



Original Research Article

Optical coherence tomographic assessment of disc changes and automated perimetric assessment of visual field changes after glaucoma filtration surgery

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ABSTRACT

Purpose: The study was conducted to find out the topographic changes of disc, macular thickness, visual field, and intra-ocular pressure (IOP) after trabeculectomy in different age and sex using Optical Coherence Tomography (OCT) machine, automated perimeter and Goldman applanation tonometer respectively.

Materials and Methods: It was a prospective, interventional case-series conducted at the glaucoma clinic at Regional Institute of Ophthalmology, Kolkata from March 2010 to August 2011. Patients of primary open angle glaucoma who fulfilled the inclusion criteria. The trabeculectomy surgeries were done by a single surgeon. The disc changes, macular thickness, IOP and visual field changes were measured before and after trabeculectomy. Preoperative OCT images of disc and macula, visual field testing by Humphrey automated perimeter and IOP by Goldman applanation tonometry were done/within 3 months prior to surgery and same investigations had been done postoperatively within 2 to 3 months after surgery. Data was collected in a standard data collection form and analysis was done by paired t-test.

Results: Significant visual field (mean deviation-MD & pattern standard deviation-PSD in decibel) changes were seen but the nerve fiber thickness in the disc and macula were not increased. Significant reduction of IOP was found after trabeculectomy.

Conclusions: Significant visual field (MD& PSD) changes were found after trabeculectomy in early glaucoma patients but disc and macular changes were found to be insignificant.

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1. Introduction

Glaucoma is a progressive optic neuropathy with characteristic appearance of the optic disc and specific pattern of visual field defect that is associated frequently but not invariably with raised intraocular pressure. As the visual loss is often symptomless it goes unnoticed and undiagnosed in many cases. Reversal of optic disc cupping following intraocular pressure (IOP) reduction is a well-known phenomenon in congenital^{1,2} and juvenile^{3,4} glaucoma. Although it has been reported in adult patients also, but the results of these studies seem conflicting. The inconsistent outcomes in adults may be due to the stage of disease, the amount of IOP reduction, and the

age of the patient. The clinical relevance of 'reversal' has not been established with certainty, although reports^{5,6} have suggested that there may be an associated improvement of visual function that corresponds to this improvement in disc appearance.

Glaucoma is a second common cause of blindness in the world after cataract. It was estimated to affect 60.5 million people in the world and 11.9 million in India in the year 2010.^{7,8} It accounts for 12.3 percent of blindness worldwide and 7.9 percent of total blindness in India.^{9,10}

The structural changes of ONH precede visual field loss in glaucoma,¹¹ although in recent times many investigators have found a structure–function dissociation^{12,13} and unbiased studies have found that the first signs of conversion or progression may appear in either structural or functional measures.¹⁴ So, most clinicians consider

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that the progressive changes in either ONH structure or function may need intervention for further lowering of IOP. Clinical examination of the optic disc is not enough to reproduce^{15,16} and sometimes, subtle changes in the optic nerve head (ONH) topography and visual field measurement may be very difficult to assess. Backward bowing of the lamina cribrosa is caused by damage of the ONH by mechanical theory that postulates raised of IOP.^{17,18} The IOP reduction may theoretically prevent this backward bowing, and it may be the mechanism of reversal of optic disc cupping even in adults. Release of pressure on the nerve fibres passing through the lamina may also result in changes in neuroretinal rim (NRR) thickness and visual field after IOP reduction.

Our study was done to measure ONH topography, macular thickness and visual field changes by OCT and automated perimeter respectively in order to demonstrate any structural improvement following IOP reduction after trabeculectomy in adult patients.

2. Materials and Methods

The study was a prospective, interventional case series. It was conducted to evaluate the patients at the Glaucoma Clinic at the Regional Institute of Ophthalmology, Medical College, Kolkata during March 2010 to August 2011. The patients were counseled and informed consent was taken for participation in the study. Detailed history and thorough ocular examination were taken. Whether patient had any risk factors like family history of glaucoma, ocular trauma, past eye surgery and other ocular morbidity were determined by personal interview. The visual acuity of each eye; both with and without corrections were noted. Refraction was carried out manually using streak retinoscope followed by subjective corrections. Anterior segment was evaluated both by diffuse light and slit-lamp. The subjects were selected for intervention after proper diagnosis. The patients who were willing to participate and fulfilled all the inclusion criteria after full ophthalmological evaluation were included. The patients with extreme age, very sick, unwilling to follow-up, failed to give consent, patients having diabetic retinopathy, age related macular degeneration, cystoid macular edema, macular dystrophy, central serous retinopathy, patients having advanced cataract and ocular pathology which can affect visual field and nerve fiber thickness other than glaucoma were not included in the study.

The diagnosis of primary open angle glaucoma was done by detailed optic disc evaluation with slit lamp biomicroscope and angle evaluation by gonioscope. Visual field and disc and RNFL changes were evaluated by automated perimeter (Humphrey Field Analyzer II) and OCT (Carl Zeiss Stratus OCT) respectively. All the procedures were done before and after glaucoma surgery. The patients were prepared for filtration surgery. And

subsequent follow up was done and findings of disc and visual field changes were recorded.

2.1. Statistical analysis

Paired t tests were used to analyze NRR (ONH) thickness, macular thickness, IOP and visual field changes in every patient. All analyses were performed with SPSS software (version 17) and p values < 0.05 were considered to be statistically significant.

3. Results

This prospective study was conducted to evaluate disc, macular thickness, visual field and IOP changes. 49 eyes of 41 patients were included in this study. The study showed slightly male (53%) preponderance. The average age of the patient was 50.18 ± 11.36 years. The average age of male and female patients were 47.42 ± 12.81 and 53.30 ± 12.17 years respectively.

The changes in the average thickness of NRR were found significant in nasal and temporal quadrant (Table 1). The IOP reduction was statistically significant irrespective of age and sex (Tables 2 and 3). The visual field (MD and PSD) changes were statistically significant in older age group (age >50 years, $p = 0.095$ & $p = 0.0003$) and in female patients ($p = 0.006$ & $p = 0.00001$). But pattern standard deviation (PSD) was only statistically significant in younger age group ($p = 0.0002$) (Table 2). It had been found that, cup/disc ratio changes were only statistically significant in older age group ($p = 0.002$) (Tables 2 and 3).

Patients aged >50 years, the MD and PSD of the preoperative visual field were -12.37 ± 4.10 dB and 7.44 ± 1.82 dB, respectively. The MD and PSD of the postoperative visual field were -10.99 ± 6.46 dB and 6.75 ± 2.15 dB, respectively. Patients aged <50 years, the MD and PSD of the preoperative visual field were -11.48 ± 4.17 dB and 7.87 ± 1.89 dB, respectively. The MD and PSD of the postoperative visual field were -10.34 ± 8.09 dB and 7.19 ± 1.97 dB, respectively (Table 2).

Similarly, in male patients, the MD and PSD of the preoperative visual field were -12.07 ± 4.45 dB and 7.33 ± 1.8 dB, respectively. The MD and PSD of the postoperative visual field were -11.86 ± 8.22 dB and 6.84 ± 2.11 dB, respectively. In female patients, the MD and PSD of the preoperative visual field were -11.74 ± 3.71 dB and 8.021 ± 1.77 dB, respectively. The MD and PSD of the postoperative visual field were -9.38 ± 5.58 dB and 7.12 ± 1.90 dB, respectively, (Table 3).

4. Discussion

This study evaluated the NRR thickness of disc and macular thickness changes as measured by OCT before and after trabeculectomy. The visual field changes were measured by Humphrey automated perimeter.

Table 1: NRR Thickness in different quadrants of disc and macular thickness before and after Filtration Surgery. (n=49)

Variable	Preoperative NRR thickness (μm)	Postoperative NRR thickness (μm)	Mean difference (μm)	P value
Superior	69.02 \pm 22.25	68.24 \pm 25.82	-0.75 \pm 5.40	0.322
Nasal	59.63 \pm 18.92	58.06 \pm 19.20	-1.53 \pm 3.34	0.0015
Inferior	45.86 \pm 11.66	44.48 \pm 13.15	-1.40 \pm 16.52	0.282
Temporal	51.10 \pm 15.28	50.39 \pm 8.08	-0.71 \pm 18.77	0.019
Macular thickness	184.02 \pm 21.03	183.14 \pm 19.57	-0.88 \pm -0.60	0.133

Table 2: Topographic changes of disc, Visual field and average macular thickness changes according to age. (n=49)

Age >50 years:(n=24)				
Variable	Pre op value	Post op value	Mean difference	P value
IOP (mmHg)	27.67 \pm 5.58	14.08 \pm 3.87	-13.58 \pm 2.93	0.00000
Cup/Disc ratio	0.78 \pm 0.104	0.80 \pm 0.122	0.02 \pm 0.02	0.002
VF (MD) dB	12.37 \pm 4.10	10.99 \pm 6.46	1.38 \pm 3.87	0.095
VF (PSD) dB	7.44 \pm 1.82	6.75 \pm 2.15	-0.69 \pm 0.80	0.0003
Macular Thickness	185.25 \pm 22.72	184.58 \pm 20.98	173.09 \pm 4.90	0.330
Age <50 years:(n=25)				
Variable	Pre op value	Post op value	Mean difference	P value
IOP (mmHg)	27.16 \pm 4.48	13.92 \pm 4.58	-13.24 \pm -1.05	2.220
Cup/Disc ratio	0.77 \pm 0.10	0.71 \pm 0.23	-0.06 \pm -3.14	0.182
VF (MD) dB	-11.48 \pm 4.17	10.34 \pm 8.09	1.10 \pm 5.55	0.330
VF (PSD) dB	7.87 \pm 1.89	7.19 \pm 1.97	-0.67 \pm 0.79	0.0002
Macular Thickness	182.84 \pm 19.21	183.76 \pm 18.07	-1.08 \pm -1.15	0.186

Table 3: Topographic changes of disc, Visual field and average macular thickness changes according to sex. (n=49)

Male: (n=24) Average age of the male patients was 47.42 \pm 12.81 year.				
Variable	Pre op value	Post op value	Mean difference	P value
IOP (mmHg)	27.08 \pm 4.67	13.58 \pm 4.16	-13.50 \pm 2.54	0.00000,
Cup/Disc ratio	0.78 \pm 0.104	0.795 \pm 0.130	0.005 \pm 0.037	0.434
VF (MD) dB	-12.07 \pm 4.45	-11.86 \pm 8.22	0.989 \pm 7.14	0.486
VF (PSD) dB	7.33 \pm 1.8	6.84 \pm 2.11	-0.488 \pm 0.738	0.002
Macular Thickness	185 \pm 18.43	184.15 \pm 16.53	-0.84 \pm 3.97	0.288
Female: (n=25) Average age of the female patients was 53.30 \pm 12.17 year.				
Variable	Pre op value	Post op value	Mean difference	P value
IOP (mmHg)	27.79 \pm 5.06	14.48 \pm 4.133	-13.3 \pm 3.12	0.059
Cup/Disc ratio	0.77 \pm 0.10	0.72 \pm 0.233	-0.05 \pm 0.22	0.272
VF (MD) dB	-11.74 \pm 3.71	-9.38 \pm 5.58	2.37 \pm 3.69	0.006
VF (PSD) dB	8.021 \pm 1.77	7.12 \pm 1.90	-0.89 \pm 0.79	0.00001
Macular Thickness	182.91 \pm 23.32	182.00 \pm 21.94	-0.91 \pm 4.15	0.303

The study done by Erol Yildirim, Ahmed H. Bilge, Sami Ilker,¹⁹ they observed an improvement in visual field in 75% of patients. Considering the whole threshold visual field improvement and deterioration, rates were 62.5% and 37.5% respectively. In present study showed no threshold visual field improvement.

Kotecha et al.²⁰ observed a significant increase in rim area and rim volume at 2 years after surgery. Segmental analysis showed a significant change in rim volume in the nasal, inferonasal, supero-nasal, and supero-temporal sectors. The present study showed significant

optic disc changes in nasal and temporal quadrants but no improvement of NRR thickness in ONH with significant reduction of IOP.

Ali Aydin et al.²¹ showed the mean MD and PSD of the preoperative visual field were -11.3 ± 9.2 dB and 8.2 ± 4.2 dB, respectively and the mean MD and PSD of postoperative visual field were -10.6 ± 8.1 dB and 7.8 ± 4.5 dB, respectively. These differences were not statistically significant ($P = 0.43$ and $P = 0.34$, respectively). The present study showed that the visual field (MD and PSD) changes was statistically significant in female ($p=0.006$ &

$p=0.00001$) and elderly group (age > 50 years, $p = 0.095$ & $p = 0.0003$).

N Raghu et al.²² observed a significant increase in inferior RNFL ($P=0.038$) thickness. No significant change was found in other ONH parameters. Present study showed that NRR thickness changes were significant in nasal and temporal quadrants. ($p=0.0015$ and $p=0.019$)

Aachal Kotecha et al.²³ showed that the ONH and VF sensitivity changes were seen in only a small proportion of eyes. In the present study, optic disc changes were significant in nasal & temporal quadrants and VF (MD & PSD) changes were also significant in elderly age group and in female patients with significant reduction of IOP.

5. Conclusion

Significant visual field (MD & PSD) changes were found after trabeculectomy in early glaucoma patients but disc and macular changes were found to be insignificant. The changes are yet to be evaluated whether they have any clinical significance in long-term follow-up.

6. Limitations of the study

Large sample size and long-term follow up is essential to assess clinical significance of changes of ONH and visual field. The recovery of patients may be hindered in advanced glaucomatous condition and old age.

7. Source of Funding

None.

8. Conflict of Interest

There are no potential, perceived, or real competing and/or conflicts of interest among authors regarding the article.

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