Outcomes of Toric Iris-Claw Phakic Intraocular Lens Implantation After Deep Anterior Lamellar Keratoplasty for Keratoconus

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ABSTRACT

PURPOSE: To assess visual and refractive outcomes of toric iris-claw phakic intraocular lens (IOL) implantation in patients who had previously undergone deep anterior lamellar keratoplasty (DALK).

METHODS: Retrospective case series including 24 eyes of 24 patients implanted with toric Artiflex or Artisan (Ophtec BV, Groningen, Holland) phakic IOL following DALK for keratoconus. During a 12-month follow-up, the main outcome measures were uncorrected and corrected distance visual acuities (UDVA and CDVA), refractive error components, topographic parameters, and endothelial cell count. Alpins vectorial analysis was performed.

RESULTS: At the last follow-up, the spherical equivalent (SE) was within ±0.50 diopters (D) in 71% of eyes and within ±1.00 D in 92% of eyes. Mean refractive astigmatism was reduced from -4.92 ± 1.55 D (range: -2.50 to -8.00 D) preoperatively to -0.66 ± 0.61 D (range: -2.00 to 0.00 D) after treatment, and 76.5% of cases were within ±1.00 D. No significant differences (P = .123) were detected in spherical equivalent values between 3- and 12-month follow-up visits. No eyes lost lines in CDVA, and 54% of eyes gained one or more lines. Postoperative UDVA was 20/40 or better in 88% of eyes. Efficacy and safety indexes at 12 months were 0.93 and 1.00, respectively. Mean endothelial cell loss was 6.10% at 12 months postoperatively. No intraoperative or postoperative complications were noted over the follow-up period.

CONCLUSIONS: The implantation of a toric iris-claw phakic IOL has shown high efficacy and safety in this series and may be considered as a reasonable option for the management of refractive errors after DALK.

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Corneal grafts are usually followed by a significant residual ametropia in patients with keratoconus.[1] Similar to penetrating keratoplasties,[2,3] several patients who underwent previous deep anterior lamellar keratoplasty (DALK) have an unsatisfactory refractive outcome after suture removal.[4] Therefore, a significant number of these patients require a subsequent refractive procedure in case of contact lens intolerance or desire for spectacle independence.[5]

Several surgical options to correct residual refractive errors after keratoplasty have been reported in the literature, such as photorefractive keratectomy,[6] LASIK,[7,8] corneal wavefront-guided customized ablation,[9] corneal relaxing incisions,[10,11] small incision lenticule extraction,[12] or intrastromal corneal ring segment implantation.[13,14] In addition, phakic intraocular lens (IOL) implantation has also been satisfactorily used for visual rehabilitation after penetrating keratoplasty.[15,16] The Artisan non-toric phakic IOL (Ophtec BV, Groningen, Holland) was reported for the correction of residual ametropia following DALK in only two cases.[17] In a prospective multicenter study, Dick et al.[18] reported for the first time the outcomes after implantation of a toric iris-claw phakic IOL for the correction of myopia or hyperopia with astigmatism in non-keratoconic eyes.

Although there are several reports demonstrating excellent results following toric phakic IOL implantation to correct moderate and high refractive errors,[19-21] further studies are still needed to investigate the outcomes of this procedure after DALK. To the best of our knowledge, no studies with a consistent sample of its use in patients after DALK have been published.

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The purpose of the current 12-month follow-up study was to analyze the refractive and visual outcomes of toric iris-claw phakic IOL implantation after DALK for keratoconus to define the safety, stability, and efficacy of this surgery.

PATIENTS AND METHODS

Study Design

This retrospective, noncomparative, interventional case series of 24 eyes (24 patients) comprised patients with keratoconus who had previous DALK and underwent a toric phakic IOL implantation (Artiflex or Artisan; Ophtec BV) for the correction of their residual ametropia at Vissum Alicante (Vissum Corporation, Alicante, Spain) between August 2011 and August 2015. All patients had a full suture removal at least 6 weeks before the phakic IOL implantation. The study was performed in accordance with the tenets of the Declaration of Helsinki and was approved by the local Clinical Research Ethics Committee.

Inclusion criteria were keratoconic eyes previously operated on with the DALK technique, phakic eyes, stable refraction for at least 6 months after full suture removal, preoperative corrected distance visual acuity (CDVA) of 0.48 logMAR (20/60 Snellen) or better, hard contact lens intolerance (established as a comfortable wearing time of less than 8 hours per day), clear cornea centrally, and spherical equivalent (SE) or cylinder of 2.75 diopters (D) or greater preoperatively.

Exclusion criteria were other ocular surgeries except previous DALK, CDVA better than 0.48 logMAR (20/60 Snellen), central anterior chamber depth (ACD) less than 2.9 mm, endothelial cell count (ECC) lower than 2,000 cell/mm^2, scotopic pupil larger than 7 mm, central corneal opacity, cataract, glaucoma, or retinal disease, and uncontrolled ocular surface inflammation or other active ocular comorbidity.

Preoperative and Postoperative Assessments

Preoperative examination including manifest and cycloplegic refractions, uncorrected distance visual acuity (UDVA), CDVA, slit-lamp biomicroscopy, Goldmann tonometry, fundus evaluation, EyeTop corneal topography (CSO, Florence, Italy), ACD measurement by Visante optical coherence tomography (Carl Zeiss Meditec, Jena, Germany), ECC by Konan-Noncon Robo specular microscope (Konan Medical, Hyogo, Japan), and pupillometry by Procyon Pupillometer P2000SA (Procyon Instruments Ltd., London, United Kingdom) was performed in all cases.

The postoperative evaluation was at day 1, week 1, month 1, month 3, month 6, and subsequently at 6-month intervals. The visual and refractive results were recorded preoperatively and postoperatively at the 3-month and 12-month visits without dropout rate. The corneal topographic parameters and ECC were registered from all patients preoperatively and at the last follow-up visit. The vectorial analysis of astigmatic changes was performed in all eyes 12 months postoperatively.

The main outcome measures were: UDVA and CDVA with the analysis of the safety and efficacy of the procedure, manifest refraction (predictability and stability), corneal topographic parameters, and ECC. The safety index (ratio of mean postoperative CDVA to mean preoperative CDVA) and the efficacy index (ratio of mean postoperative UDVA to mean preoperative CDVA) were also calculated.

Phakic IOLs

The toric Artisan (Ophtec BV) is a one-piece polymethylmethacrylate phakic IOL with an optical zone of 5 mm and a convex-concave shape. This iris-fixated phakic lens can correct from -23.00 up to +14.00 D of sphere power and from -1.00 up to -7.50 D of cylindrical power.

The Artiflex toric phakic IOL (Ophtec BV) has an optical zone of 6 mm and a convex-concave shape. This lens has a flexible optic of polysiloxane and two rigid haptics of polymethylmethacrylate. It is available with spherical powers between -1.00 and -13.50 D and cylindrical powers between -1.00 and -5.00 D.

Surgical Procedure

All surgeries described below were performed by the same surgeon (JLA) at Vissum Corporation, Alicante, Spain.

DALK. Femtosecond laser–assisted DALK with coadjuvant use of the "big bubble technique"[22] was performed successfully in all cases.[2,23] The 60-KHz Intralase femtosecond laser (Abbott Medical Optics, Santa Ana, CA) was used only to create the side cut in both donor and recipient corneas. For the side cut, a full-thickness zig-zag configuration cut was made on the donor cornea first and then a non-penetrating zig-zag configuration on the recipient. The donor button was the same diameter as the recipient cornea (8 mm). Descemet membrane and endothelium were gently stripped from all donor corneas before securing them with a double continuous 10-0 nylon suture in all cases. Suture removal was not completed in any case before 12 months postoperatively.

Iris-Claw Phakic IOL Implantation. The power calculation of the phakic IOL was obtained by Ophtec BV using the Van der Heijde formula. The power of the lens was selected to obtain a target of emmetropia in all eyes. The Artisan phakic IOL was only used when the refractive error could not be fully corrected by the Artiflex lens.

The surgical technique for the toric iris-claw phakic IOL implantation has been previously described.[24] Preoperatively, the horizontal meridian was marked at the slit-lamp with ink to avoid misalignments in relation to the cyclotorsion. The Artiflex lens was implanted through a 3.2-mm limbal incision perpendicular to the enclavation axis under topical anesthesia (preservative-free lidocaine 2.0%), whereas the Artisan lens was implanted through a 5.2-mm scleral incision under peribulbar anesthesia. A myotic agent (acetylcholine) was injected in the anterior chamber at the beginning of the procedure. Once the anterior chamber was filled with cohesive viscoelastic solution (Provisc; Alcon Laboratories, Inc., Fort Worth, TX), the phakic IOL was inserted into the anterior chamber with a specially designed spatula (Ophtec BV) and rotated to the desired orientation. Then the haptics were fixated to the iris with the enclavation needle according to the alignment marks on the cornea and the proper lens centration over the pupil was confirmed. A peripheral iridectomy was performed in all cases. The surgery concluded with an anterior chamber injection of 1 mg/0.1 mL of cefuroxime sodium in all patients.

Statistical Analysis

All data were statistically analyzed using SPSS software (version 18; SPSS Inc., Chicago, IL). When parametric analysis could be applied, the Student's *t* test for paired data was used to assess the differences between preoperative and postoperative data and to compare it between consecutive postoperative visits. When nonparametric tests were required, the Wilcoxon rank-sum test was applied. A *P* value of less than .05 was considered statistically significant. The Alpins method[25,26] was applied in all cases using the ASSORT software (ASSORT Pty Ltd., Cheltenham, Australia) for the vector analysis of refractive astigmatic changes at the last follow-up visit.

RESULTS

Thirteen patients were women and 11 were men. The mean age at the time of phakic IOL implantation was 32.66 ± 4.77 years (range: 26 to 47 years). The toric Artiflex lens was implanted in 17 eyes (71%) and the toric Artisan lens in 7 eyes (29%). In all cases, the interval between DALK and toric phakic IOL implantation was 18 months or later and the interval between suture removal and lens implantation was at least 6 months.

Preoperatively, the mean spherical error was -2.26 ± 3.06 D (range: 0.00 to -9.00 D), the mean refractive cylinder was -4.92 ± 1.55 D (range: -2.50 to -8.00 D), the mean spherical equivalent (SE) was -4.73 ± 2.59 D (range: -10.50 to 1.00 D), the mean UDVA was 1.05 ± 0.35 logMAR (20/225 Snellen) (range: 0.49 to 1.60 logMAR), and the mean CDVA was 0.21 ± 0.16 logMAR (20/32 Snellen) (range: 0.00 to 0.48 logMAR). The improvement of all refractive values was statistically significant at both postoperative visits ($P < .01$) compared to preoperatively. **Table A** (available in the online version of this article) summarizes the refractive and visual outcomes preoperatively and postoperatively. **Figure 1A** shows the cumulative Snellen lines distribution at the 12-month follow-up. The distribution of the postoperative refractive astigmatism achieved is shown in **Figure 1B**. No eye lost lines of CDVA and 13 eyes (54%) improved one or more lines (**Figure 1C**). The mean safety index (postoperative CDVA/preoperative CDVA) was 0.99 and 1.00 at 3 months and 12 months postoperatively, respectively. There were no statistically significant differences in the refractive components between the 3-month and latest reported follow-up ($P > .05$), and SE changed more than 0.50 D during the follow-up period in 2 eyes (8.3%) (**Figure 1D**). **Figure 1E** shows the attempted versus achieved SE correction ($R^2 = 0.977$). **Figure 1F** demonstrates the target induced astigmatism (TIA) versus magnitude of surgically induced astigmatism (SIA) ($R^2 = 0.984$). The UDVA at the last follow-up visit was 20/40 or better in 21 eyes (88%), 20/32 or better in 16 eyes (67%), and 20/20 or better in 6 eyes (25%) (**Figure 1G**). The mean efficacy index (postoperative UDVA/preoperative CDVA) after toric phakic IOL implantation was 0.91 and 0.93 at 3 and 12 months of follow-up, respectively. **Figure 1H** shows the SE accuracy after the procedure. **Figure 1I** shows the distribution of refractive astigmatism angle of error, in which none of the eyes showed an angle of error over 15° of the target after phakic IOL implantation.

Analyses of keratometric values revealed no statistically significant differences from baseline to 12 months after surgery, as summarized in **Table B** (available in the online version of this article) (all $P > .05$). **Table C** (available in the online version of this article) shows the mean results of the Alpins vector analysis. The mean magnitude of TIA was 4.43 ± 1.48 D (range: 2.13 to 7.49 D and the mean SIA was 4.31 ± 1.44 D (range: 1.96 to 7.00 D), showing no statistical differences between these parameters analyzed ($P = .177$). The mean magnitude of difference vector was 0.65 ± 0.60 D (range: 0.00 to 1.94 D). **Figure 2** shows the difference vector (vectorial difference between the TIA and SIA vectors) and the correction index (SIA divided by TIA; ideal value of 1), which was 0.98 ± 0.14 D (range: 0.71 to 1.42 D). The magnitude of error (positive for overcorrection and negative for undercorrection), which represents the arithmetic difference between the TIA and SIA, resulted in a mean value of -0.11 ± 0.55 D (-0.99 to 1.53 D). The index of success, which is the ratio obtained by divid-

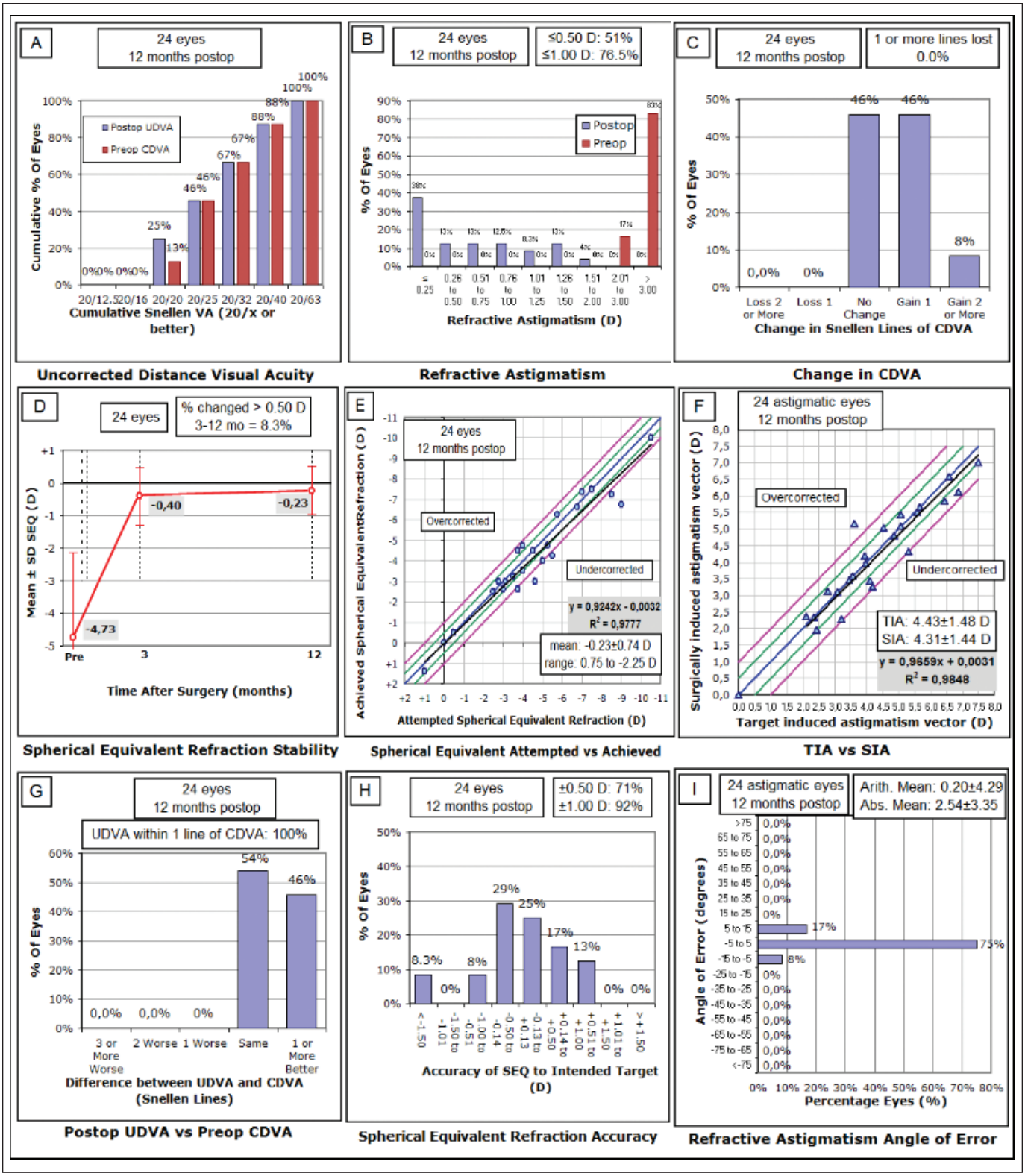

Figure 1. Postoperative results in all 24 eyes at the 12-month follow-up. (A) Cumulative Snellen visual acuity distribution. (B) Distribution of preoperative versus postoperative refractive astigmatism. (C) Postoperative changes in Snellen lines of corrected distance visual acuity (CDVA). (D) Time course of the spherical equivalent refraction (SEQ) stability. (E) Attempted versus achieved SEQ. (F) Target induced astigmatism (TIA) versus surgically induced astigmatism (SIA). (G) Difference between the postoperative uncorrected distance visual acuity (UDVA) and preoperative CDVA. (H) Accuracy of SEQ correction. (I) Distribution of the refractive astigmatism angle of error. D = diopters; SD = standard deviation

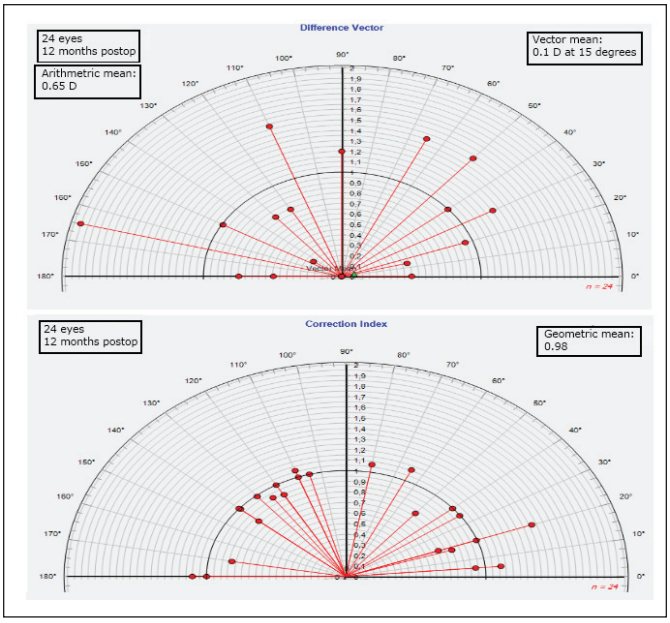

Figure 2. Vectorial displays in all 24 eyes by single-polar plots for the difference vector (DV) and correction index (CI). The vector mean is plotted as a green arrowhead. D = diopters

ing the difference vector by the TIA (preferably 0), was 0.15 ± 0.13 (range: 0.00 to 0.42).

The mean value of ECC was 2,632.25 ± 357.55 cells/mm^2 preoperatively and 2,471.52 ± 344.29 cells/mm^2 at the 12-month follow-up. A statistically significant difference was found between preoperative and postoperative ECC values ($P \leq .01$). There were no intraoperative or postoperative complications during the follow-up. **Figure A** (available in the online version of this article) shows a 1-day postoperative photograph of toric phakic IOL implanted in an eye after DALK.

DISCUSSION

In contrast to the other interventions mentioned,[27] the toric phakic IOL procedure has some benefits: preservation of structural integrity of the graft including the avoidance of tissue ablation, no risk of postoperative haze, ability to correct higher degrees of spherical and astigmatic refractive errors, and reversibility of the treatment if needed. In several reports,[15,18-21,24,28-37] the literature extensively demonstrated the safety, efficacy, stability, and predictability of iris-claw phakic IOL implantation for the treatment of spherical and cylindrical errors among different scenarios.

As recently stated by Morral et al.,[36] in a paired-eye comparison study comprising a total of 116 ametropic eyes, the phakic IOL and corneal refractive surgery interventions showed similar excellent efficacy and safety indices. In a long-term prospective randomized study, Bimbaum et al.[14] reported no significant reduction in astigmatism after intrastromal corneal ring segment implantation in patients who previously had penetrating keratoplasty. Photorefractive keratectomy was also used for the same purpose,[6] in which 20% of eyes developed severe haze over a 10-month follow-up. In 12 patients after DALK, Acar et al.[7] described a significant improvement in UDVA and no eyes lost CDVA lines after LASIK. To the best of our knowledge, because this is the first study to analyze iris-claw phakic IOL implantation following DALK, we are unable to compare our findings directly.

In 2004, Moshirfar et al.[16] reported the efficacy of the non-toric Artisan lens in correcting residual refractive error after penetrating keratoplasty. Although theirs was the first study to investigate iris-claw phakic IOL implantation in ametropia after keratoplasty, only 2 eyes were evaluated and neither of them had a significant decrease in ECC after surgery. In 2006, Tahzib et al.[15] published a prospective non-comparative case series of 36 eyes with residual ametropia from 35 patients. They concluded that Artisan toric lens implantation after penetrating keratoplasty was an effective option for the correction of astigmatism and anisometropia after keratoplasty. Regarding the ECC, they showed a mean endothelial cell loss of 21.2% (in 33 eyes) 12 months postoperatively, whereas in the current study a mean reduction of 6.10% at the 12-month follow-up was found. Despite their distinct inclusion criteria, such as a higher preoperative mean age and also pseudophakic eyes included, this difference in ECC could be explained by the investigation of Kim et al.,[38] who concluded that patients who underwent DALK achieved significantly steeper corneas than those with penetrating keratoplasty. On the contrary, in the Australian registry study, Coster et al.[39] showed that the endothelial graft survival after DALK was significantly worse when compared to penetrating keratoplasty. The observed mean ECC loss in the current study could be explained by the lens itself, by the normal ECC loss after DALK[40,41] or the combination of both. Furthermore, we hypothesize that the risk ratio of ECC decrease with toric iris-claw phakic IOL implantation in cases after DALK could not be considerably different in comparison to normal ametropic eyes.[19-21] Guerin et al.[19] similarly described a mean endothelial decrease of 6.17% after 12 months of Artiflex lens implantation. In a prospective multicenter study, Doors et al.[20] found a mean reduction of 4.8% after 3 months compared to ECC at baseline and no additional decline up to 6 months of follow-up. Alternatively, using the toric intraocular Collamer lens for post-keratoplasty astigmatism, Alfonso et al.[42] observed a mean ECC reduction of 9.84% over a 24-month period.

In the current investigation, implantation of toric phakic IOL resulted in a significant improvement in CDVA and UDVA, with 88% of eyes yielding an UDVA of 0.3 logMAR (20/40 Snellen) or better, and no eyes of this series lost CDVA lines. The visual and refractive outcomes reported herein are consistent with other studies[15,16] of iris-claw lens implantation after penetrating keratoplasty. The mean safety index achieved was 1.00, whereas Tahzib et al.[15] similarly found a value of 0.98. The efficacy index in the current study also satisfactorily reached a mean value of 0.93.

The stability and predictability outcomes of this surgery also presented a good performance. In our study, there was a robust correlation between the attempted and achieved SE, which reached a mean value of -0.23 ± 0.74 D postoperatively; 71% of eyes were within ±0.50 D and 92% were within ±1.00 D. The mean refractive cylinder improved from -4.92 ± 1.55 D preoperatively to -0.66 ± 0.61 D postoperatively; 76.5% were within ±1.00 D. In comparison to other studies with normal ametropic eyes, their outcomes are comparable to the current results. In the subgroup of 84 eyes with toric model phakic IOL implanted, Güell et al.[21] reported efficacy indexes of 0.93 and 0.96 at 3 and 12 months, respectively. In their series, a mean SE of -0.02 ± 0.63 D and a mean refractive astigmatism of -0.77 ± 0.45 D were achieved 1 year postoperatively. In the current study, a strong correlation between TIA and SIA was obtained (R^2 = 0.984). Moreover, the higher value addressed to TIA resulted in a CI of 0.98 (preferably 0) and magnitude of error of -0.11 D (ideally 0), hence reflecting the mild undercorrection achieved. The negative mean value of angle of error implies a slight clockwise deviation of the intended axis. After 12 months of iris-fixated toric phakic IOL implanted in patients after penetrating keratoplasty, Visser et al.[37] also noted a trend toward undercorrection of the refractive cylinder through correction index and magnitude of error of 0.99 and -0.32, respectively.

In addition, the visual outcomes at the 12-month follow-up found to compare favorably with the results of phakic IOL implantation in keratoconic eyes that did not undergo surgery. Alió et al.[24] showed similar results in terms of SE accuracy in the iris-claw phakic IOL group; 70% of eyes were within ±0.50 D and 90% were within ±1.00 D. Regarding the postoperative refractive cylinder, 76.5% were within ±1.00 D. They reported efficacy and safety indexes of 0.96 and 1.22, respectively.

A specific follow-up plan in the setting of phakic IOL implantation after DALK could be hypothetically proposed by a corneal endothelial evaluation and anterior segment optical coherence tomography at yearly intervals. The anterior segment optical coherence tomography is essential for the measurement between the endothelial surface of the cornea to the anterior edge of an Artiflex (minimum critical distance of 1.3 mm) or Artisan (minimum intended distance of 1 mm) lens.[43]

The implantation of a toric iris-claw phakic IOL showed outstanding results in terms of predictability, stability, and efficacy over a wide range of astigmatism, and it also seems to be a safe option for the management of residual ametropia in eyes after DALK for keratoconus. Future studies with longer follow-up periods and larger series are needed to confirm the outcomes revealed herein.

AUTHOR CONTRIBUTIONS

Study concept and design (MCT, NK-J, JLA); data collection (MCT); analysis and interpretation of data (MCT, JLADB, ABP-P, SKA-M, GZ, JLA); writing the manuscript (MCT, JLA); critical revision of the manuscript (JLADB, NK-J, ABP-P, SKA-M, GZ, JLA); obtaining funding (JLA); administrative, technical, or material support (JLA); supervision (JLA)

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TABLE A

Preoperative and Postoperative Visual Conditions (N = 24)[a]

Parameter	Preoperative	3 Months Postoperative	12 Months Postoperative	P[b]	P[c]
Sphere (D)	-2.26 ± 3.06 (-9.00 to 3.00)	0.02 ± 0.80 (-2.00 to 1.50)	0.09 ± 0.72 (-1.75 to 1.50)	< .01	.458
Cylinder (D)	-4.92 ± 1.55 (-8.00 to -2.50)	-0.80 ± 0.71 (-2.00 to 0.00)	-0.66 ± 0.61 (-2.00 to 0.00)	< .01	.159
SE (D)	-4.73 ± 2.59 (-10.50 to 1.00)	-0.40 ± 0.89 (-2.50 to 0.75)	-0.23 ± 0 .74 (-2.25 to 0.75)	< .01	.123
UDVA (logMAR)	1.05 ± 0.35 (0.49 to 1.60)	0.19 ± 0.16 (0.00 to 0.52)	0.18 ± 0.15 (0.00 to 0.52)	< .01	.033
CDVA (logMAR)	0.21 ± 0.16 (0.00 to 0.48)	0.15 ± 0.15 (0.00 to 0.48)	0.14 ± 0.13 (0.00 to 0.47)	< .01	.028
ECC (cells/mm^2)	2,632.25 ± 357.55 (2,010 to 3,200)	–	2,471.52 ± 344.29 (1,872 to 3,100)	< .01	N/A

D = diopters; SE = spherical equivalent; UDVA = uncorrected distance visual acuity; CDVA = corrected distance visual acuity; ECC = endothelial cell count; N/A = not available
[a]Values presented as mean ± standard deviation (range).
[b]Preoperative versus last follow-up visit.
[c]3 months versus 12 months.

TABLE B

Keratometry Values Measured Preoperatively and 12 Months Postoperatively[a]

Parameter	Preoperative	12 Months Postoperatively	P[b]
K1 (D)	44.13 ± 3.25 (36.8 to 50.6)	44.46 ± 2.80 (36.09 to 49.12)	.079
K2 (D)	48.90 ± 3.13 (40.57 to 54.87)	48.71 ± 2.96 (40.52 to 55.32)	.184
Km (D)	46.60 ± 3.24 (38.62 to 52.72)	46.51 ± 2.73 (38.18 to 51.86)	.749
Kmax (D)	55.89 ± 5.55 (48.80 to 67.62)	55.54 ± 5.10 (48.50 to 66.52)	.065

D = diopters; K1 = flattest meridian; K2 = steepest meridian; Km = average keratometry; Kmax = maximum keratometry
[a]Values are presented as mean ± standard deviation (range).
[b]Preoperative versus 12 months.

TABLE C

Results of Alpins Analysis 1 Year Postoperatively

Parameter	Mean ± SD	Median	Range
TIA (D)	4.43 ± 1.48	4.14	2.13 to 7.49
SIA (D)	4.31 ± 1.44	4.26	1.96 to 7.00
DV (D)	0.65 ± 0.60	0.60	0.00 to 1.94
AE (degrees)	0.20 ± 4.29	0.00	-10.00 to 10.00
ME (D)	-0.11 ± 0.55	0.00	-0.99 to 1.53
CI	0.98 ± 0.14	1.00	0.71 to 1.42
IOS	0.15 ± 0.13	0.14	0.00 to 0.42
CA	1.03 ± 0.15	1.00	0.70 to 1.41

SD = standard deviation; TIA = target induced astigmatism; D = diopters; SIA = surgically induced astigmatism; DV = difference vector; AE = angle of error; ME = magnitude of error; CI = correction index; IOS = index of success; CA = coefficient of adjustment

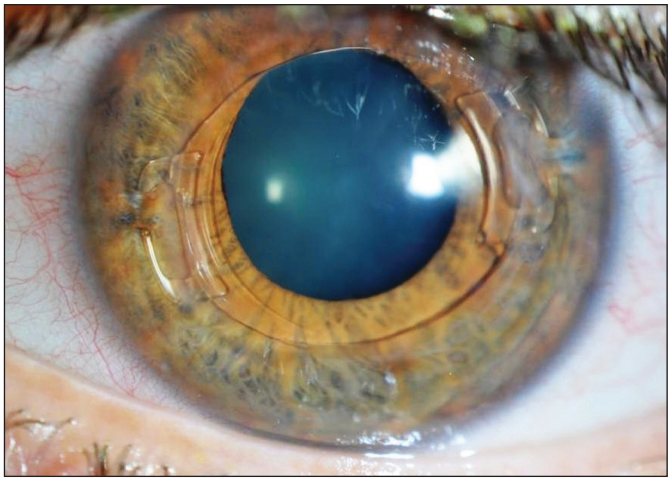

Figure A. Postoperative slit-lamp photograph 1 day after toric Artiflex (Ophtec BV, Groningen, Holland) phakic intraocular lens (PIOL) implantation in eye with previous deep anterior lamellar keratoplasty (DALK).