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Clinical Outcomes and Visual Performance of Multifocal Intraocular Lenses Following Phacoemulsification: A Retrospective Study

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ABSTRACT

Background: Cataract remains the leading cause of blindness globally, and phacoemulsification surgery has emerged as a standard treatment. Monofocal intraocular lenses (IOLs) provide good distance vision but do not accommodate near and intermediate distances, necessitating spectacle use. Multifocal IOLs offer pseudo-accommodation for enhanced visual function but may be associated with photopic symptoms. This study assesses the clinical effectiveness of multifocal IOL implantation, evaluating visual outcomes, spectacle independence, and photopic symptoms.

Data & Methods: A retrospective observational study was conducted at a tertiary eye care center over two years. Patients aged 18 and above with <1.00 D astigmatism who underwent phacoemulsification with multifocal IOL implantation were included. Patients with corneal opacities, prior ocular surgery, or systemic autoimmune conditions were excluded. Uncorrected and best-corrected visual acuity (UCVA, BCVA), near visual acuity, photopic symptoms, and contrast sensitivity were recorded preoperatively and at one-month follow-up. Data were analyzed using SPSS version 24.

Results: A total of 40 patients (mean age: 51.31 years; 55% males, 45% females) were included. At one-month follow-up, distance BCVA was 6/6 in 75% of patients, and 90% achieved uncorrected near VA of N6. Only 10% of patients had residual refractive error. No patients reported photopic symptoms. The mean contrast sensitivity score was 1.22 ± 0.31.

Conclusion: Multifocal IOL implantation provides effective near and distance vision with high spectacle independence. Proper preoperative counseling regarding patient expectations is crucial to achieving satisfactory outcomes. Further prospective studies with larger sample sizes and longer follow-up are recommended.

Keywords: Cataract surgery, IOL, mono-focal, multifocal. dysphotopsia

INTRODUCTION

Despite these advantages, multifocal IOLs have been associated with photopic symptoms such as glare, halos, and contrast sensitivity reduction, which can lead to patient dissatisfaction.[1] Modern designs aim to optimize light distribution and minimize these issues. Cataract surgery with intraocular lens (IOL) implantation is the most effective method for restoring vision in cataract patients.[2] Removal of the opacified lens and its replacement with artificial IOL is the standard treatment procedure. Phacoemulsification procedure to remove the lens and its replacement with artificial IOL has become one of the most effective and modern surgical approaches to deal with the most common blinding condition.[1,2] While monofocal IOLs provide good distance vision, they do not accommodate near and intermediate vision, often necessitating spectacles. Multifocal IOLs have been developed to provide a broader range of vision, offering pseudo-accommodation for near, intermediate, and distance tasks. While mono-focal IOLs provide good vision at a fixed distance, either a distant or near vision but do not provide the ability to accommodate for near, intermediate or distant vision as done by the natural crystalline lens. Because of this limited range of vision, patients receiving mono-focal IOLs frequently require spectacles to complete near and intermediate vision tasks.[3]

Multifocal IOLs were developed to provide patients with pseudo accommodation including full distance visual acuity and an increased depth of focus. With proper IOL power calculation, a depth of focus of approximately 3 diopters would provide both distance and near vision without the need for spectacles. Multifocal IOLs are associated with higher rates of spectacle independence than mono-focal IOLs, but are more frequently associated with photopic symptoms and reduced contrast sensitivity.[4] Photopic symptoms such as glare, starbursts, and halos can be bothersome to some patients and make tasks such as nighttime driving or reading in low light difficult contributing to patient dissatisfaction with their IOLs.[5]

There are several types of mono-focal IOLs in the market. But there is a new generation of IOLs which are multifocal. iDIFF Plus is a brand of this new generation refractive-diffractive presbyopic IOL with an increasing step height and diffractive pattern combined with increased step angulation between transition zones, resulting in superior optical quality for both distance and near vision.[6] The design has higher Modulation Transfer Function value (MTF value) which enables a balanced distribution of light and increases contrast sensitivity in all lighting conditions and reduces the effect of scattered light independent to pupillary size. Visual performance is unaffected by optic misalignment or pupil

decentration. It reduces the scattering of light and halos through slanted transition zones.[7]

The purpose of this retrospective study was to assess the effectiveness of refractive-diffractive multifocal IOLs in providing distance and near vision, spectacle independence, and reporting patient's visual photopic symptoms.

DATA & METHODS

This was a retrospective observational study conducted at a tertiary eye care center for a period of two years. The inclusion criteria comprised patients aged 18 years and above with astigmatism of less than 1.00 Diopter (D). Patients meeting these criteria and expressing a desire for spectacle-independent were included in the study. Patients with optical opacities or other pathology on slit lamp, previous corneal surgery, history of ocular trauma, previous intraocular surgery, severe dry eye, corneal disease, collagen vascular disease or other autoimmune disease were excluded from the study.

Medical records of the patients who had undergone phacoemulsification surgery with the implantation of multifocal IOLs were reviewed. Patients were assessed for the presence of photopic symptoms including glare, halos, or starbursts. Ocular examinations were done using a Topcon SL-D7 Slit lamp with detailed assessments of corneal clarity, anterior chamber depth and reactions, pupil size and light reflex, presence of posterior capsular opacity, position of the lens and any abnormality on the lens surface.

Visual acuity (VA) measurements were recorded preoperatively and postoperatively. Uncorrected pre-operative VA, uncorrected VA at the time of discharge, and one month's uncorrected and best-corrected post-operative VA was measured using a self-illuminated Snellen Vision Chart. Near vision was assessed using Jaeger near vision chart at normal reading distance, both uncorrected and best-corrected near vision were recorded. The refractive status of each patient was noted. Photopic symptoms including glare, halos, starbursts, and diplopia when present were also noted. Posterior Capsular Opacification (PCO) formation was graded using the WHO Posterior Subcapsular Grading System and contrast sensitivity was assessed using the Pelli-Robson Contrast Sensitivity Chart. The patients who did not attend follow-up visits were excluded from this study.

Ethical approval was obtained from the Institutional Review Board (IRB) of the tertiary eye care center before initiating the study. As this was a retrospective study, informed consent was waived; however, patient confidentiality was strictly maintained by anonymizing all data. No personally identifiable information was disclosed or used in the study. Statistical analysis was performed using the SPSS (Statistical Package for the Social Sciences) Version 16 (IBM Corp., Armonk, NY, USA). Descriptive statistics including mean, median, and standard deviation were calculated using the software. The mean values of subgroups were evaluated to determine the statistical significance and variability. A p-value less than 0.05 was assumed statistical significance.

RESULTS

A total of 40 patients who met the eligibility criteria and underwent phacoemulsification with multifocal intraocular lens implantation were included in the study. The mean age of the participants was 51.31 years. The largest proportion of patients [25 (63%)] belonged to the 61-70 age group, followed by 6 patients (15%) in the 51-60 age group, 5 patients (12%) in the 41-50 age group, and 4 patients (10%) in the 31-40 age group. Regarding gender distribution, 22 patients (55%) were male, while 18 patients (45%) were female (Figures 1).

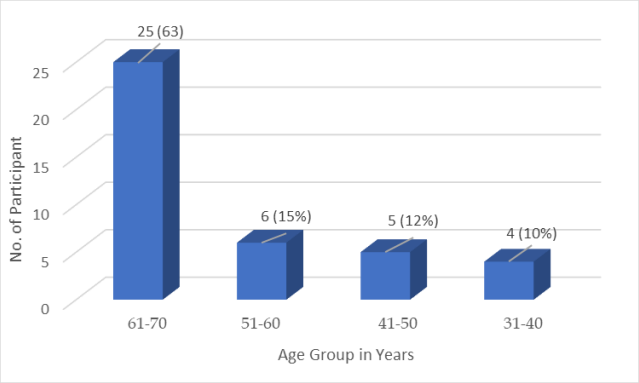

Figure 1: Age-wise distribution of the patients

Uncorrected distance pre-op visual acuity

At the time of presentation, 18 patients (45%) had an uncorrected visual acuity (UCVA) of less than 6/60, classified as economic blindness. Additionally, 15 patients (27.5%) exhibited UCVA in the range of 6/18 to 6/60, while 7 patients (17.5%) had a UCVA of 6/12.

Similarly, On the first postoperative day (at discharge), UCVA improved significantly, with 37 patients (92.5%) achieving a visual acuity of 6/6 to 6/9, and 3 patients (7.5%) attaining 6/12. At the one-month follow-up, UCVA remained stable, with 33 patients (82.5%) maintaining a visual acuity of 6/6 to 6/9, 4 patients (10%) demonstrating a UCVA of 6/12, and 3 patients (7.5%) presenting with a UCVA of 6/18 (Table 1).

Table 1: Distance uncorrected pre op, day one and follow up Visual Acuity

Snellen's VA	Pre-op UCVA	Post-op Day 1 UCVA	Post-op Day 30 UCVA
6/6	– – –	16 (40.0%)	20 (50.0%)
6/9	– – –	21 (52.5.%)	13 (32.5%)
6/12	7 (17.5%)	3 (7.5%)	4 (10.0%)
6/18	4 (10.0%)	– – – – –	3 (7.5%)
6/24	6 (15.0%)	– – – – –	– – – – -
6/36	2 (5.0%)	– – – – –	– – – – -
6/60	3 (7.5%)	– – – – –	– – – – -
<6/60	18 (45.0%)	– – – – –	– – – – -

Distance Best Corrected Visual Acuity

The mean preoperative best-corrected visual acuity (BCVA) was logMAR 0.69, which significantly improved to logMAR 0.04 at the one-month postoperative follow-up. A total of 38 out of 40 patients (95%) achieved a BCVA of 6/9 or better, while only 2 patients (5%) had a BCVA of 6/12. Prior to surgery, 18 patients (45%) had a BCVA worse than 6/60, and 11 patients (27.5%) exhibited a BCVA between 6/24 and 6/60 (Table 2).

Table 2: Distance best corrected visual acuity

Snellen's BCVA	Pre-operative BCVA	Post-op 1-month BCVA
6/6	– – – –	20 (50.0%)
6/9	4(10.0%)	18 (45.0%)
6/12	7(17.5%)	2 (5.0%)
6/18		– – – –-
6/24	6(15.0%)	– – – –-
6/36	2 (5.0%)	– – – –
6/60	3 (7.5%)	– – – –-
<6/60	18 (45.0%)	– – – –

Uncorrected near visual acuity

Preoperatively, uncorrected near visual acuity (UCNVA) was N36 in 17 patients (42.5%), N12-N28 in 11 patients (27.5%), N8-N10 in 10 patients (25%), and N8 in 8 patients (20%). At the one-month postoperative follow-up, UCNVA showed significant improvement, with 36 patients (90%) achieving N6, 3 patients (7.5%) achieving N8, and 1 patient (2.5%) achieving N10 (Table 3).

Table 3: Uncorrected near vision

Near Vision	Pre-op UCVA	Post-op day 1 UCVA	1 Month Post-Op UCVA
N6	————-	37 (92.5.0%)	36 (90.0%)
N8	8 (20.0%)	2 (5.0%)	3 (7.5%)
N10	4 (10.0%)	1(2.5%)	1(2.5%)
N12	6 (15.0%)		
N18	3 (7.5%)		————-
N28	2 (5.0%)	————	————-
N36	17 (42.5%)	————	————-

Best Corrected Near Vision

At the one-month postoperative follow-up, best-corrected near visual acuity (BCNVA) was N6 in 90% of patients. Only 3 out of 40 patients required near vision correction of less than +1.5D. None of the patients reported experiencing photopic symptoms such as glare, halos, or starbursts (Table 4).

Table 4: Best corrected near vision

Near VA	Pre-operative BCNV	1-Month Post-op BCNV
N6	4 (10.0%)	36 (90.0%)
N8	8 (20.0%)	3(7.5%)
N10	3 (7.5%)	1(2.5%)
N12	4(10.0%)	– – – –-
N18	12 (30.0%)	– – – –-
N24	– – – –-	– – – –-
N36	9(22.5%)	– – – –-

Photopic symptoms and Contrast Sensitivity

None of the patients reported experiencing photopic symptoms such as dysphotopsia, glare, or halos. Contrast sensitivity was assessed at the one-month postoperative follow-up using the Pelli-Robson Contrast Sensitivity Chart, where each optotype represents 0.03 log units. The mean contrast sensitivity score was 1.22 ± 0.31, and none of the participants reported difficulties with contrast sensitivity.

DISCUSSION

This study utilized a retrospective observational design at a tertiary eye care center over two years. Patients who underwent phacoemulsification with multifocal intraocular lens implantation were assessed for visual acuity, contrast sensitivity, and photopic symptoms at baseline and at one-month follow-up. The primary goal of cataract surgery has evolved beyond merely restoring visual acuity to improving overall visual quality. The introduction of intraocular lenses (IOLs) has significantly transformed postoperative outcomes, enabling patients to achieve better vision and greater independence. Over time, advancements in IOL technology have led to the development of various lens designs, including blue-light filtering lenses, aspheric lenses, and multifocal lenses, each aimed at enhancing postoperative visual function.[4,6]

While monofocal IOLs remain the most commonly used, they primarily provide clear distance vision, necessitating the use of corrective spectacles for near tasks. In contrast, multifocal IOLs have revolutionized cataract surgery by offering improved near, intermediate, and distance vision, thereby reducing dependence on spectacles.[7] However, despite these advantages, multifocal IOLs are associated with certain optical drawbacks, including photopic symptoms such as halos, glare, and reduced contrast sensitivity.[8]

Our study sought to evaluate these visual outcomes and potential drawbacks. The mean age of participants was 51.31 years, notably younger than in previous studies by Liang et al.[9] and Maxwell et al.[10], where the mean ages were 69.7 ± 9.6 years and 68.9 years, respectively. This suggests that a younger demographic is increasingly opting for multifocal IOLs, potentially due to occupational and lifestyle considerations.

The visual acuity outcomes in our study were highly favorable. The mean preoperative best-corrected visual acuity (BCVA) was logMAR 0.69, which significantly improved to logMAR 0.04 at one month postoperatively. These results are consistent with findings from Liang et al.[9] and Chiam et al.[11], who also reported significant postoperative improvements in BCVA. Furthermore, 75% of our patients achieved a final visual acuity of 6/6, confirming the effectiveness of multifocal IOLs in restoring high-quality vision while promoting spectacle independence.

Contrast sensitivity plays a critical role in functional vision, particularly in low-light conditions. The mean contrast sensitivity in our study was 1.22 ± 0.31, which aligns with Liang et al.[9] findings of a slight reduction in contrast sensitivity postoperatively. Some studies, such as those by Cionni et al.,[13] suggest that contrast sensitivity improves over time following bilateral multifocal IOL implantation, whereas others, including Ye et al.[14] indicate that multifocal IOLs result in lower contrast sensitivity compared to monofocal IOLs. These discrepancies highlight the importance of individualized patient selection and thorough preoperative counseling to manage expectations.

Interestingly, none of the patients in our study reported experiencing photopic symptoms such as glare, halos, or dysphotopsia. This finding contrasts with previous reports that frequently document higher rates of these visual disturbances among multifocal IOL recipients.[7,9,14] The absence of photopic symptoms in our cohort may be attributed to advancements in IOL technology, careful patient selection, or surgical expertise in lens implantation techniques.

This study reinforces the effectiveness of multifocal IOLs in providing high-quality vision across multiple focal distances while minimizing dependence on spectacles. However, patient selection remains a crucial factor in ensuring optimal postoperative satisfaction. Further large-scale, prospective studies with extended follow-up periods are warranted to fully assess the long-term visual performance and patient-reported outcomes associated with multifocal IOL implantation.

Limitations: Firstly, the relatively small sample size limits the generalizability of the findings, and larger cohort studies are required to validate these results. Secondly, the retrospective study design inherently lacks randomization, making it susceptible to selection bias. A prospective, randomized controlled trial would provide more robust evidence. Lastly, the follow-up period was relatively short, preventing comprehensive assessment of long-term complications and patient satisfaction. Future studies should incorporate extended follow-up durations to better evaluate the sustained efficacy and potential drawbacks of multifocal IOL implantation.

CONCLUSION

Multifocal IOL implantation provides excellent visual outcomes, achieving both distance and near vision with high patient satisfaction and minimal photopic symptoms. However, careful patient selection and thorough preoperative counseling are essential for optimizing surgical success. Larger prospective studies should further evaluate the long-term outcomes of multifocal IOLs.

Layman summary: Cataract is a condition of visual system where there is clouding of the natural lens inside our eyers. Lens has got very important role for the proper vision because it acts like a camera lens, to focus the image of the objects in the retina. After removal of the natural lens objects images cannot be focussed in the retina.

Thus, there is need of a thick spectacle or intra ocular lens implants (IOL). The conventional IOL are mono-focal that means they either focus for the near or far objects but not for the both distances. Hence a person after cataract surgery needs additional spectacles either for the near or the distance objects depending upon the power of the IOL implants. Now multifocal IOLs are available which can focus the objects both far or near. This study is intended to study the effectiveness of the multifocal IOLs and also the side effects if any.

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