

# Visual performance in pseudophakic patients with different intraocular lens

## *Desempenho visual dos pacientes pseudofácicos com diferentes lentes intraoculares*

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### ABSTRACT

**Objective:** Comparison of the visual performance between patients with Tecnis<sup>®</sup> MF ZM900, Acrysof<sup>®</sup> Restor<sup>®</sup> SN60D3, Acrysof<sup>®</sup> SN60AT and Acrysof<sup>®</sup> SN60WF intraocular lenses. **Methods:** This prospective comparative study included 142 eyes of 71 patients in Sao Paulo University. The ophthalmologic evaluation performed included near, intermediate and distance corrected and uncorrected visual acuity, contrast sensitivity measurement and wavefront analysis. The minimum follow-up was 6 months. **Results:** The mean age of patients was 60.7±6.6 years in the Tecnis<sup>®</sup>MF, 63.1±4.4 years in-group Restor<sup>®</sup> 63.7±4.2 years in monofocal group (SN60AT in the fellow eye SN60WF). The Restor and Tecnis groups has uncorrected near and corrected distance visual acuity statistically superior compared to SN60AT/SN60WF group ( $p<0.001$ ). There was no statistical difference between groups when compared uncorrected and best-corrected distance visual acuity ( $p=0.56$ ). Contrast sensitivity in photopic conditions was significantly lower in the Restor and Tecnis group ( $p<0.001$ ). The SN60AT showed higher spherical aberration compared to all other lenses ( $p<0.001$ ). The Tecnis showed a lower mean values of spherical aberration compared to Restor lenses ( $p<0.001$ ). **Conclusion:** Restor and the Tecnis had better near visual acuity than the SN60AT/SN60WF group. All intraocular lenses promoted good distance vision. The Tecnis group showed better contrast sensitivity, less aberrations and better intermediate vision than the Restor group.

**Keywords:** Cataract; Vision; Intraocular lens; Patient satisfaction

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## RESUMO

**Objetivo:** Comparar a performance visual dos pacientes submetidos ao implante das lentes intraoculares multifocais difrativas Tecnis® MF ZM900, Acrysof® Restor® SN60D3, Acrysof® SN60WF e Acrysof® SN60AT. **Métodos:** Estudo prospectivo comparativo, não randomizado, que incluiu 142 olhos de 71 pacientes com catarata, provenientes do ambulatório de oftalmologia do HC-FMUSP. A avaliação oftalmológica contou com medida da acuidade visual para longa, intermediária e curta distância, sem correção e com a melhor correção óptica, teste de sensibilidade ao contraste, pupilometria e análise de frente de onda por meio do aberrômetro. Todos os exames foram realizados com seis meses de pós-operatório. **Resultados:** A média de idade dos pacientes foi de 60,7±6,6 anos no grupo Tecnis, 63,1±4,4 anos no grupo Restor e 63,7±4,2 anos no grupo monofocal (SN60AT no olho contralateral SN60WF). A acuidade visual para perto não corrigida e corrigida para longe foi estatisticamente superior nos grupos multifocal Restor e multifocal Tecnis em comparação ao grupo monofocal SN60AT/SN60WF ( $p<0,001$ ). Não houve diferença estatística entre os grupos na comparação da acuidade visual para longe ( $p=0,56$ ). A sensibilidade ao contraste fotópica monocular foi estatisticamente inferior nos grupos Restor e Tecnis ( $p<0,001$ ). A SN60AT apresentou maior aberração esférica comparada a todas as outras lentes ( $p<0,001$ ). A Tecnis se mostrou com menores valores médios de aberrações esféricas na comparação com a Restor ( $p<0,001$ ). **Conclusão:** A Restor e Tecnis apresentaram melhor acuidade visual para perto do que o grupo monofocal SN60AT/SN60WF. Todas as lentes intraoculares promoveram boa visão para longe. O grupo da Tecnis apresentou melhor sensibilidade de contraste, menos aberrações ópticas e melhor visão intermediária que o grupo Restor.

**Descritores:** Catarata; Visão; Lentes intraoculares; Satisfação do paciente

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## INTRODUCTION

Cataract surgery has been evolving through new surgical techniques and intraocular lenses (IOLs) as well as new technologies and the development of improved phacoemulsification devices<sup>(1)</sup>.

To further understand the optic system of IOLs, new technologies have been developed. Aberrometers are devices with sensors capable of quantifying the deviation and imperfections of the waveform with respect to a planar wavefront<sup>(2,3)</sup>.

In order to provide additional benefits to the visual quality of pseudophakic patients, intraocular lenses have been refined using an aspherical lens design to correct positive spherical aberrations of the cornea<sup>(2-4)</sup>. This led to the development of the SN60WF aspherical lens, developed from the SN60AT lens, both produced by Alcon Laboratories (Fort Worth, Texas, USA). The former provides greater reduction in spherical aberrations with better vision in low light conditions and increased contrast sensitivity in the postoperative period compared with the latter<sup>(5-9)</sup>.

Pseudoaccommodative or multifocal lenses can be diffractive or refractive. The Tecnis™ MF and ReSTOR™ lenses are diffractive lenses designed to provide far and near vision, decreasing dependence of optical correction with little or no impairment of visual quality. Optical quality is as important as the measure of visual acuity when assessing the performance of any IOL<sup>(10)</sup>.

Monofocal IOLs are traditionally used for intraocular implants in cataract surgery. Due to their lack of optical correction, they do not provide a satisfactory depth of focus at varying distances. Despite the potential benefits of multifocal IOLs, their indications are still limited<sup>(10,11)</sup>.

More advanced multifocal IOLs aim to produce contrast sensitivities similar to those accepted for monofocal IOLs while inducing minimal optical aberrations. However, the scientific literature reports a loss of contrast sensitivity and functional vision associated with photic phenomena that affect patient satisfaction<sup>(12)</sup>.

The aim of this study was to assess the visual performance of patients undergoing phacoemulsification with implantation of the following IOLs: Tecnis™ ZM900 aspherical multifocal lens; ReSTOR™ SN60D3 spherical multifocal lens; SN60WF aspherical monofocal lens; and SN60AT spherical monofocal lens.

## METHODS

Prospective non-randomised comparative study on 142 eyes of 71 patients who spontaneously sought ophthalmic care. Subjects were recruited between March 2006 and September 2007. Evaluations took place from January 1, 2008 to August 25, 2009 at a single centre using a single-blind, prospective, comparative design at the Cataract Unit of the Department of Ophthalmology, University Hospital of the São Paulo University.

Inclusion criteria were: age between 45 and 65 years; literate patients; bilateral senile cataract; corneal astigmatism under 1.00 D in both eyes; pupil diameter of at least 3.5 mm under mesopic conditions, measured using a Colvard pupillometer (Oasis Corporation, Glendora, CA, USA); and absence of any other eye disorders, previous eye surgery, dyschromatopsias, use of topical hypotensive medications, or other systemic diseases that might affect postoperative vision with decreased contrast sensitivity, such as diabetic retinopathy. Patients who met the inclusion criteria were informed about the need for additional tests to measure optical aberrations and contrast sensitivity. Only subjects who agreed to undergo such tests were included. Exclusion criteria were: intra- or postoperative complications; doubts regarding implantation of the IOL in the capsular bag; and IOL decentration greater than 0.5 mm as measured by slit lamp examination.

In total, 46 eyes of 23 patients underwent conventional phacoemulsification with implantation of Tecnis™ MF aspherical multifocal IOLs, and 32 eyes of 16 patients received Acrysof ReSTOR™ apodised spherical multifocal IOLs. The control group comprised 32 eyes of 32 patients who underwent surgery with implantation of Acrysof™ SN60WF aspherical monofocal IOLs in one eye and AcrySof™ SN60AT spherical monofocal IOLs in the contralateral eye (Alcon Laboratories, Fort Worth, TX, USA). All procedures were performed by a single experienced surgeon (CTN) using a standardised surgical technique.

The Tecnis ZM900 multifocal IOL features 20 diffractive zones for near and far vision with an adding power of +4.00 D in its flat refraction, corresponding to +3.20 D in the flat refraction of eye glasses. Therefore, the IOL is completely diffractive, i.e., vision performance does not depend on the pupil. The AcrySof

**Table 1**  
**Assessing monocular near and intermediate visual acuity (uncorrected and corrected for far vision) in patients submitted to cataract surgery with implantation of Tecnis™ MF, ReSTOR™, SN60AT, and SN60WF IOLs.**

	<b>Tecnis MF</b> (N = 46 eyes)	<b>ReSTOR</b> (N = 32 eyes)	<b>SN60WF</b> (N = 32 eyes)	<b>SN60AT</b> (N = 32 eyes)
<b>INTERMEDIATE</b>				
J1 – J2	28,26% (13)	0	6,25% (2)	6,25% (2)
J3 – J4	45,65% (21)	12,5% (4)	6,25% (2)	25% (8)
J5 – J6	17,39% (8)	28,13% (9)	56,25% (18)	43,75% (14)
> J6	8,70% (4)	59,38% (19)	31,25% (10)	25% (8)

Chi-square and Fisher tests,  $p < 0.001$ ; *TECNIS* vs. *RESTOR.SN60WF.SN60AT*

<b>NEAR</b>	<b>N = 46 eyes</b>	<b>N = 32 eyes</b>	<b>N = 32 eyes</b>	<b>N = 32 eyes</b>
J1 – J2	95,65% (44)	96,88% (31)*	0	6,25% (2)
J3 – J4	4,34% (2)	3,13% (1)	0	31,25% (6)
J5 – J6	0	0	43,75% (14)	12,50% (4)
> J6	0	0	56,25% (18)	50% (16)

Chi-square and Fisher tests,  $p < 0.001$ . *TECNIS.RESTOR* vs. *SN60WF.SN60AT*

ReSTOR™ IOL has refractive zones for far vision, with diffractive zones for near and far vision in the centre. It is a pupil-dependent IOL with rings of different heights, starting with 1.4 mm in the centre and ending with 0.2 mm in the periphery, where the lens becomes refractive only. The lens has an optical adding power of +4.00 D in the central 3.6 mm and +4.00 D in its flat refraction<sup>(12)</sup>.

Best-distance near visual acuity was measured using the ETDRS chart at a distance between 30 and 40 cm; visual acuity was recorded in logMAR. Best-distance intermediate visual acuity was measured using the ETDRS chart at a distance between 50 and 70 cm. For near and intermediate visual acuity corrected for far vision, logMAR visual acuity was assessed using the correction obtained for manifest refraction<sup>(5,10)</sup>.

Contrast sensitivity was measured using the VCTS™ 6000 (Vistech Consultants Incorporation, Dayton, OH, USA) device under photopic (85 cd/m<sup>2</sup>) and mesopic (5 cd/m<sup>2</sup>) conditions<sup>(7-9)</sup>. The chart displays lines in five spatial frequencies between 1.5 and 18 cycles per degree (cpd).

The test was performed at the 6-month visit under controlled lighting conditions with a luminance of 85 candelas (cd/m<sup>2</sup>) as measured by a photometer (Gossen Starlite). Pupillary diameters were measured under the same lighting conditions using a Ginsburg Box (photopic and mesopic) and a Colvard (Oasis Corporation, Glendora, CA, USA) infrared pupillometer. Optical aberrations were measured using the OPD Scan II™ (Nidek Co. Ltd., Okazaki, Japan) device with pupils dilated with 1% tropicamide, with a diameter of at least 5 mm<sup>(4,13)</sup>.

A significance level of 5% was adopted; comparison tests such as the Tukey, Kruskal-Wallis, Mann-Whitney, and Chi-square (two-tailed) tests were used, adjusting the significance level when needed. The statistical power of the sample was calculated for all tests. The power to detect differences between groups was greater than 90%, with a 5% significance level for all measures of visual acuity, pupillometry, aberrometry, and monocular contrast sensitivity.

## RESULTS

The mean age of patients was  $60.7 \pm 6.6$  years in the aspherical multifocal group,  $63.1 \pm 4.4$  years in the spherical multifocal group, and  $63.7 \pm 4.2$  years in the monofocal group. There were no statistically-significant differences between groups for uncorrected far visual acuity and best corrected visual acuity ( $p = 0.144$ ). There were also no significant differences between the groups with regard to sex. No intraoperative complications occurred.

No statistically-significant differences were found for spherical equivalent and refractive cylinder between the four IOL groups. Spherical error was  $-0.068 \pm 0.410$  D (-1 to +1) for the Tecnis™ MF group;  $+0.039 \pm 0.312$  D (-0.25 to +0.5) for the ReSTOR™ group;  $-0.066 \pm 0.333$  for the SN60WF group; and  $-0.102 \pm 0.403$  for the SN60AT group, without statistically-significant differences between groups.

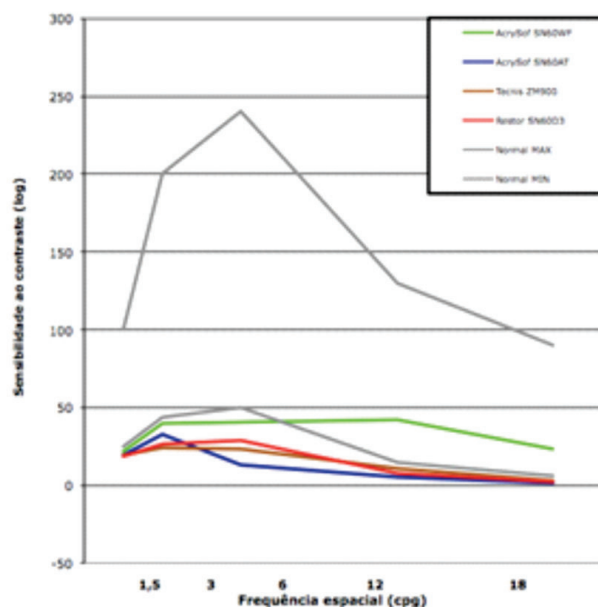
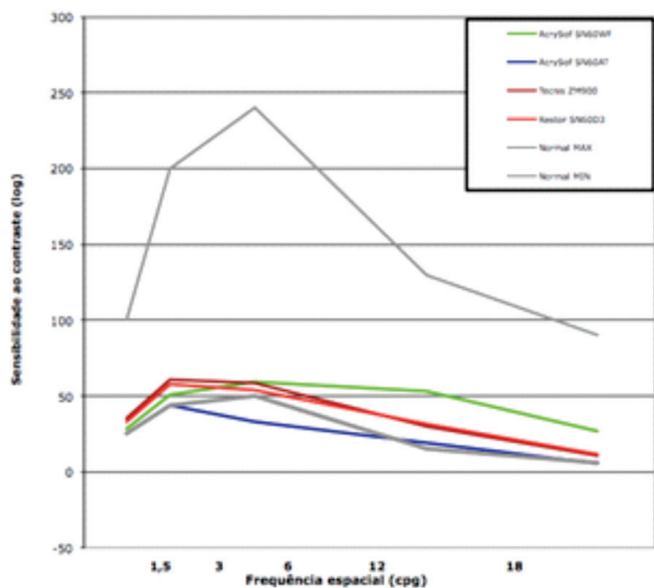
All eyes in the 4 groups were statistically equivalent for corrected visual acuity at the final 6-month postoperative visit. Mean postoperative corrected visual acuity was  $+0.006 \pm 0.028$  logMAR units ( $p < 0.01$ ) in the Tecnis™ MF group;  $0.015 \pm 0.052$  logMAR units in the ReSTOR™ group ( $p < 0.01$ );  $-0.07 \pm 0.13$  logMAR units in the SN60WF group ( $p < 0.01$ ); and  $0.006 \pm 0.16$  logMAR units in the SN60AT group ( $p < 0.01$ ).

There was no statistically-significant difference in mean uncorrected monocular far visual acuity between the monofocal and the multifocal group. Intermediate (50 to 70 cm) and near (30 to 40 cm) visual acuity without optical correction was assessed using the ETDRS™ chart; a statistically-significant difference between lenses was found only for intermediate vision, favouring the Tecnis™ MF group ( $p < 0.001$ ). No patient required optical correction for near or far vision after surgery in any everyday situation (Table 1).

In the assessment of contrast sensitivity under photopic conditions, the aspherical group (Tecnis™ MF, SN60WF) was statistically superior to the spherical group (ReSTOR™, SN60AT) at 1.5 cpd ( $p = 0.06-0.046$ ). All lenses were superior to SN60AT at 3 and 6 cpd ( $p < 0.001-0.032$ ). There were also

Chart 1

**Assessing contrast sensitivity under photopic and mesopic conditions among patients submitted to cataract surgery with implantation of Tecnis™ MF, ReSTOR™, SN60AT, and SN60WF lenses.**



statistically-significant differences between the four lenses at 12 and 18 cpd ( $p < 0.001-0.027$ ) favouring SN60WF (Chart 1).

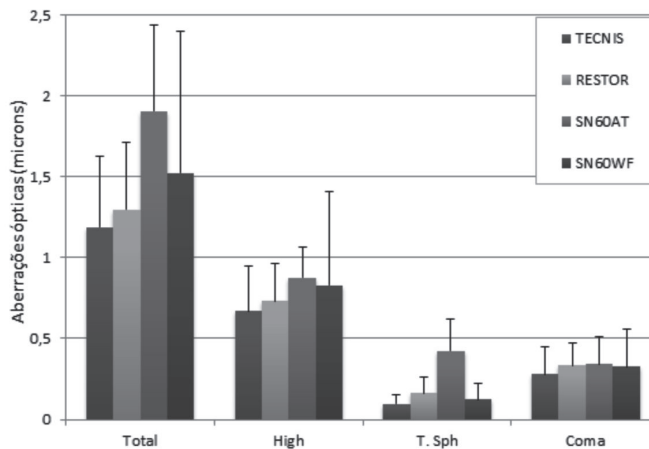
In the assessment of contrast sensitivity under mesopic conditions, the SN60WF group was statistically superior to the multifocal group (ReSTOR™, Tecnis™) at 1.5 cpd ( $p = 0.01-0.011$ ). All lenses were superior to SN60AT at 6 cpd ( $p < 0.001-0.021$ ). There were statistically-significant differences between the four lenses at 12 and 18 cpd ( $p < 0.001$ ) favouring SN60WF (Chart 1).

Chart 2 shows some variables used to assess wavefront aberrations with OPD-Scan™. The spherical and total aberrations of the SN60AT group had statistically higher mean values than all other groups (SN60WF; Tecnis™ MF; ReSTOR™). The Tecnis™ MF group had lower mean values for spherical aberrations than the ReSTOR™ ( $p < 0.001$ ) group.

The high-order aberrations in the SN60AT group had statistically higher mean values than the SN60WF and Tecnis™ groups. The SN60AT group had more comatic aberrations than all other groups. Only the Tecnis™ MF group was statistically superior for comatic aberrations.

Chart 2

**Assessing spherical, total, and high-order aberrations among patients submitted to cataract surgery with implantation of Tecnis™ MF, ReSTOR™, SN60AT, and SN60WF lenses.**



## DISCUSSION

The four groups were compared with regard to age and sex, two variables that could influence patient satisfaction. Mean age was over 60, i.e. patients were possibly economically active. Socioeconomic status and daily/professional activities were not evaluated but are important in selecting patients for multifocal IOL implantation, because patients who perform night activities such as driving and playing sports, among others, may not have the same level of satisfaction as those who do not perform these activities, due to the influence of photic phenomena such as halo and glare triggered by such lenses. Patients who require a more accurate intermediate vision, especially computer users, may not have the same level of satisfaction as patients who need to read

at an average distance of 40 cm. There is a widespread, undemonstrated notion that women tend to accept photic phenomena better in exchange for being independent from glasses. Likewise, elderly individuals would tend to be more tolerant with regard to visual quality.

There was no difference in spherical equivalent between study groups. The refractive outcome was very close to emmetropia, which was our aim. This reaffirms the importance of biometry performed by an experienced examiner using the immersion method or interferometry, which are highly accurate. This is



important because inducing a negative refractive result would favour uncorrected near vision, but would also worsen far vision. Anyway, this effect would be eliminated when measuring near vision corrected for far vision. Another important factor is the fact that no patients had a refractive outcome greater than 1 D cyl, which could lead to an increased frequency and severity of photic phenomena<sup>(14)</sup>.

Our results for uncorrected visual acuity and visual acuity corrected for far vision among patients who received the Tecnis<sup>TM</sup> MF and ReSTOR<sup>TM</sup> lenses are in agreement with the literature. In a European Multicenter Study, Kohnen et al.<sup>(15)</sup> reported that all patients who received ReSTOR<sup>TM</sup> lenses achieved an uncorrected far visual acuity of 20/40 or better, and 97.5% of patients achieved an uncorrected near visual acuity of 20/40 or better.

Chiam et al.<sup>(16)</sup> reported that all patients achieved a monocular uncorrected near visual acuity of 20/40 or better. Blaylock et al.<sup>(17)</sup> reported that 92.5% of patients had an uncorrected near visual acuity of 20/30 or better. Both studies found an uncorrected far visual acuity of 20/40 or better in all patients who received ReSTOR<sup>TM</sup> lenses. Sallet et al.<sup>(12)</sup> reported an uncorrected far visual acuity better than 20/30 in all eyes and an uncorrected near visual acuity of Jagger 3 or better in all patients.

These findings are supported by data in the literature showing that multifocal IOLs provide a statistically better uncorrected near visual acuity than monofocal lenses<sup>(18,19)</sup>.

All measures of binocular near visual acuity were better than monocular measures. This has also been observed in previous studies on multifocal IOLs<sup>(19,21)</sup>.

Uncorrected near vision in the ReSTOR<sup>TM</sup> group was comparable to best corrected near vision in the monofocal group, allowing most daily short-distance activities without the need for optical correction. Despite the existence of two images there is only one effective focus, chosen by the patient, which will depend on the distance of the object to be focused on. The good uncorrected near vision obtained in the ReSTOR<sup>TM</sup> group can be explained by the fact that this lens has an adding power of +4.0 D in its diffractive structure (+3.5 dioptres in the glasses plane). This may also explain the fact that corrected near vision was better in the ReSTOR<sup>TM</sup> group, as the adding power in the monofocal group was limited to +3.0 D<sup>(10)</sup>.

In our study, uncorrected intermediate visual acuity and best corrected far visual acuity among patients in the ReSTOR<sup>TM</sup> group were in agreement with the results of Blaylock et al.<sup>(17)</sup>, where mean visual acuity was 20/36 and 20/38, respectively. However, the same study found better intermediate visual acuity with monofocal SA60AT lenses compared with ReSTOR<sup>TM</sup> lenses, which was not observed in our study for the assessed distances. Chiam et al.<sup>(16)</sup> assessed intermediate visual acuity with ReSTOR<sup>TM</sup> lenses and found worse visual acuity for distances of 50, 60 and 70 cm compared with 33 cm. Although these studies found a worse intermediate visual acuity, mean intermediate visual acuity at 70 cm was comparable with that found in our study.

In this study, high-contrast uncorrected near and far visual acuity tested using the ETDRS<sup>TM</sup> chart in most everyday situations was similar for both IOLs, but the Tecnis<sup>TM</sup> MF group was statistically superior for uncorrected intermediate visual acuity, in agreement with the criteria of normality previously established and described by several authors<sup>(10,15,22,23)</sup>.

We found a better monocular intermediate visual acuity corrected for far vision in the multifocal group (ReSTOR<sup>TM</sup>, Tecnis<sup>TM</sup> MF) compared with the monofocal group (SN60AT; SN60AT) for distances of 40-50 cm. At 50-60 cm corrected for far vision the Tecnis<sup>TM</sup> MF group was statistically superior to all other groups. One possible explanation for this result is that the

adding power of +4.0 D in the lens plane is 3.2 D, providing clear vision at a shorter intermediate distance (in this case, 30-50 centimetres). For distances of 40-60 cm the Tecnis<sup>TM</sup> MF group was superior. For 50-70 cm, an improvement in the mean and median was found in the monofocal group. If intermediate vision was assessed at distances greater than 70 cm, a statistically-significant difference in visual acuity favouring the monofocal group (SN60AT; SN60AT) would probably be found. There was no disagreement between our results and the literature on near and intermediate visual acuity favouring multifocal over monofocal lenses<sup>(22,23)</sup>. Hützet et al.<sup>(23)</sup> reported similar data on the superiority of Tecnis<sup>TM</sup> MF lenses for intermediate vision compared with ReSTOR<sup>TM</sup> and other monofocal lenses.

Leyland et al.<sup>(24)</sup> did a meta-analysis of studies comparing multifocal and monofocal lenses and reported a better uncorrected far visual acuity in patients with monofocal lenses, while other studies found no difference<sup>(16)</sup>. This can be explained by the fact that part of the light is split to a focus anterior to the retina in near vision, while with monofocal lenses all the energy is concentrated in the far focus.

Several studies on the measurement of contrast sensitivity, aberrometry, and reading speed associated with objective measurement of visual acuity and satisfaction questionnaires provide an extensive evaluation of the optical quality and visual performance of implanted IOLs<sup>(11,22,25)</sup>.

The contrast sensitivity results in our study are in agreement with the literature for different spatial frequencies: among patients using ReSTOR<sup>TM</sup> lenses, there was a decrease in contrast sensitivity at certain frequencies (12 and 18 cpd), while it remained normal at other frequencies (3 and 6 cpd)<sup>(24)</sup>. In a study by Souza et al.<sup>(26)</sup>, photopic monocular contrast sensitivity in the ReSTOR<sup>TM</sup> group was statistically inferior to the monofocal group. In our study, under photopic conditions aspherical lenses (Tecnis<sup>TM</sup> MF, SN60WF) were statistically superior to spherical lenses (ReSTOR<sup>TM</sup>; SN60AT) at 3 and 6 cpd.

Mesopic contrast sensitivity is related to the performance of diffractive lenses under low light conditions which are usual in daily life, such as reading and driving at night. Under mesopic conditions all lenses (ReSTOR<sup>TM</sup>, Tecnis<sup>TM</sup> MF; SN60WF) were superior to SN60AT at 3 and 6 cpd. SN60WF lenses were superior to all other lenses (ReSTOR<sup>TM</sup>, Tecnis<sup>TM</sup> MF; SN60AT) at 12 and 18 cpd.

A study that assessed unilateral implantation of ReSTOR<sup>TM</sup> lenses comparing the result with the contralateral phakic eye found a lower contrast sensitivity in eyes implanted with ReSTOR<sup>TM</sup> lenses<sup>(27)</sup>. The lower contrast sensitivity found in the multifocal group (ReSTOR<sup>TM</sup>, Tecnis<sup>TM</sup> MF) can be explained by the diffraction caused by the rings in the lens structure to provide two visual foci, resulting in some loss of contrast. Although no statistical difference has been found in photopic contrast sensitivity between the two groups, the multifocal group (ReSTOR<sup>TM</sup>, Tecnis<sup>TM</sup> MF) had a lower contrast sensitivity, and the difference would possibly be clearer with a larger sample. This result stresses the importance of the aspherical component of multifocal and monofocal lenses, providing better visual performance in photopic and mesopic low contrast conditions compared with spherical lenses.

In our study, aberrometry showed less induction of spherical, high-order and total aberrations in patients implanted with Tecnis<sup>TM</sup> and SN60WF MF lenses. The mean values for high-order aberrations were statistically higher in patients who received SN60AT lenses compared with SN60WF and Tecnis<sup>TM</sup> MF lenses. The results of this study were in agreement with the literature<sup>(11,26)</sup>.

The Tecnis™ MF group had higher absolute values for spherical aberrations than the ReSTOR™ group, but the difference was not statistically significant. Another study with a smaller sample found a significant reduction in spherical aberrations especially in the Tecnis™ MF group<sup>(28)</sup>.

The superior performance of Tecnis™ MF lenses for intermediate vision, contrast sensitivity, and spherical aberrations is believed to be due to its anterior prolate aspherical platform<sup>(15,26-28)</sup>.

The diffractive rings together with the aspherical lens design partly compensate for the spherical aberration of the cornea<sup>(26,28)</sup>. Other aberrometry parameters such as comatic and high-order aberrations showed no significant differences between groups, i.e., despite having diffractive rings in its diffractive surface the IOL did not induce more high-order aberrations detectable by the aberrometer used in this study. High-order aberrations such as comatic and spherical aberrations have an impact on contrast sensitivity and visual function. The monochromatic optical aberrations described by Zernike polynomials represent a way of expressing the quality of the optical visual system. The constant evolution of wavefront analysis technology applied to refractive surgery has been extended to the study of pseudophakic patients.

## CONCLUSION

After analysing the data obtained in this study, we can conclude that the Tecnis™ and ReSTOR™ MF multifocal intraocular lenses led to a visual acuity comparable to the monofocal SN60WF and SN60AT lenses for far vision and to a better uncorrected near vision. Tecnis™ MF lenses require less light for vision in high contrast situations, produce less optical aberrations and provide better intermediate vision than ReSTOR™ lenses. Aspherical lenses (Tecnis™ MF and SN60WF) induced less spherical aberrations and provided better vision under photopic conditions than spherical (ReSTOR™ and SN60AT) lenses. With regard to contrast sensitivity under mesopic conditions, SN60WF lenses were superior to all others. All lenses induced less spherical, comatic, high-order, and total aberrations compared with monofocal SN60AT lenses.

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