AcrySof ReSTOR Multifocal versus AcrySof SA60AT Monofocal Intraocular Lenses: A Comparison of Visual Acuity and Contrast Sensitivity

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Abstract

Purpose: To compare visual quality in patients receiving Alcon AcrySof ReSTOR multifocal versus AcrySof SA60AT monofocal intraocular lenses (IOL)

Methods: In this interventional study, patients with senile cataract undergoing surgery were enrolled. The age of the patients ranged between 40 and 85 years, and their potential preoperative vision was 20/30 or better. In all patients phacoemulsification was performed through a temporal 2.8 mm incision. Postoperative visual acuity (VA), refraction, and contrast sensitivity (with and without glare) tests were done at 1 and 3 months. A total of 101 eyes were evaluated. A multifocal IOL was implanted in 52.5% of cases, and in the rest, a monofocal IOL was used.

Results: At 3 months, the mean distant VA without and with correction was 0.11 and 0.04 logMAR, respectively, in the multifocal IOL group, and 0.14 and 0.03 logMAR, respectively, in the monofocal IOL group (P>0.10). The near VA without and with correction was 0.14 and 0.05 logMAR, respectively, in the multifocal group and 0.22 and 0.04 logMAR, respectively, in the monofocal IOL group, statistically significantly better in the multifocal group (P=0.038). At 3 months after surgery, contrast sensitivity with and without glare showed statistically significant inter-group differences at 6, 12 and 18 cycles per degree (CPD), and at 6 and 12 CPD, respectively. These figures were higher in monofocal group.

Conclusion: Use of multifocal IOLs in cataract surgery can restore near vision to some extent in addition to distant vision. Contrast sensitivity in recipients of multifocal IOLs is lower than those with monofocal IOLs.

Keywords: Multifocal Lenses, Monofocal Lenses, Distant Visual Acuity, Near Visual Acuity
**Introduction**

The technique of choice in senile cataract is phacoemulsification with intraocular lens (IOL) implantation to correct refractive errors. IOLs used in cataract surgery are either monofocal or multifocal; the former group can only correct distant vision and fail to solve patients' problems with near vision which are due to impaired accommodation. As a solution, two types of IOLs were designed for correcting both near and distant vision in patients undergoing cataract surgery, as well as compensating for the impaired accommodation. These IOLs are further classified as accommodative and multifocal IOLs; the latter group comes in refractive and defractive subgroups. There is claim that multifocal IOLs are capable of correcting refractive errors as well as eliminating patients' need for near vision addition.\(^1\,^2\)

There are reports indicating that multifocal IOLs are responsible for some degrees of halo, glare\(^3\) and reduced contrast sensitivity. Nonetheless, patients seem to be very satisfied with these lenses.\(^4\,^6\) In a study by Blaylock et al.,\(^7\) they found that multifocal lenses could be useful for correcting near vision in cases of presbyopia, and the quality of life in recipients of these lenses was significantly improved after surgery. In the current study, we present a comparison of AcrySof ReSTOR and AcrySof SA60AT IOLs in terms of near and distant visual acuity (VA) and contrast sensitivity after cataract surgery.

**Methods**

In this interventional study, we enrolled patients with senile cataract whose diagnosis had been made by an ophthalmologist. The inclusion criteria were an age between 45 and 85 years, a potential preoperative VA of \(20/30\) or better, and the availability of the IOL power in the market. Patients who had any systemic disease affecting vision or any other ocular conditions were excluded. The study protocol was explained to selected patients and upon their consent to participate further procedures were discussed with the patients so that they could choose the type of IOL. To eliminate the effect of confounding factors, all surgeries were done by a single skilled surgeon. Depending on the type of implanted IOL - the multifocal AcrySof SA60AT and the multifocal AcrySof ReSTOR - patients were fit into two groups. In all cases, a similar phacoemulsification technique with a 2.8 mm temporal incision was performed.

Preoperative examinations included 1) Uncorrected distant visual acuity (UDVA) and corrected distant visual acuity (CDVA) tests using the standard Snellen chart; 2) manifest refraction; 3) slit-lamp examination; 4) fundoscopy; 5) measurement of intraocular pressure; 6) IOL power determination using the IOLMaster; and 7) keratometry and topography. Postoperative examinations, scheduled for 1 and 3 months after surgery were distant VA, uncorrected near visual acuity (UNVA), corrected near visual acuity (CNVA), refraction tests, slit-lamp examination and contrast sensitivity tests with and without glare using the CSV-1000. In all cases, VA tests were done unilaterally and NVA was tested after CDVA tests.

Near refraction was compared between the groups to show how much the lens could lower the patient's dependence on spectacle during reading or near work. This figure was measured by a retinoscope while the patients were focusing on a near target 40 cm away from their eyes. The amounts of add were calculated according to this measurement.

The Research and Ethics Committee of Noor Vision Correction Center and the Ethics Committee of the National Research Center for Medical Sciences approved the study. All participants in this study were informed about the project and the procedures in their native language before being enrolled. The participants' agreement for examination was obtained verbally. Analyses were done with the SPSS version 11.5 software. Analysis procedures including the independent sample test and repeated measures ANOVA were used.

**Results**

The study duration was from February 2006 to October 2007. During this period, 101 eyes of 80 patients eligible for cataract surgery met the inclusion criteria and were enrolled in the study. In 21 patients, both eyes were operated on. The patients were male in 62% of cases, and their mean age was 62.9±10.5 (range, 40 to 79) years. A multifocal IOL was implanted in 52.5% of cases and the rest received a monofocal IOL. There were no statistically
significant differences in terms of age or gender between the two groups of patients. There was no loss of follow-up at 1 month after surgery while 13 patients failed to have follow-up at 3 months after surgery.

**Visual acuity**

Table 1 summarizes the results of VA tests in the logMAR scale, one month and 3 months after surgery. As demonstrated in the table, the inter-group difference in UDVA and CDVA at 1 and 3 months was not statistically significant. The UNVA was significantly better in the multifocal group at one and 3 months after surgery, but the CNVA was not statistically significantly different between the two groups.

Table 2 summarizes percentages of eyes in different ranges of VA in the two groups of patients. We found that at 3 months after surgery, 60.0% in the multifocal group and 59.5% in the monofocal group had $10/10$ VA.

**Refraction**

The mean cylindrical error was -0.91 D in the multifocal group and 0.86 D in the monofocal group at preoperative (P=0.265), and spherical errors showed no difference between the two groups, postoperatively (P=0.389).

Results of the refraction tests, one and 3 months after the operation are stated in detail in Table 3. The spherical error measured in near and distant refraction tests were not significantly different between the two groups at either follow-up visit; nor were the spherical equivalent refractions.

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**Table 1. Visual acuity in the logMAR scale at one and three month follow-up visits**

|                | Multifocal | Monofocal | P-value
|----------------|------------|-----------|----------
|                | 1 month    | 3 month   | 1 month  | 3 month  |
| Far UCVA       | 0.14±0.11  | 0.11±0.11 | 0.12±0.12| 0.14±0.13| 0.230    | 0.217    |
| Far BCVA       | 0.04±0.07  | 0.04±0.07 | 0.02±0.04| 0.03±0.03| 0.115    | 0.196    |
| Near UCVA      | 0.20±0.16  | 0.14±0.16 | 0.26±0.12| 0.22±0.16| 0.035    | 0.038    |
| Near BCVA      | 0.02±0.06  | 0.05±0.08 | 0.22±0.16| 0.04±0.09| 0.416    | 0.331    |

° Comparison multifocal and monofocal with independent T-test

UCVA: Uncorrected visual acuity

BCVA: Best corrected visual acuity

**Table 2. Percentages of cases in different visual acuity ranges**

<table>
<thead>
<tr>
<th></th>
<th>UCVA</th>
<th>BCVA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Multifocal</td>
<td>Monofocal</td>
</tr>
<tr>
<td>Far</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8/10-10/10</td>
<td>69.6</td>
<td>57.1</td>
</tr>
<tr>
<td>5/10-7/10</td>
<td>23.9</td>
<td>35.2</td>
</tr>
<tr>
<td>&lt;5/10</td>
<td>6.5</td>
<td>7.1</td>
</tr>
<tr>
<td>Near</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8/10-10/10</td>
<td>43.6</td>
<td>40.5</td>
</tr>
<tr>
<td>5/10-7/10</td>
<td>51.3</td>
<td>37.8</td>
</tr>
<tr>
<td>&lt;5/10</td>
<td>5.1</td>
<td>21.6</td>
</tr>
</tbody>
</table>

UCVA: Uncorrected visual acuity

BCVA: Best corrected visual acuity
Table 3. Results of refraction tests in the two groups of patients at one and three months after surgery

<table>
<thead>
<tr>
<th>Index</th>
<th>Distance</th>
<th>Time</th>
<th>Multifocal</th>
<th>Monofocal</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sphere</td>
<td>Far</td>
<td>1 month</td>
<td>0.23±1.00</td>
<td>-0.02±0.63</td>
<td>0.156</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 month</td>
<td>0.23±0.51</td>
<td>-0.02±0.72</td>
<td>0.072</td>
</tr>
<tr>
<td></td>
<td>Near</td>
<td>1 month</td>
<td>0.70±1.05</td>
<td>0.26±1.05</td>
<td>0.072</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 month</td>
<td>0.59±0.84</td>
<td>0.43±1.08</td>
<td>0.492</td>
</tr>
<tr>
<td>Cylinder</td>
<td>Far</td>
<td>1 month</td>
<td>-0.82±0.88</td>
<td>-0.71±0.5</td>
<td>0.468</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 month</td>
<td>-0.68±0.55</td>
<td>-0.8±0.5</td>
<td>0.261</td>
</tr>
<tr>
<td></td>
<td>Near</td>
<td>1 month</td>
<td>-0.55±0.92</td>
<td>-0.6±0.55</td>
<td>0.808</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 month</td>
<td>-0.53±0.68</td>
<td>-0.54±0.56</td>
<td>0.941</td>
</tr>
<tr>
<td>Spherical equivalent</td>
<td>Far</td>
<td>1 month</td>
<td>-0.18±1.24</td>
<td>-0.37±0.63</td>
<td>0.346</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 month</td>
<td>-0.11±0.55</td>
<td>-0.32±0.78</td>
<td>0.147</td>
</tr>
<tr>
<td></td>
<td>Near</td>
<td>1 month</td>
<td>0.42±1.15</td>
<td>-0.04±1.17</td>
<td>0.087</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 month</td>
<td>0.33±0.97</td>
<td>0.16±1.25</td>
<td>0.539</td>
</tr>
</tbody>
</table>

*: Comparison multifocal and monofocal with independent T-test

**Contrast sensitivity**

The inter-group differences in contrast sensitivity, measured with and without glare at 3, 6, 12, and 18 cycles per degree (CPD), were statistically significant at one month after surgery at 12 and 18 CPD measured with glare. At 12 CPD with glare, the contrast sensitivity in the multifocal and monofocal IOL groups at one month after surgery was 0.88 and 1.08, respectively (P=0.001) (Figure 1).

Figure 1. Contrast sensitivity in multifocal and monofocal lenses at 1 and 3 months
These figures were 0.45 and 0.62, respectively, at 18 CPD. At one month after surgery, mean contrast sensitivity without glare was better in the monofocal group at 6, 12, and 18 CPD (Figure 1).

At 3 months after surgery, the mean contrast sensitivity with glare at 6, 12, and 18 CPD and the mean contrast sensitivity without glare at 6 and 12 CPD were significantly better in the monofocal group. Other values were not statistically different between the two groups (Figure 1).

**Discussion**

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 types of lenses in the correction of distant vision. Considering the special features in the design of multifocal IOLs to restore near vision in patients, a number of questions are raised. For example, does relative correction of near vision with multifocal IOLs reduce their efficiency in restoring distant vision? Or, is improved near vision to the expense of decreased contrast sensitivity?

The major weakness of this study was the selection bias created because of 12% to 30% loss of follow-up at 3 months after surgery.

As demonstrated in the results section, mean UDVA was 0.14 logMAR in the multifocal group and reached 0.11 logMAR at 3 months. In the monofocal group, these figures were 0.12 and 0.14 logMAR, respectively; there were no significant differences between the two groups during the follow-up period. Ortiz et al\(^6\) compared the visual performance of these two types of IOLs and reported a UDVA of \(8/10\) in both groups, indicating no significant differences. Cillino et al\(^5\) compared 4 types of refractive and defractive IOLs in cataract patients showing no significant difference in terms of uncorrected visual acuity (UCVA). Insignificant differences in UDVA between monofocal and multifocal IOLs have also been reported by Souza et al\(^9\) as well as Chiam et al\(^10\) who studied 80 patients (40 in each group) and found that the decimal UDVA at 2 months was 0.79 and 0.85 decimal, respectively. Overall, reports on this issue agree that multifocal IOLs are capable of correcting DVA just as well as monofocal IOLs\(^1,3,11\).

The CDVA, as demonstrated in table 1, was not significantly different between the two groups either; 0.03 and 0.04 logMAR in the monofocal and multifocal groups, respectively. Similarly, there were no significant differences in the CDVA reported for multifocal and monofocal groups in the study by Chiam et al\(^10\) (0.98 and 0.94 decimal, respectively) and Otriz et al\(^8\) (0.9 and 1.0 decimal, respectively) at six months. In another study by Chiam et al\(^12\), again they found no significant differences between their two monofocal and multifocal groups in terms of percentage of cases achieving \(20/120\) CDVA (82% and 86%, respectively). Similarly, in our patients, the percentage of cases achieving \(20/120\) CDVA in the monofocal and multifocal groups were very close (59.9% and 60.0%, respectively).

Overall, these results indicate that there are no significant differences between monofocal and multifocal IOLS in terms of distant vision with or without correction. In patients whose only concern is restoring distant vision, the extra cost of multifocal IOLs may be unnecessary, and monofocal IOLs may be a more appropriate choice.

The highlight of the present study was the differences we found between the two groups in UNVA. At 3 months after surgery, the UNVA in the monofocal and multifocal groups were 0.22 and 0.14, respectively, after correction of DVA, and the inter-group difference was statistically significant. Findings in other studies support our results, and they agree that multifocal or defractive IOLs improve UNVA.\(^9,12,13\) Ortiz et al\(^8\) reported a mean UNVA of 0.7 and 0.9 decimal in their monofocal and multifocal patients, respectively; statistically significantly better in the multifocal group. Cillino et al\(^5\) stated that these figures were 0.61 and 0.72 decimal, respectively; the difference was statistically significant and they concluded that defractive IOLs are better capable of correcting UNVA.

In the report by Chiam et al\(^10\) these figures were 0.34 and 0.72 decimal, respectively; again, the evidence on NVA was in favor of multifocal IOLs. Overall, since the multifocal IOLs are designed to improve near vision, the results were not unexpected. In terms of CNVA, the averages were 0.04 and 0.05 logMAR in the monofocal and multifocal
groups, respectively (Table 1). Other similar studies have demonstrated that there are no significant differences between these two types of IOLs.6,10

According to our findings, the contrast sensitivity with and without glare was significantly lower in the multifocal group, and this is in agreement with findings of previous studies.2,3,14,15 In the report by Vingolo et al.,3 the mean contrast sensitivity were 18.28 dB and 19.18 dB in the multifocal group and monofocal group by static program, respectively. The long-term performance of the AcrySof ReSTOR IOL after cataract surgery was assessed in the article by De Vries et al.15 They reported that contrast sensitivity was relatively acceptable after their surgeries.

Multifocal IOLs fall in the category of detractive lenses, and a lower contrast sensitivity could be due to defraction of light in higher spatial frequencies, and thus, light fails to focus correctly on the retina. This results in blurred vision and lower contrast sensitivity. We observed maximum differences between the two types of IOLs at higher spatial frequencies. One of the most important points in selecting the type of IOL for a given patient is their daily activities. For patients who spend most of their time doing work within a close distance from their eyes, multifocal IOLs can be a more appropriate choice. For those who are less involved with such types of work or who are dependent on distant vision, monofocal IOLs can be used to avoid the reduction in contrast sensitivity and associated complaints such as glare and halo experienced during driving, that is usually seen with multifocal IOLs.

Some limitations of our study should be mentioned. We did not study or compare halo in the two groups. Some studies have examined this complication and report differences between them.3,10 In most comparative studies of these two types of IOLs, or those investigating the performance of multifocal IOLs, patient satisfaction and quality of life was assessed. However, we failed to do so due to certain constraints.3,6,10 Also, the intermediate vision was not assessed in our study.

Conclusion

Based on our findings, we can claim that there are no significant differences in the DVA of patients receiving multifocal IOLs as compared to monofocal ones. In terms of UNVA, multifocal IOLs can perform significantly better than monofocal IOLs. Also, a slight reduction in contrast sensitivity should be expected postoperatively when implanting multifocal IOLs.

References


