

Change in Perimetric Global Indices Following Cataract Surgery in Patients with Glaucoma

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Purpose: To study the change in perimetric global indices following cataract surgery in patients with glaucoma & Comparison of preoperative & postoperative perimetric indices.

Methodology: This Prospective study was conducted in a major tertiary care hospital. Approval of Institutional Ethics Committee was taken before start of the study. 31 Eyes of 18 Patients with co-existing cataract & Primary Open Angle Glaucoma (POAG), who were well controlled & stable on medical therapy were screened for the study & recruited as per inclusion & exclusion criteria. Follow up visits were at one & three months. Appropriate statistical analysis was done.

Abstract

Result: Mean MD (Mean Deviation) improved significantly from -10.77 ± 9.39 dB pre-operatively to -6.52 ± 6.75 dB post-operatively at 3 months (i.e. by 4 dB) (P value < 0.0001). 39% eyes showed improvement in MD < 2 dB; 26% eyes showed improvement 2dB to 4dB & 23% showed change more than 8dB at 3 months. Mean PSD (Pattern Standard Deviation) worsened post-operatively by approximately 1dB from 4.88 ± 3.82 dB pre-operatively to 5.78 ± 4.30 dB post-operatively at 3 months. Majority of eyes showed worsening less than 2dB. (84% at 1month which increased to 94% at 3months). This was statistically significant (P value < 0.004 at 1month; < 0.006 at 3 months)

Conclusion: In POAG patients, with presence of coexisting cataract, MD is more affected than PSD. Hence, PSD is a more useful index to monitor glaucoma in these patients. Moreover, predominantly posterior subcapsular cataract doesn't affect PSD as much as it affects the MD.

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Keywords: POAG, IOP, Mean Deviation, Pattern Standard Deviation, Perimetry.

Introduction

Glaucoma: the Silent Thief of Sight, is a disease of the eye that slowly & painlessly causes permanent loss of vision. Glaucoma was defined as "pressure within the eye higher than the statistical normal of the population" from early 19th century till last quarter of the 20th century. According to American Academy Of Ophthalmology, glaucoma is defined as "multifactorial optic neuropathy with characteristic visual field defects and characteristic changes in optic nerve head."¹ After cataract, glaucoma is one of the leading cause of blindness accounting for 15% of global blindness.² Prevalence of Glaucoma in India is between 2-13%.

Glaucoma is a progressive optic neuropathy characterized by pathological loss of retinal ganglion cells and their axons, which become clinically manifest as structural changes in the optic nerve head, retinal nerve fiber layer and functional changes in the visual fields. Clinically, glaucoma is diagnosed on the basis of loss of neuroretinal rim and increased cupping of the optic nerve head. This along with wedge shaped nerve fiber layer defects help clinch the diagnosis. In diagnosed glaucoma patients when 25% of fibers are affected functional changes start appearing in the visual fields of the patient, which are measured by automated perimeter. This modality helps in diagnosing and in knowing the progression of glaucoma.

Glaucoma patients tend to have concurrent cataracts. Cataract formation, can affect the analysis of visual field global indices, therefore, following cataract surgery, glaucoma progression could be masked by improvement of the global indices. Hence, this study is being undertaken to study these effects before & after cataract surgery on

visual field global indices in glaucoma patients treated with medical therapy only.

Methodology

This prospective study was conducted in a major tertiary care hospital. Approval of Institutional Ethics Committee was taken before start of the study. 31 Eyes of 18 Patients were selected for the study. Patients with co-existing cataract & POAG, who were well controlled & stable on medical therapy were screened for the study. Patients with visually significant cataract affecting their daily activities were taken up for the study. Each participant underwent a complete ophthalmological evaluation of Anterior & Posterior Segment.

Inclusion Criteria

1. Patients with glaucoma & cataract.
2. Patients on medical management only
3. Age more than 35 yrs.
4. Visual acuity more than 6/60.
5. Cataract with \leq grade III nuclear sclerosis
6. Uneventful cataract surgery

Exclusion Criteria

1. Prior Intraocular Surgery.
2. Any Other Retinal Disease Affecting Vision
3. Cystoid macular edema post cataract surgery
4. Corneal Pathology
5. Optic Nerve Disease other than Glaucoma
6. Disc Anomaly
7. Uveitis
8. Media Haze due to causes other than Cataract
9. Pregnancy

POAG was defined in the presence of an untreated intraocular pressure (IOP) of >21mm Hg, open anterior chamber angle on gonioscopy, glaucomatous optic disc damage on clinical examination, and corresponding VF defects & patients were put on medical management with anti-glaucoma drops. Also patients with Cup/Disc (C/D) ratio more than 0.7 & cataract who were stable & with well controlled IOP on medical management were included in the study.

Cataract was graded according to the criteria of the Lens Opacities Classification System III (LOCS III).³ Participants were categorized according to their preoperative cataract type, as NS1, NS2, NS2-3 both with & without posterior subcapsular cataract (PSC). The overall cataract severity was defined as nuclear cataract or predominantly PSC. Cataract surgery with in-the-bag IOL insertion was performed under local anesthesia after obtaining preoperative fitness & informed consent in all cases by SICS or Phacoemulsification technique by an experienced Surgeon. All the surgeries were uneventful.

Perimetry – Measurement

Visual Field testing was performed on Humphrey Field Analyzer Perimeter (SITA- Standard 30-2, HFA II 740 - software version 5.1.2, Carl Zeiss Meditec, Dublin, CA) once before & at 1 & 3 months after cataract surgery. All eyes were refracted immediately before each visual field performance, and the appropriate age & distance-adjusted correction was used for visual testing. The global indices such as the Mean Deviation (MD), Pattern Standard Deviation (PSD) & Glaucoma Hemifield Test (GHT) were noted at each visit. Severity of glaucoma related field loss was noted as mild, moderate & severe. Also their relation to the type & grade of cataract were noted. VF defects were considered glaucomatous if at least 2 of the 3 Anderson criteria [3 or more nonedged points in a cluster depressed to P< 5% and one of which depressed to P<1%, Glaucoma Hemifield Test outside normal limits and pattern standard deviation (PSD) depressed to P< 5%] were present.⁴ The VFs were evaluated for reliability.

IOP was measured by Goldmann Applanation Tonometer and Gonioscopy with a Goldmann 2 mirror lens. For calculating mean visual acuity(VA), Snellen’s VA was converted to log MAR VA using Conversion Charts.

Statistical Analysis

Descriptive statistics included Mean, SD, SE, Kurtosis, Skewness, Maximum, Minimum & Range for normally distributed variables. A two-tailed paired t test was used to evaluate changes in mean deviation MD, pattern standard deviation PSD, before & after cataract extraction, to analyze which indices changed significantly. All statistical analyses were performed using SPSS for Windows (version 26.0.0, SPSS, Inc, Chicago, IL). A P value <0.05 was considered to be statistically significant.

Results

31 eyes of 18 patients were selected in our study (44% - Male & 56%-Female)(Figure 1). As for laterality 16 Right eyes & 15 Left eyes were studied. Majority of the patients (77%)

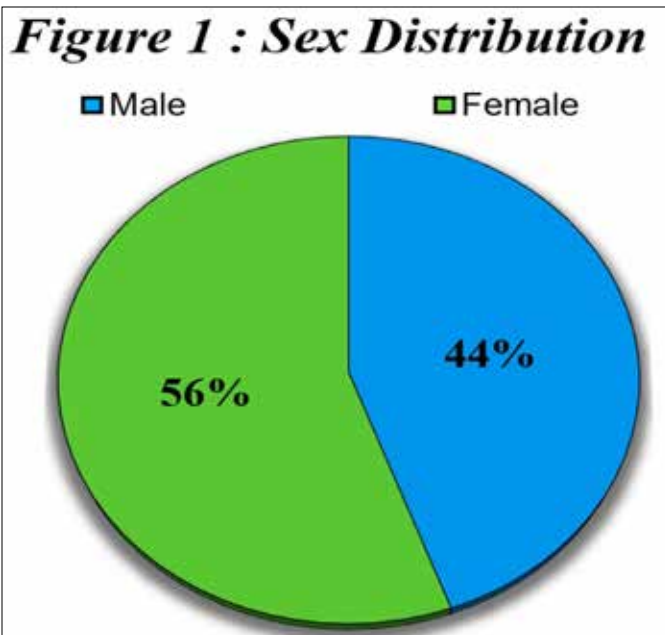


Figure 1: Sex Distribution

belonged to 51 - 70 yrs age group. Mean age of our study population was 59.89 ± 10.05 yrs. Best Corrected Visual Acuity(BCVA) improved in all Eyes.(68% of eyes improved to 0.2-0.0) & Mean BCVA improved from 0.57±0.25 log MAR pre-operatively to 0.20 ± 0.22 log MAR post-operatively. In our study 65% of the eyes had nuclear sclerosis & 35% of the eyes had predominantly posterior subcapsular cataract (Figure 2).

Also most of the eyes had NS2 grade of nuclear sclerosis with or without PSC. 90% of the Eyes had well controlled IOP with medical line of management. Mean IOP of the eyes in our study was 16.19±5.01 mm Hg pre operatively reducing to 13.42±3.65 mmHg post-operatively.(P value <0.0001). 39% eyes showed 0.7 cupping & 35% eyes showed 0.8 cupping. Mean Cup/Disc (C/D) Ratio 0.6870968±0.12039 (Figure 3). 61% eyes had GHT of Outside Normal Limits Pre-Op, 55%

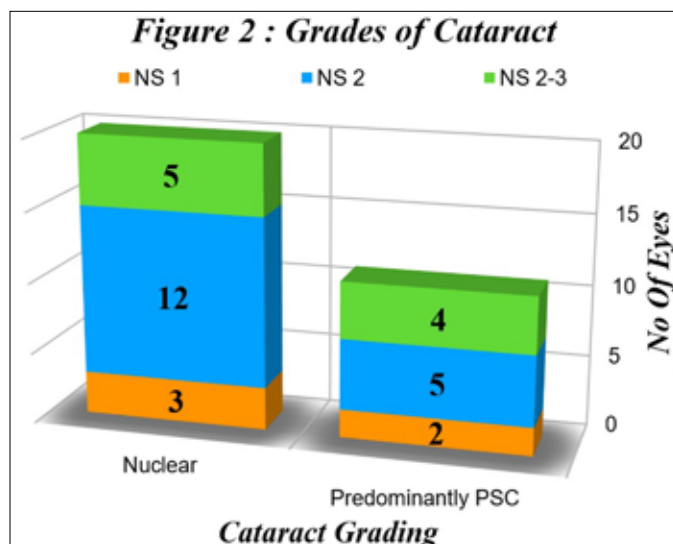


Figure 2 : Grades Of Cataract

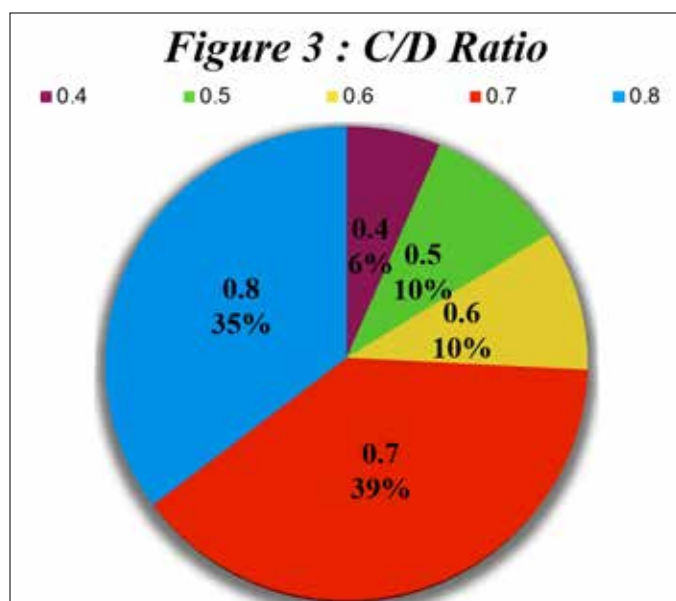


Figure 3: C/D Ratio

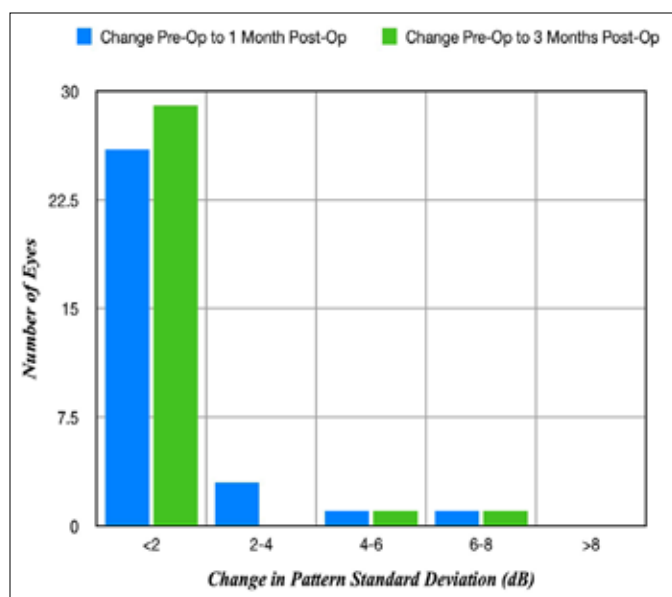


Figure 5: Change in Pattern Standard Deviation

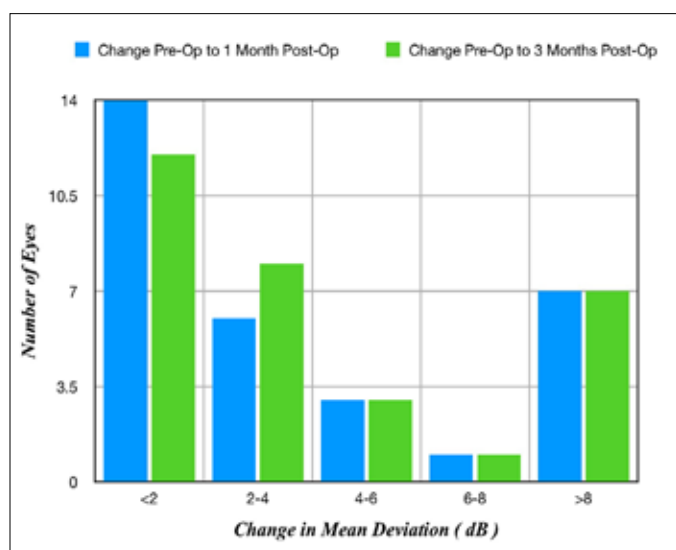


Figure 4: Change in Mean Deviation

eyes had GHT of Outside Normal Limits post-operatively. Most eyes showed improvement in MD in post-operative period. Mean MD improved from -10.77 ± 9.39 dB pre-operatively to -6.52 ± 6.75 dB post-operatively at 3 months (approx 4dB), 39% eyes showed improvement in MD < 2dB; 26% eyes showed improvement 2dB to 4dB & 23% eyes showed change more than 8 dB at 3 months (Figure 4).

Mean PSD worsened post-operatively by approx 1dB from 4.88 ± 3.82 dB pre-operatively to 5.78 ± 4.30 dB post-operatively at 3 months. Majority of eyes showed worsening in PSD less than 2dB. (84% at 1month which increased to 94% at 3months) (Figure 5).

As Per (Table 1)

MD: As the NS grade increases, improvement in MD increases, the change is more when associated with PSC. Maximum improvement is seen with NS2-3 with PSC at both 1 & 3 months post-op. However, with predominantly PSC,

Table 1 : Correlation Of Change In Various Parameters Post -Operatively With Cataract Grading Pre-Operatively

Cat GRADING	Mean Deviation CHANGE Preop- 1 month Postop	Mean Deviation CHANGE Preop- 3 month Postop	Pattern Std Deviation CHANGE Preop- 1 month Postop	Pattern Std Deviation CHANGE Preop- 3 month Postop
Ns1	2.6433333	2.7866667	0.3433333	0.3666667
Ns1 with PSC	1.455	1.445	-0.03	-0.085
Ns 2	2.2316667	2.7325	1.2191667	0.9916667
Ns 2 with PSC	6.228	6.262	1.864	2.036
Ns 2-3	4.028	3.99	0.384	0.314
Ns 2-3 with PSC	9.45	9.135	0.9125	0.78
Nuclear Cataract	2.7425	3.055	0.879	0.7285
Predominantly PSC	6.5318182	6.4309091	1.1736364	1.1936364

Table 2 : Correlation Of Change In Various Parameters Post-Operatively With Severity Scale Of Galucoma (As Per Mean Deviation)

Pre op Glaucoma Severity as per MD	Mean Deviation CHANGE Preop- 1 month Postop	Mean Deviation CHANGE Preop- 3 month Postop	Pattern Std Deviation CHANGE Preop- 1 month Postop	Pattern Std Deviation CHANGE Preop- 3 month Postop
< - 6 dB (Mild)	1.5207143	1.4714286	0.2392857	0.2235714
- 6 dB to -12 dB (Moderate)	2.8483333	3.5866667	1.755	1.3966667
>-12 dB (Severe)	8.0290909	8.1563636	1.51	1.4718182

Tables 3 : Correlation Of Change In Various Parameters Post-Operatively With The Improvement In BCVA (LogMAR)

Change in Vision	Mean Deviation CHANGE Preop- 1 month Postop	Mean Deviation CHANGE Preop- 3 month Postop	Pattern Std Deviation CHANGE Preop- 1 month Postop	Pattern Std Deviation CHANGE Preop- 3 month Postop
>0.0 to ≤ 0.3	4.72125	4.836875	0.788125	0.8275
>0.3 to ≤ 0.6	3.6523077	3.9153846	1.17	0.9169231
>0.6	1.84	1.775	1.335	1.27

the changes are more enhanced with all grades of cataract.

PSD: Maximum worsening is seen with NS2 grade both with & without PSC.

As Per (Table 2)

MD: More the pre-op severity of glaucoma, more the improvement in MD post-operatively.

PSD: As the severity of glaucoma increases, PSD worsens post-operatively

As Per (Table 3)

MD: Improvement in MD is seen even with a small improvement in BCVA.

PSD: Maximum worsening of PSD is noted with maximum improvement in BCVA.

Discussion

Cataract is one of the most commonly encountered pathological condition in the ophthalmology clinic, & increased prevalence of glaucoma is seen in elderly population, they often co-exist, hence, it is important to understand the effect of cataract on various perimetric global indices in glaucoma patients on medical therapy, before & after cataract surgery.

GHT: GHT showed no significant change after cataract extraction. 61% Eyes had GHT of Outside Normal Limits Pre-Op, 55% Eyes had GHT of Outside Normal Limits Post-Op at 3 months. 35% eyes remained within normal limits both pre-operatively & post-operatively. Zalta et al found that in early glaucoma, the Glaucoma Hemifield Test (GHT) interpreted 27% of 1676 fields as "within normal limits" despite the presence of real scotomas on numeric pattern deviation displays ($P < 0.0001$). In early glaucoma, visual field analysis based on the GHT alone is at significant risk for misinterpretation, underdiagnosis, and under-treatment.⁵

Change In Mean Deviation

Cataracts can diffusely depress retinal light sensitivity, thereby lowering the overall hill of vision of the visual field. This is measured as a reduction in the mean deviation.⁶ Cataract surgery in eyes with only mild glaucoma-related visual field defects has been shown to result in significant improvement in the mean deviation.^{7,8,9} Improvement and even disappearance of arcuate visual field defects have been

reported after cataract extraction.¹⁰ In our study mean MD improved significantly from -10.77 ± 9.39 dB pre-operatively to -6.52 ± 6.75 dB post-operatively at 3 months (i.e. by 4dB) (P value < 0.0001). 39% eyes showed improvement in MD < 2 dB; 26% eyes showed improvement 2dB to 4dB & 23% showed change more than 8dB at 3 months. Chen PP et al found that mean deviation improved significantly ($P < 0.0001$).¹¹ Rehman et al found that SITA-standard mean MD improved from -12.3 ± 5.8 to -11.1 ± 6.3 ($P = 0.023$).¹² Rao et al found Median MD (25th and 75th percentiles) after cataract surgery [-10.52 dB (range, -19.25 to -4.86 dB)] was significantly better ($P = 0.003$) than that before surgery [-11.74 dB (range, -20.61 to -7.15 dB)].¹³ Koucheiki et al found in the entire study group, MD improved significantly after surgery ($P < 0.001$).¹⁴ Our study showed similar results.

Change In Pattern Standard Deviation

In our study mean PSD worsened post-operatively by approx 1dB from 4.88 ± 3.82 dB pre-operatively to 5.78 ± 4.30 dB post-operatively at 3 months. Majority of eyes showed worsening less than 2dB. (84% at 1month which increased to 94% at 3months). This was statistically significant (P value < 0.004 at 1month; < 0.006 at 3 months). Various studies on PSD have shown varied results. Chen PP et al found the mean pattern standard deviation and corrected pattern standard deviation increased (worsened) significantly after cataract extraction ($P = 0.03$ and 0.01 , respectively). Rao et al found median PSD after surgery [4.76 dB (range, 2.48 to 9.83)] was worse ($P = 0.01$) than that before surgery [3.50 dB (range, 1.93 to 8.20 dB)]. However, Rehman et al found the change in mean PSD was statistically nonsignificant (from 7.2 ± 3.0 to 7.3 ± 3.6 ; $P = 0.84$) & hence, concluded that the PSD values of SITA are not affected by the lens opacities in glaucoma patients. SITA-standard PSD was, therefore, suggested as the best metric for monitoring glaucomatous change. Cataract can induce various degrees of relative scotoma, an actual glaucomatous field defect can be hidden to some extent and can lead to worsening of pattern standard deviation after surgery.

As Per (Table 1)

MD: As the NS grade increases, improvement in Mean Deviation increases, the change is more when associated with PSC. Maximum improvement is seen with NS2-3 with PSC at both 1 & 3 months post-operatively in our study. Rao et al evaluated the effect of the type of cataract on the global indices and found that MD was significantly depressed in eyes with both nuclear sclerotic and posterior subcapsular cataracts. However, the improvement in MD in our study was significantly more in predominantly posterior subcapsular cataracts as compared with nuclear sclerotic cataracts. Therefore, MD is an unreliable index in glaucoma patients with cataract especially if associated with predominantly posterior subcapsular cataracts.

PSD: Maximum worsening is seen with NS2 grade both with & without PSC. Hayashi et al noted in the group with dense scotoma, the mean pattern standard deviation and corrected pattern standard deviation worsened significantly after surgery, However, in the group without dense scotoma,

the pattern standard deviation(PSD) and corrected pattern standard deviation(CPSD) showed a slight improvement.¹⁵

As Per (Table 2)

MD: More the preoperative severity of glaucoma, more the improvement in Mean Deviation post-operatively in our study. Therefore, in advanced glaucoma with cataract this index becomes much more unreliable. Koucheiki et al noted that the threshold sensitivity in the deepest areas of scotomas remained unchanged, & eyes with a better MD before surgery had a greater magnitude of improvement of MD when correlation analysis was performed based on glaucoma severity. Chen PP et al divided the eyes into three groups by preoperative mean deviation and found that eyes with the worst preoperative visual field loss(mean deviation -21.0dB or worse) did not have significant postoperative improvement in mean deviation (P=0.60). However, eyes in the two groups with less severe visual field loss (mean deviation 2-13.0dB or between -13.0dB and -21.0dB) improved significantly (P<0.0001) & eyes with more severe visual field loss had less improvement in the mean deviation.¹⁶

PSD: As the severity of glaucoma increases, PSD worsens post-operatively. Koucheiki et al found that indices of localized field loss, PSD and CPSD, became mildly worse after cataract extraction in the study group as a whole & therefore, in patients with advanced glaucoma with cataract, preoperative PSD is falsely low.

As Per (Table 3)

MD: Improvement in MD is seen even with a small improvement in BCVA in our study. On improvement in BCVA \leq 0.3 logMAR improvement in mean MD was 4.72dB at 1 month, 4.83dB at 3 months. On improvement in BCVA>0.3 to \leq 0.6 logMAR improvement in mean MD was 3.65dB at 1 month, 3.91dB at 3months. However, on improvement in BCVA by >0.6 logMAR an improvement in mean MD noted was only 1.84dB. This was because there were only 2 eyes in the study population whose BCVA improved by more than 0.6 logMAR, & their pre-operative MD itself was relatively less at -3.74dB(which improved to -1.38dB at 3 months) & -3.89dB(which improved to -2.70dB at 3 months) Siddiqui et al found that, the MD value improved after surgery (p>0.001), however, the changes of MD and VA were not correlated (p=0.252,R2=0.252).¹⁷

PSD: Maximum worsening of PSD is noted with maximum improvement in BCVA in our study. Siddiqui et al found that, the extent of VA improvement correlated with the deterioration of PSD score. The Pearson correlation test showed a statistically significant correlation between the postoperative VA improvement and the PSD change (p=0.024,R2=0.478).

Conclusion

In conclusion, Automated perimetry is Vital to monitor the progress of glaucoma. However, cataract especially the posterior subcapsular type can depress the retinal sensitivity more than the other types, thereby affecting the various perimetric global indices.

Cataract diffusely depresses retinal light sensitivity, thereby lowering the overall hill of vision of the visual field. This is measured as a reduction in the mean deviation. Cataract surgery has been shown to result in significant improvement in the mean deviation. Improvement and even disappearance of arcuate visual field defects may occur after cataract extraction.

Therefore, we infer that in presence of coexisting cataract, MD is more affected than PSD. Hence, PSD is a more useful index to monitor glaucoma in these patients. Moreover, predominantly posterior subcapsular cataract doesn't affect PSD as much as it affects the MD. Hence, in cases of cataract coexisting with glaucoma PSD on perimetry is a relatively more reliable index.

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