

Comparison of Diffractive and Refractive Multifocal Intraocular Lenses in Presbyopia Treatment

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ABSTRACT

Multifocal intraocular lenses (MFIOL) enable good near and far vision after cataract surgery. Excellent results with cataract patients encouraged ophthalmologists to implant MFIOL after clear lens extraction (CLE). There are two types of MFIOL: diffractive and refractive. In our prospective study we compared clinical outcomes after CLE and bilateral implantation of diffractive (Tecnis Multifocal), (N = 100 eyes, 50 patients) and refractive (ReZoom), (N = 100 eyes, 50 patients) MFIOL to patients with presbyopia and hyperopia. Near and distant uncorrected visual acuity (UCVA), spectacle dependency, subjective satisfaction and visual disturbances were measured and compared between two groups. Patients achieved good near and distant UCVA in both groups. »Tecnis« group had better near UCVA (statistically not significant) and less night time visual disturbances. »ReZoom« group reported less problems with intermediate vision. Diffractive and refractive MFIOL enable high rate of spectacle independency to presbyopic hyperopic patients with low rate of side-effects. Refractive MFIOL provide better intermediate vision and diffractive slightly better near vision and less haloes and glare.

Key words: presbyopia, hyperopia, multifocal, lenses, diffractive, refractive, phacoemulsification, pseudophakia

Introduction

Presbyopia and its treatment options are intensively investigated in modern ophthalmology. Although, there are numerous discussions regarding causes and optimal treatment of presbyopia, clear answers are still not available. At the moment, glasses are mostly used for correction of presbyopia but many patients dislike them. In everyday practice we see that more and more people want to become independent of glasses.

»Monovision« principle, contact lenses, laser refractive surgery and new accommodative intraocular lenses are current attempts for presbyopia treatment¹. Those methods did not achieve completely satisfying outcomes and have many limits in patient selection.

Multifocal intraocular lenses (MFIOL) have two or more focuses and they enable good near and distant vision after lens removal^{2,3}. They can be implanted to cataract patients and after clear lens extraction as refractive surgery procedure⁴. Cataract patients who received MFIOL

have well near and far uncorrected visual acuity (UNCVA), low spectacle dependency and they are highly satisfied⁵. Thanks to the fact that MFIOL can produce two images and excellent experience in cataract patients, we started to use them in refractive lens exchange (RLE) as presbyopia treatment.

There are some side-effects of MFIOL implantation such as visual disturbances at night, halos and glare and problems with intermediate vision (work at computer)⁶. Those problems are reduced three to twelve postoperative months, so most of patients do not have serious complains⁷. Postoperative astigmatism is one of the most important issues. It is the most common reason for wearing glasses after MFIOL implantation so we have to avoid patients with more than 1D of preoperative astigmatism.

There are two types of MFIOL: diffractive and refractive. Diffractive MFIOL use light diffraction at an inter-

ference grid to produce two different focal points⁸. In refractive MFIOL, refractive power changes from centre to periphery of lens and produces many focuses⁹. Tecnis Multifocal is diffractive MFIOL which has diffractive posterior surface and prolate anterior surface that suppresses spherical aberrations. It has +4.00 D addition for reading distance. Light distribution between two focuses is 50–50%. ReZoom is refractive MFIOL composed of 5 optical zones with aspherical transition. Three zones, including central, are for far vision, other two for near. ReZoom distributes 10–11% of light to intermediate focus. In our study we have investigated clinical outcomes of Tecnis and ReZoom implantation to presbyopic and hyperopic patients after clear lens extraction and compared obtained differences between two lenses.

Patients and Methods

In this prospective, randomized, comparative study, we divided patients in two groups. Clear lens extraction was performed in both groups on the same PHACO machine using the same operative technique by two experienced surgeons, followed by MFIOL implantation. In first group, Tecnis MFIOL were bilaterally implanted to 50 patients (N = 100 eyes) and in second, ReZoom MFIOL also to 50 patients (N = 100 eyes). There were no significant differences between the two investigated groups regarding age, gender and ocular pathology. Mean age was 52 ± 3.7 years in »Tecnis« group and 54 ± 2.6 years in other one, 29 females and 21 males in both groups. Including criteria were presbyopia and hyperopia more than +1.00 D, need for a bilateral IOL implantation, patients who dislike glasses and were highly motivated for such procedure. Patients with astigmatisms over 1.00 D, retinal or any other serious ocular pathology, professional drivers, people with high professional visual needs or unrealistic expectations were excluded. Preoperative best corrected visual acuity in all cases was 1.0. Follow up was at least 6 months. Near and distant uncorrected visual acuity (UCVA), spectacle dependency, subjective satisfaction and visual disturbances were measured and compared in both groups.

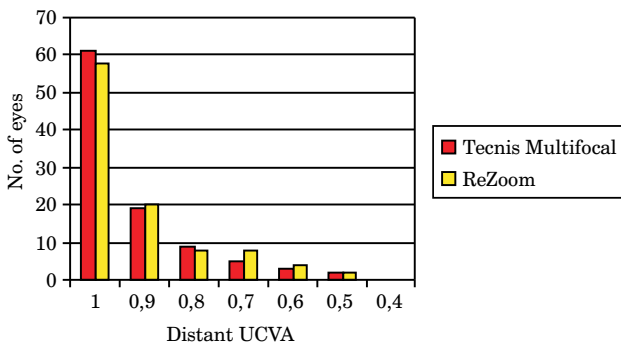


Fig. 1. Distance uncorrected visual acuity (UCVA) at six postoperative months on eyes implanted with diffractive (Tecnis Multifocal) and refractive multifocal intraocular lens (ReZoom).

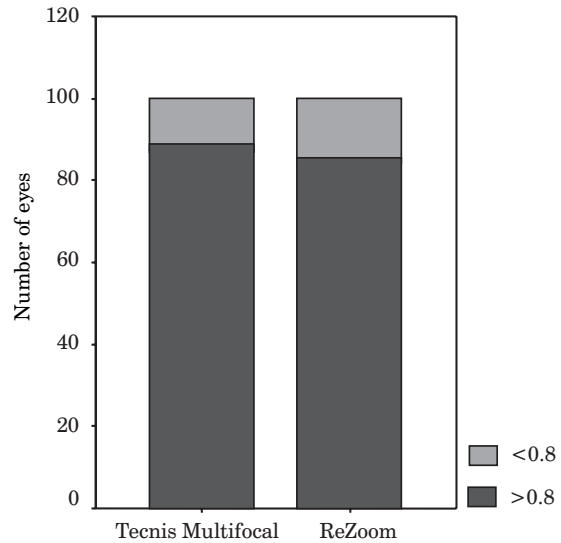


Fig. 2. Statistical analysis of difference between distance uncorrected visual acuity (UCVA) in Tecnis Multifocal and ReZoom group. $\chi^2 = 0.41$; $df = 1$; $p = 0.670$.

SPSS 11.0 for Windows was used for statistical analysis. Since there were two investigated groups with dichotomous variables, statistical significance was determined by χ^2 test at level of 5%.

Results

Patients achieved excellent distance and near uncorrected visual acuity (UCVA) in both groups. UCVA better than 0.8 (20/25) was achieved in 89.00% eyes in »Tecnis« group and 86.00% in »ReZoom« group (Figure 1). There was no statistically significant differences between groups ($\chi^2 = 0.41$; $df = 1$; $p = 0.670$) (Figure 2). Near UCVA was also good, 85.00% read J2 or better in »Tecnis« group and 79.00% in »ReZoom group (Figure 3), without statistically significant differences between lenses ($\chi^2 = 0.866$; $df = 1$; $p = 0.457$) (Figure 4). 72.00% of patients never wear glasses and 28.00% wear them sometimes when they read small letters or work at computer in »Tecnis«

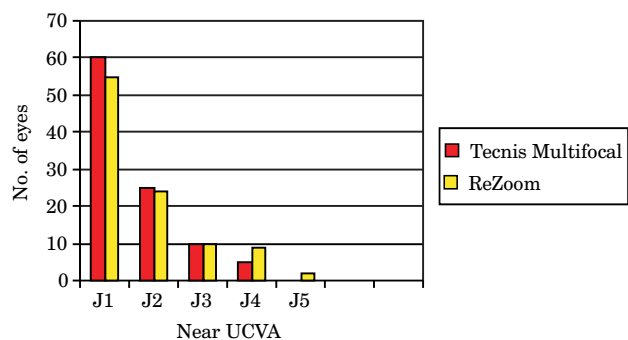


Fig. 3. Near uncorrected visual acuity (UCVA) at six postoperative months on eyes implanted with diffractive (Tecnis Multifocal) and refractive multifocal intraocular lens (ReZoom).

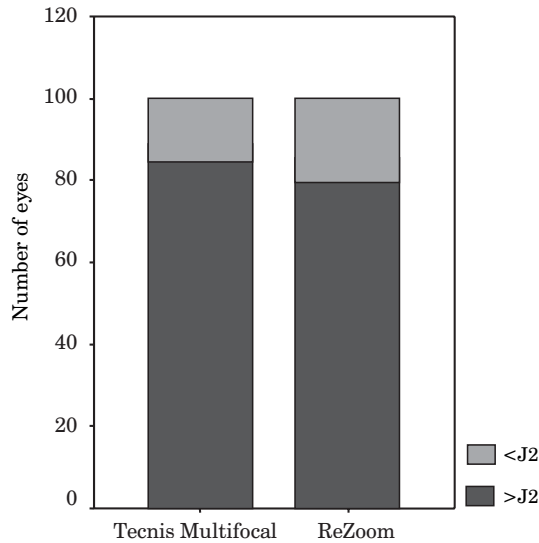


Fig. 4. Statistical analysis of difference between near uncorrected visual acuity (UCVA) in Tecnis Multifocal and ReZoom group. $\chi^2 = 0.866$; $df = 1$; $p = 0.457$.

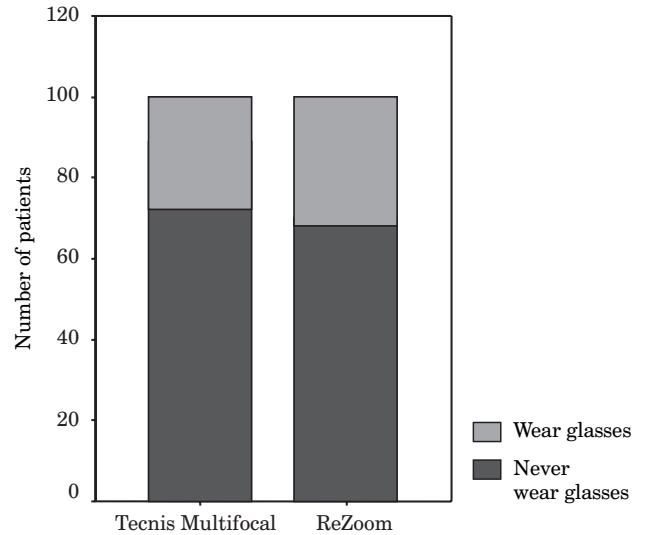


Fig. 6. Statistical analysis of difference between portion of time patients wear reading glasses in Tecnis Multifocal and ReZoom group. $\chi^2 = 0.190$; $df = 1$; $p = 0.828$

group. 8.00% of »ReZoom« patients have to wear glasses half time, 24.00% wear them sometimes and 68.00% never (Figure 5), also there was no statistically significant differences between groups ($\chi^2 = 0.190$; $df = 1$; $p = 0.828$) (Figure 6). Binocular UCVA was even better, 84.00% of patients read 1.0 and 72.00% J1. All »Tecnis« patients would implant the same lens again (Figure 7) and average satisfaction mark was 8.9 at 1–10 scale. In »ReZoom« group, 4 patients would not implant it again (Figure 7) and average mark was 7.8. 10 patients in »Tecnis« group and 21 in »ReZoom« complained at mild to moderate night driving visual disturbances. In »ReZoom« group we had to explant 4 lenses (2 patients) due to severe haloes and secondary implanted monofocal IOL. In »Tecnis« group 7 patients had problems with work at computer and they have to use reading glasses (+ 0.75 dsph) when they work for a longer time. In »ReZoom« group 4 patients had to wear glasses for computer occasionally. Three patients had decentration of IOL, we made successful reposition of IOL. Other intra-operative or post-operative complications were not reported.

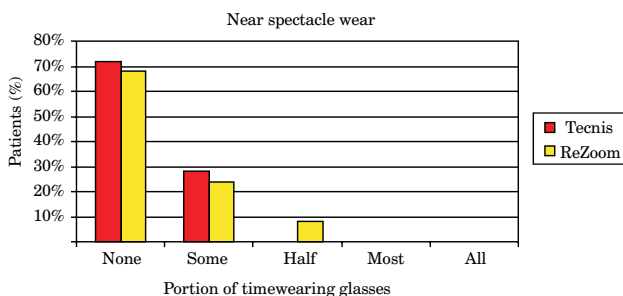


Fig. 5. Portion of time patients wear reading glasses at six post-operative months after implantation of diffractive (Tecnis Multifocal) and refractive multifocal intraocular lens (ReZoom).

Discussion

Hyperopic and presbyopic patients in this study, who underwent refractive lens exchange followed by implantation of diffractive or refractive multifocal intraocular lens, were highly satisfied. They have good near and far vision in both groups, diffractive and refractive and they are free of glasses most of time. ReZoom patients have excellent far vision in bright light because central zone is for distant focus and it acts like monofocal lens, but they have very poor near vision in same light conditions. Patients who received ReZoom reported less problems with intermediate vision and less need for small hyperopic correction (+0.75 dsph). Refractive lenses produce multiple focuses and distribute 10–18% of light, depend on pupil size so they have better vision at 60–80 cm. Diffractive lenses are bifocal and light distribution is between near and far focus (50–50%) so intermediate vision is poorer than refractive, but they are independent on pupil size¹⁰. Night time visual disturbances, haloes and glares were reported by patients in both groups and

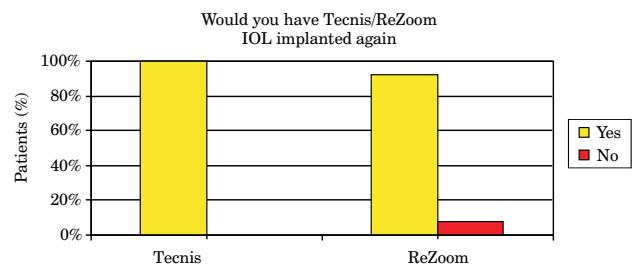


Fig. 7. Patient's subjective satisfaction after diffractive (Tecnis Multifocal) and refractive multifocal intraocular lens (ReZoom) implantation.

those are side-effects of MFIOL because one image is always blurred and this defocused light energy creates disturbances. ReZoom patients reported more severe problems with halos and we had to explant four lenses in two patients. Other patients who complained of night time visual disturbances had these issues weakened and almost disappeared in six months of follow up. Also, after that period, portion of time they wore reading glasses was reduced. This is explained by the fact that time is necessary for brain to adjust to new situation with two images. Optimal results are accomplished with bilateral implantation and patients faster adapt themselves to lenses if we perform simultaneous implantation. Three patients complained of blurred image due to IOL decentration so we performed reposition of IOL which was successful and complains disappeared. These emphases that surgeon's skill and experience is important and this kind of lens must be very well centered during surgery. Most of patients who did not achieve UCVA 1.0 had postoperative astigmatism; although we excluded those with more than 1.00 D preoperative astigmatism. For them, it is possible to perform laser refractive surgery 3–6 months after operation to correct this postoperative astigmatism¹¹. Satisfaction was high, especially in presbyopes with higher hyperopia. Average mark in Tecnis group was 8.9 and 7.8 in ReZoom group. Patients in Tecnis group complained to mild halos, glare, longer period of accommodation, reading problems with very small letters and computer, but all patients would implant the same lens again. Patients in ReZoom reported serious problems with halos and moderate with near reading. They needed longer period of adaptation. Four patients would not implant this lens again.

In our practice we meet patients who do not want to wear glasses. Many of them are presbyopes and laser refractive surgery or Phacic IOL is not helpful for them. MFIOLs proved to be good choice for patients who are highly motivated and have realistic expectations^{12,13,14}. Patient selection is the key point for refractive lens ex-

change because these patients have big expectations and request perfect vision; as good as they had before operation. It is important to spend enough time with patients before surgery and to explain them all advantages and some potential disadvantages of this treatment. Patients who ask for guaranties and can not accept possibility to wear glasses sometimes when they work at computer are not candidates for MFIOL.

If we compare our results with recent studies (2008), we will see that F. J. Goes and S. Cillino in their studies have similar results for distance UCVA, visual disturbances and intermediate vision for both lenses, but better near UCVA and spectacle independence for Tecnis Multifocal and worse for ReZoom^{6,7}.

At the moment we do not have perfect solution for patients with presbyopia and refractive lens exchange with implantation of MFIOL is the optimal treatment for carefully selected patients. Our study proved that CLE+MFIOL highly reduce spectacle dependency and insure patient's satisfaction with minimal visual disturbances. Attention should be made that those patients whose professional or living style is not favorable for MFIOL are excluded from this treatment. People who often drive in night and live active professional and private life are not perfect for refractive IOL. We have also concluded that patients with diffractive IOL who work more than 4–5 hours at computer should accept possibility to wear reading glasses sometimes.

Conclusion

Diffractive MFIOL enable excellent near and far vision and have no restriction on pupil size and reduce night visual issues but intermediate vision is poor. Refractive lenses give excellent far vision, good near and intermediate images but their disadvantages are problems with halo and glare.

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USPOREDBA DIFRAKTIVNIH I REFRAKTIVNIH MULTIFOKALNIH INTRAOKULARNIH LEĆA U TERAPIJI PRESBIOPIJE

S A Ž E T A K

Multifokalne intraokularne leće (MFIOL) omogućuju dobar vid na blizinu i daljinu nakon operacije katarakte. Odlični rezultati s bolesnicima kojima je operirana katarakta ohrabrila je oftalmologe na ugradnju MFIOL nakon odstranjenja bistre leće (CLE). Postoje dvije vrste MFIOL: difraktivne i refraktivne. U našoj prospektivnoj studiji uspoređivali smo kliničke rezultate nakon CLE i obostrane ugradnje difraktivne (Tecnis Multifocal), (N = 100 očiju, 50 bolesnika) i refraktivne (ReZoom), (N = 100 očiju, 50 bolesnika) MFIOL presbiopima i hipermetropima. Mjerili smo nekorigitiranu vidnu oštrinu (UCVA) na blizinu i daljinu, ovisnost o naočalama, subjektivno zadovoljstvo i vidne smetnje bolesnika i uspoređivali ih između dvije skupine. Bolesnici su ostvarili dobru UCVA na blizinu i daljinu u obje skupine. »Tecnis« skupina imala je nešto bolju UCVA na blizinu (bez statističke značajnosti) i manje noćnih smetnji vida. »ReZoom« skupina prijavila je manje problema s intermedijarnim vidom. Difraktivne i refraktivne MFIOL omogućuju visok stupanj neovisnosti o naočalama presbiopima hipermetropima uz mali broj nuspojava. Refraktivne MFIOL osiguravaju bolji intermedijarni vid, a difraktivne nešto bolji vid na blizinu i manje haloa i zablještenja.