

# The Effects of AcrySof® ReSTOR Intraocular Lenses on Visual Quality\*

AcrySof® ReSTOR Göz İçi Lenslerin Görme Kalitesi Üzerindeki Etkileri

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Orijinal Article

Klinik Çalışma

## ABSTRACT

**Purpose:** To compare the modulation transfer function (MTF), the root mean square (RMS) of higher order aberrations, and the point-spread function (PSF) values in 20 eyes in which multifocal apodized diffractive intraocular lenses (IOLs) (AcrySof® ReSTOR) and monofocal IOLs (AcrySof® Natural) were implanted.

**Materials and Methods:** In this comparative and prospective study, 10 patients (20 eyes) who underwent cataract surgery using phacoemulsification and IOL implantation were included. Two types of IOLs were used in this study. In Group 1 AcrySof® ReSTOR diffractive IOLs (model SN60D3, Alcon Research Ltd. Fort Worth, TX) were used, and in Group 2 AcrySof® Natural monofocal IOLs (model SN60AT, Alcon Research Ltd. Fort Worth, TX) were used. Mean age of the patients was  $67.6 \pm 2.7$  and  $58.8 \pm 4.3$  in Group 1 and Group 2, respectively. At the fourth postoperative week, PSF, MTF, and RMS measurements were obtained by Nidek optical pathway difference (OPD)-Scan (Nidek Co. Ltd. Jp.).

**Results:** Postoperative uncorrected visual acuities in all the eyes were 20/20. In Group 1 postoperative mean values were as follows: MTF:  $0.426 \pm 0.165$ ; PSF:  $0.055 \pm 0.066$ ; RMS  $0.766 \pm 0.494$ . In Group 2 postoperative mean values were as follows: MTF:  $0.388 \pm 0.168$ ; PSF:  $0.077 \pm 0.121$ ; RMS:  $0.899 \pm 0.616$ . There were no statistically significant differences in postoperative PSF, MTF, or RMS values between the two groups.

**Conclusion:** There was no significant difference in the visual quality outcome in terms of MTF, PSF, or RMS values in the eyes with AcrySof® ReSTOR diffractive (SN60D3, Alcon Research Ltd. Fort Worth, TX) and AcrySof® Natural monofocal (SN60AT, Alcon Research Ltd. Fort Worth, TX) IOLs.

**Key Words:** Intraocular lenses (IOLs), diffractive IOLs, phacoemulsification.

## ÖZ

**Amaç:** Multifokal apodize difraktif göz içi lens (AcrySof® ReSTOR) ve monofokal göz içi lens (AcrySof® Natural) yerleştirilmiş hastaların MTF (modulation transfer function), RMS (root mean square of higher order aberrations) ve PSF (point-spread function) değerlerinin karşılaştırması.

**Gereç ve Yöntem:** Bu karşılaştırmalı ve prospektif çalışmada 10 hastanın 20 gözüne fakoemülsifikasyon ve intraoküler lens implantasyonu yapıldı. Bu çalışmada iki tip intraoküler lens kullanıldı. Grup 1'de AcrySof® ReSTOR difraktif GİL (model SN60D3, Alcon Research Ltd. Fort Worth, TX), Grup 2'de AcrySof® Natural monofokal GİL (model SN60AT, Alcon Research Ltd. Fort Worth, TX) kullanıldı. Hastaların yaş ortalaması Grup 1'de  $67.6 \pm 2.7$ , Grup 2'de  $58.8 \pm 4.3$  idi. Postoperatif 4. haftada PSF, MTF ve RMS ölçümleri Nidek OPD (optical pathway difference)-Scan (Nidek Co. Ltd. Jp.) ile yapıldı.

**Bulgular:** Ameliyat sonrasında bütün hastaların tashihsiz görme keskinliği tamdı. Grup 1'de ameliyat sonrası ortalama değerler şöyledi: MTF:  $0.426 \pm 0.165$ ; PSF:  $0.055 \pm 0.066$ ; RMS  $0.766 \pm 0.494$ . Grup 2'de ameliyat sonrası ortalama değerler şöyledi: MTF:  $0.388 \pm 0.168$ ; PSF:  $0.077 \pm 0.121$ ; RMS:  $0.899 \pm 0.616$ . İki grup arasında, ameliyat sonrası PSF, MTF ve RMS değerleri bakımından istatistiksel olarak anlamlı bir fark yoktu.

**Sonuç:** Mültifokal apodize difraktif göz içi lens (AcrySof® ReSTOR) ve monofokal göz içi lens (AcrySof® Natural) uygulanan gözler arasında nihai görme kalitesinde MTF, PSF ve RMS değerleri açısından anlamlı bir fark saptanmadı.

**Anahtar Kelimeler:** Göz içi lensleri, difraktif GİL, fakoemülsifikasyon.

Glo-Kat 2009;4:109-111

Geliş Tarihi : 12/01/2009

Kabul Tarihi : 10/03/2009

Received : January 12, 2009

Accepted : March 10, 2009

\* Bu çalışma 41. TOD (2007) Ulusal Oftalmoloji Kongresinde sunulmuştur.  
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## INTRODUCTION

Innovations in the cataract surgery and implantation of multifocal intraocular lenses restore the far and near sight of the patients and reduce the need of the glasses.<sup>1</sup> It is known that multifocal intraocular lenses (IOL) which are manufactured to resolve the far and near problems of the pseudophakic patients reduce the spherical aberration more than the monofocal IOL.<sup>2</sup>

The optical quality of an eye can be evaluated with wavefront analysis, modulation transfer function (MTF) and point-spread function (PSF) measurements. MTF and PSF are direct quantitative measurements of the visual quality. MTF describes contrast degradation between object and image in various spatial frequencies. PSF expresses the spread of the point-shaped stimulation on the retina. Because of this, MTF and PSF are the concepts related with image quality and contrast sensitivity.<sup>3</sup>

In this study, the effect of the AcrySof® ReSTOR multifocal apodized diffractive IOL on MTF, PSF and the aberration of the higher order wavefront RMS values are investigated.

## MATERIALS AND METHODS

In this prospective study two different types of IOL were compared. After the phacoemulsification with clear corneal temporal incision, 10 eyes of 5 patients received AcrySof® ReSTOR (model SN60D3, Alcon Research Ltd. Fort Worth, TX) in Group 1 and 10 eyes of 5 patients received AcrySof® Natural (model SN60AT, Alcon Research Ltd. Fort Worth, TX) in Group 2 (Figure 1-2).

Eyes with more than 1.0 D astigmatism, corneal scarring or leukoma, large capsulorhexis more than 5 mm and postoperative IOL tilting were excluded from the study. Cases having postoperative UCVA of 20/20 were included in the study. All the eyes were operated by one surgeon only (NO). And postoperative wavefront analyses were done by one clinician only (GO). All patients were examined on the 1<sup>st</sup>, 2<sup>nd</sup>, and 4<sup>th</sup> postoperative weeks. On the 1st postoperative month visual acuity measurements and wavefront, MTF and PSF analyses were

done with Snellen acuity chart and Nidek OPD-Scan (Nidek Co. Ltd. Jp.) respectively. There were no difference in the pupil size on both groups during the wavefront analyses. Statistical analysis was done with Mann-Whitney U method and  $p < 0.05$  was considered as significant.

The approval of the Ethical Committee of the Cukurova University Medical Faculty has been received for this study.

## RESULTS

Ten patients (6 women and 4 men) were recruited to the study. Mean age of the patients were  $68 \pm 3$  (range 64-72), and  $59 \pm 4$  (range 51-65) in Group 1 and Group 2 respectively. In terms of age, there was no statistical difference between the groups ( $p > 0.05$ ).

All the eyes have uncorrected visual acuity of 20/20 in both groups. Mean power of the implanted IOL's was  $19.2 \pm 1.81D$  and  $19.85 \pm 1.65D$  in Group 1 and 2 respectively and there was no statistical difference between the two groups ( $p > 0.05$ ). Mean follow-up time was 1 month. No IOL decentralization was observed during the slit lamp examinations. In postoperative wavefront analyses the mean pupil sizes were  $5.34 \pm 0.4$  mm and  $5.4 \pm 0.7$  mm in Group 1 and 2 respectively; and the difference between the pupil sizes was statistically insignificant.

Postoperative mean HOA RMS values were  $0.766 \pm 0.494$  (range 0.336-1.723) and  $0.898 \pm 0.614$  (range 0.209-2.0) in Group 1 and 2 respectively. The difference between the two groups was statistically insignificant ( $p > 0.05$ ). Postoperative mean MTF values were  $0.426 \pm 0.165$  (range 0.16-0.64) and  $0.388 \pm 0.168$  (range 0.10-0.64) in Group 1 and 2 respectively. The difference between the two groups was statistically insignificant ( $p > 0.05$ ).

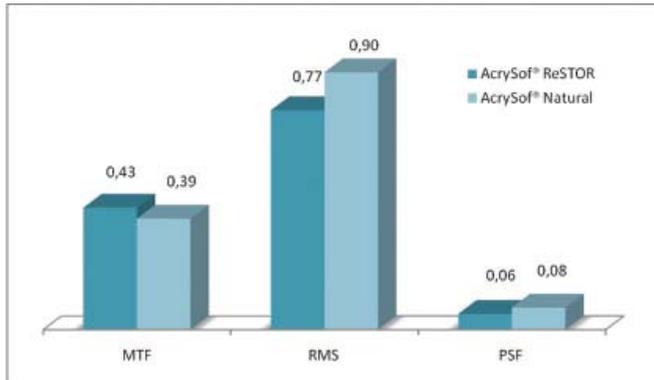
Postoperative mean PSF values were  $0.055 \pm 0.066$  (range 0.009-0.219) and  $0.077 \pm 0.121$  (range 0.002-0.322) in Group 1 and 2 respectively. The difference between the two groups was statistically insignificant ( $p > 0.05$ ) (Figure 1).



**Figure 1-2:** The view of AcrySof® ReSTOR implanted in the bag before and after the myotic application into the anterior chamber during the operation.



**Figure 3:** AcrySof® ReSTOR apodized diffractive multifocal IOL.



**Graphic:** The comparison of MTF, WF HOA RMS and PSF values between AcrySof® ReSTOR and AcrySof® Natural IOL's.

## DISCUSSION

Current IOL technology offers the surgeons the possibility of using monofocal, multifocal and accommodative IOL's individually or in combination. Richard L. Lindstrom, professor of ophthalmology, University of Minnesota, has stated that the goal of the current cataract surgery is, not only to achieve the visual acuity of 20/20 but also to have a 20/happy patient. It means that postoperatively achieved uncorrected far and near visual acuities are 10/20 and J3 respectively. That is why the multifocal IOL's became widespread to provide a satisfactory far and near vision without glasses after the cataract surgery. But it has been stated that multifocal IOL technology has some postoperative optical side effects.<sup>4</sup>

In this study, the eyes which have been implanted multifocal IOL's and monofocal IOL's were compared by wavefront analyses in order to evaluate the effects of the multifocal IOL implantation on the optical quality of the eye. Wavefront technology is developed for the evaluation of the higher and lower order aberrations in the phakic eyes. This technology can be utilized to obtain information about the optical quality of pseudophakic eyes as well.<sup>5-7</sup>

The studies done with wavefront show that the IOL implantations increase particularly the spherical aberrations.<sup>8,9</sup> Visual problems such as glare and halo are assumed to be related with spherical aberrations in pseudophakic eyes.<sup>8</sup>

Multicentric studies show that the multifocal IOL's decreasing the eyeglass dependence of the pseudophakic patients cause clinically acceptable but undesirable photic phenomenon.<sup>10</sup>

In our study MTF, PSF and the wavefront RMS values are compared to evaluate the effects of the monofocal and multifocal IOL's on the optical quality of the eye after the cataract operation.

Multifocal IOL's (AcrySof® ReSTOR) used in this study has 3.6mm apodized diffractive anterior surface which is designed according to the Huygens-Fresnel principle (Pic. 3). Its material is identical with the materi-

al of the monofocal IOL (AcrySof® Natural) used in the control group.

In our study, the age difference between the groups was statistically insignificant.

Moreover, for the sake of standardization, only the eyes with postoperative uncorrected visual acuity of 20/20 were included in the study.

When the postoperative measurements were compared with the preoperative values, there were statistically insignificant changes (increase in the MTF and decrease in the PSF and WF RMS values) in the eyes of AcrySof® ReSTOR group.

Even though the increase of the MTF values and the decrease of the WF RMS values were statistically insignificant, we think that these changes may have a positive effect on the optical quality of the eye. But the decrease of PSF values which was thought to have a negative effect on optical quality was not statistically significant.

MTF and PSF values along with the wavefront RMS values quantitatively showed that the apodized diffractive anterior surface of the multifocal IOL's, compared to the monofocal IOL's, had no negative effect on the optical quality of the eye.

In conclusion, we think that AcrySof® ReSTOR multifocal apodized diffractive IOL implantation has provided sufficient visual performance in terms of optical quality.

We suggest that multifocal IOL's could improve the patients' quality of life and meet their visual expectations by reducing the necessity of far and near glasses after an uneventful cataract surgery.

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