

## A COMPARATIVE STUDY ON VISUAL OUTCOME BETWEEN MULTIFOCAL AND MONOFOCAL INTRAOCULAR LENSES

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### ABSTRACT

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#### AIM OF THE STUDY

The study was carried out with the aim of comparing multifocal intraocular lenses with current standard treatment of monofocal intraocular lenses in respect to distant visual acuity, near visual acuity, and contrast sensitivity.

#### METHODOLOGY

This is a prospective randomised study conducted from January 2014 to January 2015 consists a total of 50 patients with senile cataract requiring cataract surgery divided randomly into two groups, 25 patients in each group. In the first group, 25 eyes of 25 patients underwent phacoemulsification with monofocal intraocular lens (IOL) implantation and in the second group 25 eyes of 25 patients underwent phacoemulsification with multifocal implantation. Age of these patients ranged from 50-70 years.

#### RESULTS

In our study, there was significant difference in the uncorrected near visual acuity. There was no difference in the corrected near visual acuity in both the groups. There is no significant difference in uncorrected distant visual acuity after 1 and 6 weeks postoperatively in both the groups.

#### CONCLUSION

Multifocal IOLs offer best near visual acuity, good distance visual acuity in selected and motivated individuals.

#### KEYWORDS

Multifocal IOLs, Monofocal IOLs, Phacoemulsification, Intraocular Lens.

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**INTRODUCTION:** Multifocal IOLs are growing in popularity among patients and surgeons and opened the way to refractive lens exchange. Still, they are not used routinely in cataract surgery. Multifocal IOLs are available, which claim to allow good vision at a range of distances and are capable of correcting refractive errors as well as eliminating patients need for near-vision addition. There are reports indicating that multifocal IOLs are responsible for some degrees of halo, glare, and reduced contrast sensitivity. Nonetheless, patients seem to be very satisfied with these lenses. Meanwhile, the emergence of different contrasting reports was produced regarding the efficacy of multifocal IOLs, its side effects, and patient discomfort. Hence, a need automatically arises to study their efficacy. In the current study, we present a comparison of monofocal IOL and multifocal IOL in terms of near and distance visual acuity (VA) and contrast sensitivity after cataract surgery.

Throughout the history, the ability to see clearly at near has had a deep impact on a person's occupational performance and recreational pursuits. Prior to spectacles correction for presbyopia over 200 years ago, many people in their later years in life suffered a severe visual handicap due to the loss of adequate near vision. The initial use of single power spectacles followed by the popularity of bifocals has greatly enhanced the lives of presbyopic patients. However, the nuisance and expense of spectacles frequently make this method unpopular.

Over the past decade, refractive surgical procedures have been rapidly evolving especially for myopic and astigmatic eyes. Correction of presbyopia has remained somewhat elusive. However, cataract surgeons have been making steady progress in improving near vision IOL's and newer operative techniques with improvements in IOL power calculations and the reduction of postoperative astigmatism. Patients are now enjoying and even expecting better unaided distance and near vision after cataract removal.

**Accommodation And Presbyopia.<sup>(1)</sup>** Accommodations, the mechanism by which the eye changes refractive power by altering the shape of its crystalline lens. The mechanisms that achieve this alteration have been described by Helmholtz.

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The posterior focal point is moved forward in the eye during accommodation. Correspondingly, the far point moves closer to the eye. Accommodative effort occurs when the ciliary muscle contracts in response to parasympathetic stimulation thus allowing the zonular fibers to relax. The outward-directed tension on the lens capsule is decreased and the lens becomes more convex. The movement of the equatorial edge of the lens is thus away from the sclera during accommodation and toward the sclera again when accommodation is relaxed. Accommodative response results from the increase in lens convexity (Primarily the anterior surface) and it may be expressed as the amplitude of accommodation (In dioptres) or as the range of accommodation, the distance between the far point of the eye, and the nearest point at which the eye can maintain focus (Near point).

It is evident that as the lens loses elasticity from the ageing process, the accommodative response wanes (A condition called presbyopia), even though the amount of ciliary muscle contraction or accommodative effort is virtually unchanged. For calculation of the additional spectacle lens power requirement for an eye with this condition, the amplitude is a more useful measurement. For appraising, an individual's ability to perform a specific visual task, the range is more informative.

**Characters of Multifocal IOL.<sup>(2)</sup>:** Multifocal IOL's have two or more optical foci. This means, the presence of at least two coaxial dioptric powers usually separated by a 4D interval to provide 3D interval at the spectacle plane. On the retina, the two dioptric powers will produce two super improved images of any observed object. Under the best condition, one image will be in sharp focus and the other image will be blurred by a 3D defocus aberration. For example, a black line on white paper will appear surrounded by a narrow grey ribbon. This is the optical reason for the reduction in modulation transfer function observed with multifocal IOL's unfortunately a reduction strictly connected to the presence of coaxial different process. This lower optical quality as compared with monofocal IOL's emerges and as lower contrast sensitivity in implanted patients.

**History:** Hoffer in 1982 was the first to hit upon the idea of multifocal IOL. Dr. John Pierce in 1986 was the first to implant Bell's eye style of multifocal IOL. The first multifocal IOL product approved by FDA was manufactured by Precision Cosmetics and later acquired by IOLAB Corporation. This is a refractive type of PMMA bifocal IOL.

**Types of Multifocal IOL:**

1. Refractive.
2. Diffractive.
3. Combination of Refractive and Diffractive.

**Optical Principles of Multifocal IOL:** Optics of refractive multifocal lens is based on refraction of light at the lens optic obeying Snellen's laws of refraction. It has a concentric zone refracting the incoming light from a near object towards the

retina peripheral concentric zone refracting light from a distant object towards retina.

**Disadvantages:** Pupil size and decentration of the lens affect the optical behaviour of the IOL. To reduce pupil dependent behaviour of multifocal IOL, more concentric zones are added and zone transition can be made aspherical.

**Key for Successful MFIOL Implantation:**

**Patient Selection:**

**Accurate Biometry:** IOL master is strongly recommended as it is 10 times more accurate in power calculation.

**Surgical Technique:** Round centered CCC completely overlapping the lens optic. Removal of all the viscoelastic from behind the IOL. The amount of chair time spent with the patient prior to surgery greatly reduces chair time spent afterwards.

**AIMS AND OBJECTIVES:** The study was carried out with the aim of comparing multifocal IOLs with current standard treatment of monofocal IOLs in respect to.

- Distant visual acuity (Uncorrected and best corrected distant visual acuity) UCDVA and BCDVA.
- Near visual acuity (Uncorrected and best corrected visual acuity) UCNVA and BCNVA.
- Contrast sensitivity.

**MATERIALS AND METHODS:** This is a prospective randomised study conducted at Sarojini Devi Eye Hospital, Hyderabad, from January 2014 to January 2015, consists a total of 50 patients with senile cataract requiring cataract surgery divided randomly into two groups, 25 patients in each group. In the first group, 25 eyes of 25 patients underwent phacoemulsification with monofocal intraocular lens implantation and in the second group 25 eyes of 25 patients underwent phacoemulsification with multifocal implantation. Age of these patients ranged from 50-70 years. Phacoemulsification cataract surgery was undertaken on all patients under local anaesthesia. Continuous curvilinear capsulorhexis was done in all cases.

This study was designed and conducted to compare near and distant vision in two groups of patients receiving multifocal and monofocal IOLs during cataract surgery to supplement our knowledge regarding the role of these two of lenses in the correction of both distant and near vision. All the patients under the study were examined postoperatively at day 1 and weekly for 6 weeks.

Data was entered in excel sheet and results were expressed in terms of percentage and proportions. Chi-square test was used to determine whether there is a significant association between the two variables.

Age Distribution	51-55	56-60	61-65	66-70	Total
Monofocal	4(16%)	7(28%)	8(32%)	6(24%)	25
Multifocal	4(16)%	10(40%)	6(24%)	5(20%)	25

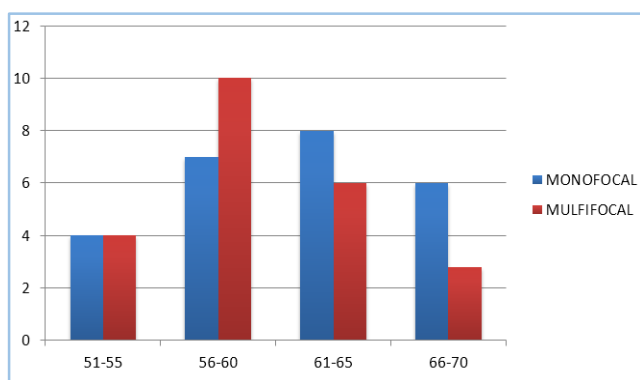
**Inclusion Criteria:**

1. Patients with senile and presenile cataract without any other ocular pathology.
2. Patients not having inclination to near postoperative glasses.

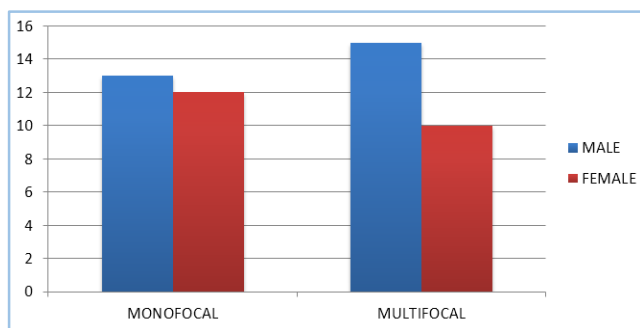
**Exclusion Criteria:**

1. Complicated cataract.
2. Eye diseases either systemic disorders like glaucoma, diabetes.
3. Cases with intraoperative and postoperative complications.
4. Pre-existing astigmatism >1.5 D.
5. Retinal/Optic Nerve Pathology.
6. High ametropia.
7. Anxious patients.
8. Drivers by professional.

**RESULTS:**



**Graph 1: Age Distribution**



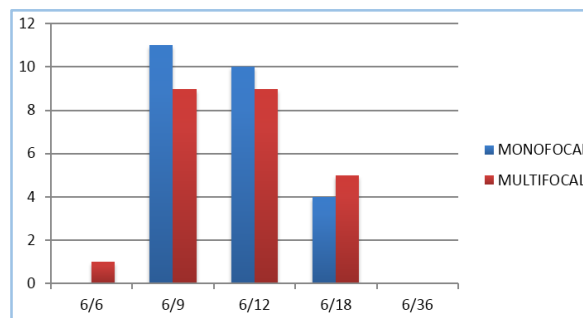
**Graph 2: Sex Distribution**

Group	Male	Female
Monofocal	13(42%)	12(48%)
Multifocal	15(60%)	10(40%)

Postoperative Uncorrected Distant Visual Acuity at 1 Week.

UCDVA	Monofocal	Multifocal
6/6-6/9	11(44%)	10(40%)
6/12	10(40%)	10(40%)
≥6/18	04(16%)	05(20%)
<b>TOTAL</b>	<b>25</b>	<b>25</b>

p-value-0.7745. The difference between monofocal and multifocal uncorrected distant visual acuity was not statistically significant.

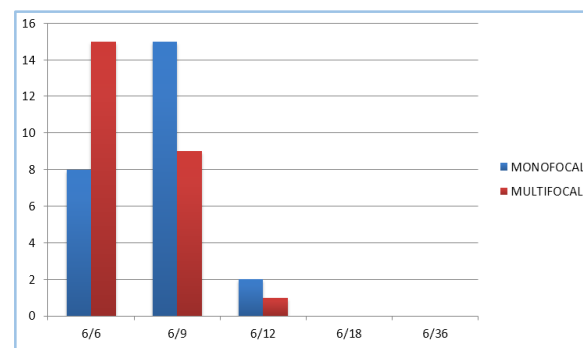


**Graph 3: Postoperative UCDVA at 1 Week**

Postoperative Best Corrected Distant Visual Acuity at 1 Week.

BCDVA	Monofocal	Multifocal
6/6-6/9	23(92%)	24(96%)
6/12	02(8%)	01(4%)
6/18	0	0
<b>Total</b>	<b>25</b>	<b>25</b>

p-value- 0.5515. The difference between monofocal and multifocal best corrected distant visual acuity was not statistically significant.

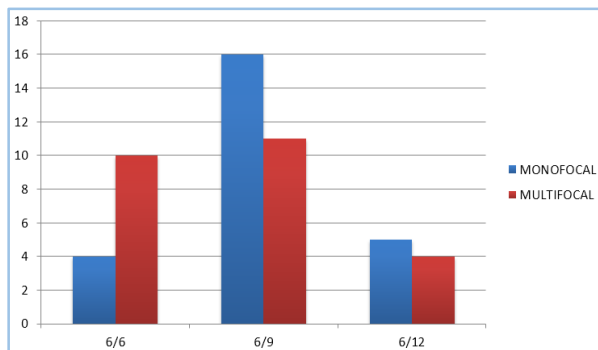


**Graph 4: BCDVA at 1 Week**

Postoperative Uncorrected Distant Visual Acuity at 6 Weeks.

UCDVA	Monofocal	Multifocal
6/6-6/9	20(80%)	21(84%)
6/12	05(20%)	04(16%)
6/18	0	0
<b>Total</b>	<b>25</b>	<b>25</b>

P value-0.7128. The difference between uncorrected distant visual acuity among two groups was not statistically significant.

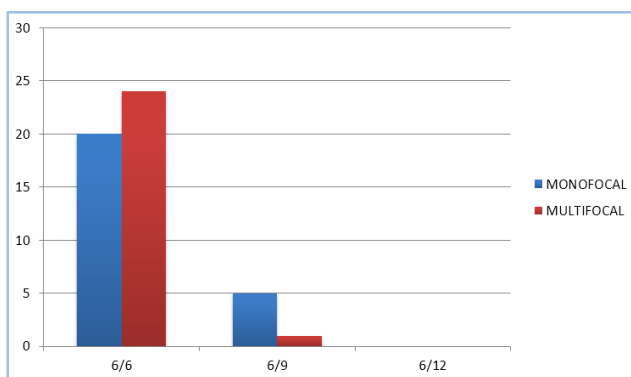


**Graph 5: UCDVA at 6 Weeks**

Postoperative Best Corrected Distant Visual Acuity at 6 Weeks.

BCDVA	Monofocal	Multifocal
6/6	20(80%)	24(96%)
6/9	05(20%)	01(4%)
<b>Total</b>	<b>25</b>	<b>25</b>

p-value-0.1917. The difference was not statistically significant.

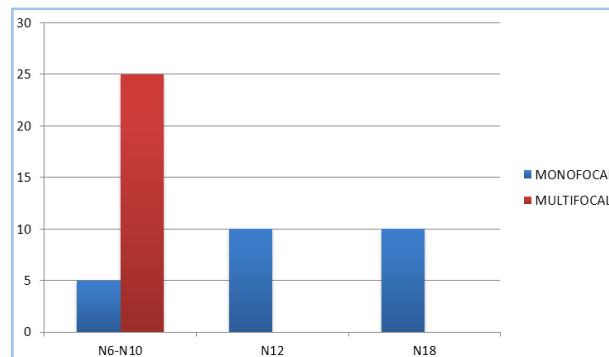


**Graph 6: BCDVA at 6 Weeks**

Postoperative Uncorrected Near Visual Acuity at 1 Week.

UCNVA	Monofocal	Multifocal
N6-N10	05(20%)	25(100%)
N12	10(40%)	0
N18	10(40%)	0
<b>Total</b>	<b>25</b>	<b>25</b>

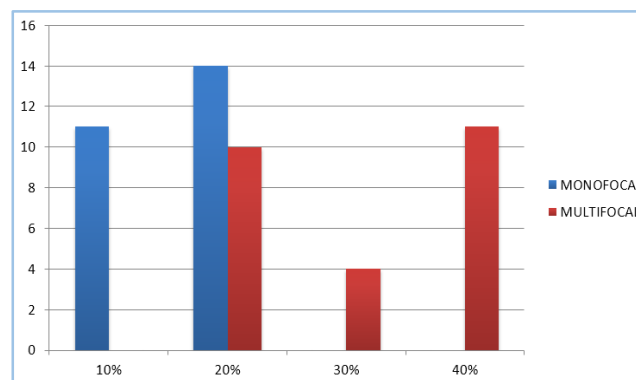
p-value-0.0001. The difference among the two group was found to be statistically significant.



**Graph 7: UNCVA at 1 Week**

**Contrast Sensitivity:**

Contrast Sensitivity	Monofocal	Multifocal
10%	11	0
20%	14	10
30%	0	04
40%	0	11
<b>Total</b>	<b>25</b>	<b>25</b>



**Graph 8: Contrast Sensitivity**

**DISCUSSION:** Age-related cataracts represent the most common cause of blindness in the world. The available treatment option is surgical extraction of cataract and implantation of IOL to replace the focusing power of the natural lens. IOLs used in cataract surgery are either monofocal or multifocal. The former can be used to give clear point of focus for distance or near, but can choose only point of focus. Spectacles provide extra lens power, which enables focusing at other points whereas multifocal IOL can correct both distant and near vision, which eliminates near vision addition.

**Distant Visual Acuity:** As demonstrated in the result 11 (44%) patients had an UDVA  $\geq 6/9$  in monofocal IOL group at first week (Mean 0.18 LogMAR). At the end of 6 weeks follow up, 20 (80%) of patients had a UDVA of  $\geq 6/9$  (Mean 0.14 LogMAR). 10 (40%) patients had an UDVA  $\geq 6/9$  in multifocal IOL group (0.15 LogMAR). At the end of 6 weeks follow up, 21 (84%) patients had a UDVA of  $\geq 6/9$  (Mean 0.09 LogMAR). At the end of the first week follow up, 23 (92%) monofocal patients had a BCDVA of  $\geq 6/9$  (Mean 0.12

LogMAR). At the end of 6 weeks follow up, 25 (100%) patients had a BCDVA of  $\geq 6/9$  (mean 0.03 LogMAR).

24 (96%) patients had BCVA of  $\geq 6/9$  in multifocal group at first week (Mean 0.06 LogMAR) and 6<sup>th</sup> week (Mean 0.01 LogMAR). Chiam et al. who studied 80 patients 40 in each group and found that the decimal equivalent UDVA at 2 months was 0.79 and 0.85 respectively.<sup>(3),(4)</sup> Cillino et al. compared 4 types and refractive and diffractive IOLs in cataract patients showing no significant difference in terms of UDVA.<sup>(5)</sup> There were no significant differences in both the groups  $p > 0.01$  during follow period, which was the same in Hashemi et al. study in which mean UDVA and BDVA was 0.14 and 0.05 LogMAR respectively in the monofocal group and 0.11 and 0.04 LogMAR respectively in the multifocal IOL group.<sup>(6)</sup> Ortiz et al compared the visual performance of these two types of IOLs and reported UDVA of 8/9 in both groups indicating no significant differences.<sup>(7)</sup> IOLs are capable of correcting DVA just as monofocal IOLs. In another study by Chiam et al., they found no significant differences between the monofocal and the multifocal groups in terms of percentage of cases achieving 20/20 CDVA (82% and 86% respectively). In our study, CDVA was not significantly different between the two groups either.

23 (92%) and 24 (93%) patients had more than 6/9 (mean 0.03 LogMAR) in both groups respectively. In 2014, Nian Tan et al studied 128 eyes, IOL implantation with monofocal and multifocal types.<sup>(8)</sup> Patients in the multifocal group exhibited better distance corrected visual acuity and experienced more pseudoaccommodation than patients in monofocal group (3 months  $p < 0.05$ , 12 months  $p < 0.01$ ). 3 months after surgery, total spectacle independence was achieved by 84.4% in multifocal and 17.2% in monofocal group. This is in accordance with our study. In 2010, Zhao G et al conducted a prospective RCT to compare visual function after phacoemulsification with implantation of multifocal IOL or a monofocal IOL.<sup>(9)</sup>

There were no statistically significant differences in UDVA or CDVA between the 2 groups over the 6-month followup. The multifocal group had statistically significantly better pseudoaccommodation than the monofocal group. The monofocal group had significantly better contrast sensitivity (both  $P < 0.05$ ). These results are same as our study.

**Near Visual Acuity:** 15 (60%) patients had UCNVA  $\geq N12$  (mean 0.2 LogMAR) at first week postoperatively in the monofocal IOL group. 25 (100%) patients had UCNVA  $\geq N12$  (mean 0.01 LogMAR) at the end of first week postoperatively, which was statistically significant  $p < 0.001$ . The study done by Hashemi et al. showed that at 3 months after surgery the UCNVA monofocal and multifocal groups were 0.22 and 0.14 respectively after correction of DVA and the intergroup difference was statistically significant. Findings in other studies support our results and they agree that multifocal IOLs improve UCNVA. Ortiz et al. reported a mean UCNVA of 0.7 and 0.9 decimal in their monofocal and multifocal groups respectively statistically significant in multifocal group. Cilino et al. stated that these figures were

0.61 and 0.7 decimal respectively. The difference was statistically significant and they concluded that multifocal IOLs are better capable of correcting NVA.

In the report by Chiam et al., these figures were 0.34 and 0.7 decimal respectively. The evidence on NVA was in favour of multifocal IOLs. In our study, CNVA was similar in both and monofocal and multifocal IOL group. Other similar studies have demonstrated that there are no significant differences between these groups.

**Contrast Sensitivity:** Contrast sensitivity in our study was lower in multifocal IOL group, which is similar in other studies. Study by Winglo et al. showed that mean contrast sensitivity was 18.28 db and 19.18 db in multifocal and monofocal group by static program.

**CONCLUSION:** In our study, there was significant difference in the uncorrected near visual acuity. There was no difference in the corrected near visual acuity in both the groups. There is no significant difference in uncorrected distant visual acuity after 1 and 6 weeks postoperatively in both the groups.

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