e-ISSN: 0976-822X, p-ISSN:2961-6042

Available online on http://www.ijcpr.com/

International Journal of Current Pharmaceutical Review and Research 2024; 16(5); 487-492

Original Research Article

Investigate the Visual Functions in Patients with Age-Related Cataract Who Have Had Phacoemulsification Surgery, Comparing the Outcomes of Multifocal and Mono Focal Intraocular Lenses

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Received: 08-03-2024 / Revised: 13-04-2024 / Accepted: 25-05-2024
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Conflict of interest: Nil

Abstract

Aim: Investigate the visual functions in patients with age-related cataract who have had phacoemulsification surgery, comparing the outcomes of multifocal and mono focal intraocular lenses.

Materials and Methods: This study was conducted in the department of Ophthalmology, Patna medical college and hospital, Patna, Bihar, India for 6 months. 40 eyes of patients reporting to outpatient services of our tertiary eye care health institute, with decreased vision due to age related cataract for cataract surgery and intraocular lens implantation. Patients between 40-80 years reporting with cataract (less than grade 3), managed by phacoemulsification and willing for implantation of multifocal IOLs and having astigmatism less than 1.5D cylinder were included in the study. Post-operative exclusion criteria included persistent corneal oedema, excessive post operative inflammation and absent fundal glow. Detailed pre operative history regarding age, sex, type of cataract, history of trauma and any associated ocular or systemic diseases having effect on vision was recorded.

Results: On post-operative day 1, the UCVA was found to be 6/12 in 6 patients (30%), 6/9 in 4 patients (20%), 6/18 in 4 patients (20%), 6/24 in 4 patients (20%) while 6/6 in 2 patients (10%) while in mono focal it was 6/9 in 8 patients (40%) and 6/12 in 7 patients (35%) while 6/18 in 3 patients (15%) and 6/6 in 2 patients (10%). At the last follow-up, there were 9 patients (45%) with 6/9 vision, 7 patients (35%) with 6/12, and 4 patients with 6/6 vision while in mono focal group 10 patients (50%) had 6/12 vision, 8 patients (40%) had 6/9 vision while only 2 patients (10%) had 6/6 vision (Table 1). However, both at first post-operative day and last follow-up the two group's visual acuity was found to be statistically insignificant with p-value less than 0.05. Post-operatively at day 1, 5 patients (25%) had visual acuity of N10, also the same number had N18 visual acuity while 3 patients (15%) had N6 and N8 visual acuity, only 2 patients had N12 visual acuity while 1 patient (5%) had N24 and N36, but later at the last follow-up there were 7 patients (35%) with visual acuity N6, 7 patients (35%) with N8, 3 patients (15%) with N12, 2 patients (10%) with N10 and only 1 patient (5%) with N18 visual acuity, thus signifying an overall improvement in visual acuity with the course of time.

Conclusion: Thus, our results demonstrate that a new generation, refractive-diffractive design, multifocal IOL decreases the spectacle dependence of patients without compromising the subjective visual functions.

Keywords: Visual functions, Cataract Phacoemulsification surgery, Multifocal Mono focal intraocular lenses.

Introduction

Phacoemulsification, a widely utilized technique for cataract extraction, involves the emulsification and removal of the opacified crystalline lens, followed by the implantation of an intraocular lens (IOL). The selection of an appropriate IOL is pivotal to restoring optimal visual function post-surgery. Among the available options, multifocal and mono focal IOLs are commonly considered, each offering distinct advantages and potential limitations regarding postoperative visual outcomes. [1-3] Mono focal IOLs, designed to provide clear vision at a single focal distance (typically distance vision), have been the standard choice for many years. Patients with mono focal IOLs often require

additional spectacles for near or intermediate tasks, such as reading or computer work. Despite this limitation, mono focal IOLs are favoured for their simplicity and predictability, providing high-quality distance vision with minimal photic phenomena. Multifocal IOLs, on the other hand, are engineered to distribute light across multiple focal points, enabling patients to achieve a broader range of vision, including near, intermediate, and distance. This design aims to reduce or eliminate the need for spectacles, enhancing overall visual independence. However, multifocal IOLs are associated with unique challenges, including potential compromises in contrast sensitivity and the induction of photic phenomena such as halos and glare . [4-8] The assessment of visual functions following the implantation of these IOLs encompasses several parameters, including visual acuity, contrast sensitivity, and patient-reported visual disturbances. Studies have demonstrated that multifocal IOLs generally provide superior uncorrected near and intermediate visual acuity compared to mono focal IOLs, thereby reducing dependence on corrective lenses for these distances. However, this benefit may come at the expense of reduced contrast sensitivity, particularly under low-light conditions, and an increased incidence of photic phenomena. Patient satisfaction and quality of life are critical factors in evaluating the success of cataract surgery and IOL choice. Surveys and questionnaires, such as the Visual Function Index (VF-14) and the National Eye Institute Visual Function Questionnaire (NEI VFQ-25), are commonly employed to gauge these subjective outcomes. Multifocal IOL recipients often report higher satisfaction with their ability to perform near and intermediate tasks without spectacles, although some may experience dissatisfaction due to visual disturbances. In recent years, advancements in multifocal IOL design, including extended depth of focus (EDOF) IOLs, have sought to mitigate some of the limitations of traditional multifocal lenses. EDOF IOLs aim to provide a continuous range of vision with fewer photic phenomena, thereby enhancing visual quality and patient satisfaction . Ultimately, the choice between multifocal and mono focal IOLs should be individualized, taking into account the patient's visual needs, lifestyle, and tolerance for potential visual disturbances. Comprehensive preoperative counselling and a thorough evaluation of ocular health are essential to optimizing outcomes and patient satisfaction. [9-12]

Materials and Methods

This study was conducted in the department of Ophthalmology, Patna medical college and hospital, Patna, Bihar, India for 6 months. 40 eyes of patients reporting to outpatient services of our tertiary eye care health institute, with decreased vision due to age related cataract for cataract surgery and intraocular lens implantation. Patients between 40-80 years reporting with cataract (less than grade 3), managed by phacoemulsification and willing for implantation of multifocal IOLs and having astigmatism less than 1.5D cylinder were included in the study. The other inclusion criteria was that they should have the ability to understand the type questionnaire. Patients with age less than 40 years, professional drivers or mentally retarded, having a pre-cataract myopia or hyperopia of 3D or more, history of amblyopia, fundus abnormalities that could cause significant vision impairment, previous surgical intraocular procedures and ocular co-morbidities, such as previous trauma, glaucoma, diabetic retinopathy, pseudo exfoliation syndrome, chronic uveitis and corneal opacities, were all excluded from the study. Intra operative exclusion criteria included iris pupillary trauma, vitreous loss and inability to place the IOL in the capsular bag. Post-operative exclusion criteria included persistent corneal oedema, excessive post operative inflammation and absent fundal glow. Detailed pre operative history regarding age, sex, type of cataract, history of trauma and any associated ocular or systemic diseases having effect on vision was recorded. Patients were subjected to complete ocular examination which included visual acuity on Snellen's chart for distant, intermediate and near vision, refraction for recording BCVA, applanation tonometry, slit lamp examination with both dilated and un dilated pupil, fundus examination using indirect ophthalmoscopy and slit lamp bio microcopy, keratometry using Bausch and Laumb keratometry, biometry and lens power calculation using SRK-T and SRK-II formula was done. Informed and written consent was taken and patients were divided into two groups of 20 each. Group A underwent phacoemulsification with multifocal [refractive-diffractive design] IOL implantation. Group B underwent phacoemulsification with mono focal IOL implantation. All patients underwent phacoemulsification with IOL implantation performed by a single surgeon and only aspheric of IOLs were implanted in both groups to ensure proper matching of the groups. Patients were followed up on post-operative days 1,7,30,60 and 90 and evaluated for unaided distance, intermediate and near visual acuity. Contrast sensitivity was recorded on the Pelli Robson chart. Glare/haloes were reported using the type questionnaire. The 'glare, haloes and rings around lights' were quantified into 0-4 as per the type questionnaire, where 'not at all' scores 0, 'a little bit' scores 1, 'moderately' scores 2, 'quite a bit' scores 3 and extremely scores 4. [13,14]

Results

The mean age of the study population in group 1 was 59.6±8.39year and group 2 was 64.75±8.39 year.

The majority of the patients in both the groups were between 56-65 years of age (group 1-40.0% and group 2-48.0%). In multifocal group (group -1), the number of female patients were more as compared to male patients, thus difference among the two groups was not statistically significant, the p-value being 0.114(>0.05). On post-operative day 1, the UCVA was found to be 6/12 in 6 patients (30%), 6/9 in 4 patients (20%), 6/18 in 4 patients (20%), 6/24 in 4 patients (20%) while 6/6 in 2 patients (10%) while in mono focal it was 6/9 in 8 patients (40%) and 6/12 in 7 patients (35%) while 6/18 in 3 patients (15%) and 6/6 in 2 patients (10%). At the last follow-up, there were 9 patients (45%) with 6/9 vision, 7 patients (35%) with 6/12, and 4 patients with 6/6 vision while in mono focal group 10 patients (50%) had 6/12 vision, 8 patients (40%) had 6/9 vision while only 2 patients (10%) had 6/6 vision (Table 1). However, both at first post-operative day and last follow-up the two group's visual acuity was found to be statistically insignificant with p-value less than 0.05. Post-operatively at day 1, 5 patients (25%) had visual acuity of N10, also the same number had N18 visual acuity while 3 patients (15%) had N6 and N8 visual acuity, only 2 patients had N12 visual acuity while 1 patient (5%) had N24 and N36, but later at the last follow-up there were 7 patients (35%) with visual acuity N6, 7 patients (35%) with N8, 3 patients (15%) with N12, 2 patients (10%) with N10 and only 1 patient (5%) with N18 visual acuity, thus signifying an overall improvement in visual acuity with the course of time. (Table 2). However, there was no significant change in the near visual acuity in the mono focal group with 15 patients (75%) with N18 visual acuity, 3 patients (15%) with N12 and 1 patient (5%) with N18 visual acuity, thus showing there was paramount statistical significance between the groups with p-value higher than 0.05. Post-operatively at day 1, there were 6 patients (30%) with N18 intermediate visual acuity, 5 patients (25%) with N36 visual acuity, 3 patients (15%) with N24 visual acuity, 2 patients (10%) with N8 and N10 visual acuity and only 1 patient (5%) with N6 and N12 visual acuity but later at the last follow-up 5 patients (25%) had N6 and N18 visual acuity each while 4 patients (20%) had visual acuity N8 and N12 and only 2 patients (10%) had N10 visual acuity, thus showing progressive improvement in visual acuity.(Table 3). However, in mono focal group at last follow-up 15 patients (75%) had N24 visual acuity, 4 patients (20%) had N18 visual acuity and only 1 patient with N10 visual acuity. Thus, showing there was paramount statistical significance between the groups with p-value higher than 0.05. Post-operatively at day 1, there were 16 patients (75%) with no complaint of glare and haloes and only 4 patients (25%) with little complaint of glare and haloes while in the mono focal group there were no patients with any complaint of glare and haloes and at the last follow-up there were no patients in any group with the complaint of glare and haloes.(Table 4) In the multifocal group (Group 1), on day 1 the mean contrast sensitivity as assessed by the Pelli-Robson chart was 1.29±0.41 which was lower as compared to the mean contrast sensitivity in the mono focal group (Group 2) which was 2.20±0.07, thus, the difference between the groups was statistically significant (p=0.001). On further follow- up, there was a slight improvement in contrast sensitivity in the multifocal group, with mean contrast sensitivity being 1.59±0.38 on day 7, 1.92±0.36 on day 30, 1.99±0.27 on day 60 and 2.04±0.23 on day 90. The mean contrast sensitivity in the multifocal group remained the same being 2.20±0.07 on day 90. (Table 5). On the last follow-up i.e. day 90, the difference among the two groups was statistically significant (p=0.007), thus, the two groups were different in terms of contrast sensitivity but the mean of contrast sensitivity in the multifocal group were in the normal range of contrast sensitivity as measured by the Pelli-robson chart.

Table 1: Visual Acuity on Post-Operative Day 1 and at Last Follow-Up

Group	Visual Acuity	Post-Operative Day 1 (n, %)	Last Follow-Up (n, %)
Multifocal	6/6	2 (10%)	4 (20%)
	6/9	4 (20%)	9 (45%)
	6/12	6 (30%)	7 (35%)
	6/18	4 (20%)	0 (0%)
	6/24	4 (20%)	0 (0%)
Mono focal	6/6	2 (10%)	2 (10%)
	6/9	8 (40%)	8 (40%)
	6/12	7 (35%)	10 (50%)
	6/18	3 (15%)	0 (0%)

Table 2: Near Visual Acuity on Post-Operative Day 1 and at Last Follow-Up

Group	Near Visual Acuity	Post-Operative Day 1 (n, %)	Last Follow-Up (n, %)
Multifocal	N6	3 (15%)	7 (35%)
	N8	3 (15%)	7 (35%)
	N10	2 (10%)	2 (10%)
	N12	2 (10%)	3 (15%)
	N18	5 (25%)	1 (5%)
	N24	1 (5%)	0 (0%)
	N36	1 (5%)	0 (0%)
Mono focal	N12	3 (15%)	3 (15%)
	N18	15 (75%)	15 (75%)
		1 (5%)	1 (5%)

Table 3: Intermediate Visual Acuity on Post-Operative Day 1 and at Last Follow-Up

Group	Intermediate Visual Acuity	Post-Operative Day 1 (n, %)	Last Follow-Up (n, %)
Multifocal	N6	1 (5%)	5 (25%)
	N8	2 (10%)	4 (20%)
	N10	2 (10%)	2 (10%)
	N12	1 (5%)	4 (20%)
	N18	6 (30%)	5 (25%)
	N24	3 (15%)	0 (0%)
	N36	5 (25%)	0 (0%)
Mono focal	N10	1 (5%)	1 (5%)
	N18	4 (20%)	4 (20%)
	N24	15 (75%)	15 (75%)

Table 4: Contrast Sensitivity (Pelli-Robson Chart)

Time Point	Multifocal Group (Mean ± SD)	Mono focal Group (Mean ± SD)	p-value
Day 1	1.29 ± 0.41	2.20 ± 0.07	0.001
Day 7	1.59 ± 0.38	2.20 ± 0.07	0.001
Day 30	1.92 ± 0.36	2.20 ± 0.07	0.001
Day 60	1.99 ± 0.27	2.20 ± 0.07	0.001
Day 90	2.04 ± 0.23	2.20 ± 0.07	0.007

Discussion

In our study, on last day of follow up(day 90), in the multifocal group 65% patients had uncorrected distance visual acuity(UCDVA) of 6/9 or better while 35%had 6/12, while in the monofocal group 50%had UCDVA 6/9 or better while 50% had 6/12. In 2015, a similar study was conducted in India by Kumare and colleagues. They also found no statistical difference between two groups. [15] Study conducted by Yamauchi and colleagues who compared Teknis mono focal and multifocal IOLs also found no difference in UCDVA of two groups. [16] Cionni et al. in 2009 also observed similar results. [17] At the end of our study, multifocal group had 35% patients with near vision N6 and 35% with N8 near visual acuity while in mono focal group 75% patients had N18 and 15% had N12. Thus, difference in uncorrected near visual acuity between the two groups was found to be statistically significant (p=0.001) at the end of 3 months. Harman et al. in 2006 concluded that UNVA in multifocal in 1CU and Array groups (N6) was better than mono focal(N10). It was found to be statistically significant (p<0.001). [18] Alio et al. also concluded that multifocal IOL group had significantly better uncorrected near acuity and DCNVA (Jaeger [J] 5 versus J2) (both P<.01). [19] Also a clinical trial by Cillino et al. observed similar results, UCNVA was 20/50 in the mono focal IOL group, compared with 20/32 or better in the multifocal IOL groups (P<0.0005). [20] At the last follow-up, i.e., day 90, the multifocal group had 25% (5 patients) with N6 and 20% (4 patients) with N8 un-corrected intermediate visual acuity (UIVA), the rest 55% (11 patients) with N18 or better UIVA 75% (15 patients) had N24 and 20% (4UIVAThe difference in the groups was statistically significant (p= 0.001). Our results are well comparable to the results of Yamauchi et al, Cillino et al. and Cionni et al. who also observed that statistically significant differences were found favoring the multifocal group for uncorrected intermediate visual acuity. [16,17,20] In our study, the contrast sensitivity log values as measured by the Pelli-Robson chart were 2.04+/-0.23 in the multifocal group and 2.20+/-0.07 in the mono focal group, the difference in two groups being statistically significant(p=0.007).But nevertheless the values of contrast sensitivity were well within normal range as assessed by Mantyjarvi

et al. in 2009. [21] In 2006, Harman et al. conducted a study to compare the binocular near vision performance in patients implanted with the 1CU accommodating intraocular lens(IOL) with a multifocal and mono focal IOL. They observed no significant difference in mean contrast sensitivity ($p<0.05$). [18] In 2005, Alio and colleagues compared multifocal and mono focal IOLs and found no significant difference in contrast sensitivity. [19] In a randomized control trial by Cilino et al. in 2008, it was concluded that new generation, diffractive, pupil independent multifocal IOLs provide better near vision, equivalent intermediate vision, less unwanted photic phenomenon and greater spectacle independence than either mono focal or refractive multifocal IOL thus refractive multifocal IOL group exhibited lower contrast sensitivities at 3 cycles/degree($p=0.038$). 20 In study by Cionni et al. in 2009, even though it was observed that contrast sensitivity was significantly better in mono focal patients yet they concluded that multifocal IOLs provide high patient satisfaction, excellent functional vision and high rates of spectacle freedom. [17] In our study, on the first day of follow up, on assessing glare and haloes using type questionnaire, there were 16 patients (75%)with a score of 0 while 4 patients (25%) with a score of 1, signifying very little bother from glare and haloes and the p value being 0.106. At the last follow up there were no patients with complaints of glare and haloes in either group. This observation in our study varied from the scores observed by Leyland et al., who conducted a study in 2002, to evaluate the functional effect of bilateral implantation of two different IOLs compared with the standard mono focal IOL and found that mono focal and bifocal scores were 0(0-2) and 0(0-3) respectively, while the multifocal group scored slightly worse, with 1(0-4) equating to a median score of a 'a little bit bothered'($p=0.01$) at a follow up of 2 months, which was statistically significant ($p<0.05$). [22] In our study, on initial follow ups, few patients reported bother from glare and haloes but on subsequent visits they reported improvement. This might be explained as most patients being housewives adapted well to discomfort, since they had no cumbersome work, like driving, to perform. In 2015, a similar study was conducted in India by Kumare and colleagues who observed that in the multifocal IOL group 10% reported of halos as compared to 7.5% by mono focal IOL group. The chi square value comes out to be 0.0611 and p value is 0.8048(not significant). In the multifocal IOL and mono focal IOL group the complaint of glare was reported by 12.5% and 10% patients respectively($p=0.6445$). Thus, there was no significant difference in terms of haloes and glare. [15] In the present study, the visual performance of multifocal IOLs and mono focal IOLs composed of the same optic material and design was compared. The mean un-corrected distance visual acuity (UDVA) was almost similar in both the groups. (UNVA) and uncorrected intermediate visual acuity (UIVA) was significantly better and the rate of spectacle dependence was significantly lower in the multifocal group. The contrast sensitivity was better in the mono focal group, however, both groups had values of contrast sensitivity lying in t'glare, haloes and rings around lights' quantified into 0-4 as per the type questionnaire, exhibited no significant differences between the two groups.

Conclusion

Thus, our results demonstrate that a new generation, refractive-diffractive design, muti focal IOL decreases the spectacle dependence of patients without compromising the subjective visual functions.

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