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COMPARISON OF VISUAL OUTCOMES FOLLOWINGPHACOEMULSIFICATION WITH MONOFOCAL ANDMULTIFOCAL INTRAOCULAR LENS DESIGNS: A PROSPECTIVE COMPARATIVE STUDY

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Abstract

Background: Cataract is one of the leading causes of avoidable visual impairment worldwide. Phacoemulsification with intraocular lens implantation is the standard surgical treatment for age-related cataract. Conventional monofocal intraocular lenses provide excellent distance vision but usually leave patients dependent on spectacles for near activities. Multifocal intraocular lenses are designed to provide vision at multiple distances and potentially reduce spectacle dependence, although they may be associated with photic phenomena such as glare and halos.

Aim: To compare postoperative visual outcomes, spectacle dependence and subjective visual disturbances following phacoemulsification with implantation of monofocal and multifocal intraocular lenses.

Methods: A prospective comparative study was designed involving 100 patients with age-related cataract. Patients were divided into two groups of 50 each. Group A received a monofocal intraocular lens and Group B received a multifocal intraocular lens following uncomplicated phacoemulsification. Uncorrected distance visual acuity (UDVA), corrected distance visual acuity (CDVA), uncorrected near visual acuity (UNVA), postoperative spherical equivalent, spectacle dependence, glare and halos were assessed at 1 week, 1 month, and 3 months and 6 months. Statistical analysis was performed using independent-samples t-test and chi-square test.

Results: At 6 months, the mean UDVA was 0.08 ± 0.09 logMAR in the monofocal group and 0.07 ± 0.08 logMAR in the multifocal group. The difference was not statistically significant (p=0.56). Mean

CDVA was 0.03 ± 0.05 and 0.03 ± 0.04 logMAR, respectively (p=0.84). However, UNVA was significantly better in the multifocal group (0.18 ± 0.10 vs 0.48 ± 0.15 logMAR; p<0.001). Spectacle independence was achieved by 76% of patients in the multifocal group compared with 24% in the monofocal group (p<0.001). Glare and halos were reported more frequently in the multifocal group.

Conclusion: Both monofocal and multifocal IOLs provided good postoperative distance visual acuity following phacoemulsification. Multifocal IOLs provided significantly better uncorrected near vision and greater spectacle independence but were associated with a higher frequency of glare and halos. Appropriate patient selection and counselling regarding the advantages and limitations of different IOL designs are essential.

Keywords: Cataract; phacoemulsification; monofocal IOL; multifocal IOL; visual acuity; spectacle independence; glare; halos

Introduction

Cataract remains an important cause of visual impairment, particularly among the ageing population. Modern cataract surgery aims not only to remove the opacified crystalline lens but also to provide good functional vision after surgery.

Phacoemulsification followed by implantation of an intraocular lens has become the standard approach for cataract surgery. Conventional monofocal IOLs generally provide excellent distance visual acuity but do not restore physiological accommodation. Consequently, patients commonly require spectacles for near tasks.

Multifocal IOLs were developed to provide useful vision at more than one focal distance. Clinical studies have demonstrated that multifocal IOLs can improve uncorrected near vision and reduce spectacle dependence compared with monofocal IOLs.

However, multifocality involves optical compromises. Patients may experience glare, halos, reduced contrast sensitivity and other photic phenomena. Comparative evidence has generally shown improved near vision and spectacle independence with multifocal IOLs, with increased glare and halos.

More recent IOL technologies, including enhanced monofocal and extended-depth-of-focus designs, have further expanded the range of available choices. Therefore, comparing the clinical performance of different IOL designs remains relevant for cataract surgeons and patients.

2. Aim and Objectives

Aim

To compare visual outcomes following phacoemulsification with implantation of monofocal and multifocal intraocular lenses.

Objectives

- To compare postoperative uncorrected distance visual acuity.
- To compare corrected distance visual acuity.
- To compare uncorrected near visual acuity.
- To compare postoperative refractive error.
- To determine spectacle dependence.
- To compare the incidence of glare and halos.

- To assess postoperative complications.

3. Materials and Methods

3.1 Study design

Prospective comparative observational study.

3.2 Study setting

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3.3 Study period

October 2021 to February 2021

3.4 Sample size

A total of 100 patients with age-related cataract were included. Group A: 50 eyes receiving monofocal IOL; Group B: 50 eyes receiving multifocal IOL. Only one eye per patient was included in the analysis to avoid inter-eye statistical dependence.

3.5 Inclusion criteria

- Age ≥50 years.
- Visually significant age-related cataract.
- Preoperative CDVA appropriate for cataract surgery.
- Regular corneal astigmatism.
- Adequate ocular surface health.
- Willingness to attend follow-up visits.

3.6 Exclusion criteria

- Corneal opacity.
- Advanced glaucoma.
- Significant diabetic macular edema.
- Retinal disease affecting visual acuity.
- Previous corneal refractive surgery.
- Significant amblyopia.
- Pseudoexfoliation with major zonular instability.
- Complicated cataract.
- Intraoperative complications.
- Inability to complete follow-up.

3.7 Preoperative assessment

All patients underwent detailed ophthalmic history, visual acuity assessment, slit-lamp examination, intraocular pressure measurement, dilated fundus examination, keratometry, optical biometry and IOL power calculation.

4. Surgical Procedure

All surgeries were performed under topical/local anaesthesia using standard phacoemulsification techniques. A clear corneal incision was created, followed by continuous curvilinear capsulorhexis, hydrodissection, phacoemulsification of the nucleus and cortical aspiration. The selected IOL was implanted into the capsular bag. Patients received standard postoperative topical antibiotic and

corticosteroid treatment according to institutional protocol. Patients with intraoperative complications were excluded from the final comparative analysis.

5. Outcome Measures

The primary outcome was postoperative visual acuity at 6 months. Secondary outcomes included uncorrected distance visual acuity, corrected distance visual acuity, uncorrected near visual acuity, spherical equivalent, spectacle dependence, glare, halos and postoperative complications. Visual acuity was recorded in Snellen notation and converted to logMAR for statistical analysis.

6. Statistical Analysis

Data were entered into a statistical software package. Continuous variables were expressed as mean ± standard deviation. Categorical variables were expressed as frequency and percentage. The independent-samples t-test was used to compare continuous variables between groups. The chi-square test was used for categorical variables. A p-value <0.05 was considered statistically significant.

7. Results

Table 1. Baseline demographic characteristics

Variable	Monofocal (n=50)	Multifocal (n=50)	p-value
Mean age (years)	67.2 ± 7.1	66.8 ± 6.8	0.78
Male	28 (56%)	27 (54%)	0.84
Female	22 (44%)	23 (46%)	0.84
Right eye	26 (52%)	25 (50%)	0.84
Left eye	24 (48%)	25 (50%)	0.84
Mean preoperative CDVA, logMAR	0.63 ± 0.21	0.61 ± 0.22	0.64

Table 2. Postoperative uncorrected distance visual acuity

Follow-up	Monofocal mean logMAR	Multifocal mean logMAR	p-value
1 week	0.18 ± 0.14	0.17 ± 0.13	0.72
1 month	0.11 ± 0.11	0.10 ± 0.10	0.64
3 months	0.09 ± 0.10	0.08 ± 0.09	0.61
6 months	0.08 ± 0.09	0.07 ± 0.08	0.56

Table 3. Corrected distance visual acuity

Follow-up	Monofocal	Multifocal	p-value
1 week	0.07 ± 0.08	0.07 ± 0.07	0.93
1 month	0.04 ± 0.05	0.04 ± 0.05	0.91
3 months	0.03 ± 0.05	0.03 ± 0.04	0.87
6 months	0.03 ± 0.05	0.03 ± 0.04	0.84

Table 4. Uncorrected near visual acuity at 6 months

UNVA category	Monofocal n (%)	Multifocal n (%)
≤0.20 logMAR	8 (16%)	32 (64%)
0.21–0.40	16 (32%)	13 (26%)
0.41–0.60	19 (38%)	4 (8%)
>0.60	7 (14%)	1 (2%)
Total	50 (100%)	50 (100%)

Chi-square = 29.6; p <0.001

Table 5. Mean uncorrected near visual acuity

Time point	Monofocal	Multifocal	p-value
1 week	0.61 ± 0.17	0.31 ± 0.15	<0.001
1 month	0.54 ± 0.16	0.23 ± 0.13	<0.001
3 months	0.50 ± 0.15	0.19 ± 0.11	<0.001
6 months	0.48 ± 0.15	0.18 ± 0.10	<0.001

Table 6. Postoperative refractive error at 6 months

Parameter	Monofocal	Multifocal	p-value
Mean spherical equivalent	-0.18 ± 0.46 D	-0.12 ± 0.41 D	0.49
Mean cylinder	-0.51 ± 0.38 D	-0.48 ± 0.35 D	0.68
Within ±0.50 D	38 (76%)	40 (80%)	0.63
Within ±1.00 D	47 (94%)	48 (96%)	0.65

Table 7. Spectacle dependence at 6 months

Spectacle status	Monofocal	Multifocal
Spectacle independent	12 (24%)	38 (76%)
Requires spectacles for near	35 (70%)	11 (22%)
Requires spectacles for distance	3 (6%)	1 (2%)

Chi-square = 28.5; p <0.001

Table 8. Postoperative visual symptoms at 6 months

Symptom	Monofocal n (%)	Multifocal n (%)	p-value
Glare	7 (14%)	19 (38%)	0.008
Halos	4 (8%)	21 (42%)	<0.001
Night-vision difficulty	5 (10%)	14 (28%)	0.025
No significant symptoms	39 (78%)	21 (42%)	<0.001

Table 9. Postoperative complications

Complication	Monofocal	Multifocal
Transient corneal edema	3	2
Mild anterior chamber reaction	4	3
Raised IOP	2	2
Posterior capsular opacification	3	2
Cystoid macular edema	1	1
IOL-related complication	0	0
Endophthalmitis	0	0

No statistically significant difference in postoperative complications was observed.

8. Discussion

The present comparative study evaluated the visual performance of monofocal and multifocal IOLs following phacoemulsification.

The principal finding was that both IOL groups provided good postoperative distance visual acuity. At six months, mean UDVA was 0.08 logMAR in the monofocal group and 0.07 logMAR in the multifocal group, with no statistically significant difference.

The most important difference in the present dataset was near vision. Patients receiving multifocal IOLs demonstrated substantially better uncorrected near visual acuity. The mean UNVA at six months was 0.18 logMAR compared with 0.48 logMAR in the monofocal group.

Spectacle independence was another major difference. In the dataset, 76% of multifocal-IOL recipients were spectacle independent compared with 24% of monofocal-IOL recipients.

However, the advantages of multifocal IOLs were accompanied by a greater frequency of photic phenomena. Halos were reported by 42% of multifocal-IOL recipients compared with 8% of monofocal-IOL recipients. Glare was also more common in the multifocal group.

The results therefore emphasize that selection of an IOL should not be based exclusively on postoperative distance visual acuity. Patient expectations, occupational requirements, reading requirements, tolerance for photic phenomena and willingness to use spectacles should all be considered.

Newer IOL designs have attempted to address these limitations. Enhanced monofocal and extended-depth-of-focus technologies aim to provide useful intermediate or extended-range vision while maintaining good distance visual performance.

9. Limitations

- Relatively small sample size of 100 patients.
- Short follow-up period of six months.
- Subjective symptoms such as glare and halos may be influenced by individual perception.
- Contrast sensitivity was not assessed.
- No formal quality-of-life questionnaire was used.
- Only one eye per patient was analyzed.

- Results may not be generalizable to all IOL models.
- Longer follow-up would be useful for assessing posterior capsular opacification and long-term satisfaction.

10. Conclusion

Phacoemulsification with implantation of either monofocal or multifocal IOL provides significant improvement in visual function following cataract surgery. In this dataset, both groups achieved comparable distance visual acuity. Multifocal IOLs provided significantly better uncorrected near vision and substantially greater spectacle independence. However, multifocal IOLs were associated with a greater frequency of glare and halos. Therefore, multifocal IOLs may be particularly suitable for appropriately selected cataract patients who prioritize spectacle independence, whereas monofocal IOLs remain an excellent choice for patients prioritizing high-quality distance vision and minimizing photic phenomena.

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