

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

ABSTRACT

Aims: To compare the visual function outcomes in tinted versus non tinted IOL in cataract patients.

Study design: Prospective , Randomized, Clinical study .

Place and Duration of Study: Upgraded Department of Ophthalmology Government Medical College Jammu between 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 first post operative day, 2nd week and third month.

Results: The mean change between the uncorrected visual acuity (day 1) and best corrected visual acuity(BCVA) (3 rd month) reveals a non significant change between the two groups,however the mean change in tinted group was more than non tinted groups (76.17 % and (p value 0.101).Pre and Post operative colour vision(CV) remained same in both the groups and mean change in contrast sensitivity(CS) after day 1 and contrast sensitivity(3 rd month) also revealed a non significant change ,however mean change in tinted group was more ie 64.55 % than non tinted group (33.28 percent). (p value 0.283).

Conclusion: Even though the mean change in best corrected visual acuity and contrast sensitivity is more for patients implanted with tinted IOLs but this change is statistically insignificant.

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 in the world today, accounting for 50 % of blindness worldwide [1].

[2] defined cataract as any opacity in the lens. [3] defined senile cataract as any cataract that occurs after the age of 50 years and that has no evident cause. It is however more useful to use the term age related because age is the most important factor. Other influences such as environment, toxic, nutritional and systemic factors that affect an individual throughout life have a cumulative effect. Age related cataract is very common and may be a rule in advanced age. Extracapsular cataract extraction with PCIOL implantation remained a popular technique for a long time but the problems faced were –long incision (10-12 mm) multiple sutures & astigmatism.

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

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

Until a few years ago, colour of IOLs was not taken into account when choosing IOL for a patient having cataract surgery. The patient had a totally transparent IOL implanted, which filtered only UV rays between 200nm 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 photo protection. 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).

35

36 A yellow chromophore has been added in the IOL which absorbs the blue light. Therefore, in addition
37 to blocking UV light wavelengths between 400 and 50 nm are only partially transmitted. The high-
38 frequency blue wavelength light may be more likely to damage the retina through release of free
39 radicals. The AcrySof Natural IOL blocks the unnatural transmission of this blue light and protects
40 retina. The yellow colored lens is also more easily visible inside the cartridge and easier to load and
41 implant.

42 The cut off value considered best for photo protection is around 445 nm [4]. Furthermore, any spectral
43 filter that reduces blue-green phototoxicity causes a percentage decrease in scotopic sensitivity [5].
44 There are no IOLs in the market that offer a good compensation between retinal protection and
45 reduction in the blue light reaching the ocular fundus (photoreception). It is a proven fact that the
46 human crystalline lens turns yellow with age, and this change in colour of the human lens blocks the
47 shorter wavelengths and may contribute in retinal protection as shorter wavelength light may
48 contribute to retinal damage in middle age to elderly patients.

49 However there are few direct experimental measurements that show what this age related yellowing is
50 like. The clearest way to show this process is to determine the spectral transmission of the crystalline
51 lens [6].

52 [7] performed direct measurements of the spectral transmission of the crystalline lens, but only
53 showed the absorbance as a function of age for seven wavelengths and fitted a logarithmic equation.
54 As crystalline lens of elderly person is yellowish in order to protect retina. Yellow or orange filters are
55 being incorporated in IOLs so as to imitate this yellowing.

56 It has been a concern that exposure to sunlight may be a risk factor for the development of AMD (age
57 related macular degeneration).
58

59 Initially intraocular lens implanted during cataract surgery allowed the passage of all the visible light
60 [8]. However, it was found erythropsia [9] (objects appearing with a reddish hue), photic
61 retinopathy (retinal dysfunction which induced by too much light exposure), and cystoid macular
62 edema [10]. (fluid accumulation in the outer plexiform layer and cyst formation a common cause of
63 decreased vision after cataract surgery) occurred in patients with these IOLs.

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

66 Our study is an attempt to compare the visual functions (best corrected visual acuity, contrast
67 sensitivity and colour vision) in patients implanted with non-tinted IOLs versus short wavelength blue
68 light blocking yellow tinted IOLs.
69

70 **2. MATERIAL AND METHODS**

71
72 This prospective, randomized, clinical study was conducted on patients attending the eye OPD of
73 Government Medical College Jammu from October 2016 to November 2017 appropriate inclusion and
74 exclusion criteria was applied and any complications if arising due to the procedure were recorded.
75

76 Total of 200 patients were studied and cases were divided into two groups of 100 each.

77 Group-I: comprised of 100 patients who were subjected to manual small incision cataract surgery with
78 yellow tinted posterior chamber intraocular lens implantation.

79 Group-II: comprised of 100 patients who were subjected to manual small incision cataract surgery
80 with non-tinted posterior chamber intraocular lens implantation.

81 **Inclusion criteria**

82 a. Patients of cataract of grade I, II & III

83 b. Patients of either sex.

84 c. Both unilateral & bilateral cataract cases.

85

86 Exclusion criteria

87 a. Patients with coexisting glaucoma, uveitis, subluxated lens, traumatic cataract, corneal
88 opacity, corneal dystrophy, exotropia, esotropia, high myopia

89 b. Patients with posterior segment pathology (Retinitis pigmentosa, Retinal Detachment, Age
90 Related Macular Degeneration, Diabetic retinopathy, Hypertensive retinopathy)

91 The study proceeded as follows

92 • Detailed history pertaining to visual impairment & relevant medical & surgical history was
93 recorded.

94 • Patients were subjected to General Physical Examination to rule out any associated diseases.

95 • Each patient underwent detailed ocular examination.

96

97 • Pre-operative antibiotic drops & oral antibiotics were given a day before the surgery.

98 • Mydriasis was achieved using 1% cyclopentolate and 1% tropicamide with 10%
99 phenylephrine eye drops.

100 • 4% xylocaine was instilled topically.

101 • All patients were operated using peribulbar block by single surgeon.

102 • The eye planned for surgery was cleaned and draped.

103 Surgical Technique

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

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

108 The incision had 3 components:- External sclera incision, Sclero-corneal tunnel ,Internal incision.

109 External incision

110 It was a frown shaped, parabolic groove which was convex towards the limbus, 5.5 mm in length &
111 1.5-2 mm behind the limbus. The edges of the frown were 3 mm from the limbus & its centre 2mm
112 from the superior limbus. It was given with a No.15 disposable blade.

113 Sclero corneal tunnel

114 Sclero-corneal tunnel was created with a crescent knife. As soon as one reaches the limbus, the
115 blade was lifted up anteriorly along the dome of the cornea to dissect uniformly 1.5-2 mm of clear
116 cornea. Once a straight track was created, the crescent was moved sideways to right & left, keeping it
117 in the dissecting plane.

118 Internal incision

119 The 2.8 mm angled keratome was parallel to the iris to create a side port at 9 o' clock position in the
120 right eye & at 3 o'clock position in the left eye. Anterior chamber was entered with the same keratome
121 and entry will be parallel to the external incision. The keratome was lifted to dip the tip into the anterior
122 chamber with a forward movement.

123 The anterior chamber was deepened with hydroxypropylmethylcellulose and a continuous curvilinear
124 capsulorrhexis was initiated and completed using a 26 gauge bent needle through the main incision.

125 Hydrodissection was carried out using a curved cannula connected to BSS bottle with a drip set. The
126 fluid was injected beneath the anterior capsule at one or two places. The nucleus was prolapsed
127 slightly out of the bag. Viscoelastic was then injected into the anterior chamber and behind the
128 nucleus so that the posterior capsule is pushed well away from it. The nucleus was rotated with a
129 sinskey hook in clockwise & anticlockwise direction to bring it into the anterior chamber. A cushion of
130 viscoelastic was then placed anterior and posterior to the nucleus and a wire vectis was brought
131 below the nucleus and once the nucleus is engaged, the surgeon brought the vectis out along with the
132 nucleus while pressing the posterior lip of the tunnel .Pressure on posterior lip guided the nucleus out.
133 A conscious effort was made to keep the AC deep by injecting viscoelastics as and when required.

134 Cortical cleaning was done using two way simcoe cannula with BSS. Viscoelastic material was
135 injected into capsular bag and yellow tinted PCIOl was implanted.

136 All viscoelastic material was removed from AC & thorough section washing was done with BSS using
137 hydrodissection cannula. AC was reformed with BSS. Integrity of self sealing scleral incision was
138 ensured and conjunctival flap was apposed.

139 FOR GROUP –II: Manual small incision cataract surgery through superior sclera-corneal tunnel
140 approach with the implantation of non- tinted IOL was performed as described earlier.

141 In both groups I & II postoperative injection of dexamethasone and gentamycin was given and eye
142 pad was applied for 24 hours.

143 Patients of both the groups were followed up on 1st post op day, 2nd week, 3 months for visual
144 acuity, contrast visual acuity, colour vision, slit lamp examination & refraction. Any complication if
145 occurs were recorded.

146 Statistical analysis

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

154 3. RESULTS AND DISCUSSION

155

156 The study comprised of the following results

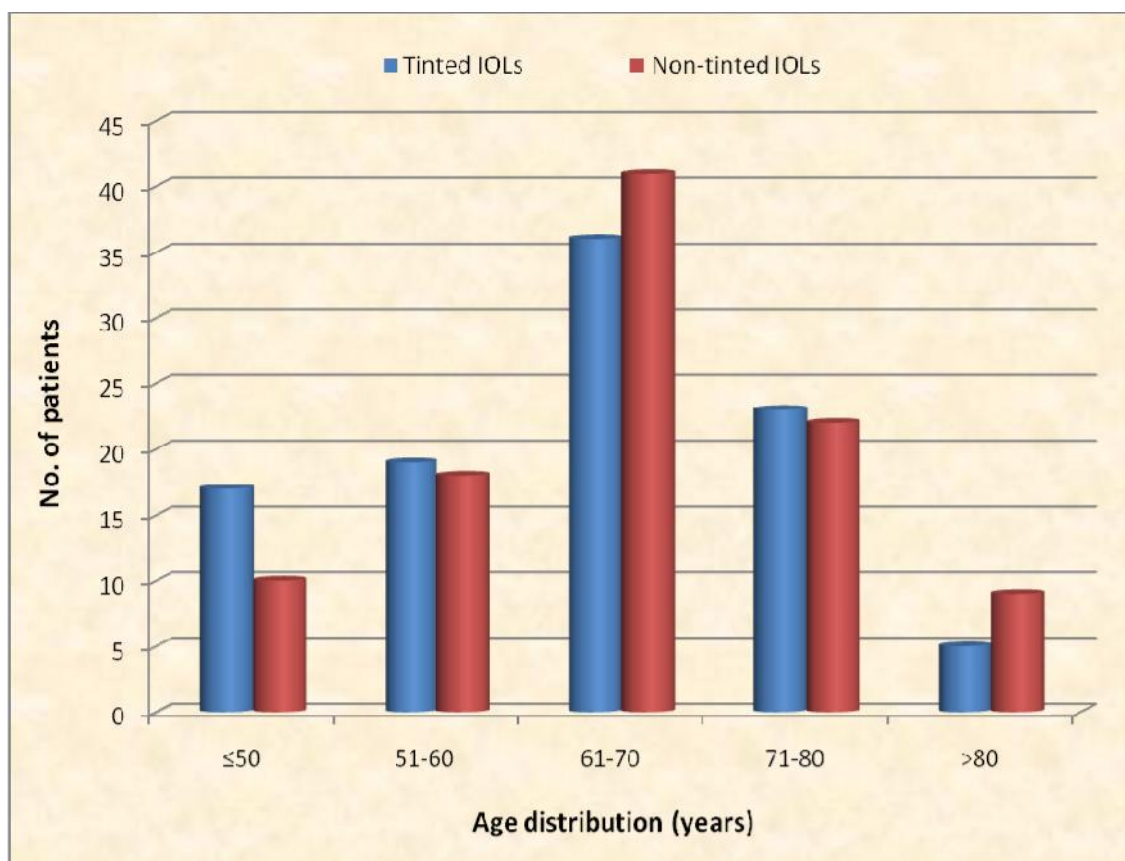
157 Age

158 Maximum number of patients (36 and 41) in both tinted and non-tinted IOLs groups were recorded in
159 the age group of 61-70, while minimum number of patients were recorded in the age group of >80
160 years, respectively. The mean age of the patients in Tinted group was 64.54 years and in non-tinted
161 group it was 66.60 years. The differences between the two groups were found non-significant with p-
162 value of 0.178.

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	

Fig.



169 Sex

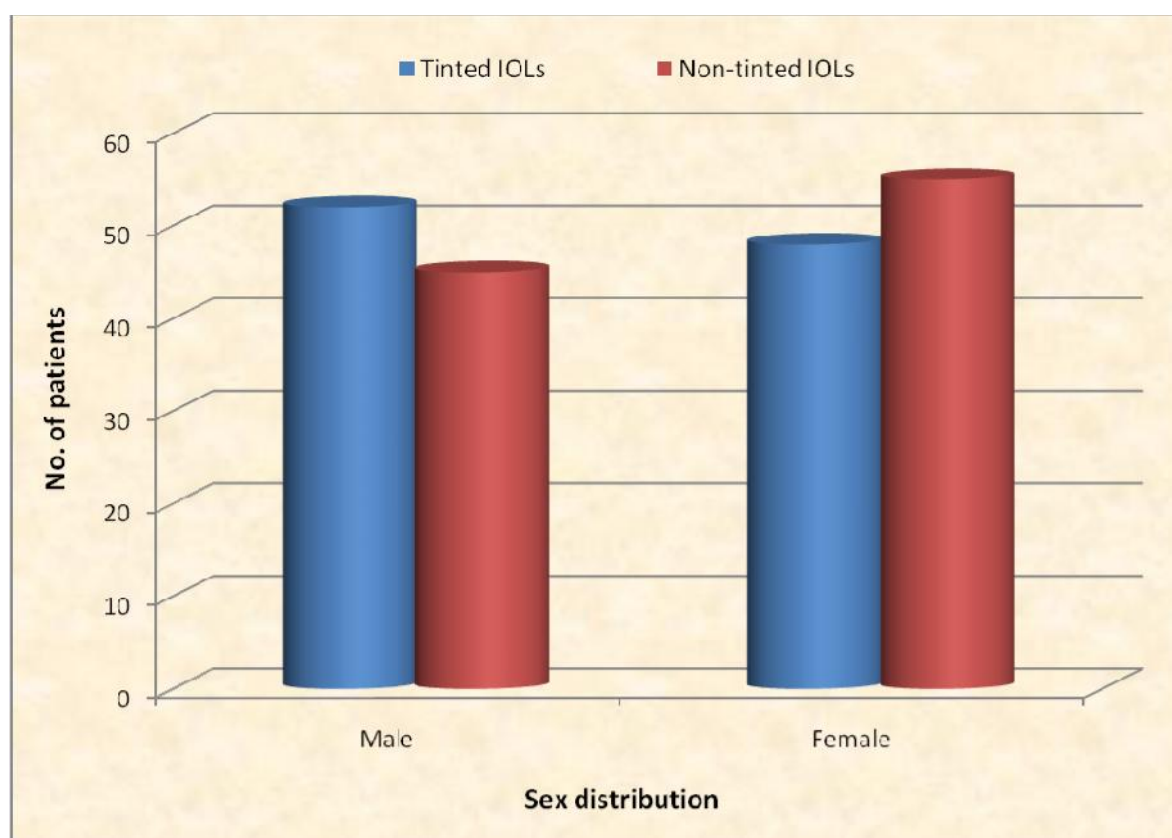
170 With regard to the sex distribution of the patients, the number of males and females in the tinted
 171 group was 52 and 48 and in the non-tinted group it was 45 and 55, respectively. Non-significant
 172 association was recorded between the two groups with p-value of 0.321.

173 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	

174

175 Fig.



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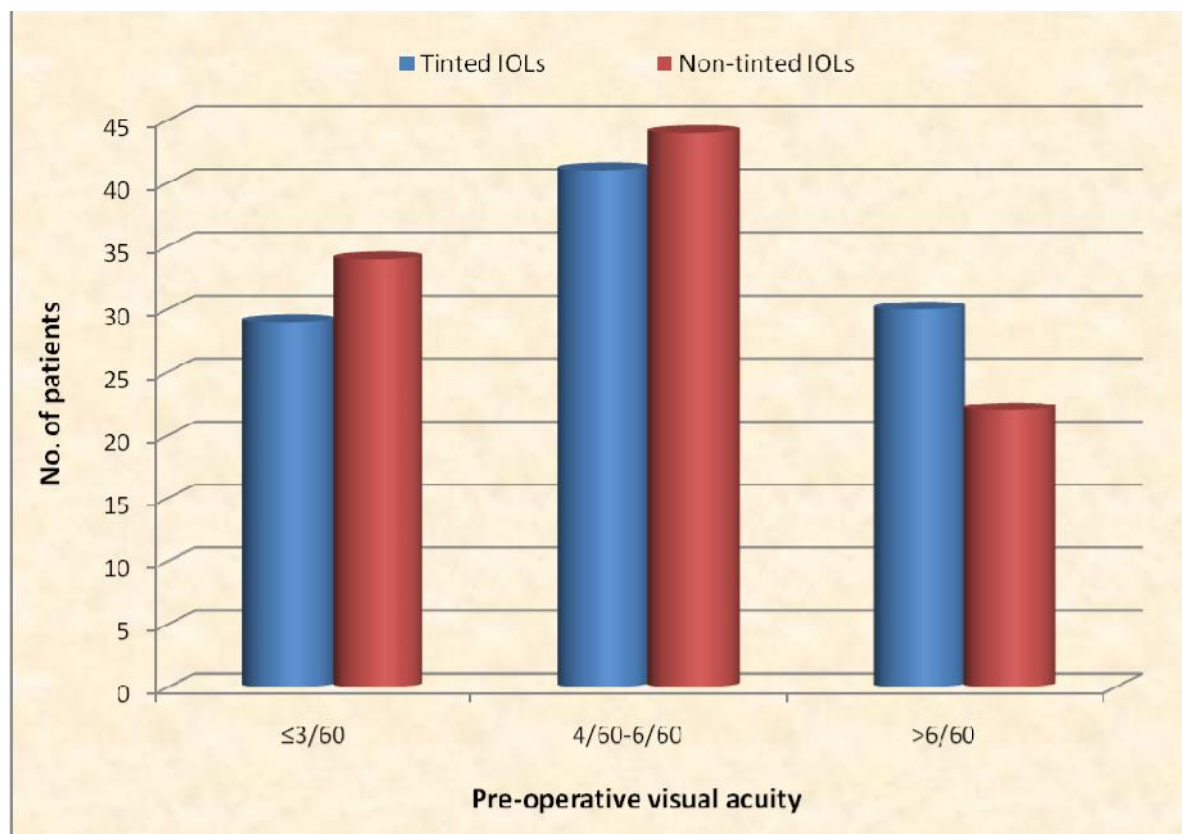
179 Pre-operative visual acuity

Perusal of the data presented in Table 3 shows that out of 100 patients in tinted group, the highest number of patients (41) were recorded in 4/60-6/60 range which was followed by >6/60 (30 patients) and the lowest number of patients were recorded in $\leq 3/60$ (29 patients). Similarly in the non-tinted group, the maximum (44 patients) and minimum (22 patients) were recorded in 4/60-6/60 and >6/60 range, respectively. The two groups were non-significantly associated with each other with p-value of 0.421.

Table 3: Pre-operative visual acuity

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

Fig.



192 **Uncorrected visual acuity (day1)**

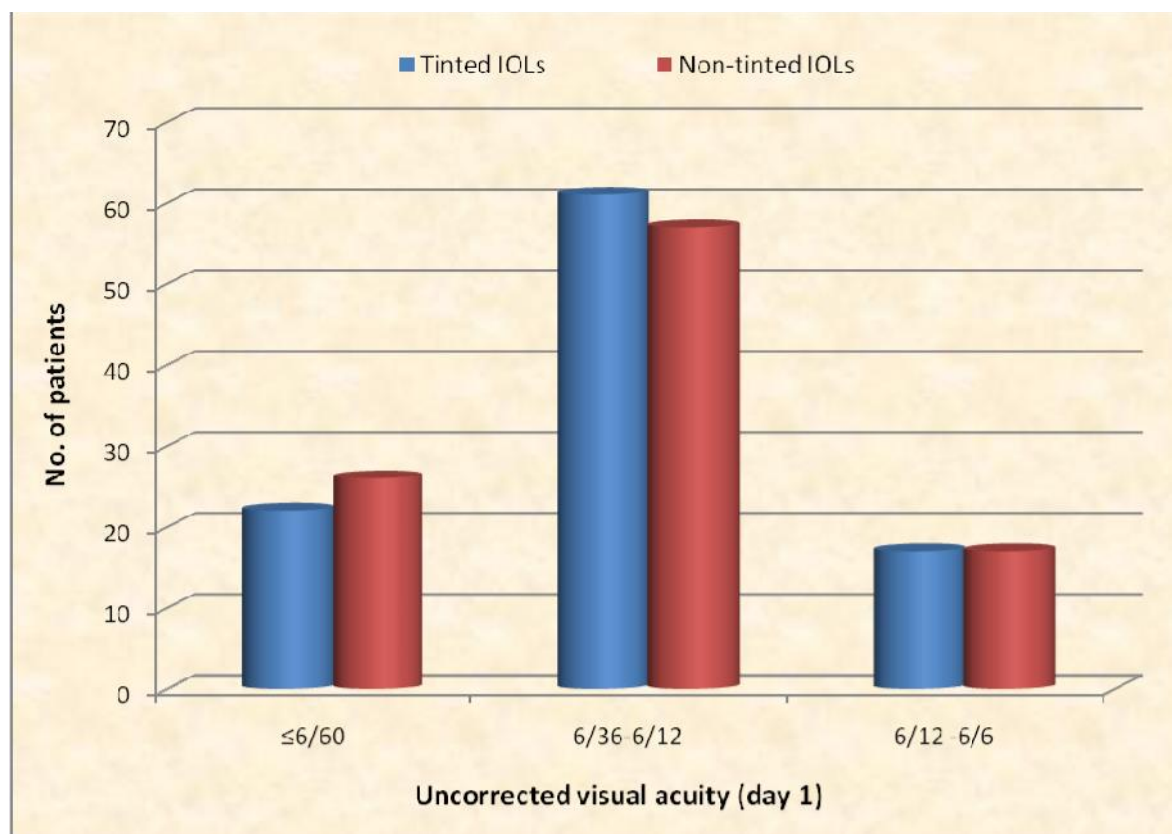
193 The data demonstrated below shows that out of 100 patients in tinted IOL group maximum patients
 194 (61) recorded a UCVA between (6/36-6/12) similarly in non-tinted group maximum patients (57) also
 195 recorded a UCVA between (6/36-6/12).

196 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	

197

198 Fig.



199

200 **Uncorrected visual acuity week 2**

201 Data presented in Table 5 and Fig. ... indicated that the two groups viz., tinted and non-tinted IOLs
 202 were significantly associated with each other with p-value of <0.0001. Maximum number of patients

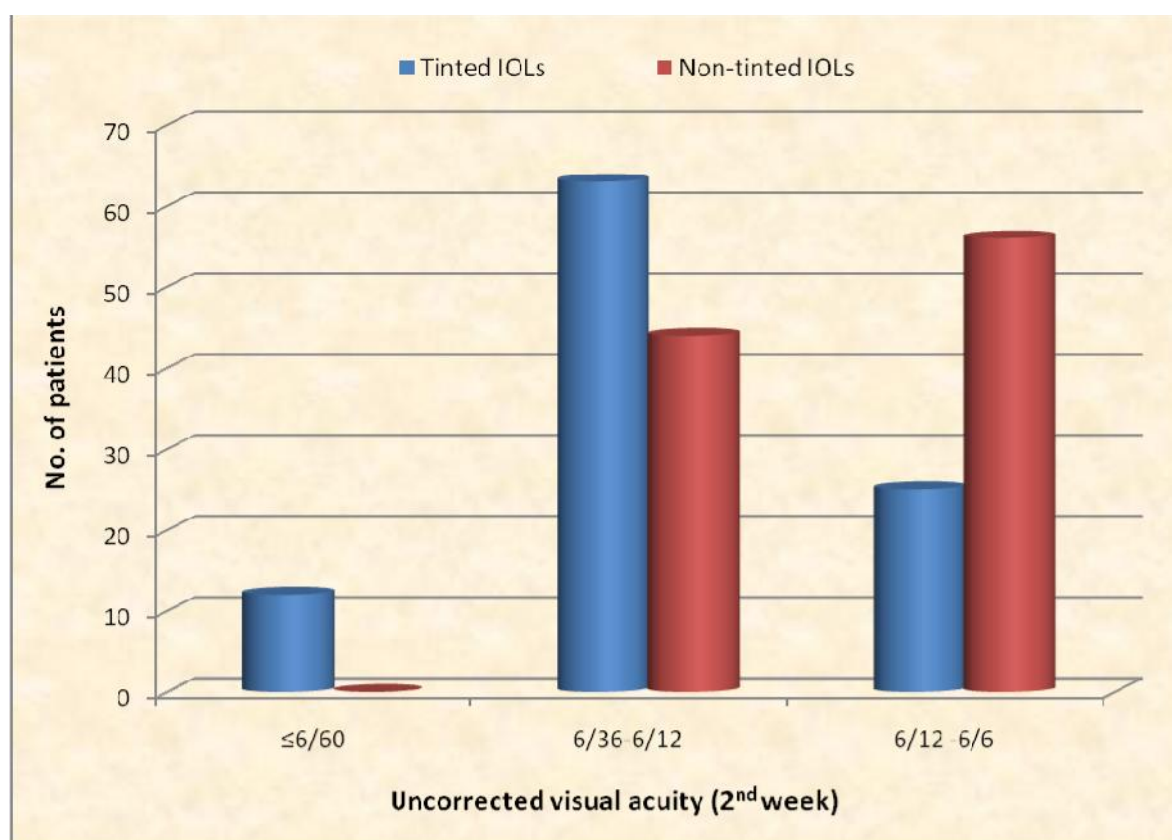
(63) in the tinted group were recorded in 6/36-6/12 range and the minimum number of patients (12) were recorded in >6/60 range. In non-tinted group no patient was recorded in >6/60 range, however, maximum number of patients (56) were recorded in 6/12 -6/6 range.

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	

Fig.

Fig.



Best Corrected Visual Acuity 3 rd month:-

The data below shows that out of 100 patients in tinted IOL group maximum (71) showed BCVA in the range of (6/12-6/6) and in non tinted group maximum (60) patients also showed BCVA in the range of (6/12-6/6).

The data below shows that out of 100 patients in tinted IOL group maximum (71) showed BCVA in the range of (6/12-6/6) and in non tinted group maximum (60) patients also showed BCVA in the range of (6/12-6/6).

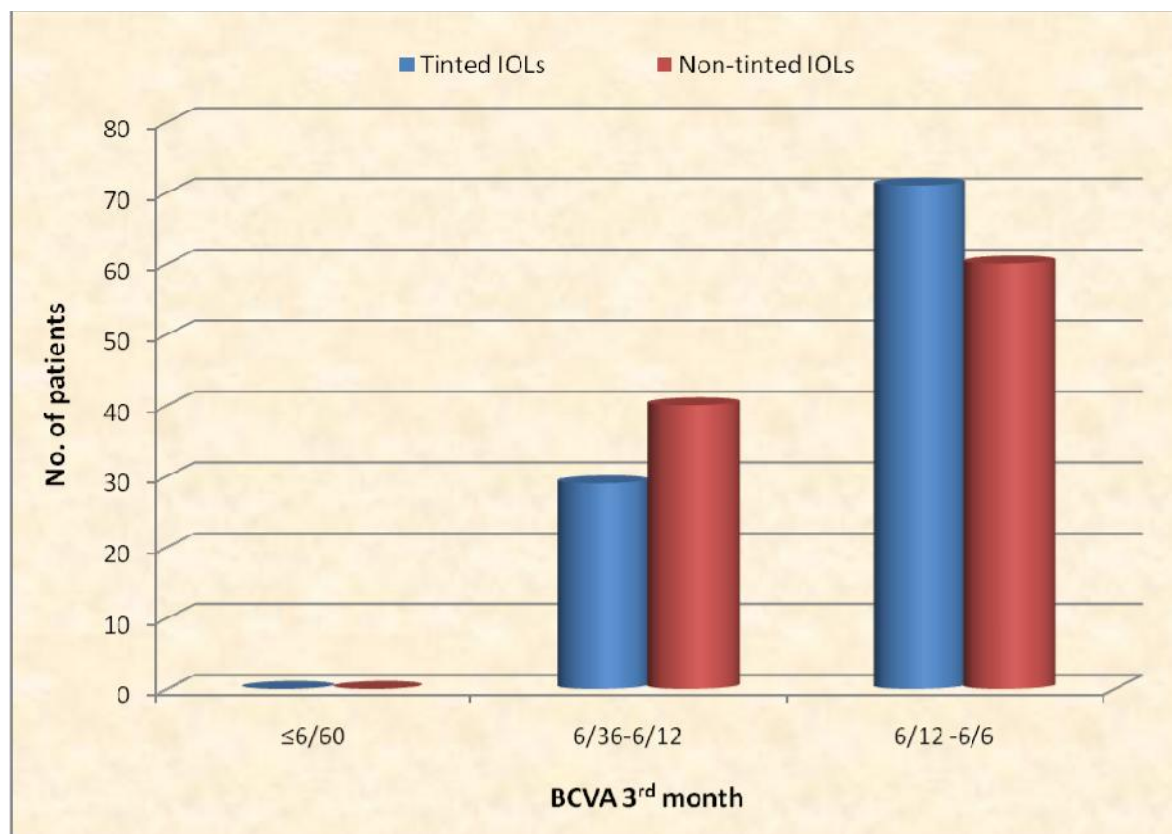
The data below shows that out of 100 patients in tinted IOL group maximum (71) showed BCVA in the range of (6/12-6/6) and in non tinted group maximum (60) patients also showed BCVA in the range of (6/12-6/6).

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	

216

217 Fig.



218

219 Change between Uncorrected visual acuity (day 1) and BCVA (3rd month)

220 The data with regard to change between uncorrected visual acuity (day 1) and best corrected visual
 221 acuity (3rd month) is presented in Table 7 and Fig. ... perusal of the data presented in the table
 222 reveals non-significant change between the two groups, however the maximum change per cent
 223 (100.0% and 100.0%) in tinted and non-tinted groups were recorded in ≤6/60 range, while the
 224 minimum change per cent (52.46% and 29.82%) was recorded in 6/36-6/12 range, respectively. Mean
 225 change in tinted IOL group was more than non tinted group.

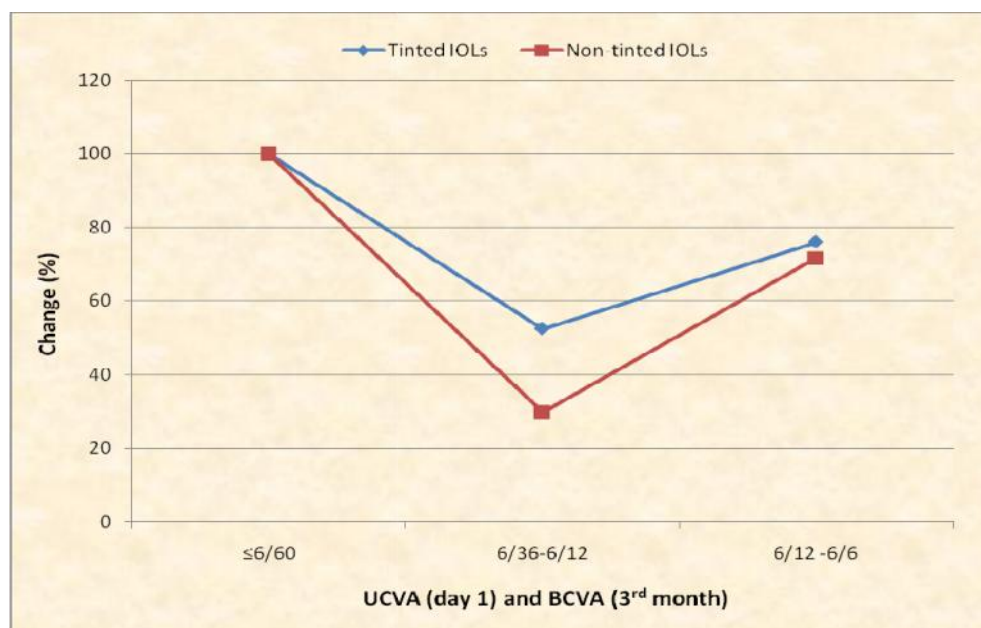
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Table 7: Change between Uncorrected visual acuity (day 1) and BCVA (3rd month)

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					

228

229 Fig.



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231

232 Preoperative colour vision

233 The pre operative colour vision remained normal in both tinted and non tinted IOL group as shown by
234 the table below.

235 Table 8:

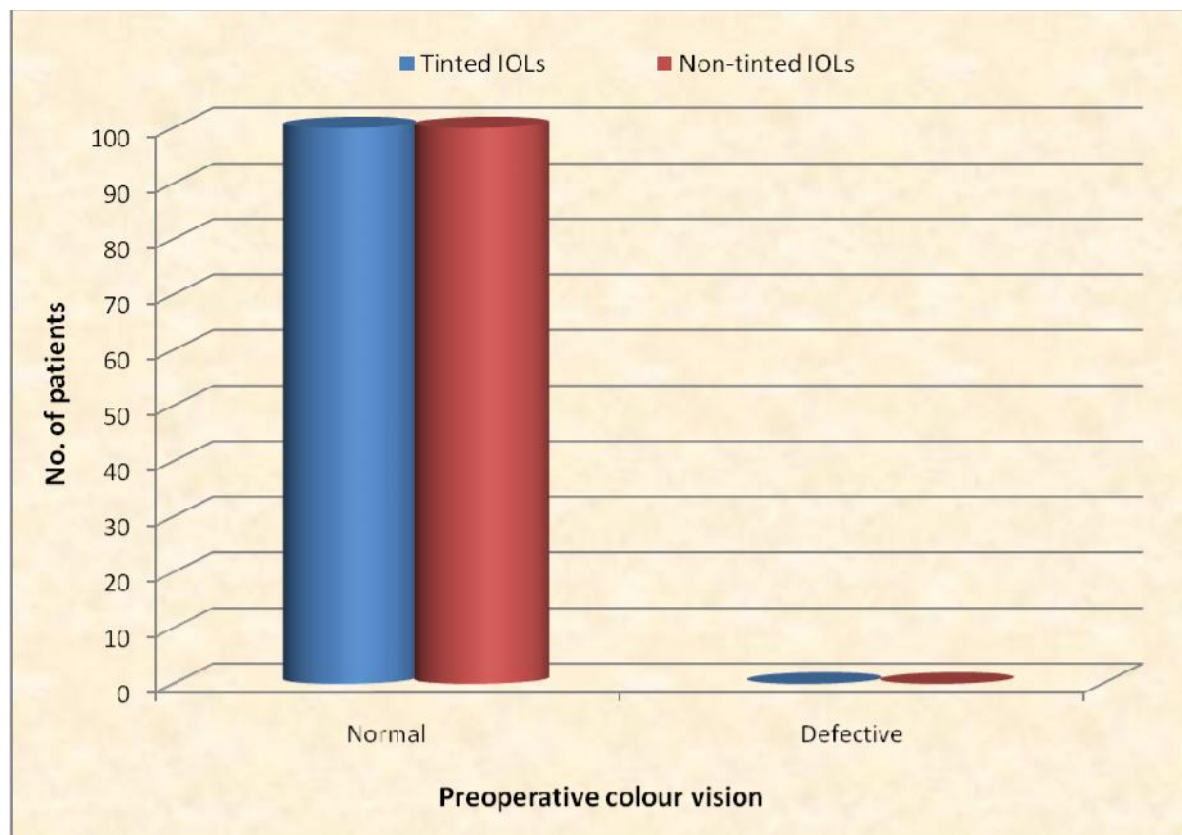
Preoperative colour vision	Number of patients	
	Tinted IOLs	Non-tinted IOLs

	(n=100)	(n=100)
Normal	100	100
Defective	0	0
p-value	0.104	

236

237

Fig.



238

239 Preoperative contrast sensitivity

240 Perusal of the data presented in Table 9 revealed that the two groups were non-significantly
 241 associated with one another (p-value = 0.221). In tinted group maximum number of patients (48) were
 242 recorded in 0.90 – 1.65 log units range which was closely followed by 0.0 – 0.75 log units range (47
 243 patients), while minimum number of patients (5) was recorded in 1.80 – 2.25 log units range. Similarly,
 244 the maximum (54 patients) and minimum number of patients (9) with regard to contrast sensitivity
 245 were recorded in 0.0 – 0.75 log units and 1.80 – 2.25 log units, respectively

246 **Table 9: Preoperative contrast sensitivity**

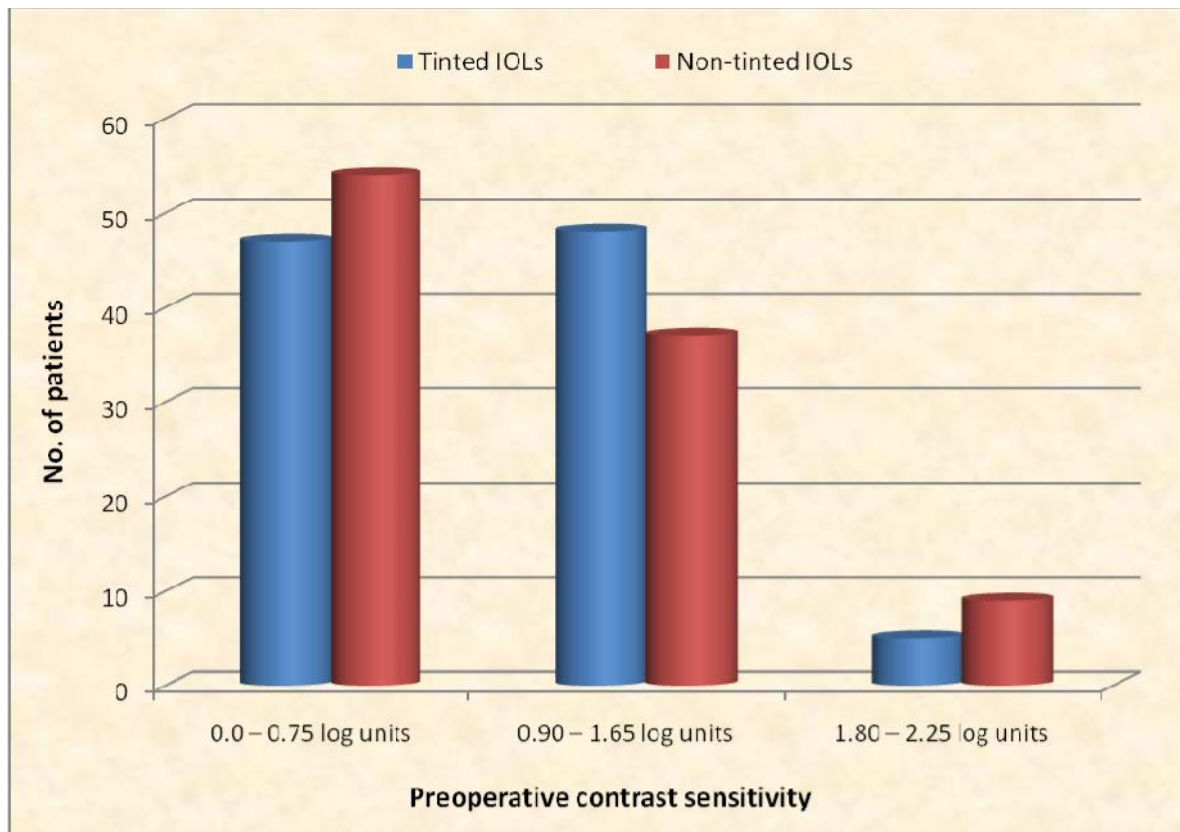
Preoperative contrast sensitivity	Number of patients	
	Tinted IOLs (n=100)	Non-tinted IOLs (n=100)
0.0 – 0.75 log units	47	54

0.90 – 1.65 log units	48	37
1.80 – 2.25 log units	5	9
p-value	0.221	

247

248

Fig.



249

250 **Post operative contrast sensitivity day 1:**

251 In the table below the maximum patients having post operative contrast sensitivity on day 1 in tinted
 252 group were in the range of (1.80-2.25 log units) and minimum below 1.05 log units similarly in the non
 253 tinted group also the maximum patients fell under the range of (1.80-2.25 log units) and minimum
 254 below 1.05 log units.

255

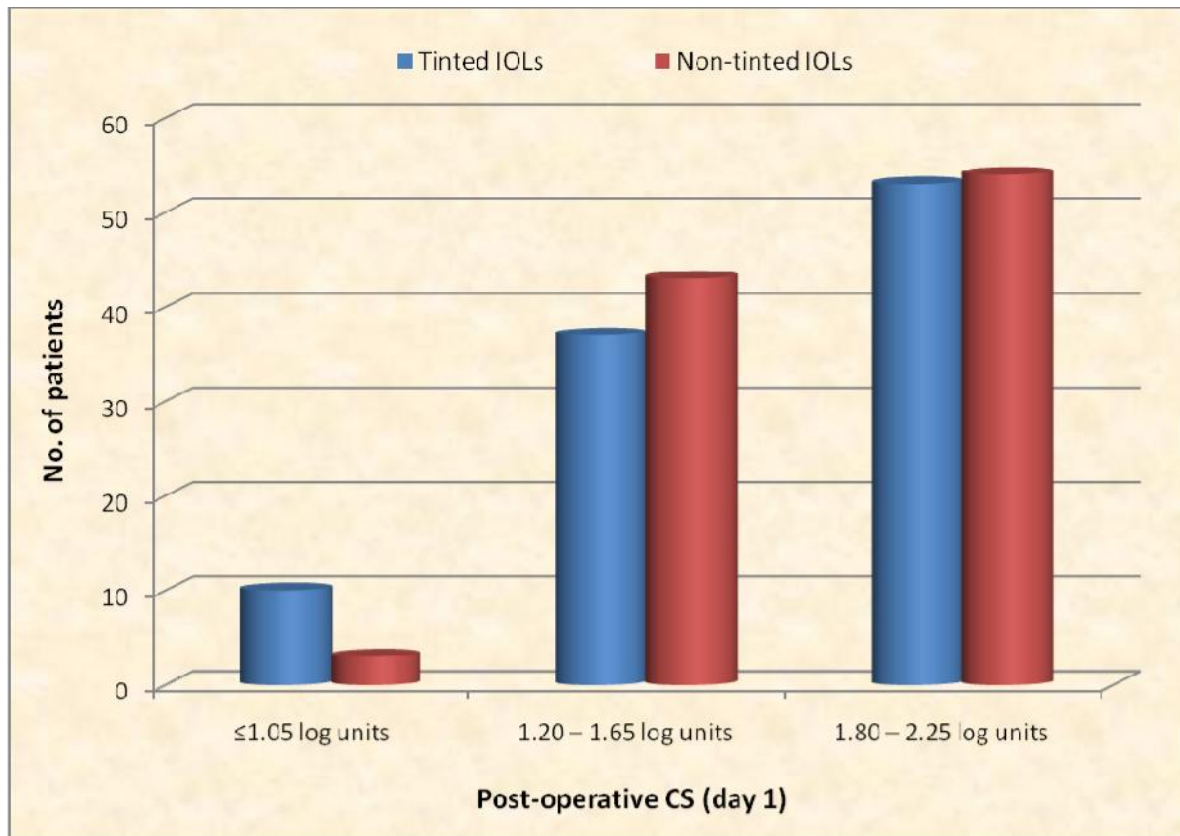
256 Table 10: Post-operative contrast sensitivity day 1

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	

257

258 Fig.



259

260

261 Post operative contrast sensitivity 2 nd week:-

262 In the table 11 below the maximum patients having post operative contrast sensitivity on 2 nd week in
 263 tinted group were in the range of (1.80-2.25 log units) and minimum below 1.05 log units similarly in
 264 the non tinted group also the maximum patients fell under the range of (1.80-2.25 log units) and
 265 minimum below 1.05 log units.

266

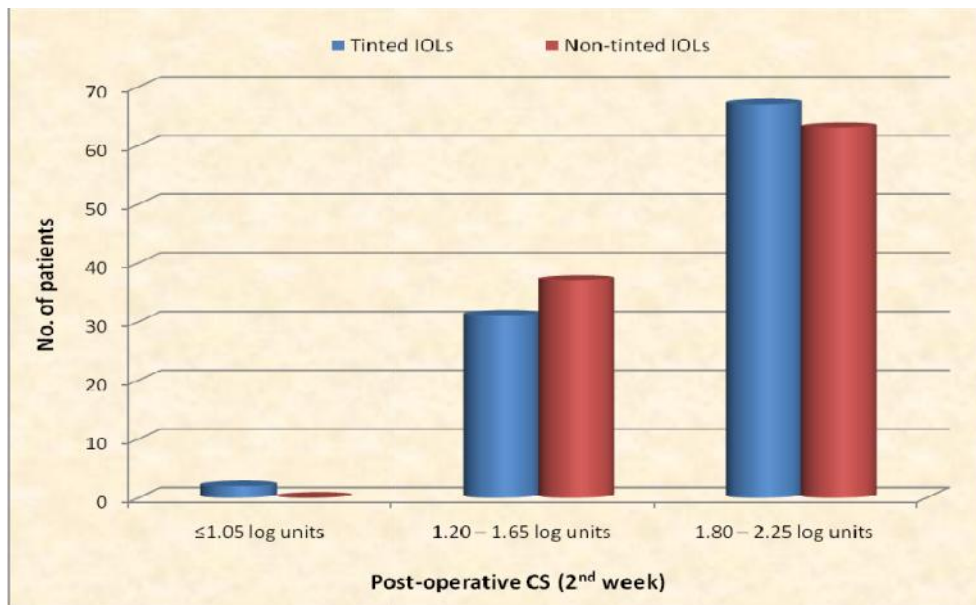
267 Table 11: Post-operative contrast sensitivity 2nd week

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	

268

269 Fig.



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271

272 **Post operative contrast sensitivity 3rd month**

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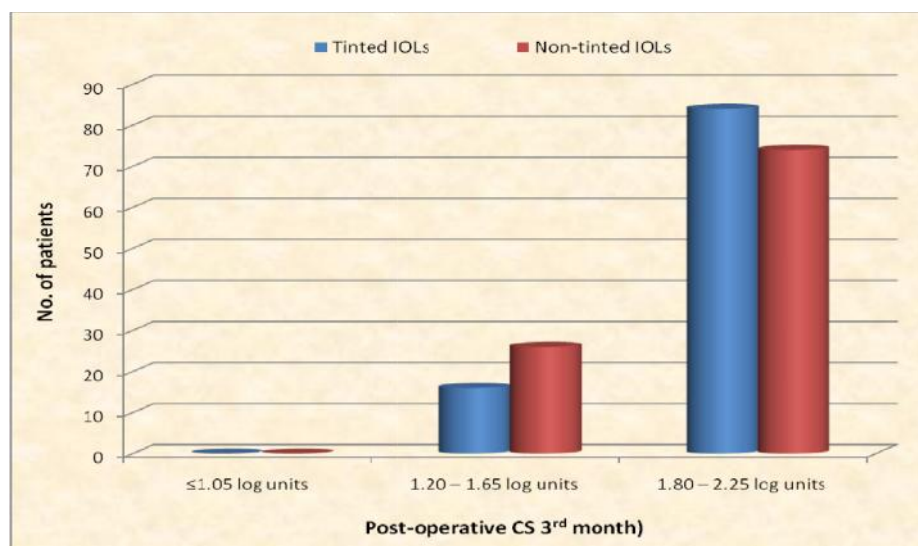
274 In the table below the maximum patients having post operative contrast sensitivity on 3rd month in
 275 tinted group were in the range of (1.80-2.25 log units) and minimum below 1.05 log units similarly in
 276 the non tinted group also the maximum patients fell under the range of (1.80-2.25 log units) and
 277 minimum below 1.05 log units.

278 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	

279

280 Fig.



281

282

283 Change between contrast sensitivity (day1) and contrast sensitivity(3 rd month)

284 The data with regard to change between contrast sensitivity (day 1) and contrast sensitivity (3rd
 285 month) is presented in Table 13 and Fig. ... perusal of the data presented in the table reveals non-
 286 significant change between the two groups, however the maximum change per cent (100.0% and
 287 100.0%) in tinted and non-tinted groups were recorded in ≤1.05 log units range, while the minimum
 288 change per cent (36.90% and 27.03%) was recorded in 1.80-2.25 log units range, respectively.

289 Table 13: Change between contrast sensitivity (day 1) and BCVA (3rd month)

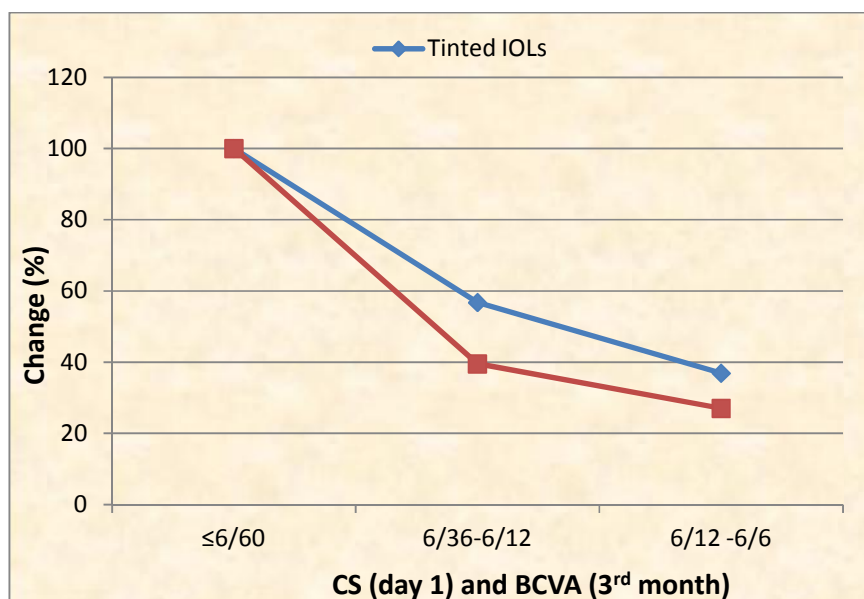
Contrast sensitivity	Number of patients					
	Tinted IOLs (n=100)			Non-tinted IOLs (n=100)		
	CS (day 1)	CS (3 rd month)	Change (%)	CS (day 1)	CS (3 rd month)	Change (%)
≤1.05 log units	10	0	100.00	3	0	100.0
1.20 – 1.65 log units	37	16	56.75	43	26	39.53
1.80 – 2.25 log units	53	84	36.90	54	74	27.03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

290

291

292

293 Fig.



DISCUSSION

AGE DISTRIBUTION

Maximum number of patients (36 and 41) in both tinted and non-tinted IOLs groups were recorded in the age group of 61-70, while minimum number of patients were recorded in the age group of >80 years, respectively. The mean age of the patients in Tinted group was 64.54 ± 11.57 years and in non-tinted group it was 66.60 ± 11.16 years. The differences between the two groups were found non-significant with p-value of 0.178. Mean age of patients reported by [11] was 70.9 ± 6.4 with range of 58-85 years for both the groups which is comparable to the present study in terms of mean age. [12] reported a mean age of 72 ± 6 years in both the groups in his study on effects of tinted IOLs on visual quality which is slightly on a higher side as compared to the present study. This can be attributed to geographical variations.

GENDER DISTRIBUTION

In the present study with regard to the gender distribution of the patients, the number of males and females in the tinted group was 52 and 48 and in the non-tinted group it was 45 and 55, respectively. Non-significant association was recorded between the two groups with p-value of 0.321

[11] reported that there were 50 females and 24 males in their study ($p=0.5$) which is statistically non significant as in the present study. [12] reported that there were 30 females and 21 males in their study which was statistically non significant. [13] reported a total of 12 males and 13 females in the tinted group and 7 females and 20 males in the non tinted group which was also statistically insignificant as in the present study.

CHANGE IN BEST CORRECTED VISUAL ACUITY

The data with regard to change between uncorrected visual acuity (day 1) and best corrected visual acuity (3rd month) in the present study shows a mean change percent of 76.17 % in tinted group and of 67.16 % in non tinted group ($p=0.101$) and reveals a non-significant change between the two groups, however the maximum change per cent (100.0% and 100.0%) in tinted and non-tinted groups were recorded in ≤6/60 range, while the minimum change per cent (52.46% and 29.82%) was recorded in 6/36-6/12 range, respectively.

323 [11] reported no significant differences between mean change in best corrected visual acuity at 1 st
324 day and 3 rd month for both tinted and non tinted group ($p=0.8$) and ($p=0.5$) respectively. These
325 results are comparable to the present study.

326 [12] reported a pre operative BCVA of $0.3 + 0.1$ logMAR for non tinted group and $0.3 + 0.2$ logMAR
327 ($p=0.23$) for tinted group. And 3 months after surgery of $0.02 + 0.1$ logMAR ($p=0.84$) for both the
328 groups. Hence there was a statistically significant change in their study. [14] found no statistically
329 significant results for change in best corrected visual acuity in their study ($p=0.1$) which is comparable
330 to the present study.

331 [13] reported no statistical difference in mean BCVA 0.01 ± 0.1 logMAR ($p=0.432$) in tinted and
332 0.02 ± 0.02 logMAR ($p=0.475$) in non tinted group. [15] also reported no significant differences in
333 change in BCVA in both the groups ($p=0.40$).

334 CHANGE IN COLOUR VISION

335 In the present study both pre and post operative colour vision remained normal in both tinted and non
336 tinted IOL groups.

337 [11] also reported no difference in pre and post operative colour vision both remaining normal which is
338 comparable to the present study. [12] also reported no difference in this parameter as it remained
339 normal in both the groups. [14] reported a better colour perception in non tinted group as compared to
340 tinted group. [15] found no difference in colour vision and it remained normal in both the groups.

341 CHANGE IN CONTRAST VISUAL ACUITY

342 The data with regard to change between contrast sensitivity (day 1) and contrast sensitivity (3rd
343 month) in the present study shows a mean percent change of 64.55 % in the tinted group and a mean
344 percent change of 33.28 % in the non tinted group ($p=0.283$) which is statistically non significant,
345 however the maximum change per cent (100.0% and 100.0%) in tinted and non-tinted groups were
346 recorded in ≤ 1.05 log units range, while the minimum change per cent (36.90% and 27.03%) was
347 recorded in 1.80-2.25 log units range, respectively.

348 [11] reported no statistically significant change in mean contrast visual acuity in both tinted and non
349 tinted group ($p=0.47$) which is comparable to the present study.

350 [12] also found no statistically significant change in contrast sensitivity in both photopic and mesopic
351 illumination conditions ($p=0.43$) and ($p=0.92$).

352 [16] found that blue filtering tinted IOLs had worse contrast sensitivity ($p=0.0004$) and foveal threshold
353 ($p=0.008$) compared to non tinted IOLs which is different to the present study. This may be because it
354 is measured at different illumination levels unlike in the present study. [14] found no statistically
355 significant difference in mean contrast visual acuity in both the groups ($p=0.42$). [15] reported no
356 significant change in contrast acuity from day 1 to 3 rd month post operative month ($p=0.2$) which is
357 comparable to the present study.

358 So the above mentioned studies regarding change in post operative contrast sensitivity are
359 comparable to our present study.

360 4. CONCLUSION

361
362 The present study concludes that even though the mean change in best corrected visual acuity and
363 contrast sensitivity is more for the patients implanted with tinted IOL but this change is statistically
364 insignificant. However, because studies have shown that short wavelength blue light has phototoxicity
365 for retinal pigment epithelial cells so the blue light absorbing tinted IOLs could prevent age related
366 macular degeneration. Therefore their use is recommended for eyes at high risk to develop ARMD
367 such as eyes with drusens or atrophy of retinal pigment epithelium in the macula. Although no
368 statistically significant effect of tinted IOLs on visual function was found in the present study.
369

370 CONSENT

371
372 A written informed consent was obtained from all patients participated in the study after explaining the
373 whole procedure and possible complications.
374

375 ETHICAL APPROVAL

376
377 All authors hereby declare that all experiments have been examined and approved by the
378 appropriate ethics committee and have therefore been performed in accordance with the ethical
379 standards laid down in the 1964 Declaration of Helsinki.
380

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