006$), and the intraocular pressure also decreased from 25.85 ± 6.51 to 10.78 ± 3.21 ($p = 0.053$). for those over 50

years, the cusp disc ratio significantly decreased from 0.87 ± 0.12 to 0.83 ± 0.17 ($p = 0.03$), the average RNFL increased from 49.98 ± 15.19 to 53.37 ± 19.01 ($p = 0.023$), the visual field (dB) decreased from 6.91 ± 3.61 to 6.44 ± 3.12 non-significantly ($p < 0.312$), and the intraocular pressure decreased from 27.81 ± 4.22 to 14.52 ± 5.71 ($p < 0.0001$). For every age group, there was a considerable rise in the RNFL thickness and a significant decrease in intraocular pressure. These results were similar to those of studies conducted in 2013 by Chauhan BC et al. and in 2019 by Enders P et al., who also reported age-related changes in RNFL thickness.

In the present study, RNFL thickness was raised in both male and female subjects whose intraocular pressure was much lower. Gender-wise, the visual field grew non-significantly ($p = 0.8407$) for females and the cusp disc ratio dropped ($p = 0.0948$) for females, going from 0.86 ± 0.12 to 0.73 ± 2.59 . The intraocular pressure considerably dropped from 27.27 ± 6.88 to 14.19 ± 6.11 mm Hg ($p < 0.0001$), while the average RNFL rose from 49.53 ± 14.71 μm to 54.23 ± 17.15 μm ($p = 0.0052$). In men, there was a substantial drop in the visual field from 7.19 ± 2.92 to 6.25 ± 2.85 ($p = 0.01$), and a significant decrease in the cusp field ratio from 0.86 ± 0.11 to 0.78 ± 0.16 ($p < 0.0001$).

The average RNFL increased significantly ($p=0.001$) from $52.29\pm 19.33\mu\text{m}$ to $62.31\pm 22.17\mu\text{m}$, and intraocular pressure dropped dramatically ($p<0.0001$) from 26.61 ± 5.98 to 11.65 ± 3.62 mm Hg. These findings aligned with those of Gardiner SK et al. (2015) and Reis ASC et al. (2017), who found gender-related differences in RNFL thickness after glaucoma filtration surgery, as indicated by optical coherence tomography.

CONCLUSION

The current study, within the bounds of its limitations, finds that after glaucoma filtration surgery, RNFL thickness increases in conjunction with a decrease in intraocular pressure. Age and gender were likewise associated with this rise in thickness. Notwithstanding its strengths, the current study was limited by its single-institution design, smaller sample size, and biases related to recall and geographic location. Therefore, in order to draw a firm conclusion, more prospective and longitudinal research including bigger sample numbers and longer monitoring periods are required.

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TABLES

Quadrant	Preoperative RNFL Thickness (μm)	Preoperative RNFL Thickness (μm)	p-value
Temporal	43.45 ± 14.07	46.73 ± 16.69	0.067
Inferior	53.39 ± 25.77	60.92 ± 30.70	0.002
Nasal	47.91 ± 19.30	54.47 ± 20.11	0.007
Superior	65.71 ± 27.76	70.16 ± 29.06	0.007
Overall	52.58 ± 17.38	58.50 ± 20.18	0.0001

Table 1: Retinal Nerve Fiber Layer Thickness alteration before and after glaucoma filtration surgery

Parameter	Preoperative RNFL Thickness (μm)	Preoperative RNFL Thickness (μm)	p-value
Age less than 50 years			
Visual Field (dB)	7.21 \pm 2.33	6.76 \pm 2.29	< 0.0001
Cup: Disc Ratio	0.85 \pm 0.11	0.79 \pm 0.12	0.0006
Average RNFL (μm)	55.72 \pm 19.62	63.53 \pm 20.85	< 0.0001
Intraocular Pressure (mm Hg)	25.85 \pm 6.51	10.78 \pm 3.21	0.053
Age more than 50 years			
Visual Field (dB)	6.91 \pm 3.61	6.44 \pm 3.12	0.312
Cup: Disc Ratio	0.87 \pm 0.12	0.83 \pm 0.17	0.03
Average RNFL (μm)	49.98 \pm 15.19	53.37 \pm 19.01	0.023
Intraocular Pressure (mm Hg)	27.81 \pm 4.22	14.52 \pm 5.71	< 0.0001

Table 2: Retinal Nerve Fiber Layer Thickness alteration based on the age

Parameter	Preoperative RNFL Thickness (μm)	Preoperative RNFL Thickness (μm)	p-value
Females			
Visual Field (dB)	6.89 \pm 3.26	7.03 \pm 2.59	0.8407
Cup: Disc Ratio	0.86 \pm 0.12	0.82 \pm 0.14	0.0948
Average RNFL (μm)	49.53 \pm 14.71	54.23 \pm 17.15	0.0052
Intraocular Pressure (mm Hg)	27.27 \pm 6.88	14.19 \pm 6.11	< 0.0001
Males			
Visual Field (dB)	7.19 \pm 2.92	6.25 \pm 2.85	0.01
Cup: Disc Ratio	0.86 \pm 0.11	0.78 \pm 0.16	< 0.0001
Average RNFL (μm)	52.29 \pm 19.33	62.31 \pm 22.17	0.001
Intraocular Pressure (mm Hg)	26.61 \pm 5.98	11.65 \pm 3.62	< 0.0001

Table 3: Retinal Nerve Fiber Layer Thickness alteration based on the gender