Comparison of visual functions and contrast sensitivities between monoblock hydropheric acrylic monofocal and monoblock hydropheric acrylic multifocal intraocular lenses: treatment of the genitourinary syndrome of menopause

Abstract

**Purpose:** To compare monoblock hydropheric acrylic monofocal ultraflex (UF) and monoblock hydropheric acrylic multifocal revision (RV) intraocular lens implantations on visual acuities and contrast sensitivities after bilateral cataract extraction.

**Setting:** Cumhuriyet University, Faculty of Medicine, Department of Ophthalmology.

**Design:** Prospective, randomized-controlled clinical study.

**Methods:** Sixty eyes of 45 patients (Group 1: n=30 UF; Group 2: n=30 RV) with cataracts operated by phacoemulsification technique were included. The patients were examined at one day, one week, and one month, postoperatively. At three months, contrast sensitivity tests for distance were performed at 1.5, 3.6, 12, and 18 cpd as photopic with/without glare and mesopic with/without glare. Patients with corneal astigmatism >1.0 diopter, glaucoma or retinal detachment history, corneal disease, previous cataract or intraocular surgery, abnormal iris, pupil deformation, trauma-related zonular defects, iris and lens capsule defect, macular degeneration or retinopathy, neuro-ophthalmic disease, history of amblyopia, and ocular inflammation, intraoperative capsular defects and vitreous loss, and postoperative visual acuity <0.5 were excluded.

**Results:** Although it was not statistically significant (p>0.05), compared to Group 1, visual acuity was superior in Group 2. Spectacle independency for Distance visual acuity of the groups were similar (p>0.05). The visual acuity was increased with -3.00 and -3.50 refraction values in defocus curve in Group 2. In all spatial frequencies, contrast sensitivity test values were higher in Group 1 than Group 2.

**Conclusion:** Our study results show that although both lenses provide comparable visual acuity level, UF lens has a better optic performance on the contrast sensitivity test.

**Keywords:** contrast sensitivity, mesopic, photopic, multifocal intraocular lens

Introduction

The quality of life following cataract surgery may be reduced in patients who become partially or completely dependent on eyeglasses. After cataract extraction and the implantation of a monofocal intraocular lens in patients with unilateral cataract, binocular visual functions can be compromised at intermediate and near vision. The main goal of multifocal IOL models is to restore both distance and near visual function. This improvement in the ability of reading is important in today’s information-based society. Multifocal IOLs are used to compensate for pseudophakic presbyopia and thus improving functional distance, near, and even intermediate vision. Beside offering good uncorrected near visual acuity in most cases, multifocal IOLs provide also better uncorrected distance visual acuity (UDVA) than most of the monofocal IOLs. The design of multifocal IOLs depend on two optical principles: diffraction, refraction or a combination of diffraction and refraction. With the introduction of novel technologies, incoming light rays are distributed to two principal focal points, near vision and distance vision, or to several foci. However, several optical side effects including decreased contrast sensitivity, glare disability, or the presence of halos, were reported. These effects can significantly affect the patient’s visual performance due to decreased retinal image quality.

In this study, we aimed to compare monoblock hydropheric acrylic monofocal ultraflex (UF) and monoblock hydropheric acrylic multifocal revision (RV) intraocular lens implantations on visual acuities and contrast sensitivities after bilateral cataract extraction.

**Methods**

This prospective randomized-controlled clinical trial, a total of 60 eyes of 45 patients (Group 1: n=30 UF; Group 2: n=30 RV) with cataracts were operated by phacoemulsification technique using either monoblock hydropheric acrylic monofocal UF lens or monoblock hydropheric acrylic multifocal RV lens at Cumhuriyet University, Faculty of Medicine, Department of Ophthalmology between November 2012 and May 2013 were included. In our study, eyes in Group 1 and Group 2 had similar preoperative characteristics. The study adhered to the tenets of the Declaration of Helsinki and was approved by the local ethical committee. Informed consent was...
Comparison of visual functions and contrast sensitivities between monoblock hydrophobic acrylic monofocal and monoblock hydrophobic acrylic multifocal intraocular lenses

**Results**

Of 60 eyes of 45 patients, 33 were males and 27 were females. The mean age was 63.18±12.03 years in Group 1 and 59.86±10.46 years in Group 2. There were no statistically significant differences in age (p=0.987, p>0.05), (p=0.458; p>0.05), and visual acuity between the groups. The results were statistically significant at mesopic and photopic tests with glare and without glare at 1.5, 3.6, 12 cpd, however, mesopic test results with glare at 18 cpd did not reach statistical significance (p>0.05) (Tables 1–4) and (Figures 1–4). All patients had 20/25 or more best corrected distance visual acuity at three months following surgery. The distance visual acuity was superior in Group 2 compared to Group 1; however, it did not indicate statistical significance. There was no statistically significantly difference in the patient’s being eyeglasses-free for distance visual acuity between two groups. (P=0.114, P>0.05) (Table 5). Group 1 completely dependent on eyeglasses for near vision but there were no patient used eyeglasses for near vision. The visual acuity was increased with -3.00 and -3.50 refraction values in defocus curve in Group 2 (Figure 5). There was no statistically significant difference at mesopic without glare at 18 cpd (p>0.05), however a statistically significant difference was observed at 1.5, 3.6, 12 cpd (p<0.05). Contrast sensitivity results in mesopic conditions with glare showed higher values in all spatial frequencies (1,5,3,6,12 and 18 cpd) in Group 1. Contrast sensitivity results in photopic conditions without glare showed higher in all spatial frequencies (1,5,3,6,12 and 18 cpd) in Group 1, indicating statistical significance (p<0.05). There were no statistically significant differences in the distance visual outcomes or manifest refraction between the two groups (PR.07, Mann-Whitney test). The uncorrected near visual acuity (UNVA) and distance corrected near visual acuity (DCNVA) were statistically significantly improved in the multifocal IOL group (both P<0.01, Mann-Whitney test).

**Statistical analysis**

Statistical analysis was performed using SPSS v15.0 for Windows software (SPSS Inc. Chicago, IL, USA). The normally distributed data were studied by the Kolmogorov-Smirnov test and Chi-square test. A p value of <0.05 was considered statistically significant.

Table 1

| Mesopic Without Glare | UF Contrast Sensitivity Scores $\bar{x}$±S | RV Contrast Sensitivity Scores $\bar{x}$±S | Result |
|-----------------------|----------------------------------------|----------------------------------------|--------|
| 1.5cpd                | 25.06±4.91                             | 19.70±5.34                             | $T=4.04; p=0.001^*$ |
| 3cpd                 | 31.40±6.32                             | 22.53±7.45                             | $T=4.96; p=0.001^*$ |
| 6cpd                 | 26.36±6.89                             | 20.53±8.39                             | $T=2.94; p=0.005^*$ |
| 12cpd                | 12.73±2.63                             | 10.50±1.72                             | $T=2.58; p=0.010^*$ |
| 18cpd                | 5.00±1.14                              | 4.80±1.34                              | $T=0.61; p=0.539$ |

**Citation:** Demirci Y, Toker MI, Bozali E, et al. Comparison of visual functions and contrast sensitivities between monoblock hydrophobic acrylic monofocal and monoblock hydrophobic acrylic multifocal intraocular lenses. *Adv Ophthalmol Vis Syst.* 2019;9(3):85–90. DOI: 10.15406/aovs.2019.09.00352
Table 2 Contrast sensitivity scores in spatial frequencies in mesopic conditions with glare with FACT (Functional Acuity Contrast Test)

| Spatial Frequency | UF Contrast Sensitivity Scores | RV Contrast Sensitivity Scores | Result |
|------------------|-------------------------------|-------------------------------|--------|
| 1.5 cpd          | 23.10±5.09                   | 15.83±4.47                   | T=5.87; p=0.001* |
| 3 cpd            | 27.53±6.46                   | 17.76±4.68                   | T=6.70; p=0.001* |
| 6 cpd            | 24.80±8.29                   | 16.53±4.32                   | T=4.84; p=0.001* |
| 12 cpd           | 12.60±3.20                   | 9.16±2.03                    | T=4.95; p=0.001* |
| 18 cpd           | 5.13±1.13                    | 4.46±1.13                    | T=2.27; p=0.027* |

Table 3 Contrast sensitivity scores in spatial frequencies in photopic conditions without glare with FACT (Functional Acuity Contrast Test)

| Spatial Frequency | UF Contrast Sensitivity Scores | RV Contrast Sensitivity Scores | Result |
|------------------|-------------------------------|-------------------------------|--------|
| 1.5 cpd          | 25.76±4.59                   | 22.70±4.70                   | T=2.55; p=0.013* |
| 3 cpd            | 40.10±9.86                   | 29.70±9.58                   | T=4.14; p=0.001* |
| 6 cpd            | 39.13±7.23                   | 29.03±9.72                   | T=4.56; p=0.001* |
| 12 cpd           | 18.96±5.17                   | 12.20±4.83                   | T=3.68; p=0.001* |
| 18 cpd           | 7.06±2.21                    | 5.73±2.44                    | T=2.21; p=0.030* |

Table 4 Contrast sensitivity scores in spatial frequencies in photopic conditions with glare with FACT (Functional Acuity Contrast Test)

| Spatial Frequency | UF Contrast Sensitivity Scores | RV Contrast Sensitivity Scores | Result |
|------------------|-------------------------------|-------------------------------|--------|
| 1.5 cpd          | 25.56±7.38                   | 21.70±4.30                   | T=2.47; p=0.016* |
| 3 cpd            | 37.46±7.41                   | 26.60±7.69                   | T=5.57; p=0.001* |
| 6 cpd            | 38.73±7.23                   | 27.26±9.92                   | T=5.11; p=0.001* |
| 12 cpd           | 17.90±4.93                   | 13.40±4.18                   | T=3.81; p=0.001* |
| 18 cpd           | 6.60±1.49                    | 5.66±1.89                    | T=2.11; p=0.039* |

**Figure 1** Contrast sensitivity scores in different spatial frequencies in mesopic conditions without glare.

**Figure 2** Contrast sensitivity scores in different spatial frequencies in mesopic conditions with glare.

**Citation:** Demirci Y, Toker MI, Bozali E, et al. Comparison of visual functions and contrast sensitivities between monoblock hydrophobic acrylic monofocal and monoblock hydrophobic acrylic multifocal intraocular lenses. *Adv Ophthalmol Vis Syst.* 2019;9(3):85–90. DOI: 10.15406/aovs.2019.09.00352
Comparison of visual functions and contrast sensitivities between monoblock hydrophobic acrylic monofocal and monoblock hydrophobic acrylic multifocal intraocular lenses

Table 5 Distribution of spectacle use in distance vision

| Eye glasses | Gl | Gz |
|------------|----|----|
| UF         | 15 | 15 |
| %          | 50.0 | 50.0 |
| RV         | 9 | 21 |
| %          | 30.0 | 70.0 |
| Total      | 24 | 36 |
| %          | 40.0 | 60.0 |

Discussion

In the earlier years, multifocal oils were developed to provide functional near and intermediate vision by increasing the depth of field in the eye. Currently, there are three types of multifocal oils used in clinical practice: multi-zone refractive, diffractive, and a combination of these two IOLs. Multifocal diffractive IOLs have concentric rings in the posterior or anterior surface. The rings form two primary focal points independent of the pupil size. On the other hand, multifocal diffractive IOLs restore both distance and near visual function. However, several optical side effects have been reported with multifocal IOLs; these include induction of halos and glare, and loss of contrast sensitivity.

In this study we compared the visual acuity outcomes and the ocular and intraocular optical quality in patients with diffractive multifocal IOLs and patients with conventional monofocal IOLs to identify which one provides the highest spectacle independency as well as to establish possible relationship between the optical performance and clinical visual outcomes. In a study, patients with multifocal IOLs reported less spectacle dependency than patients with monofocal IOLs. Nonetheless, the visual acuity is not the only critical factor in the assessment of visual function. Although patients have high visual acuity levels, they may still suffer from low contrast sensitivity-related vision problems. In this study, the FACT test was used to identify the contrast sensitivity function (CSF), as this test is one of the reliable methods available for testing the contrast sensitivity.

In our study, eyes in Group 1 and Group 2 had similar preoperative characteristics. This allowed us to compare the postoperative outcomes between similar groups. We found no statistically significant difference in age and sex between the groups. In addition, we observed no statistically significant difference in the postoperative distance-vision outcomes between the multifocal IOL group and the monofocal IOL group. However, the multifocal IOL group had significantly improved near visual acuity. Furthermore, the defocus curve is useful in assessing the visual behavior of a specific IOL model. The curve represents the results with different levels of defocus. In our study, there were two peaks of maximum visual acuity at a defocus of approximately 0.00 D and approximately -3.50 D in all eyes in the multifocal IOL group. In a study, the range of focus in near vision was significantly larger in the multifocal IOL group with peaks of maximum visual acuity approximately at the 0.00 D and +3.00 D levels of defocus. In another study, there were two peaks at the expected near focus and far focus (corresponding to 0.00 D and approximately -3.00 D, respectively) in both IOL groups with relatively reduced acuity (0.3 logmar [equivalent to 20/40]) at intermediate distances.
In addition, there are multiple images focused on retina with the use of multifocal IOLs, therefore, it is inevitable to lose contrast sensitivity. Review of the literature has shown several studies on this subject. In a study, Cillino et al.\textsuperscript{13} reported that multifocal IOLs produced better postoperative visual acuity, compared to monofocal IOLs. The authors concluded that multifocal IOLs offered sufficient mid and near visual acuity and spectacle independency was higher with multifocal IOLs. Likewise, Goes et al.\textsuperscript{14} also observed similar findings in their study. Using both static and dynamic contrast sensitivity programs, Vingolo et al.\textsuperscript{15} found higher contrast sensitivity values in the eyes with monofocal IOLs than diffractive multifocal IOLs. In patients with multifocal IOLs, binocular CSF was better than the monocular CSF and the difference in CSF between the conventional monofocal IOL implanted eyes and multifocal IOL implanted eyes seemed to be reduced based on the binocular assessment compared than monocular assessment. The authors reported that 92% of the patients achieved spectacle independency with restor (Alcon Laboratories Inc., Texas, USA) multifocal IOLs.\textsuperscript{16} In another study with diffractive IOLs, Souza et al.\textsuperscript{17,18} showed that monocular photopic CS values with Restor IOL were lower than monofocal Acrysoft IOLs, however, there was no significant difference in binocular values between the two types of IOLs. Similarly, Nijkamp and Blaylock\textsuperscript{19,20} also reported consistent results with the previous study findings.

The IOL technology provides a wide range of focus with no significant decrease in the optical quality. It also offers significantly better uncorrected near visual acuity (UNVA) and distance corrected near visual acuity (DCNVA) than the monofocal IOL. Additionally, Yuvaci et al.\textsuperscript{21} observed that the contrast sensitivity levels were lower at one month in both mesopic and photopic environment with multifocal IOLs for near vision, in particular. At three months, the relatively low levels remained in mesopic environment at high spatial frequencies for near vision.\textsuperscript{22} Furthermore, Mesci et al.\textsuperscript{23} compared monofocal IOLs with multifocal IOLs (refractive and diffractive) and accommodative lenses in terms of visual acuity and contrast sensitivity. The authors demonstrated that multifocal IOLs produced better results in near visual acuity; however, found no significant difference in the distance visual acuity among the groups. In addition, monofocal and accommodative lenses had higher contrast sensitivity than multifocal IOLs. Similarly, our study findings were also consistent with the aforementioned study results.

**Conclusion**

Multifocal IOLs may offer better near visual acuities, however, lower CS scores, compared to monofocal IOLs. Therefore, we conclude that, the patients who are scheduled for multifocal IOL implantation should be selected carefully. Given the fact that the social needs and today’s information-based society requires better mid-range visual acuity, their occupations and the need of near-mid-distance acuity should be thoroughly interrogated.

**What was known**

Higher success rate of multifocal IOLs in offering better near visual acuities compared to monofocal IOLs has been reported in the literature. Multifocal IOLs has also been reported to be associated with lower contrast sensitivity than monofocal IOLs. However, in none of those studies comparing multifocal and monofocal IOLs, Zaraccom IOLs with either multifocal or monofocal property were used for comparisons.

**What this paper adds**

This is the first study using Zaraccom trademark IOLs to compare IOLs with multifocal and monofocal properties. In our study, we also found that Zaraccom IOLs with multifocal property offer better near visual acuities comparing to monofocal IOLs. Additionally, contrast sensitivity was also lower with Zaraccom multifocal IOLs compared to monofocal IOLs.

**Financial support and sponsorship**

Nil.

**Conflicts of interest**

There are no conflicts of interest.

**References**

1. Radner W, Oehmayer M, Richter-Muksch S, et al. The validity and reliability of short German sentences for measuring reading speed. *Graefe Arch Clin Exp Ophthalmol.* 2002;240(6):461–467.
2. Richter-Muksch S, Weghaupt H, Skorpik C, et al. Reading performance with a refractive multifocal and a diffractive bifocal intraocular lens. *J Cataract Refract Surg.* 2002;28(11):1957–1963.
3. Bellucci R. Multifocal intraocular lenses. *Curr Opin Ophthalmol.* 2005;16:33–37.
4. Dick HB. Accommodative intraocular lenses: current status. *Curr Opin Ophthalmol.* 2005;16(1):8–26.
5. Alio JL, Plaza-Puche AB, Piñero DP, et al. Quality of life evaluation after implantation of 2 multifocal intraocular lens models and a monofocal model. *J Cataract Refract Surg.* 2011;37(4):638–648.
6. Mesci C, H Erbil H, Olgun A, et al. Differences in contrast sensitivity between monofocal, multifocal and accommodating intraocular lenses: long-term results. *Clin Exp Ophthalmol.* 2010;38:768–777.
7. Alio JL, Grabner G, Plaza-Puche AB, et al. Postoperative bilateral reading performance with 4 intraocular lens models: six-month results. *J Cataract Refract Surg.* 2011;37(5):842–852.
8. Chen W, Meng Q, Ye H, et al. Reading ability and stereoacuity with combined implantation of refractive and diffractive multifocal intraocular lenses. *Acta Ophthalmol.* 2011;89(4):376–381.
9. Lipner M. Entering the expanding world of multifocal accommodative iols. *Eye World.* 2008;13(7):41–43.
10. Çelik L, Gonenç Ü. Multifokal intraoküler linsler: Difraktif ve refraktif tasarlamaların klinik değerlendirilmesi. *M N Oftalmol.* 2004;11:4–10.
11. Gonenç Üln, Can İ, Muthuay AH, et al. Multifokal göz içi lensler. Refraktif Cerrahi, 1\textsuperscript{\textsuperscript{st}} ed. *TOD Kitaplar*, Ankara: Şahin Mathaus. 2004;209–218.
12. Leyland M, Zinicola E. Multifocal versus monofocal intraocular lenses in cataract surgery; a systematic review. *Ophthalmology.* 2003;110:1789–1798.
13. Woodward MA, Randleman JB, Stulting RD. Dissatisfaction after multifocal intraocular lens implantation. *J Cataract Refract Surg.* 2009;35:992–997.
14. Hofmann T, Zuberbühler B, Cervino A, et al. Retinal straylight and complaint scores 18 months after implantation of the acryls of monofocal and restor diffractive intraocular lenses. *J Refract Surg.* 2009;25(6):485–492.
15. Montés-Micó R, Alío JL. Distance and near contrast sensitivity function after multifocal intraocular lens implantation. *J Cataract Refract Surg.* 2003;29(4):703–711.
16. Pielh S, Lackner B, Hanselmaier G, et al. Halo size under distance and near conditions in refractive multifocal intraocular lenses. *Br J Ophthalmol.* 2001;85(7):816–821.
Comparison of visual functions and contrast sensitivities between monoblock hydrophobic acrylic monofocal and monoblock hydrophobic acrylic multifocal intraocular lenses

17. Steinert RF, Aker BL, Trentacost DJ, et al. A prospective comparative study of the AMO ARRAY zonal- progressive multifocal silicone intraocular lens and a monofocal intraocular lens. *Ophthalmology.* 1999;106:1243–1255.

18. Chiam PJT, Chan JH, Aggarwal RK, et al. Restor intraocular lens implantation in cataract surgery: quality of vision. *J Cataract Refract Surg.* 2006;32(9):1459–1463.

19. Davison JA, Simpson MJ. History and development of the apodized diffractive intraocular lens. *J Cataract Refract Surg.* 2006;32(5):849–858.

20. Cerviño A, Hosking SL, Montés-Micó R, et al. Retinal stray- light in patients with monofocal and multifocal intraocular lenses. *J Cataract Refract Surg.* 2008;34(3):441–446.

21. Renieri G, Kurz S, Schneider A, et al. Restor! Dif- fractive versus Array!2 zonal- progressive multifocal intraocular lens: a contralateral comparison. *Eur J Ophthalmol.* 2007;17(5):720–728.

22. Souza CE, Muccioli C, Soriano ES, et al. Visual performance of acrysof restor apodized diffractive IOL: a prospective comparative trial. *Am J Ophthalmol.* 2006;141(5):827–832.

23. Knorz MC, Claessens D, Schaefer RC, et al. Evaluation of contrast acuity and defocus curve in bifocal and monofocal intraocular lenses. *J Cataract Refract Surg.* 1993;19(4):513–523.

24. Alfonso JF, Puchades C, Fernández-Vega L, et al. Visual acuity compari- son of 2 models of bifocal aspheric intraocular lenses. *J Cataract Refract Surg.* 2009;35(4):672–676.

25. Cillino S, Casuccio A, Di Pace F, et al. One-year outcomes with new-generation multifocal intraocular lenses. *Ophthalmology.* 2008;115(9):1508–1516.

26. Goes FJ. Refractive lens exchange with the diffractive multifocal Tecnis ZM900 intraocular Lens. *J Refract Surg.* 2008;24(3):243–250.

27. Vingolo EM, Grenga P, Isacobelli L, et al. Visual acuity and contrast sen- sitivity: acrysof restor apodized diffractive versus acrysof SA60AT mono- focal intraocular lenses. *J Cataract Refract Surg.* 2007;33(7):1244–1247.

28. Nijkamp MD, Dolders MG, de Brabender J, et al. Effectiveness of mul-tifocal intraocular lenses to correct presbyopia after cataract surgery: a randomized controlled trial. *Ophthal- mology.* 2004;111(10):1832–1839.

29. Blaylock JF, Si Z, Vickers C. Visual and refractive status at different focal distances after implantation of the Restor multifocal intraocular lenses. *J Cataract Refract Surg.* 2006;32(9):1464–1473.

30. Yuvaci S, Ünlü C, Bayramlar H, et al. Acri Lisa356D implantas yonu Yapılan Hastalarda Görsel Sonuçlar. *TJO.* 2011;41:4.