

## ORIGINAL RESEARCH

### Effect of Cataract Surgery on Central Corneal Thickness and Visual Fields in Glaucomatous and Non-Glaucomatous Eyes: A Comparative Study in Rural Tertiary Care Hospital

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#### ABSTRACT

**Background:** Cataract and glaucoma are both common conditions and are often present in the same patient. The incidence of these diseases increases with age. Besides vision impairment, these diseases are associated with decrement in quality of life (QOL). **Objective:** To study the effect of cataract surgery on Central Corneal Thickness and Visual Fields in glaucomatous and non-glaucomatous eyes.

**Materials and Methods:** We enrolled 60 patients with glaucoma and concomitant cataract (Group A) and 60 patients with only cataract (Group B) scheduled for phacoemulsification cataract surgery. A record was made which included number of anti-glaucoma medications, visual acuity (VA), intra-ocular pressure (IOP), Central corneal thickness (CCT), visual field (VF) analysis: mean deviation (MD) and pattern standard deviation (PSD). The patients were re-evaluated at 1st week, 4th week and 3rd month after cataract extraction and the above parameters were again obtained to compare them with the baseline values.

**Results:** The mean age of patients is  $50.70 \pm 8.42$  years in Group A &  $50.83 \pm 8.29$  years in Group B. Following cataract extraction, VA improved while CCT changes were insignificant in both the groups. The VF analysis showed that there was an improvement in mean deviation and worsening in pattern standard deviation after the cataract surgery in glaucomatous patients. Similar result was seen for mean deviation in control group. But there was no effect of cataract surgery on pattern standard deviation in non-glaucomatous patients.

**Conclusion:** Cataract extraction proves to be a beneficial management in both glaucomatous and non-glaucomatous patients in terms of vision and mean deviation. PSD was not affected in non-glaucomatous patients.

**Keywords:** Cataract, glaucoma, central corneal thickness, visual fields.

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#### INTRODUCTION

Glaucoma is a leading cause of irreversible blindness worldwide. Glaucoma and cataract are frequently encountered in the same patient, their prevalence increases with age.<sup>[1]</sup> An increasing number of patients who present to the ophthalmologist with symptoms of cataract or glaucoma are diagnosed with both conditions.<sup>[2]</sup> Although it is an increasingly common situation, the management of combined cataract and glaucoma is still a subject of debate.

Considering the high incidence and prevalence of cataract and glaucoma as separate clinical entities in general population, it seems reasonable to consider that the association of both conditions in the same patients is also common.

The sequence of cataract surgery relative to glaucoma surgery impacts the likelihood of complications and surgical success. There are multiple benefits to perform cataract surgery prior to glaucoma surgery while cataract surgery after trabeculectomy increases the risk of subsequent filtration failure.

Cataract surgery lowers intraocular pressure (IOP) and reduces the need for anti-glaucoma drugs, especially in patients with lens-induced glaucoma, angle-closure glaucoma and pseudo-exfoliation glaucoma (PXG).<sup>[3]</sup> The reduction in IOP is the result of increased anterior chamber depth (ACD) and widening of the iridocorneal angle following cataract surgery.<sup>[4]</sup>

Central Corneal Thickness measurement is essential in the work-up for glaucoma since a thinner cornea underestimates and a thicker cornea over estimates the IOP on applanation tonometry. A low CCT (<545 microns) is an independent risk factor for conversion of ocular hypertension to POAG.

Considering the great variety of visual function changes associated with glaucoma and cataract, there are well-established guidelines for each of them considered separately, but a consensus on the management of the patient with both conditions is lacking. Therefore, it is important to underline the effect of treating one of them on the concurrent disease progression. Cataract removal may improve the practitioner's ability to interpret perimetric testing, and re-establishing perimetric and optic nerve imaging baselines is recommended after cataract surgery.

This study reports the short-term outcome of cataract surgery (CCT and Visual Fields) in glaucomatous patients (eyes) and compared it with non- glaucomatous patients (eyes).

## MATERIALS & METHODS

This study was a prospective interventional clinical study in which patients (eyes) were selected from the glaucoma clinic and outpatient department of ophthalmology of rural tertiary care hospital during the period of 2 years from October 2018 to October 2020. Informed consent was taken from patients participating in study. Ethical clearance was taken from institutional ethical committee.

**Inclusion criteria:** patients of age > 40 years having significant cataract (GRADE NS2 and above) & glaucomatous changes (IOP > 21 mmHg), optic disc changes (e.g., cup-to-disc ratio  $\geq$  0.5) and visual fields changes. 20 patients each of PACG (primary angle closure glaucoma), POAG (primary open angle glaucoma) and secondary glaucoma were included. Inclusion criteria for controls (non-glaucomatous) was age > 40 years having significant cataract but not a single glaucomatous finding.

Patients with previous ocular surgery /trauma or any other ocular pathology than cataract and glaucoma were excluded from the study. Patients with any intra or postoperative complications of the cataract surgery and Perimetric false negative /positive consistently greater than 15% and fixation loss indices consistently more than 33 %, were also excluded. Baseline data of all patients was recorded. All the patients underwent clinical examination that included BCVA (Best corrected visual acuity) using Snellen chart, Complete Anterior segment examination, GAT (Goldmann Applanation Tonometry), CCT (Central corneal thickness) using Pachymeter, Visual field was recorded with automated visual field analyser (Humphrey Field Analyzer; Carl Zeiss Ophthalmic Systems Inc) with a 30-2 test pattern, size III white stimulus with the Swedish Interactive Threshold Algorithm standard strategy.

Reliability was defined as less than 30% fixation losses, less than 30% false-positive rates, and less than 30% false-negative rates. Gonioscopy & Fundus Evaluation were also done.

So, we had taken 60 patients of glaucoma (Group A) and 60 patients without glaucoma (Group B).

Group A – Patients with glaucoma (n = 60) Group B – Patient without glaucoma (n = 60)  
Group A was further divided into three groups-

- Group-1- Patients with POAG (n =20)
- Group-2- Patients with PACG (n =20)
- Group-3-Patients with secondary glaucoma (pseudo-exfoliation glaucoma, aphakic glaucoma) (n =20).

### Surgical Methods

After the clinical examination, Phacoemulsification surgery was done using operating microscope (Optikon,US) under peribulbar anaesthesia with full aseptic precautions. In the postoperative period, patients received topical antibiotic-steroid combination eye drop with tapering doses for four weeks.

### Post-Operative Follow UP

Postoperative examinations were performed with following periodicity: one week, one month, three months and following examination was done at each visit – BCVA, CCT, Visual field Perimetry.

### Statistical Analysis

Data were analysed and statistically evaluated using SPSS-PC-17 version. Quantitative data was expressed in mean  $\pm$  standard deviation and depends on normality distribution difference between two comparable groups were tested by student's t-test (unpaired) or Mann Whitney 'U' test while for more than two groups ANNOVA test or Kruskal Wallis H test followed by posthoc test was used. Qualitative data were expressed in percentages. Statistical difference between the proportions were tested by chi square test or Fisher's exact test. 'P' value less than 0.05 was considered statistically significant.

### RESULTS

We studied 120 patients; Cases (Group A) had a mean age of  $50.70 \pm 8.42$  years while Controls (Group B) had a mean age of  $50.83 \pm 8.29$  years ( $p = 0.93$ ). There were 32 (53.3%) male patients and 28 (46.7%) female patients in Group A and 36 (60%) male patients and 24 (40%) female patients in Group B ( $p = 0.46$ ). Various parameters were assessed preoperatively including CCT, IOP, visual field (MD), visual field (PSD) and visual acuity. On comparing these parameters between both the groups, we found that there was no significant difference in CCT of both the groups. IOP and visual field loss (MD & PSD) was higher in the glaucoma group of patients as compared to non-glaucoma group ( $p < 0.001$ ). Visual acuity (log MAR) values showed that vision was better in non-glaucomatous patients (Group B) as compared to glaucoma patients (Group A). [Table 1].

**Table 1: Comparison of preoperative ocular parameters between both groups**

	Group A (n=60)	Group B (n=60)	P value
CCT	543.68 $\pm$ 37.79	543.13 $\pm$ 43.92	0.94
IOP	31.57 $\pm$ 5.13	14.10 $\pm$ 2.51	<0.001
MD	-9.82 $\pm$ 2.22	-5.30 $\pm$ 1.35	<0.001
PSD	4.77 $\pm$ 1.19	4.29 $\pm$ 1.25	0.06
Visual acuity	0.91 $\pm$ 0.25	0.84 $\pm$ 0.27	0.23

Comparison of pre-operative and post-operative parameters between both groups

1. CCT – In both groups i.e., Group A & B, it was seen that central corneal thickness firstly increased at 1st week after the cataract surgery, thereafter, it decreased to almost reaching the pre-operative values at 4th week after the surgery and remained almost same at 3rd month after the surgery, that means Central corneal thickness followed the similar pattern in both the groups [Table 2].

**Table 2: Comparison of pre-operative and post-operative Central corneal thickness between both groups**

Central corneal thickness	Group A (n=60)	Group B (n=60)	P value between group
Preoperative	543.68±37.79	543.13±43.92	0.94
Postoperative 1 <sup>st</sup> week	558.17±34.96	554.72±42.47	0.62
P value between preoperative and postoperative 1 <sup>st</sup> week within group	<0.001	<0.001	
Postoperative 4 <sup>th</sup> week	542.33±36.37	541.05±43.81	0.86
P value between preoperative and postoperative 4 <sup>th</sup> week within group	0.002	<0.001	
Postoperative 3rd month	542.15±37.16	541.40±43.92	0.92
P value between preoperative and postoperative 3 months within Group	0.44	0.49	



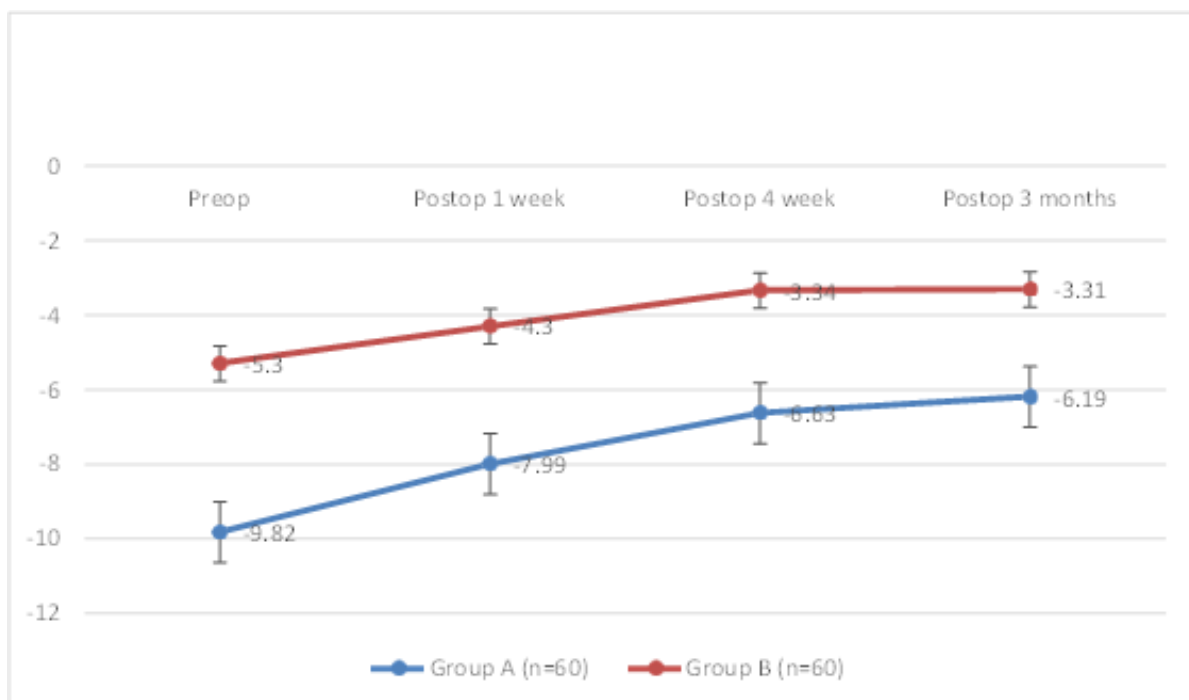
**Figure 1: shows comparison of pre-operative and post-operative central corneal thickness between both the groups.**

## 2. Visual Field Changes

1. MD (Mean Deviation) – In Group A, the visual field (MD) at 1st week was  $-7.99 \pm 2.12$ , at 4th week was  $-6.63 \pm 2.12$  and at 3rd month was  $-6.19 \pm 2.93$  after cataract surgery ( $p < 0.001$ ). Similar results were seen in Group B i.e., visual field (MD) improved at 1st week, 4th week and 3rd month after the cataract surgery in both the groups. (Table 3)

**Table 3: Comparison of pre-operative and post-operative Visual field MD between the groups**

Visual field (MD)	Group A (n=60)	Group B (n=60)	P value between group
Preoperative	$-9.82 \pm 2.22$	$-5.30 \pm 1.35$	$<0.001$
Postoperative 1st week	$-7.99 \pm 2.80$	$-4.30 \pm 1.86$	$<0.001$
P value between pre-operative and postoperative 1st week within group	$<0.001$	$<0.001$	
Postoperative 4th week	$-6.63 \pm 2.12$	$-3.34 \pm 1.26$	$<0.001$
P value between pre-operative and postoperative 4th week within group	$<0.001$	$<0.001$	
Postoperative 3rd month	$-6.19 \pm 2.93$	$-3.31 \pm 1.24$	$<0.001$
P value between preoperative and postoperative 3rd month within group	$<0.001$	$<0.001$	



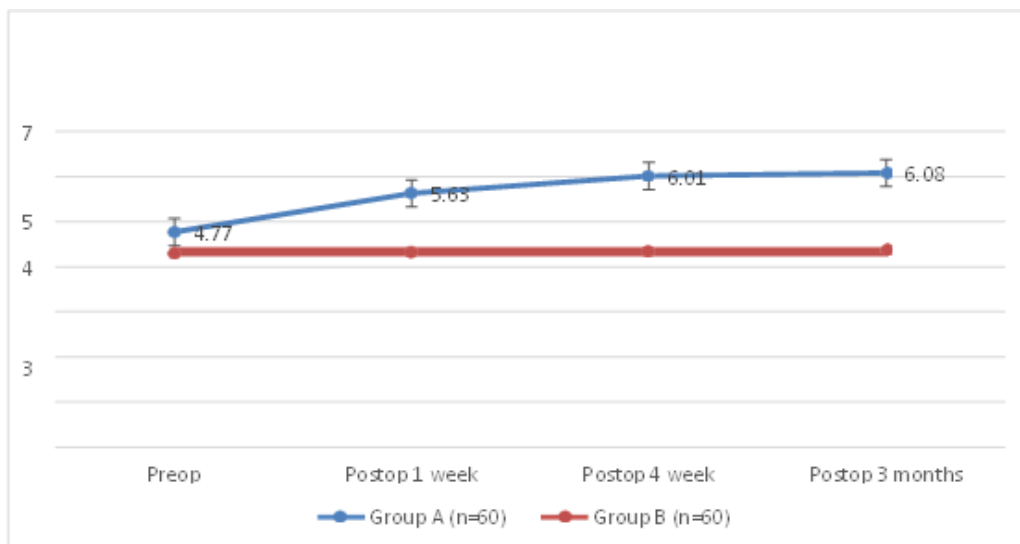
**Figure 2: shows comparison of pre-operative and post-operative visual fields MD between both the groups.**

2. PSD (Pattern Standard Deviation) – There was significant worsening in visual fields (PSD) in the glaucoma patients i.e., Group A after cataract surgery at 1st week, 4th week and 3rd month as compared to pre-operative visual fields (PSD). On the contrary, there was no effect

on the visual fields (PSD) after cataract surgery in non-glaucoma patients i.e., Group B. [Table 4]

**Table 4: Comparison of pre-operative and post-operative Visual field PSD between both groups**

Visual field PSD	Group A (n=60)	Group B (n=60)	P value between group
Preoperative	4.77±1.19	2.29±1.25	0.06
Postoperative 1st week	5.63±1.28	2.31±1.03	0.29
P value between preoperative and postoperative 1st week within group	<0.001	0.32	
Postoperative 4th week	6.01±1.35	2.34±1.18	0.20
P value between preoperative and postoperative 4th week within group	<0.001	0.34	
Postoperative 3rd month	6.08±1.34	2.36±1.22	0.18
P value between preoperative and postoperative 3rd month within group	<0.001	0.35	



**Figure 3: show comparison of pre-operative and post-operative visual field (PSD) between both groups.**

3. VISUAL ACUITY - There was improvement in visual acuity in both the glaucomatous (Group A) and non-glaucomatous group (Group B) after the cataract surgery. [Table 5]

**Table 5: Comparison of preoperative and post-operative visual acuity between both groups**

Visual acuity (log MAR)	Group A (n=60)	Group B (n=60)	P value between group
Preoperative	0.91±0.25	0.84±0.27	0.23
Postoperative 1st week	0.46±0.26	0.36±0.24	0.01
P value between preoperative and postoperative 1st week within group	<0.001	<0.001	
Postoperative 4th week	0.45±0.26	0.31±0.22	<0.01

P value between preoperative and postoperative 4th week within group	<0.001	<0.001	
Postoperative 3rd month	0.447±0.25	0.32±0.22	<0.01
P value between preoperative and postoperative 3rd month within group	<0.001	<0.001	

## DISCUSSION

Glaucoma is a slowly progressive and irreversible disease characterized by morphological changes in the optic disc, retinal nerve fiber layer and associated defects in the visual field. Detection and monitoring of this blinding disease requires structural and functional changes, but it is only via functional measurements that one can quantify the visual status. Cataract and glaucoma are common conditions and often present in the same patient.

When planning cataract surgery on patients with glaucoma, it is important to separate the visual field loss caused by cataract from actual glaucomatous field defects. Bigger and Becker,<sup>[5]</sup> using manual perimetry, showed a reduction in glaucomatous visual field defects after cataract surgery. In contrast, many studies using automated perimetry reported that cataract can cause diffuse loss of sensitivity but does not produce changes in the pattern of glaucomatous field defects.<sup>[6-10]</sup>

In our study, the mean age of glaucomatous patient (Group A) undergoing cataract surgery was 50.70±8.42 years but the mean age was 74.6±7.1 in the glaucoma (PXG) patients of Hayanshi et al study.<sup>[11]</sup> Similarly, other studies also show mean higher age of glaucoma patients.<sup>[12-16]</sup> Thus, the glaucoma develops in older age. Most of the studies have found that females are more affected by glaucoma.<sup>[11,12,14]</sup> But our study shows male predominance (60%), also seen in Siddiqui et al study.<sup>[16]</sup> The study done by Siddiqui et al,<sup>[17]</sup> showed equal gender distribution.

The mean preoperative CCT in our study was 543.68±37.79 um in glaucoma patients (Group A). The study conducted by Hayanshi et al,<sup>[11]</sup> showed mean preoperative CCT as 533.0±40 um. Preoperative mean IOP was higher in our study (31.57±5.13 mm Hg) in glaucoma patients. But various other studies had a mean IOP lower than our study like Bhandari S et al,<sup>[18]</sup> study had mean preoperative IOP of 14.56±3.75 mm Hg in glaucoma patients (on anti-glaucoma medications). AGIS,<sup>[19]</sup> and Philip P Chen et al,<sup>[13]</sup> study had a mean preoperative IOP of 15.10±4.7 and 17.0±5.8 mmHg respectively.

In our study preoperative visual field had a mean deviation of -9.82±2.22 in glaucoma patients which is consistent with the AGIS,<sup>[19]</sup> Bhandari S et al,<sup>[18]</sup> study study with MD of -10.9±3.0 and -11.51±7.45 respectively. Similarly, in our study mean preoperative PSD was 4.77±1.19 in glaucoma patients which is consistent with the preoperative PSD in study conducted by Ken Hayashi et al and Bhandari S et al study.<sup>[14,18]</sup> So, MD and PSD both are affected in patients of glaucoma.

Preoperative visual acuity was 0.91±0.25 log MAR in glaucoma patients, which is consistent with the study done by Ken Hayashi et al (14) whereas AGIS (19) study had mean visual acuity of 0.4±0.2 log MAR.

### Perioperative Assessment of Parameters in Both the Groups

1. CCT- In our study, postoperative value of CCT showed significant change at 1st week, 4th week ( $p < 0.001$ ) but not significant at 3rd month ( $p = 0.44$ ). So, the CCT increased in early postoperative period, but gradually returned to normal at or before 3 months. This is similar to study done by Hayanshi et al,<sup>[11]</sup> and Kongsap P.<sup>[20]</sup> When glaucomatous patients were compared with the controls, our study showed that the increase in mean CCT was more in glaucomatous group at 1st week after the surgery which was not significant ( $p = 0.62$ ). Similarly decrease in CCT at 4th week and 3rd month was not significant in both the groups

( $p = 0.86$  and  $0.92$  respectively). The Hayashi et al,<sup>[11]</sup> study showed that the changes in CCT were not significant in glaucoma group as compared to controls at follow up visits.

2. MD - In our study also, there was significant improvement in MD postoperatively in both the groups as compared to preoperative MD ( $p < 0.001$ ). Also, there was significant improvement in MD at 1st week, 4th week and 3rd month in between the two groups ( $p < 0.001$ ), which was consistent with Bhandari et al study.<sup>[18]</sup> Many other studies had shown improvement in MD after the cataract surgery.<sup>[13-19,21]</sup> However, in a study by Monica M. Carrillo,<sup>[15]</sup> no change in MD was observed after cataract extraction in glaucomatous eyes. Several investigators have studied the effect of cataract on static automated perimetry. Guthauser and Flammer,<sup>[22]</sup> and Lam et al,<sup>[23]</sup> found a diffuse effect of cataract on the visual field in a group of glaucoma and non-glaucoma patients. Chen and Budenz,<sup>[24]</sup> found that the improvement in MD after cataract surgery depended on the level of glaucomatous field loss, with patients with more severe loss showing more modest improvement.

3. PSD - In our study, PSD showed significant worsening postoperatively at 1st week, 4th week and 3rd month as compared to preoperative PSD ( $P < 0.001$ ). But in Bhandari Set al study,<sup>[18]</sup> when VF was analyzed, PSD did not change significantly. However, the PSD results have varied among the studies (Chen et al, 1998; Hayashi et al, 2001, Koucheiki et al, 2004; Musch et al, 2006, Siddiqui et al, 2007; Ang et al, 2010; Rao et al, 2013).<sup>[24-30]</sup> There was no effect on visual fields (PSD) after the cataract surgery in control group.

So, there was an improvement in mean deviation and worsening in pattern standard deviation after the cataract surgery in glaucomatous patients. Similar result was seen for mean deviation in control group. But there was no effect of cataract surgery on pattern standard deviation in non-glaucomatous patients.

The differences in the density of scotoma among patients in these studies might be the possible reason for these conflicting results. Hayashi et al in 2001,<sup>[25]</sup> have in fact reported that the PSD deteriorated in VFs with dense scotoma whereas it remained unchanged in VFs with less dense scotoma. They hypothesized that relatively less scotoma resulting from cataract decreased after surgery whereas dense scotoma remained virtually unchanged, leading to enhanced asymmetry of the glaucomatous field defects after cataract extraction and a worsening of the PSD.

4. VISUAL ACUITY - In our study, there was significant improvement in visual acuity in the glaucomatous group after the cataract surgery ( $p < 0.001$ ). Most of the studies,<sup>[12,15-21]</sup> also showed significant improvement in visual acuity in glaucomatous patients after the cataract surgery ( $p < 0.001$ ). Thus, it was seen that visual acuity improves after the cataract surgery in glaucomatous patients. When the visual acuity of glaucomatous patients was compared with the controls after the surgery, our study showed significant difference in visual acuity at 1st week, 4th week and 3rd month post-operatively ( $p < 0.01$ ) which was also seen in Bhandari S et al study.<sup>[13]</sup> The study conducted by Ken Hayashi,<sup>[11]</sup> resulted in no significant change in visual acuity in glaucomatous and non-glaucomatous eyes ( $p > 0.25$ ). So, the improvement in the visual acuity in both the groups after the cataract surgery was similar.

## CONCLUSION

Cataract extraction results in significant improvement in the mean deviation during visual field analysis, an index of diffuse depression of the visual field. The PSD, an index of localized depression also changed significantly. The pattern standard deviation is a reliable indicator of glaucoma-related damage in eyes with cataract, but further study is needed in this area. CCT changes in early post-operative period may affect the assessment of IOP and thus the glaucoma. Cataract extraction in patients with glaucoma results in a significant improvement in vision. This improvement can be appreciated irrespective of the type of glaucoma or whether glaucoma is present or not. Further prospective controlled studies with a



clearly defined and standardized grading system for cataract are necessary to determine and more clearly interpret the effect of the different types of cataracts on the visual field in the whole spectrum of glaucoma patients.

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