Intrastromal Corneal Ring Segment and intraocular lens implantation in patients with keratoconus and cataract

Jose F. Alfonso, MD, PhD; Luis Fernández-Vega Cueto, MD; David Madrid-Costa, OD, PhD; Robert Montés-Micó, OD, PhD

PURPOSE: To evaluate the efficacy, safety and predictability of sequential KeraRing Intrastromal corneal ring segment (ICRS) and intraocular lens (IOL) implantation with opposite clear corneal incisions in patients with keratoconus and cataract.

SETTING: Fernandez-Vega Ophthalmological Institute (Oviedo, Spain).

METHODS: This study comprised patients with keratoconus and cataract who had ICRS implantation, followed 6 months later by IOL implantation with corneal relaxing incisions. The uncorrected (UDVA) and corrected (CDVA) distance visual acuities and residual refractive errors, analyzed using vector analysis, were recorded preoperatively, 6 months after ICRS implantation, and 6 months after IOL implantation.

RESULTS: The study enrolled 32 eyes (21 patients). The mean UDVA (Snellen decimal) was 0.02 ± 0.02 preoperatively, 0.06 ± 0.05 six months after ICRS implantation (P = 0.004), and 0.53 ± 0.22 six months after IOL implantation (P < 0.0001). The CDVA changed from 0.46 ± 0.22 before surgery to 0.54 ± 0.21 six months after KeraRing ICRS implantation (P = 0.0002) and to 0.71 ± 0.19 six months after IOL implantation (P < 0.0001). Six months after IOL implantation, the efficacy index was 1.15 and the safety index, 1.54. At 6 months, 70.97% of eyes were within ± 1.00 diopter (D) of the desired refraction and 45.16% were within ± 0.50 D. The mean spherical equivalent after IOL implantation was −0.53 ± 1.13 D.

CONCLUSION: Sequential KeraRing ICRS and IOL implantation plus corneal relaxing incisions provides good visual and refractive outcomes, indicating that it is a predictable procedure for patients with keratoconus and cataracts.

J Emmetropia 2012; 3: 193-200

Keratoconus is a progressive, non-inflammatory disorder of the cornea in which the cornea assumes a conical shape. The corneal thinning induces irregular astigmatism, myopia and protrusion, leading to a mild to severe decrease in the visual quality. The onset is usually at puberty, and progression mainly occurs until the third or fourth decade of life. Recent studies have shown that intrastromal corneal ring segment (ICRS) implantation with femtosecond laser is an effective method for improving the corneal shape, reducing astigmatism and corneal higher order aberrations (HOAs) in patients with clear corneas and contact lens intolerance. Indeed, a recently published study found that sequential ICRS and an implantable collamer phakic intraocular lens (IOL) with relaxing incision provided good visual and refractive outcomes, indicating that this is a predictable procedure for refractive correction of keratoconus. In this previous study, all patients were young and had clear lens. Logically, patients with cataract and keratoconus will not obtain the same visual results as those with clear lens.

Submitted: 10/24/2012
Accepted: 11/6/2012

1 Fernández-Vega Ophthalmological Institute, Oviedo, Spain.
2 Surgery Department, School of Medicine, University of Oviedo, Spain.
3 Optics Department, Faculty of Physics, University of Valencia, Spain.

Financial Disclosure: The authors have no proprietary interest in any of the materials mentioned in this article.

Corresponding Author: José F. Alfonso, MD, PhD
Instituto Oftalmológico Fernández-Vega Avda. Dres. Fernández-Vega 34, 33012 (Oviedo), Spain
Tel: +34 985 245533 Fax: +34 985 233288
E-mail: j.alfonso@fernandez-vega.com

© 2010 SECOR
Sociedad Española de Cirugía Ocular Implanto-Refractiva
ISSN: 2171-4703 193
For the combined treatment of cataract and keratoconus, several previous studies\textsuperscript{11-14} have evaluated the results of lens replacement (either by refractive lens exchange or cataract extraction) by capsular bag toric IOL. The visual outcomes of these studies suggest that capsular bag toric IOL implantation may be an effective option to restore visual function in patients with stable keratoconus. These results are due to toric IOLs compensating for corneal astigmatism, improving the uncorrected visual acuity values. However, after this procedure the corneal abnormalities are still present, and could lead to a decrease in visual quality. ICRS implantation with laser femtosecond has been shown to be an effective and safe method for improving corneal shape and visual quality in keratoconus patients\textsuperscript{3,9}. In the current study we present a series of 32 eyes of 21 patients with keratoconus and cataracts who underwent sequential ICRS and monofocal IOL implantation with corneal relaxing incision.

PATIENTS AND METHODS

This prospective study included eyes with keratoconus and cataract that had sequential KeraRing ICRS (Mediphacos Ltd. Belo Horizonte, Brazil) and IOL implantation plus corneal relaxing incision at the Fernández-Vega Ophthalmological Institute (Oviedo, Spain). The tenets of the Declaration of Helsinki were followed and full ethical approval was obtained from the institute. After receiving a full explanation of the nature and possible consequences of the study and surgery, all patients provided informed consent.

Inclusion criteria were patients who had keratoconus and cataracts, contact lens intolerance and clear cornea, maximum keratometric (K) reading less than 55.00 diopters (D), minimum K reading more than 40.00 D, and minimum corneal thickness more than 400 \(\mu\)m. In addition, the differences between the axis of the corneal cylinder measured with a Javal keratometer and with an Orbscan IIz topographic system (Bausch & Lomb, Rochester, New York, USA) had to be less than 30 degrees.

Exclusion criteria included previous corneal or intraocular surgery, history of herpetic keratitis, diagnosis of autoimmune disease, systemic connective tissue disease, endothelial cell density < 2000 cell/mm\(^2\), history of glaucoma or retinal detachment, macular degeneration or retinopathy, neuro-ophtalmic diseases, and history of ocular inflammation.

All eyes in this study received KeraRing ICRS (Mediphacos Ltd. Belo Horizonte, Brazil). These Ferrara-type ICRS are polymethyl methacrylate with a triangular cross-section that induces a prismatic effect on the cornea. The apical diameter of the ICRS is 5.0 mm, and the flat basis width is 0.6 mm with variable thickness (0.15 mm to 0.30 mm, with 0.05 mm steps) and arc lengths (90 degrees, 120 degrees, 160 degrees, 210 degrees).

Before KeraRing ICRS surgery and after IOL implantation, patients had a complete ophthalmological examination, including uncorrected visual acuity (UDVA), corrected distance visual acuity (CDVA), manifest and cycloplegic refraction, keratometry, corneal topography, endothelial cell count, pachymetry, slitlamp microscopy, Goldmann applanation tonometry, and binocular indirect ophthalmoscopy through dilated pupils. Axial length and anterior segment size were measured with the IOLMaster biometer (Carl Zeiss Meditec, Germany). Contact lens use was discontinued 6 months before corneal topography was performed. Diagnosis of keratoconus was established by the combination of computerized videokeratography for the anterior and posterior corneal surface (Orbscan IIz; Bausch & Lomb, Rochester, NY), K readings, and corneal pachymetry\textsuperscript{15-18}. All eyes showed an inferior-superior corneal shape index greater than 1.40 D (from a mean of 5 points with 30 degree intervals located 3 mm from centre)\textsuperscript{2}.

The decision to implant the ICRS was made according to the manufacturer’s nomogram (KeraRing Mediphacos Inc., Belo Horizonte, Brazil). One or two segments were implanted based on the distribution of the ectatic area on the cornea surface. The thickness of the segment was decided based on the distribution of the ectatic area and the spherical equivalent\textsuperscript{5-7}. The same surgeon (JFA) performed all ICRS implantation procedures using topical anaesthesia. Preoperative medications included proparacaine 0.5%, ciprofloxacin 0.3%, and oxybuprocaine CIH 0.2%. After the center of the pupil was marked and corneal thickness at the area of the implantation (5.0 mm diameter) was measured by ultrasonic pachymeter, a disposable suction ring was placed and centred with respect to the pupil center.

A tunnel was created at 80% corneal thickness using a 60 KHz femtosecond laser (Intralase; IntraLase, Corp. Irvine, CA, USA). This infrared neodymium glass femtosecond laser has a wavelength of 1053 nm. The laser beam, which has a 3 \(\mu\)m diameter (spot size), is optically focused at a specific predetermined intrastromal depth by computer scanners, which give a focus (dissection) range between 90 \(\mu\)m and 400 \(\mu\)m from the corneal surface. The beam forms cavitations, microbubbles of carbon dioxide, and water vapour by photodisruption, and the interconnecting series of these bubbles forms a dissection plane. An inner diameter of 5.0 mm and outer diameter of 5.7 mm was programmed with the laser software, giving a tunnel width of 0.7 mm (the same as the segment width) and an incision length of 1.4 mm on the steepest topographic axis. In all eyes, the power used to create the tunnel and the incision was 5 mJ. The procedure lasted approximately 15 seconds.

Five minutes later, and after clearance of the gas bubbles, the ICRS were implanted under full aseptic conditions with a dedicated forceps. The segments were
placed in the final position with a Sinskey hook through a dialing hole at both ends of the segment.

Postoperative treatment included a combination of antibiotic (tobramycin, 3 mg/ml) and steroid (dexamethasone, 1 mg/ml) eye drops (Tobradex, Alcon Laboratories, Inc. Fort Worth, TX, USA) 3 times daily for 2 weeks, after which the dose was tapered for the following 2 weeks.

Cataract extraction with IOL implantation was performed 6 months after ICRS implantation. The IOLs used were the AcrySof SN60WF in 18 cases, and Acrysof MN60AC in 14 cases (both Alcon Laboratories, Fort Worth, Fort Worth, TX, USA). All surgeries in this study were performed by one experienced surgeon (JFA) using topical anaesthesia, and a 2.2 mm to 3.2 mm clear corneal incision placed in the steepest meridian to reduce the pre-existing astigmatism. Phacoemulsification was performed with the Infiniti Vision System (Alcon Laboratories, Fort Worth, Fort Worth, TX, USA). Phacoemulsification was followed by irrigation and aspiration of the cortex and IOL implantation in the capsular bag using the injector developed for the specific IOL. In cases of bilateral implantation, the second eye was operated within the first week of the fellow eye. We chose the SRK-T formula for IOL power calculation. In eyes with astigmatism less than 1.25 D, one clear corneal incision (2.2 mm) was performed on the steepest meridian. In eyes with astigmatism higher than 1.50 D, two opposite clear corneal incisions (3.2 mm) were created on the steepest meridian and at 90° after IOL implantation to reduce it, as previous authors have done in phacoemulsification19. All incisions were performed with either a 2.2 or 3.2 mm bevel-up steel blade (Equipsa S.A, Madrid, Spain), and were approximately 1 mm from the limbus.

Patients were scheduled for clinical evaluation 1 day, 1 week, and 1 and 6 months postoperatively. A standard ophthalmologic examination, including manifest refraction, slitlamp biomicroscopy, Goldmann applanation tonometry, binocular indirect ophthalmoscopy, UDVA, CDVA were performed at all visits.

Using the power vector method of Thibos and Horner20, the refractions obtained before surgery, 6 months after ICRS implantation and 6 months after IOL implantation were assessed. Using this notation, any spherocylindrical refractive error can be expressed by three dioptric powers: M, J₀ and J₄₅, where M is a spherical lens equal to the spherical equivalent of the given refractive error, and J₀ and J₄₅ are two Jackson crossed cylinders equivalent to the conventional cylinder. These numbers are the coordinates of a point in a three-dimensional dioptric space, where the power vector is the vector from the origin of this space to the point (M, J₀, J₄₅). Consequently, the length of this vector is a measure of the overall blurring strength (B) of a spherocylindrical refractive error. Manifest refractions in conventional script notation (S [sphere], C [cylinder] × φ [axis]) were converted to power vector coordinates and overall blurring strength (B) using the following formulas: M = S + C/2; J₀ = (–C/2) cos(2 φ); J₄₅ = (–C/2) sin(2 φ); and B = (M² + J₀² + J₄₅²)½.

All examinations were performed at 6 months post-ICRS implantation and 6 months after IOL implantation by an ophthalmic technician who was unaware of the study objective. Figure 1 shows the one-month postoperative visit of one patient after the sequential procedures. Data analysis was performed using SPSS for Windows, version 14.0 (SPSS Inc.,

![Figure 1. Slit-lamp picture of one of the cases one month after both procedures, ICRS and IOL implantations.](image)

### Table 1. Patient demographics. Age, sex, pre-sphere, pre-cylinder, pre-K1 value and pre-K2 value, shown as mean and standard deviation (SD).

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Preoperative data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eyes (n)</td>
<td>32</td>
</tr>
<tr>
<td>Age (years)</td>
<td>56 ± 10.2</td>
</tr>
<tr>
<td>Gender (Male/Female)</td>
<td>4 / 17</td>
</tr>
<tr>
<td>Mean Sphere (D)</td>
<td>–10.26 ± 5.67</td>
</tr>
<tr>
<td>Range of Sphere (D)</td>
<td>–2.00 to -22.00</td>
</tr>
<tr>
<td>Mean cylinder (D)</td>
<td>–4.79 ± 1.98</td>
</tr>
<tr>
<td>Range of cylinder (D)</td>
<td>–2.00 to -10.00</td>
</tr>
<tr>
<td>K1 (D)</td>
<td>46.44 ± 3.65</td>
</tr>
<tr>
<td>Range K1 (D)</td>
<td>40.50 to 54.50</td>
</tr>
<tr>
<td>K2 (D)</td>
<td>50.82 ± 3.60</td>
</tr>
<tr>
<td>Range K2 (D)</td>
<td>44.00 to 57.50</td>
</tr>
<tr>
<td>D: Diopters</td>
<td></td>
</tr>
<tr>
<td>K: Keratometry</td>
<td></td>
</tr>
</tbody>
</table>
Chicago, IL, USA). Normality was checked by the Kolmogorov-Smirnov test, and a repeated-measures analysis of variance (ANOVA) was performed to compare outcomes. Differences were considered to be statistically significant when the $P$-value was $< 0.01$.

RESULTS

This study comprised 32 eyes of 21 patients with a mean age of $56 \pm 10.2$ years old. Table 1 shows the patient demographics.
UDVA/mean preoperative CDVA) 6 months after ICRS implantation was 0.13, and 6 months after IOL implantation with corneal relaxing incision, 1.15.

No eye lost more than 1 line of CDVA six months after ICRS implantation; no eyes lost any lines six months after the second procedure (IOL implantation with corneal relaxing incision) (see figure 3). By 6 months after ICRS implantation, 1 eye had lost 1 line of monocural CDVA, 16 had not changed, 9 eyes gained 1 line, 4 eyes gained 2 lines and 2 eyes gained more than 2 lines. The safety index 6 months after ICRS implantation (ratio of postoperative and preoperative monocular CDVA) was 1.16. By six months after IOL implantation, 7 eyes had no change in CDVA, 3 eyes gained 1 line, 6 eyes gained 2 lines and 16 eyes gained more than 2 lines. The safety index 6 months after IOL implantation was 1.54.

The M value (spherical equivalent) changed from −12.26 ± 6.04 D before surgery to −10.28 ± 5.98 D after ICRS implantation (P = 0.001) and to −0.53 ± 1.11 D after IOL implantation with corneal relaxing incision (P < 0.0001). The B value (blur strength) was 12.56 ± 5.96 before ICRS implantation, 7.34 ± 7.04 six months after ICRS implantation (before IOL implantation) (P < 0.0001) and 1.10 ± 0.95 six months after IOL implantation with corneal relaxing incision (P < 0.0001).

Figures 4 and 5 show the attempted refraction versus the achieved refraction after ICRS, and after IOL implantation plus corneal relaxing incision, respectively. No correlation was found between the attempted change and the achieved change in the M value six months after ICRS implantation (top of figure 4; r = 0.30; P = 0.1). For J30, 80.64% of eyes were within ± 1.00 D and 58.06% were within ± 0.50 D (centre of figure 4; r = 0.75; P < 0.0001). For J45, 83.87% of eyes were within ± 1.00 D and 61.29% were within ± 0.50 (bottom of figure 4; r = 0.92; P < 0.0001). Six months after IOL implantation plus corneal relaxing incision, for M, 70.97% of eyes were within ± 1.00 D of the desired refraction and 45.16% were within ± 0.50 (top of figure 5; r = 0.98; P < 0.0001). For J30, 96.77% of eyes were within ± 1.00 D and 70.97% were within ± 0.50 (centre of figure 5; r = 0.97; P < 0.0001). For J45, 96.77% of eyes were within ± 1.00 D and 77.42%
were within ± 0.50 (bottom of figure 5; r = 0.92; P < 0.0001).

Figure 6 shows the astigmatism component of the power vector represented by a 2-dimensional vector \((J_0, J_{45})\). The origin of the graph (0, 0) represents an eye free of astigmatism. The spread of the post-ICRS implantation data from the origin is more concentrated than the spread of the preoperative data. The spread in the post-ICRS implantation data is converted into a concentrated data set around the origin after IOL implantation plus corneal relaxing incision.

**DISCUSSION**

Recently, it has been reported\(^{10}\) that in patients with clear lens, sequential ICRS and intraocular collamer lens posterior IOL implantation with corneal relaxing incisions provides good visual and refractive outcomes, and is a predictable procedure for refractive correction of keratoconus. Logically, this combined procedure should only be performed in patients with clear lens. Several previous reports\(^{11-14}\) have evaluated the results of lens replacement by a toric IOL in patients with keratoconus. Navas et al.\(^{11}\) presented two cases of form fruste keratoconus that had refractive lens exchange with capsular bag toric IOL implantation. In both cases, there was a marked improvement in UDVA. In another two case reports\(^{12,13}\), cataract extraction with toric IOL implantation was performed in patients with keratoconus and showed similar results. The largest sample of patients with keratoconus to date, in whom the crystalline lens was replaced by a toric IOL, was recently presented by Jaimes et al.\(^{14}\). This study included 19 eyes treated with refractive lens exchange and bag toric IOL implantation. As in the aforementioned case report, there was a large increase in UDVA; however, the authors did not find any statistically significant differences in CDVA before and after toric IOL implantation. Hence, cataract extraction with a toric IOL implantation in patients with keratoconus and cataract may be a good option to correct astigmatism and to restore optimal visual quality. However, after this procedure the corneal abnormalities are still present, and could lead to a decrease in visual quality. Several studies\(^{5,9}\) have shown that ICRS implantation with femtosecond laser is a safe and effective procedure for decreasing the corneal abnormalities in keratoconus and improving visual quality. In the current study, we present a series of 32 eyes of 21 patients with keratoconus and cataract who had sequential ICRS and monofocal IOL implantation with corneal relaxing incision.

Regarding the first procedure (ICRS implantation), our results are in agreement with those obtained in previous reports\(^{5-10}\), which showed that UDVA and CDVA improved after KeraRing ICRS implantation with femtosecond laser; furthermore, most of the eye maintained or improved the CDVA (see figure 3), obtaining satisfactory visual outcomes in relation to the safety index (1.16 at 6 months after ICRS implantation).

In relation to refractive outcomes, the preoperative astigmatism components \((J_0, J_{45})\) correlated highly with the amount of change in the post-ICRS implantation astigmatism component \((J_0, J_{45})\) (middle and bottom of figure 4). However, no correlation was found between the attempted change and the achieved change in the M value six months after ICRS implantation (top of figure 4), and the M value after ICRS implantation was high \((-10.281 \pm 5.977 \text{ D})\), which may explain why the efficacy index (mean postoperative UDVA/mean preoperative CDVA) 6 months after ICRS implantation was low (0.13; see figure 2). After ICRS implantation the corneal shape improved; however, as shown in previous reports\(^5-9\), and as we found, patients may still have a significant degree of ametropia. Phakic IOL implantation\(^{10}\), glasses or contact lenses\(^{11-23}\) are some of the options that can be used to compensate the residual refractive error in patients with clear lens; however in patients with cataract, the crystalline lens should be replaced to restore the visual quality.

In the present study, UDVA improved greatly after IOL implantation plus corneal relaxing incision (from 0.02 ± 0.02 before ICRS implantation to 0.06 ± 0.05 six months after ICRS implantation \((P = 0.004)\) and to 0.53 ± 0.22 six months after IOL implantation plus corneal relaxing incision \((P < 0.0001)\). The efficacy index improved after IOL implantation plus corneal relaxing incision compared to that obtained after ICRS implantation (0.13 and 1.15, respectively). This could be mainly due to two reasons: the cataract extraction on one hand and, on the other, the blur strength was reduced greatly after IOL implantation plus corneal relaxing incision (from 12.56 ± 5.96 D before ICRS implantation to 7.34 ± 7.04 D six months after ICRS implantation and to 1.10 ± 0.95 D six months after IOL implantation with corneal relaxing incision). The visual outcomes of this sequential procedure were satisfactory based on the safety index (1.54), with most of the eyes improving CDVA.

Because ours is the first study to assess sequential ICRS and IOL implantation in patients with keratoconus and cataracts, we could not compare our results with those in previous studies. However, it seems worthwhile to compare our results with those of the study by Jaimes et al.\(^{14}\), who reported the visual and refractive outcomes of patients with non-progressive keratoconus treated with in-the-bag toric IOL implantation. These authors reported a significant reduction in the mean sphere and cylinder after toric IOL implantation; they also found a marked improvement in UDVA. However, in this study the mean CDVA did not change after toric IOL implantation. In our study, CDVA improved after each procedure (ICRS and IOL implantation).
Differences between the patients in each study should be taken into consideration, because in our study, patients had cataracts while in the study by Jaimes et al., the patients had clear lens. Hence one may think that differences in the improvement in CDVA are due to the different patient profiles. However, in our study CDVA also improved after ICRS implantation, because the ICRS decreases the corneal abnormalities in keratoconus and improves visual quality.

Therefore, these results suggest that sequential ICRS and IOL implantation in patients with keratoconus and cataract is a better option to restore optimal visual quality.

Predictability was also good after IOL implantation plus corneal relaxing incision, with 70.97% of eyes within ± 1.00 D of the spherical equivalent (M) (see top of the figure 5). Most patients were within ± 1.00 D of the attempted astigmatism components (J0, J45) (see figure 5, middle and bottom). In figure 6, the spread of the post-IOL implantation is more concentrated around the origin of the graph (0, 0) (this point represents an eye free of astigmatism) than after ICRS implantation. This is because after IOL implantation, we performed a clear corneal relaxing incision on the steepest meridian in eyes with astigmatism. These results are in agreement with a previous study, and suggest that clear corneal relaxing incision can compensate for residual astigmatism after ICRS implantation.

Undoubtedly, the IOL power may be a challenge in keratoconus patients. In our study, we used the SRK/T formula for calculating the IOL power and fortunately, in most cases, no significant refractive surprises were found in the IOL calculations. Thebpatiphat et al. compared the SRK I, SRK II, and SRK/T IOL formulas in patients with keratoconus and suggested that the SRK II formula might provide the most accurate IOL power in patients with mild keratoconus. However, in moderate and severe keratoconus, IOL calculations were less accurate and no differences in calculation formulas could be found. ICRS implantation before IOL implantation could help to calculate IOL power, because ICRS implantation improves the shape of the cornea and could help to obtain a more accurate central corneal power and better estimate the effective lens position. However this hypothesis should be examined in future studies.

Taking into account the refractive outcomes in our study and those of the study by Jaimes et al., one may argue that toric IOLs and sequential ICRS and IOL implantation plus corneal relaxing incision are a viable option to correct the refractive error in patients with keratoconus and cataract. It would be interesting to carry out further studies to compare the refractive and visual results of this sequential procedure with a toric IOL and with a standard IOL plus corneal relaxing incision.

The success of this sequential procedure requires knowledge of when the refraction is stable after ICRS insertion and the risk of progression of keratoconus, because this may lead to refraction change, which could be a problem after IOL implantation. Regarding the first issue, a previous paper evaluated long-term results and stability of ICRS (Intacs) implantation for keratoconus correction. The authors found that CDVA stability was achieved, with no significant differences in refraction from 6 months to 36 months after ICRS implantation. Hence, we consider that six months after ICRS implantation is a good time to perform the second procedure. Before surgery, a careful examination should be performed to analyze whether signs of keratoconus progression are present. However, a major risk factor for progression of keratoconus is young age; in fact, the onset of keratoconus is usually at puberty, and progression mainly occurs until the third or fourth decade of life. Therefore, in this age-group, the risk of keratoconus progression is minimal.

In our study, no complications occurred during the surgeries or over the entire follow-up time. The use of the femtosecond technique to create the corneal tunnel made the ICRS implantation safer and provides a significant reduction in complications (such as ring extrusion) due to the precise depth of the implantation with the femtosecond laser. Although there were no complications in any case, long-term, randomized, comparative, prospective studies should be carried out to assess this procedure and its complications.

In conclusion, our medium-term outcomes are encouraging. Therefore, it suggests that Sequential KeraRing ICRS and IOL implantation plus corneal relaxing incision provides good visual and refractive outcomes, and is a predictable procedure for the treatment of patients with keratoconus and cataract.

REFERENCES