Retrospective Outcomes and Patient Satisfaction with Previous Refractive Surgery and Multifocal Intraocular Lens Implantation

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Aim: To report pre, post-surgical visual outcomes and satisfaction after cataract or clear lens surgery, with multifocal intraocular lens implantation, in patients with previous refractive surgery.

Methods: Retrospective study of postoperative outcomes and satisfaction in patients with previous refractive surgery and Multifocal Intraocular Lens (MF-IOL) implantation. Preoperative variables: time LASIK performed, visual acuity, Uncorrected (UCVA) and best corrected (BCVA), Spherical Equivalent (SE), Addition (Add), SimK and pachymetry. Postoperative data: UCVA, BCVA, SE, and Add. Results grouped as: general, cataracts vs. clear lens (CL), segmented vs. trifocal MF-IOL, and myopes vs. hyperopes. Patients completed a satisfaction and difficulty questionnaire (Q). Data was analyzed using paired student-t test, with Bonferroni adjustment. Linear regression analysis between normally distributed preoperative variables and survey data were reported.

Results: Mean results recorded for 30 eyes, mean age 52.3 ± 6.2 years; pre-LASIK SE -2.8 ± 3.8D, segmented MF-IOL in 22 eyes and 8 eyes with trifocal IOL. Pre/postoperative results: SE: -0.02 ± 2.5/-0.1 ± 0.25D, far UCVA: 0.34 ± 0.2/0.90 ± 0.1, near UCVA: 0.43 ± 0.4/1.0 ± 0.02, Add: 1.4 ± 1.2/0.2 ± 0.6D, far BCVA: 0.90 ± 0.2/0.95 ± 0.1, and near BCVA: 0.99 ± 0.04/1.0 ± 0.0. Mean Q satisfaction points (0-10): far VA: 7.5 ± 2, near VA: 8.1 ± 2.3, intermediate VA 8.1 ± 1.7. Mean questionnaire difficulty points (0-4) results were: far VA 1.3 ± 1.5, near VA 1.5 ± 1.5, halos 1.5 ± 1.6, and 94% would repeat their choice. Near vision and night driving difficulties scored higher for myopes with greater preoperative SE (R²=0.5; p=0.05 and R²=0.7; p=0.02, respectively).

Conclusion: Multifocal intraocular lens implantation, in patients with previous refractive surgery, significantly improved mean near and far UCVA, and addition. Satisfaction was high and post LASIK SE correlated significantly with near vision and night driving difficulty in myopic patients.

Keywords: Cataract; LASIK; Multifocal intraocular lens; Presbyopia

Introduction

Patients with previous refractive surgery, either laser in situ keratomileusis (LASIK) or photorefractive keratectomy (PRK) usually seek to remain spectacle-free after cataract or presbyopia surgery. Studies have reported satisfactory refractive results after implantation of premium intraocular lens (IOL) in eyes with previous myopic or hyperopic LASIK [1-6].

Although reports are limited, cases could be challenging due to postoperative refractive surprises, with posterior lens exchange or laser surgery enhancement, and little is known regarding patient presurgical characteristics or postoperative satisfaction, spectacle independence, or the effect of LASIK induced corneal aberration [1,6,7].

Newer diffractive trifocal and sectorial refractive multifocal intraocular lenses (MF-IOL) have shown to provide effective visual function restoration and high patient satisfaction [8-17].

Trifocal diffractive IOLs, like FineVision IOL (25% hydrophilic acrylic and 6.15 mm optic diameter, PhysiOL, Liège, Belgium) combine two diffraction gratings, one with +1.75D and the other with +3.5D for near vision, which truly offers trifocality during myosis [13,16]. The segmented refractive MF-IOL (Lentis Mplus ,Oculentis GmbH, Berlin, Germany) is a one-piece zonal intraocular lens with plate haptics having large aspheric distance-vision zone and a sector-shaped zone with 3.0D of near addition (Add), embedded on the posterior surface [12].

Recently, Yoshino et al. reported good visual results in LASIK patients with diffractive IOL, however, a review highlighted the lack of information regarding LASIK patients’ characteristics, side effects, and satisfaction after MF-IOL implantation [1,15].

We present a retrospective report on pre and post-surgical outcomes and patient satisfaction, after clear lens (CL) or cataract surgery with trifocal or segmented IOL implantation, in patients with previous refractive surgery.

Subjects and Methods

This was a retrospective, observational, longitudinal study of patients with previous refractive surgery who underwent multifocal intraocular lens (MF-IOL) implantation, after cataract or clear lens (CL) surgery, with at least 12 months follow-up. We complied with the 1995 Declaration of Helsinki principles and all patients read and
signed a written informed consent form before undergoing any surgical procedure. Medical charts were reviewed, pre and post-operative data (last visit) was recorded for analysis, and patients were later asked to fill out a satisfaction and difficulty questionnaire (Q), the cataract TyPE Spec questionnaire translated to Spanish and modified to include: General far and near vision satisfaction (0-10 points each) and difficulties (0-4 points each) for far, near, intermediate visions, halos, specific activities, and whether or not they would repeat the procedure. Patients personally filled out the questionnaire (Q), on the medical center or online [18]. Preoperative data included: time LASIK had been performed, far and near (30 cm) uncorrected visual acuity (UCVA), best corrected (BCVA; decimal scale), spherical equivalent (SE), addition (Add), topography data (SimK, corneal astigmatism, and corneal thinnest pachymetry; ORBSCAN DP-3002 model, v. 3-14; Technolas Perfect Vision, GmBH), pupillometry (Colvard, Oasis medical, Glendora, California, USA), RMS in µm (Zywave II Aberrometer v 5.2, Bausch & Lomb), and MF-IOL implanted (segmented or trifocal). Postoperative data records for far/near UCV A, hyperopic or myopic LASIK, for comparative purposes (based on premedical, Glendora, California, USA), RMS in µm (Zywave II Meditec AG, Jena, Germany), and MF-IOL power calculated with the Haigis-L formula [7].

Data was introduced on a Microsoft 2013 Excel sheet (Microsoft Corporation). Results were recorded as mean and standard deviation (SD), student t-test (with Bonferroni adjustment) used for data results comparison [19]. Bonferroni adjustment set a stricter threshold to define significance (multiplying the p-values for each of the pair-wise comparisons by the number of comparisons) and thus reducing type I error. Bonferroni correction for p ≤ 0.05 was set at p ≤ 0.002 for general and CL variables (N=30 and N=24 eyes, respectively), p ≤ 0.01 for myopic and hyperopic group variables, and p ≤ 0.003 for questionnaire variables (N=15).

Pre and post-operative results were recorded for all eyes, eyes with cataracts, and clear lens (CL) eyes. Patients were also grouped into those implanted with trifocal vs segmented IOL, and with either hyperopic or myopic LASIK, for comparative purposes (based on pre LASIK refractive error).

The Shapiro-Wilk normality tests run for preoperative nominal variables. Linear regression analysis for normally distributed dependent variables matched to survey data scores.

### Results

Data was collected for 17 patients (9 men and 8 women; 30 eyes), with mean age of 51.5 ± 6.3 years, pre-LASIK refraction yielded 16 hyperopic eyes, 14 myopic eyes, one CL patient had preop mixed refractive error (RE pre -4.3D SE, post 0.0D SE; LE pre 0.8D SE, post -0.6D SE, 12.2 ± 3.5 years mean time LASIK performed, and mean pre-LASIK SE was -2.8 ± 3.7D. LASIK had been performed in 29 eyes, PRK in one, and re-treatment with flap re-lift and laser in 7 eyes. Mean values included: pupil diameter of 5.7 ± 0.9 mm, pachymetry 510 ± 54.5 µ, SimK 42 ± 2.8D, topography astigmatism 1.1 ± 1.1D, RMS 1.9 ± 1.7 µm (12 eyes), and MF-IOL mean power +21 ± 3.5D. General mean pre-LASIK SE was -3.6 ± 3.7D, 1.8 ± 0.6D for hyperopes, and -5.5 ± 2.2D for myopes. Twenty-two eyes underwent implantation of refractive segmented IOL (17 eyes with +3.0 Add-Oculentis MPLUS LS 313; 5 eyes +1.50 Add COMFORT LS 313) while eight eyes were implanted with the trifocal diffractive IOL (FineVision Physiol). We implanted segmented IOL (+1.50 Add) in three patients (55-y-old bilateral cataract, 46-y-old monocular cataract, and 45-y-old bilateral CL. Six eyes underwent cataract surgery (two patients bilateral and 2 monocular surgery) while 24 eyes had CL surgery (12 patients had bilateral simultaneous surgery; 5 were myopes and 7 hyperopes). Four patients underwent monocular surgery and, of these, one with cataracts and the other with amblyopia, and two CL surgery.

Mean preoperative data for patients who underwent clear lens surgery included: age 51 ± 7 years, pupil 5.1 ± 0.9 mm, pre-LASIK SE -1.4 ± 4D, years LASIK performed 12 ± 4.4 years; pachymetry 533 ± 41 µ and far BCVA 0.9 ± 0.1 (p ≤ 0.05), 42 ± 2.8D, far UCVA 0.4 ± 0.2, near UCVA 0.3 ± 0.3, near BCVA 1.0 ± 0.0, and Add 1.3 ± 1.1D. Preoperative data comparison for the myopic and hyperopic group, respectively, in age 48.5 ± 4.3; 54.2 ± 8.4 years, pupil 5.1 ± 0.7; 4.9 ± 1.1 mm, RMS 3.6 ± 1.7; 1.1 ± 1.1 µm (p>0.05), years LASIK performed 13.2 ± 3.4; 10.8 ± 3.6 years; (p>0.05). Pre-LASIK sphere was -5.5 ± 2.2; 1.8 ± 0.6D and SE -4.3 ± 3.0; 1.7 ± 0.5D, respectively; (p<0.05).

Table 1 registers general mean pre and postoperative results. Overall, a mean of 5.4 ± 2 lines of distance UCVA and 5.9 ± 3.6 lines for near UCVA improvement were recorded (p ≤ 0.05).

### Table 1: Mean pre-and postoperative general results. Significant improvement recorded for far and near uncorrected visual acuity (UCVA).

| Mean general results (30 eyes) | Follow-up (y) | Spherical equivalent (diopters) | FAR uncorrected visual acuity (decimal scale) | NEAR uncorrected visual acuity (decimal scale) | Addition (diopters) | FAR best corrected visual acuity (decimal scale) | NEAR best corrected visual acuity (decimal scale) |
|-------------------------------|--------------|--------------------------------|-----------------------------------------------|-----------------------------------------------|--------------------|-----------------------------------------------|-----------------------------------------------|
| PRE multifocal intraocular lens | -0.02 ± 2.3 | 0.34 ± 0.2 | 0.43 ± 0.4 | 1.4 ± 1.2 | 0.90 ± 0.2 | 0.99 ± 0.04 |
| POST multifocal intraocular lens | 1.4 ± 0.8 | -0.09 ± 0.3 | 0.90 ± 0.1 | 1.0 ± 0.02 | 0.20 ± 0.6 | 0.95 ± 0.1 | 1.0 ± 0.0 |
| p=paired t-student; p ≤ 0.002; Statistical significance | p=0.9 | P ≤ 0.00001 | P ≤ 0.0001 | p=0.08 | p=0.2 | p=0.9 |

Postoperative mean results for segmented vs trifocal IOL group, respectively, included SE -0.1 ± 0.27D; -0.1 ± 0.2, far UCVA 0.9 ± 0.1; 1.0 ± 0.1, near UCVA 0.99 ± 0.02; 1.0 ± 0.0, Add 0.26 ± 0.7; 0.0 ± 0.0, far BCVA 0.9 ± 0.1; 1.0 ± 0.0, and near BCVA 1.0 ± 0.0; 1.0 ± 0.0 (p>0.05). Mean postoperative follow-up was 1.4 ± 0.8 years.
Table 2: General mean results pre-and post MF-IOL implantation.

For all clear lens patients, postoperative results were significant for far UCV A, near UCV A, and Add (p<0.002). Significant results were recorded for near UCV A (p=0.03) and addition (p=0.005) in patients with trifocal intraocular lens. Data from +1.5 Add MF-IOL patients was included.

Table 2 displays mean MF-IOL results. Table 3 compares mean post-operative results for myopes vs. hyperopes, who underwent clear lens surgery. Table 4 shows cataract patients’ pre and post-operative data. For the cataract group, the +3.0 Add segmented MF-IOL group gained a mean of 5.5 ± 1.8 far UCV A lines and the trifocal 3.7 ± 2.1 lines (p ≤ 0.05). The former gained a mean of 6.3 ± 3.5 near UCV A lines and trifocal group gained 6.5 ± 3.3 mean near UCV A lines (p ≥ 0.05).

Table 3: Mean results for patients with previous hyperopic or myopic LASIK.

| PRE/POSTOP results cataract | Spherical equivalent (SE) | FAR UCVA (DECIMAL) | NEAR UCVA (DECIMAL) | ADD (Diopters) | FAR BCVA (Decimal) | NEAR BCVA (Decimal) | Multifocal intraocular lens | Follow-up (years) | Years LASIK performed; (PRELASIK SE in Diopters) |
|----------------------------|--------------------------|-------------------|-------------------|---------------|------------------|------------------|--------------------------|-----------------|-----------------------------------------------|
| Patient 1 55-y-old         |                          |                   |                   |               |                  |                  |                          |                 |                                               |
| PRE                        | -2.6                     | 0.05              | 1                 | 0             | 0.8              | 1                | +1.5 Segmented ADD       | 2               | 9; (-6.25D)                                   |
| POST                       | -0.25                    | 0.8               | 1                 | 0             | 0.8              | 1                |                          |                 |                                               |
| PRE                        | -1.25                    | 0.5               | 1                 | 0             | 0.8              | 1                | +1.5 Segmented ADD       | 2               | 9; (-4.75D)                                   |
| POST                       | -0.25                    | 0.8               | 1                 | 2.5           | 0.8              | 1                |                          |                 |                                               |
Table 4: Cataract patients.

Hyperopic patients had significant improvement in SE and significantly in far UCVA, near UCVA, and Add; (p ≤ 0.005). Myopic patients improved in postoperative SE, far UCVA, while significantly for near UCVA and Add (p ≤ 0.005). Far UCVA was significantly better for hyperopes; (p ≤ 0.005).

Post-operative complications included one eye with macular edema, after MF-IOL decentration and uneventful repositioning, which resolved after topical non-steroidal anti-inflammatory therapy (Nepafenac® Alcon laboratories Ltd., Surrey, UK).

Final postoperative far BCVA was 0.9 (0.7 preoperatively) and 1.0 for both near UCVA and BCVA. One eye (3%) with refractive surprise in a patient with previous myopic LASIK (-9.0D) Uneventful MF-IOL exchange resulted in final 1.0 far and near UCVA. Eight eyes (27%) underwent flap re-lift and laser re-enhancement for postoperative residual refraction. One developed dry eye syndrome and grade II Machat epithelial ingrowth but later stabilized at 0.9 final far and 1.0 near UCVA, with continued artificial tears use. One eye lost one line of far UCVA due to herpetic stromal keratitis and residual leukoma, 4 years post MF-IOL implantation.

Fifteen patients answered the questionnaire (14 underwent binocular and 1 monocular surgery), eight hyperopes and seven myopes, 11 with segmented and 4 with trifocal IOL. Two patients declined answering it.

Table 5 summarizes questionnaire difficulty scores for varying situations, in the general, trifocal, and segmented IOL groups. Figures 1 and 2 show satisfaction and difficulty mean scores for the general and trifocal vs. segmented IOL groups, respectively. Mean satisfaction scores for patients with previous hyperopic or myopic LASIK, respectively were distance VA 8.0 ± 2.2 / 8.3 ± 1.2, near VA 7.7 ± 2.8 / 8.5 ± 1.8, intermediate VA 8.0 ± 2.4 / 8.3 ± 0.9; (p>0.003).
Table 5: Questionnaire mean difficulty scores post MF-IOL implantation. Seventy-five percent reported not wearing glasses. All groups reported the greatest difficulty scores for halos and both day and night driving.

| Group                  | No: 75% | No: 100% | No: 50% |
|------------------------|---------|----------|---------|
| Difficulty             |         |          |         |
| Night driving          | 2.3 ± 2 | 2.3 ± 1  | 1.3 ± 2 |
| Daylight driving       | 2.0 ± 1.5| 2.0 ± 1  | 1.1 ± 2 |
| Reading supermarket    | 1.7 ± 1 | 1.7 ± 0.9| 0.9 ± 1 |
| Sports                 | 1.0 ± 1.3| 1.0 ± 0.3| 0.3 ± 0.8|
| Halos                  | 2.0 ± 1.1| 2.0 ± 0.9| 0.9 ± 1.5|
| Reading white paper    | 1.7 ± 1.4| 1.7 ± 0.9| 0.3 ± 0.5|

Figure 1: Mean questionnaire VA satisfaction scores for the trifocal and segmented MF-IOL groups. Higher satisfaction scores were recorded for the trifocal group; particularly for near UCVA, (7.0 ± 2.3 vs. 9.8 ± 0.5 points; p=0.03.)

Normal distribution was found for age (W=0.93), and in all 30 eyes for preoperative pachymetry (W=0.95), preoperative SE (W=0.90), far and near UCVA (W=0.74), Add (W=0.85), pupil (W=0.92), pachymetry (W=0.93). For hyperopic pre-LASIK sphere (W=0.90), pachymetry (W=0.92), pupil (W=0.87), postoperative SE (W=0.81), postoperative Add (W=0.50), postoperative far UCVA (W=0.72), postoperative near UCVA (W=0.34). For myopic eyes, normality was recorded for preoperative SE (W=0.84), preoperative sphere (W=0.87), Add (W=0.80), pupil (W=0.91), and pachymetry (W=0.95). Myopic postoperative SE (W=0.60), Add (W=0.50), far UCVA (W=0.90), near UCVA (W=0.50). Pearson correlation results for hyperopic pupil and questionnaire were: general satisfaction R²=0.40, reading satisfaction R²=0.40, intermediate vision satisfaction R²=0.40, near vision difficulty R²=0.20, far vision difficulty R²=0.74, halos difficulty R²=0.85, paper reading difficulty R²=0.43, daylight driving R²=0.25, night driving difficulty R²=0.35, double vision difficulty R²=0.5. Pearson correlation between pachymetry in hyperopic patients and questionnaire results were: general satisfaction R²=-0.34, near vision satisfaction R²=-0.06, intermediate vision satisfaction R²=-0.07, far vision difficulty R²=0.40, near vision difficulty R²=0.02, paper reading difficulty R²=0.14, double vision R²=0.77, daylight driving R²=0.50.

Discussion

Premium IOL implantation improves UCVA in patients with previous refractive surgery but few reports address outcomes and satisfaction in this patient group [1-6]. LASIK patients usually have no differences in VA with controls but this patient group is more prone to postoperative refractive surprise, requiring further laser enhancement, halos, and degradation in contrast sensitivity [5,12,15-17].

Figure 2: Mean questionnaire VA difficulty scores for trifocal and segmented IOL groups. All groups scored some degree of difficulty for all VA distances. Higher difficulty scores were recorded for far and near vision in the segmented IOL group. Results were significant for near VA in the latter group (0.0 vs. 1.3 ± 2 points; p=0.0001).

Figure 3: Mean difficulty scores for myopes and hyperopes. Difficulty scores were higher in they hyperopic group, for most variables. In near vision (A) and night driving difficulties (B); the latter was significant. Near vision difficulty scores were also higher for myopes with larger negative post LASIK spheres. (C) Near vision satisfaction scores were higher in myopes with larger negative post LASIK SE. (D).
Vega et al. provided evidence that implanting an aspheric multifocal IOL in eyes, after myopic LASIK, resulted in similar optical and visual quality to phakic myopic LASIK eyes [3]. They concluded that visual results and quality were superior to the use of a spherical MF-IOL [3].

Newer MF-IOLs, segmented and trifocal, implanted in this patient group, are effective in visual restoration, for specific cases [7-9,11-15,17].

Segmented MF-IOLs have one addition sector, which is the only area that directs light to a near focal point, thus allowing for the remainder of the optic to act as a monofocal IOL for distance vision [12]. They are more suitable for larger pupils and provides adequate VA and patient satisfaction [10,12].

Newer trifocal diffractive IOLs also provide general satisfactorily UCVA for all distances and improved contrast sensitivity [7-9,11-15]. Khoramnia et al. bilaterally implanted toric-segmented MF-IOL in a patient with repeated LASIK who improved both far and near UCVA, and gained 6 lines of UCVA [8].

We analyzed post-operative results in patients with previous refractive surgery and post MF-IOL (segmented or trifocal) implantation for cataract or presbyopia with CL. Overall, postoperative far and near UCVA improved significantly, after MF-IOL implantation (p ≤ 0.002). In this small retrospective study, 97% of previous LASIK eyes had final SE within ± 0.50D, 90% at least 0.7 far UCVA, four eyes gained postoperative BCVA (13%), and no eyes lost BCVA. These results are similar or better than other reports with MF-IOL implantation in post refractive surgery patients [5,4,15,17].

We also found no VA differences between all patients and those requiring subsequent enhancement (0.9 ± 0.12; 0.88 ± 0.13); (p>0.002). One eye (20%) lost one VA line due to herpetic keratoma, postoperatively, 4 eyes with cataract and 2 CL eyes gained VA lines. We also recorded refractive surprise on one eye (3%), which underwent uneventful MF-IOL exchange.

Patients implanted with segmented IOL (+3.00 Add) significantly improved post-operative far and near UCV (p<0.0001), while those with trifocal IOL improved postoperative near UCVA (p=0.0001). Postoperative addition values also decreased in both groups (p>0.002). The trifocal IOL group gained higher far UCVA lines than the +3.00 Add segmented IOL group (p=0.1). Patients with clear lens surgery significantly improved postoperative Add and both near and far UCVA (p ≤ 0.002), while final mean SE was 0.03D. Alfonso et al. also reported -0.06 mean SE in CL LASIK patients implanted with diffractive IOL [4]. In this study, 98% were within ± 0.50D final SE, compared to reports ranging from 72%-84% [4,5]. Mean postoperative far UCVA results were better for hyperopes than myopes with clear lens surgery (0.94 ± 0.08 vs. 0.85 ± 0.16; p=0.03), but so were their preoperative values (0.47 ± 0.14 vs. 0.35 ± 0.28; p=0.3). Despite significant lower preoperative Add values for myopes (1.0 ± 1.1D) compared to hyperopes (2.1 ± 0.50; p=0.03), postoperative mean Add values were not significant (p=0.1).

All cataract eyes had previously undergone myopic LASIK and we recorded significant improvement for post-operative far UCVA, p=0.001. Their post-operative Add results were not significant, probably due to the inclusion of younger patients implanted with a +1.5 Add segmented IOL and the small sample case series. Mean postoperative SE was higher to that already reported by Miyajima et al. (0.22 ± 0.21D vs. -0.03 ± 0.38D) for cataract patients with previous LASIK [17].

Visual satisfaction and difficulty information are lacking for this patient group, post MF-IOL implantation for presbyopia or cataract. Satisfaction was high in patients with segmented IOLs but one point lower than patient reports with no previous corneal surgery, (>7 points for all distances vs. 8.1 points, respectively), as reported by Muñoz et al. [12]. Ninety percent of the segmented IOL group would recommend their MF-IOL choice compared to the 98% reported by Venter et al. in patients with no previous corneal surgery [9].

Gatinel et al. reported that diffractive IOL showed better near focal point resolution than segmented IOLs [16]. The trifocal group reported higher satisfaction for all VA distances compared to the segmented IOL group. We recorded higher, though non-significant, near VA satisfaction in the trifocal IOL group (p=0.04) and 100% answered they would repeat their MF-IOL selection. The fact that only 4 patients with trifocal and 11 with segmented IOL answered the questionnaire, could explain these non-significant findings, while final conclusions could be drawn when the former sample increases.

Regarding difficulty scores for daily activities, the trifocal group reported less difficulty, significant when reading supermarket labels. The latter finding may be an attributable to the superior near focus for the trifocal IOL, while segmented IOL provides less adequate near UCVA [12,16].

Halos has already been reported in 10.6% regular patients with segmented IOLs while Muñoz et al. concluded it should be expected, in a small number of patients, despite very good functional results [12,20]. In this study, sixty-three percent reported some degree of halos difficulty, particularly in patients with previous hyperopic LASIK or segmented IOL. Hyperopic patients reported higher halos difficulty scores (mean 2 ± 1.2 points) than myopes (1.3 ± 1.8 points); p>0.4, and could be explained by the fact that hyperopic LASIK correction induces greater changes in corneal asphericity, is associated to smaller effective optical zones, and slightly more third order aberrations than in myopes could explain this finding [21,22]. In addition, higher halos difficulty scores were associated to larger post LASIK pachymetry and smaller pupil size in hyperopic patients. Hyperopic LASIK treatment is peripheral and the further from the center of the cornea the more the ablation is having a different effect on each quadrant because it acts at different depths and with varying hydration along the surface [5].
A recent study concluded that, after phacoemulsification, unsatisfied patients reported worse OSDI scores and would need to determine, to what extent postoperative dry eye could also be responsible for these findings [23].

Regarding the negative correlation between pupil size and halos, Oshika et al. have reported the higher influence of coma-like aberrations on visual performance in LASIK patients with smaller pupils, and could also explain our findings [24]. This could also explain why myopic LASIK patients reported higher satisfaction, for all VA distances, and less difficulties than those with hyperopic laser treatment (p=0.08). In addition, the MF-IOL aspheric design might be contributing to improving visual quality in myopes and Alfonso et al. found no differences in corneal aberrations for patients with previous myopic LASIK implanted with diffractive IOL [2]. We found higher RMS in myopes than hyperopes (3.6 vs. 1.1 µm; p=0.3), which can be attributed to the small case sample, and aberrations will be accounted for in future studies with larger samples. Linear regression analysis concluded greater near vision difficulty was associated to higher post LASIK negative SE and sphere (R²=0.60 and R²=0.70), significant for the former (p ≤ 0.01). Bissen-Miyajima et al. concluded degradation in contrast sensitivity was greater for post-LASIK eyes with higher myopic corrections, after implantation of diffractive IOL for cataracts [17]. Although both hyperopic and myopic patients reported similar night driving difficulties (2 ± 1.8 and 1.6 ± 1.7 points, respectively; p=0.7), we can highlight that linear regression analysis showed significant association with greater post LASIK negative SE in myopes (R²=0.90; p=0.001). This result is consistent with a previous report associating greater night difficulties on myopic patients with higher attempted degree of LASIK corrections [25]. Pop et al. also reported no association between pupil diameter and night driving difficulties in myopes after LASIK, as our study also showed, (R²=0.14) [26,27].

It remains unclear whether these worsened after a MF-IOL implantation and a pre-operative questionnaire could help.

After at least 12 months, UCVA for all patients improved a mean of five lines, BCVA significantly improved in 20% of all eyes, patients are highly satisfied, 63% manifested halos or night driving difficulties, 38% near vision difficulties, and most are spectacle free. Despite scoring visual difficulties, 94% would repeat the procedure.

This study is limited due to its retrospective nature of a small sample case series, the inclusion of different MF-IOL models for clear lens and cataract patients, lack of objective intermediate VA data, no preoperative questionnaire, and need for longer post-operative follow-up. In addition, MF-IOLs were not chosen according to refractive error and DMF-IOL models were not chosen according to the latest premium IOLs. Patients with previous refractive surgery and trifocal or segmented MF-IOL implantation were generally satisfied and significantly improved post-operative far and near UCVA. Post LASIK SE, in myopic patients with MF-IOL implantation, could determine postoperative visual difficulties, although further study and follow-up is required.

References
1. Khor WB, Ashfari NA (2013) The role of presbyopia-correcting intraocular lenses after laser in situ keratomileusis. Curr Opin Ophthalmol 24: 35-40.
2. Alfonso JF, Madrid-Costa D, Poo-Lopez A, Montés-Micó R (2008) Visual quality after diffractive intraocular lens implantation in eyes with previous myopic laser in situ keratomileusis. J Cataract Refract Surg 34:1 848-1854.
3. Fernandez-Vega L, Madrid-Costa D, Alfonso JF, Montés-Micó R, Poo-Lopez A (2009) Optical and visual performance of diffractive intraocular lens implantation after myopic laser in situ keratomileusis. J Cataract Refract Surg 35: 825-832.
4. Alfonso JF, Fernandez-Vega L, Baamonde B, Madrid-Costa D, Montés-Micó R (2009) Refractive lens exchange with spherical diffractive intraocular lens implantation after hyperopic laser in situ keratomileusis. J Cataract Refract Surg 35: 1744-1750.
5. Mufuuogho O, Dao L, Mootha VV, Verity SM, Bowman RW, et al. (2010) Apodized diffractive intraocular lens implantation after laser in situ keratomileusis with or without subsequent Excimer laser enhancement. J Cataract Refract Surg 2010; 36: 1813-1821.
6. Albarrán-Diego C, Muñoz G, Ferrer-Blasco T, García-Lázaro S (2011) Prevention of hyperopic surprise after LASIK in patients with refractive multifocal intraocular lenses. Eur J Ophthalmol 21: 826-829.
7. Haigis W (2008) Intraocular lens calculation after refractive surgery for myopia: Haigis-L formula. J Cataract Refract Surg 34:1658-1663.
8. Khorambia R, Auffarth GU, Rabislberl TM, Holzer MP (2012) Implantation of a multifocal toric intraocular lens with a surface-embedded near segment after repeated LASIK treatments. J Cataract Refract Surg 38: 2049-2052.
9. Venter JA, Pelouskova M, Collins BM, Schalhorn AC, Haninan SJ (2013) Visual outcomes and patient satisfaction in 5366 eyes using a refractive segmented multifocal intraocular lens. J Cataract Refract Surg 39: 1477-1484.
10. García-Domene MC, Felipe A, Peris-Martínez C, Navea A, Artigas JM, et al. (2015) Image quality comparison of two multifocal IOLs: influence of the pupil. J Refract Surg 31: 230-235.
11. Kretz FTA, Brenner D, Diakonis VF, Klabe K, Henke F, et al. (2013) Clinical outcomes after binocular implantation of a new diffractive intraocular lens. J Ophthalmol 2013: 982891.
12. Muñoz G, Albarrán-Diego C, Ferrer-Blasco T, Sakla HE, García-Lázaro S (2011) Visual function after bilateral implantation of a new zonal refractive aspheric multifocal intraocular lens. J Cataract Refract Surg 37: 2043-2052.
13. Lesieur G (2012) Outcomes after implantation of a trifocal diffractive IOL. J Fr Ophthalmol 34: 338-342.
14. Cochen B (2016) Prospective clinical comparison of patient outcomes following implantation of trifocal or bifocal intraocular lenses. J Refrac Surg 32: 146-151.
15. Yoshino M, Minami K, Hirasawa M, Oki S, Bissen-Miyajima H (2015) Clinical results of diffractive multifocal intraocular lens implantation after Laser In Situ Keratomileusis Nippon Ganka Gakkai Zasshi 119:613-618.
16. Gatine D, Houbrechts Y (2013) Comparison of bifocal and trifocal diffractive and refractive intraocular lenses using an optical bench. J Cataract Refract Surg 39:1093-1099.
17. Bissen-Miyajima H, MinamiK, Yoshino M (2016) Effect of previous myopic laser in situ keratomileusis on contrast sensitivity after diffractive multifocal intraocular lens implantations. J Clin Exp Ophthalmol. 7: 540.
18. Javitt JC, Jacobson G, Schiffman RM (2003) Validity and reliability of the cataract Type Spec: an instrument for measuring outcomes of cataract extraction. Am J Ophthalmol 136: 285-290.
19. Holm S (1979) A simple sequential rejective method procedure. Scand J Stat 6: 65-70.
20. Gaetano J (2013) Holm-Bonferroni sequential correction.
