

Visual Function Outcomes in Tinted versus Non-Tinted IOLs in Cataract Patients

Prateek Koul^{1*}, Sachit Mahajan² and Satish Gupta²

¹Department of Ophthalmology, VCSG Government Medical College, Srinagar, Uttarakhand, India.

²Upgraded Department of Ophthalmology, Government Medical College (GMC), Jammu, India.

Original Research Article

ABSTRACT

Aims: The study aims to compare the visual function outcomes in tinted versus non-tinted IOL in cataract patients.

Study Design: Prospective, randomised, clinical study was conducted on patients.

Place and Duration of Study: The study was carried out at Upgraded Department of Ophthalmology, Government Medical College Jammu, India during November 2016 to October 2017.

Methodology: This study included two groups of 100 patients each. 100 patients in group 1 were randomly implanted with tinted IOLs, and another 100 patients in group 2 were implanted with non-tinted IOLs. Visual functions such as Best Corrected Visual Acuity (BCVA), Colour Vision (CV) and Contrast Sensitivity (CS) were compared after 1st post-operative day, 2nd week and 3rd month.

Results: The mean changes between the uncorrected visual acuity (UCVA) (day 1) and best corrected visual acuity (3rd month) reveals a non significant change between the two groups, however, the mean change in tinted group was more than nontinted groups i.e. 76.17% (p =0.101). Pre- and Post-operative colour vision remained same in both the groups and mean change in contrast sensitivity after day 1 and contrast sensitivity (3rd month) also revealed a non significant

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*Corresponding author: E-mail: prateek.koul913@gmail.com;

change, however mean change in tinted group was more (64.55%) in compared to non-tinted group (33.28%) withp value of 0.283.

Conclusion: The mean change in best corrected visual acuity and contrast sensitivity is statistically insignificant for both the groups.

Keywords: Tinted IOL; non-tinted IOL; best corrected visual acuity; contrast sensitivity; colour vision.

1. INTRODUCTION

Cataract is a clouding of the normally clear transparent lens of the eye, which may prevent a clear image from forming on the retina. It is one of the leading causes of blindness, accounting for 50% of the blindness worldwide [1].

Duke [2] defined cataract as any opacity in the lens. Yanoff [3] defined senile cataract as any cataract that occurs after the age of 50 years having no evident cause [3]. However, more useful to use the term age-related as age is the most important factor in the development of cataract. Other influences such as environment, toxic, nutritional and systemic factors that affect an individual throughout the life have a cumulative effect on the development of cataract. Agerelated cataract is a prevalent condition, and the cataract may become more mature as the age advances. Extracapsular cataract extraction with PCIOL implantation remained a popular technique for a long time, but it had some disadvantages i.e., long incision (10-12 mm) multiple sutures & astigmatism.

These days Manual small incision cataract surgery (MSICS) and phacoemulsification are the two most contemporary procedures performed for cataract extraction in India.

Manual SICS has been found to be as safe as phacoemulsification with similar visual rehabilitation outcomes [4].

Previously, the colour of IOLs was not taken into account while choosing an IOL for patients undergoing surgery for cataract. The patient had a transparent IOL implanted, which filtered only UV rays between 200 nm and 400 nm.

At present, there are several options of IOLs with filters available. They all attempt to block the passage of blue light to retina, establishing the cut-off at different wavelengths to provide good photoprotection. Thus, there are Violet filter lenses that block visible spectrum of wavelength (400- 440 nm) and blue filter lenses that block the spectrum between 440-500 nm.

A yellow chromophore has been added in the IOL which absorbs the blue light. Therefore, in addition to blocking UV light, wavelengths between 400 and 500 nm are only partially transmitted. The high-frequency blue wavelength light may be more likely to damage the retina through the release of free radicals. The AcrySof Natural IOL blocks the unnatural transmission of this blue light and protects the retina. The yellow coloured lens is also more easily visible inside the cartridge and easier to load an implant.

The cut off value considered best for photoprotection is around 445 nm [5]. Furthermore, any spectral filter that reduces blue-green phototoxicity causes a percentage decrease in scotopic sensitivity [6]. There are no IOLs in the market that offer a good compensation between retinal protection and reduction in the blue light reaching the ocular fundus (photoreception). It is a proven fact that the human crystalline lens turns yellow with age, and this change in colour of the human lens blocks the shorter wavelengths and may contribute in retinal protection as shorter wavelength light may contribute to retinal damage in middle age and elderly patients.

However, few direct experimental measurements show what this agerelated yellowing is due to. The most precise way to explain this process is to determine the spectral transmission of the crystalline lens [7].

Weale experimentally performed direct measurements of the spectral transmission of crystalline lens, but determined the absorbance as a function of age for seven wavelengths and fitted it with a logarithmic equation [8], as the crystalline lens of elderly person is yellowish in nature to protect retina. Yellow or orange filters are being incorporated in IOLs to imitate this yellowing.

It has been a concern that exposure to sunlight may be a risk factor for the development of ARMD (age-related macular degeneration).

Initially, intraocular lens implanted during cataract surgery allowed the passage of all the

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visible light [9]. However, it was reported that erythropsia [10] (objects appearing with a reddish hue), photic retinopathy (retinal dysfunction which was induced by too much light exposure), and cystoid macular oedema [11] (fluid accumulation in the outer plexiform layer) and cyst formation had a common cause of decreased vision after cataract surgery occurred in patients with these IOLs.

Blue blocking IOLs provide 27-38% less melatonin suppression than a UV only blocking IOL, whereas reduction is 15-16% for violet blocking IOL [6].

The present study is an attempt to compare the visual functions (best corrected visual acuity, contrast sensitivity and colour vision) in patients implanted with non-tinted IOLs versus short wavelength blue light blocking yellow tinted IOLs.

2. MATERIALS AND METHODS

This prospective, randomised and clinical study was conducted on patients attending the eye OPD of Government Medical College Jammu, India during October 2016 to November 2017. Appropriate inclusion and exclusion criteria were applied and any complications occurred due to the procedure were recorded.

A total of 200 patients were studied, and cases were divided into two groups of 100 each.

Group-1: Comprised of 100 patients who were subjected to manual small incision cataract surgery with yellow tinted posterior chamber intraocular lens implantation

Group-2: Comprised of 100 patients who were subjected to manual small incision cataract surgery with non-tinted posterior chamber intraocular lens implantation

2.1 Inclusion Criteria

- Patients of cataract of grade I, II & III
- Patients of either sex
- Both unilateral & bilateral cataract cases

2.2 Exclusion Criteria

- Patients with coexisting glaucoma, uveitis, subluxated lens, traumatic cataract, corneal opacity, corneal dystrophy, exotropia, esotropia, high myopia

- Patients with posterior segment pathology (retinitis pigmentosa, retinal detachment, age-related macular degeneration, diabetic retinopathy, hypertensive retinopathy)

The study proceeded as follows:

- Detailed history pertaining to visual impairment & relevant medical as well as surgical history was recorded
- Patients were subjected to general physical examination to rule out any associated diseases
- Each patient underwent a detailed ocular examination
- Pre-operative antibiotic drops & oral antibiotics were given a day before the surgery
- Mydriasis was achieved by using 1% cyclopentolate and 1% tropicamide with 10% phenylephrine eye drops
- 4% xylocaine was instilled topically
- All patients were operated using peribulbar block by a single surgeon
- The eye planned for surgery was cleaned and draped

2.3 Surgical Technique

Group 1- Manual small incision cataract surgery through superior sclero-corneal tunnel approach with yellow tinted PCIOL was done.

After placing wire speculum & reflecting fornix based conjunctival flap, tenon's & episcleral attachments from sclera was cleaned. A gentle & just adequate cautery was applied.

The incision had 3 components; external sclera incision, sclero-corneal tunnel, internal incision.

External incision: It was a frown shaped, parabolic groove which was convex towards the limbus, 5.5 mm in length & 1.5 - 2 mm behind the limbus. The edges of the frown were 3 mm from the limbus & its centre 2 mm from the superior limbus. It was given with a No.15 disposable blade.

Sclero corneal tunnel: Sclero-corneal tunnel was created with a crescent knife.

Internal incision: The 2.8 mm angled keratome was parallel to the iris to create a side port at 9 o'clock position in the right eye & at 3 o'clock position in the left eye. Anterior chamber was

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entered with the same keratome and entry will be parallel to the external incision. The keratome was lifted to dip the tip into the anterior chamber with a forward movement.

2.4 Capsulorrhexis, Nucleus Delivery and Intraocular Lens Implantation

The anterior chamber was deepened with hydroxyl propylmethyl cellulose, and a continuous curvilinear capsulorrhexis was initiated and completed by using a 26 gauge bent needle through the main incision. Hydrodissection was carried out by using a curved cannula connected to BSS bottle with a drip set. The fluid was injected beneath the anterior capsule at one or two places. The nucleus was prolapsed slightly out of the bag. Pressure on posterior lip guided the nucleus out. Cortical cleaning was done by using two-way simcoe cannula with BSS. Viscoelastic material was injected into capsular bag, and yellow tinted PCIOI was implanted. The same procedure was repeated for patients in group 2.

2.5 Measuring Visual Acuity Postoperatively

The distant visual acuity was tested with Snellen's test chart. It consists of a series of black capital letters on a whiteboard, arranged in lines, each progressively diminishing in size. The letter on the top line of the chart should be read clearly at a distance of 60m. Similarly, the letters in the subsequent lines should be read from a distance of 36, 24, 18, 12, 9, 6 and 5 m.

For testing, the patient was seated at a distance of 6 m from the chart, so that the rays of light are practically parallel to each other. The chart should be properly illuminated (20 footcandles). The patient was asked to read the chart with each eye separately, and the visual acuity was recorded as a fraction, the numerator being the distance of patient from the letters and denominator being the smallest letters accurately read.

2.6 Measuring Colour Vision

The colour vision was measured using Ishihara's plates. There are patterns of coloured and grey dots which reveal one pattern to the normal individuals and another to colour deficient. The patient was made to identify the patterns on the plates, and the results were recorded.

2.7 Measuring Contrast Sensitivity

It was measured using Pelli-Robson contrast sensitivity chart. This chart consists of letters that subtend an angle of 3 degree at a distance of 1 m. The letters on chart were organised as triplets, having two triplets in each line. The contrast decreases from one triplet to the next. The log contrast sensitivity varies from 0.00 to 2.25. While recording, the patient was sitting 1 m in front of the chart. Patient was made to name each letter starting from the upper left corner and reading horizontally. Patient was made to guess even when he or she believes the letters are invisible. The test concludes when the patient guesses two of the three letters incorrectly.

Patients of both the groups were followed up on 1st post-operative day, 2nd week & 3rd month for visual acuity, contrast visual acuity, colour vision, slit lamp examination & refraction. Any complication if occurred due to the procedure was recorded.

2.8 Statistical Analysis

Statistical analysis was carried out using SPSS 16 for Windows (SPSS Inc., Chicago, Illinois, USA). The statistical result was expressed with appropriate charts and tables. Mean and standard deviation were determined for continuous variables. Categorical data were presented with absolute and relative frequencies. In order to detect differences between the two groups; unpaired students t-test was carried out for continuous variables, while, for categorical variables, the Chi-square test was used. All tests were two-tailed. A p-value of less than 0.05 was considered statistically significant.

3. RESULTS AND DISCUSSION

The study comprised of the following results:

Age:

Table 1. Group comparison for age distribution (years)

Age (years)	Number of patients	
	Tinted IOLs (n=100)	Non-tinted IOLs (n=100)
≤50	17	10
51-60	19	18
61-70	36	41
71-80	23	22
>80	5	9
Mean age ± SD	64.54 ± 11.57	66.60 ± 11.16
p-value	0.178	

IOL - Intraocular Lens

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Sex:

Table 2. Sex distribution

Sex	Number of patients	
	Tinted IOLs (n=100)	Non-tinted IOLs (n=100)
Male	52	45
Female	48	55
p-value	0.321	

IOL - Intraocular Lens

Uncorrected visual acuity (day 1):

Table 4. Uncorrected visual acuity (day 1)

Uncorrected visual acuity	Number of patients	
	Tinted IOLs (n=100)	Non-tinted IOLs (n=100)
≤6/60	22	26
6/36-6/12	61	57
6/12 -6/6	17	17
p-value	0.793	

IOL - Intraocular Lens

Pre-operative visual acuity:

Table 3. Pre-operative visual acuity

Visual acuity	Number of patients	
	Tinted IOLs (n=100)	Non-tinted IOLs (n=100)
≤3/60	29	34
4/60-6/60	41	44
>6/60	30	22
p-value	0.421	

IOL - Intraocular Lens

Uncorrected visual acuity week 2:

Table 5. Uncorrected visual acuity week 2

Uncorrected visual acuity	Number of patients	
	Tinted IOLs (n=100)	Non-tinted IOLs (n=100)
≤6/60	12	0
6/36-6/12	63	44
6/12 -6/6	25	56
p-value	<0.0001	

IOL - Intraocular Lens

Best corrected visual acuity 3rd month:

Table 6. Best corrected visual acuity 3rd month

BCVA 3 rd month	Number of patients	
	Tinted IOLs (n=100)	Non-tinted IOLs (n=100)
≤6/60	0	0
6/36-6/12	29	40
6/12 -6/6	71	60
p-value	0.104	

BCVA - Best Corrected Visual Acuity

IOL - Intraocular Lens

Changes between uncorrected visual acuity (day 1) and BCVA (3rd month):

Table 7. Change between Uncorrected visual acuity (day 1) and BCVA (3rd month)

Visual acuity	Number of patients					
	Tinted IOLs (n=100)			Non-tinted IOLs (n=100)		
	UCVA (day 1)	BCVA (3 rd month)	Change (%)	UCVA (day 1)	BCVA (3 rd month)	Change (%)
≤6/60	22	0	100.00	26	0	100.0
6/36-6/12	61	29	52.46	57	40	29.82
6/12 -6/6	17	71	76.05	17	60	71.66
Mean Change	76.17			67.16		
p-value	0.101					

UCVA - Uncorrected Visual Acuity

BCVA - Best corrected Visual Acuity

Preoperative colour vision:

Table 8. Preoperative colour vision

Preoperative colour vision	Number of patients	
	Tinted IOLs (n=100)	Non-tinted IOLs (n=100)
Normal	100	100
Defective	0	0
p-value	0.104	

Preoperative contrast sensitivity:

Table 9. Preoperative contrast sensitivity

Preoperative contrast sensitivity	Number of patients	
	Tinted IOLs (n=100)	Non-tinted IOLs (n=100)
0.0 – 0.75 log units	47	54
0.90 – 1.65 log units	48	37
1.80 – 2.25 log units	5	9
p-value	0.221	

Post operative contrast sensitivity day 1:

Table 10. Post-operative contrast sensitivity day 1

Post-operative contrast sensitivity day 1	Number of patients	
	Tinted IOLs (n=100)	Non-tinted IOLs (n=100)
≤1.05 log units	10	3
1.20 – 1.65 log units	37	43
1.80 – 2.25 log units	53	54
p-value	0.121	

Post operative contrast sensitivity 2nd week:

Table 11. Post-operative contrast sensitivity 2nd week

Post-operative contrast sensitivity 2 nd week	Number of patients	
	Tinted IOLs (n=100)	Non-tinted IOLs (n=100)
≤1.05 log units	2	0
1.20 – 1.65 log units	31	37
1.80 – 2.25 log units	67	63
p-value	0.271	

Post operative contrast sensitivity 3rd month:

Table 12. Post-operative contrast sensitivity 3rd month

Post-operative contrast sensitivity 3 rd month	Number of patients	
	Tinted IOLs (n=100)	Non-tinted IOLs (n=100)
≤1.05 log units	0	0
1.20 – 1.65 log units	16	26
1.80 – 2.25 log units	84	74
p-value	0.082	

Change between contrast sensitivity (day 1) and contrast sensitivity (3rd month):

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Table 13. Changes between contrast sensitivity (day 1) and BCVA (3rd month)

Contrast sensitivity	Number of patients					
	Tinted IOLs (n=100)			Non-tinted IOLs (n=100)		
	CS (day 1)	CS (3 rd month)	Change (%)	CS (day 1)	CS (3 rd month)	Change (%)
≤1.05 log units	10	0	100.00	3	0	100.0
1.20 – 1.65 log units	37	16	56.75	43	26	39.53
1.80 – 2.25 log units	53	84	36.90	54	74	27.03
Mean Change	64.55			33.28		
p-value	0.283					

CS – Contrast sensitivity

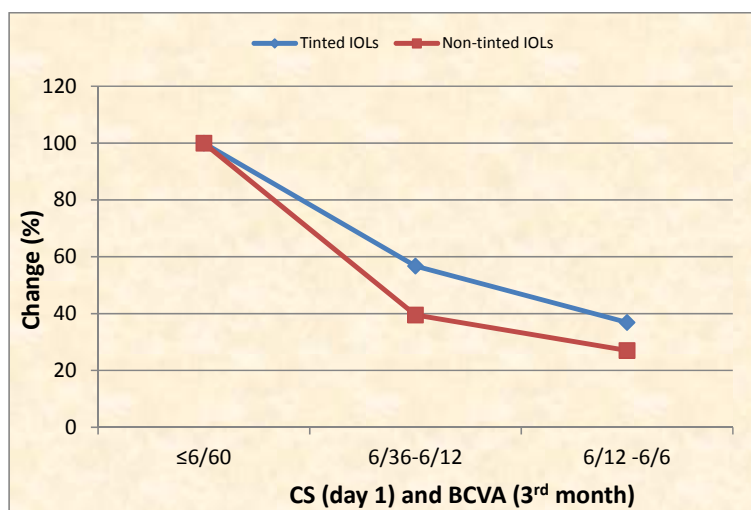


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3.1 Discussion

Since Ridley introduced IOLs in cataract surgery, evolution in their materials and design has been the main area of ophthalmology research. The realization that the spectral characteristics of human lens plays an important role in protecting the retina led to the implementation of UV filters in IOLs, and these IOLs are almost universally used today. In addition to filtering UV light, several IOLs that further filter blue wavelengths have been available since a long time.

There is no doubt about the importance of ultraviolet (UV) blockers in IOLs, but there is still a lot of discussion about the usefulness of filtering short-wavelength blue light with IOLs. People advocating these IOLs argue that they might protect the retina from phototoxic damage

and increase visual quality by reducing chromatic aberration. Surgeons refusing to use these lenses are worried about the mesopic and scotopic contrast and colour sensitivity after using these IOLs.

It has been demonstrated that cataract surgery is a risk factor for the development of ARMD [12], although other studies reported no such risk [13]. The risk was attributed to the fact that extraction of the yellow crystalline lens in older patients enhances exposure of the phototoxic short wavelength blue light to the retina, which may lead to ARMD. Furthermore, there is a great deal of biological evidence that short wavelength light is hazardous to the neural retina as well as retinal pigment epithelial cells [14]. Specifically, short wavelength light has been shown in vitro to damage the retinal pigment epithelial cells, in a

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way that is mediated by the accumulation of lipofuscin and its component A2E [15]. Although a clinical effect has not been clearly defined, it is assume that a yellow tinted IOL can protect the RPE from light damage, and help to prevent the development of ARMD.

Few studies on post-operative visual outcomes of tinted and non-tinted IOLs were performed worldwide. However, no such studies were performed in our set up here. These studies had a wide range of outcomes as will be discussed and compared to the present study. Hayashi & Hayashi [16] reported no significant change in post-operative BCVA at 2 weeks ($p=0.8711$) and post-operative BCVA at 3rd month ($p=0.5556$). Diez-Ajenjo et al. [17] reported a pre-operative BCVA of 0.3 ± 0.1 logMAR for non tinted group and 0.3 ± 0.2 logMAR ($p=0.23$) for tinted group. And 3 months after surgery of 0.02 ± 0.1 logMAR($p=0.84$) for both the groups. Hence there was a statistically significant change in their study. Kara-Junior et al. [18] found no statistically significant results for change in best corrected visual acuity in their study ($p=0.1$). They reported no statistical difference in mean BCVA 0.01 ± 0.1 logMAR ($p=0.432$) in tinted and 0.02 ± 0.02 logMAR ($p=0.475$) in non-tinted group. Schmack et al. [19] also reported no significant differences in change in BCVA in both the groups ($p=0.40$).

Hayashi & Hayashi [16] reported no difference in pre- and post operative colour vision both remaining normal and no statistically significant change in mean contrast visual acuity in both tinted and non tinted group ($p=0.47$). Diez-Ajenjo et al. [17] also reported no difference in this parameter as it remained normal in both the groups and no statistically significant change in contrast to sensitivity in both photopic ($p=0.43$) and mesopic ($p=0.92$) illumination conditions. Schmack et al. [19] reported a better colour perception in non tinted group as compared to tinted group. Wohlfart et al. [20] reported no difference in colour vision and it remained normal in both the groups.

Wirtitsch et al. [21] reported that blue filtering tinted IOLs had worse contrast sensitivity ($p=0.0004$) and foveal threshold ($p=0.008$) in compared to non-tinted IOLs which is different to the present study. This may be due to its measurement at different illumination levels unlike in the present study. Kara-Junior et al. [18] reported no statistically significant difference ($p=0.42$) in mean contrast visual acuity in both the groups. Schmack et al. [19] reported no

significant change in contrast acuity from day 1 to 3rd post operative month ($p=0.2$) which is comparable to the present study.

4. CONCLUSION

The present study concludes that the change in mean visual acuity and contrast sensitivity is statistically insignificant. However, because studies have shown that short wavelength blue light has phototoxicity for retinal pigment epithelial cells so the blue light absorbing tinted IOLs could prevent age-related macular degeneration. Therefore their use is recommended for eyes at high risk to develop ARMD such as eyes with drusens or atrophy of retinal pigment epithelium in the macula. Although no statistically significant effect of tinted IOLs on visual function was recorded in the present study.

CONSENT

Written informed consent was obtained from all patients who participated in the study after explaining the whole procedure and possible complications.

ETHICAL APPROVAL

All authors hereby declare that all experiments have been examined and approved by the appropriate ethics committee and have therefore been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki. The ethical approval number for the present study is IEC/Thesis/Research/T9B/2016/294.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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It appears that a comma is missing after the introductoty phrase, consider adding a comma