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Intracorneal ring segments followed by toric pseudoaccomodating IOL for treatment of patients with corneal ectasia and cataract

Sneha Konda[a], Balamurali K. Ambati[b,*]

[a] Texas A&M College of Medicine, 8447 Bryan Road, College Station, TX, USA
[b] Pacific Clear Vision Institute, 1125 Darlene Lane #100, Eugene, OR, USA

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ABSTRACT

Purpose: Surgical management of keratoconus aims to improve corneal curvature, prevent progression of corneal ectasia, and manage refractive error. In older individuals with concurrent cataracts, management can be challenging due to topographic irregularity and difficult-to-interpret IOL calculations. We describe a sequential combination of two surgical techniques—intrastromal corneal ring segments (e.g. intacs) insertion and toric pseudoaccomodating lens implantation—to successfully manage concurrent keratoconus and cataracts.

Observations: In this case series, we present three eyes with corneal ectasia in two cataractous patients successfully managed by (1) Intacs placement to normalize corneal contour/asymmetry and enable more regular keratometry measurements, followed by (2) correction of astigmatism and presbyopia by placement of toric pseudoaccommodating IOL (Trulign) after cataract extraction.

Conclusions and Importance: This is the first description, to the authors' knowledge, of the use of intraocorneal ring segments + toric pseudoaccommodating intraocular lenses for the management of concurrent keratoconus, cataract, and presbyopia.

1. Introduction

Corneal ectasia is defined as any non-inflammatory weakening, thinning or abnormal curvature of the corneal layers and is typically classified as one of three entities: keratoconus, pellucid marginal corneal degeneration or keratoglobus.

Keratoconus is the most common corneal ectasia, and is characterized by localized stromal thinning and steepening/conical protrusions of the cornea, typically with inferotemporal thinning and steepening with with-the-rule astigmatism. The resultant high myopia and irregular astigmatism in these conditions is usually not amenable to spectacle correction, and is typically managed with contact lens wear, However, severe forms may require surgical intervention, namely, corneal transplantation.

In older patients with concurrent cataracts and corneal ectasia, obtaining accurate IOL measurements can be challenging due to steep corneal curvature and resultant irregular astigmatism.[1] Keratometry using manual methods, topography, or biometry is compromised by the presence of irregular astigmatism, since the axis, average power, and steep, flat meridians are variable in each zone. This leads to suboptimal spheroequivalent IOL calculations.[2] Limbal relaxing incisions to treat astigmatism are generally contraindicated in keratoconic cataract patients due to risk of progression of ectasia. Contact lens wear or a second procedure might be necessary post-cataract extraction due to inability to accurately anticipate corneal contour and refractive power pre-surgery and suboptimal visual performance/acuity post-surgery.

Another surgical intervention that has gained prominence due to its minimal invasiveness is implantation of intrastromal corneal ring segments (Intacs)—either single or double crescent-shaped pieces of plastic polymer placed into the mid-deep stroma of the corneal midperiphery. These inserts serve to flatten the area of conical protrusion, and slow the stress and alteration in structural properties of the cornea, thereby reducing corneal asymmetry. This method is of growing popularity in stabilizing corneas with keratoconus, and has often enabled patients to return to soft contact lenses or glasses.[3,4]

The use of toric intraocular lenses, is less popular but has also been reported in literature as a means to address irregular astigmatism and concurrent cataracts/keratoconus in a one-step procedure. However, this particular route of management is successful and applicable to a certain select group of patients, requiring careful review and customized management of each case—(1) age of patient (2) stage and stability of corneal ectasia (3) topographic and keratometric measurements, axis of astigmatism, manifest refraction, axial length, IOL power. Typically, the more stable and mild the corneal ectasia, the more viable

* Corresponding author. 1125 Darlene Lane #100, Eugene, OR, 97401, USA.
E-mail address: bambati@pcvi.com (B.K. Ambati).

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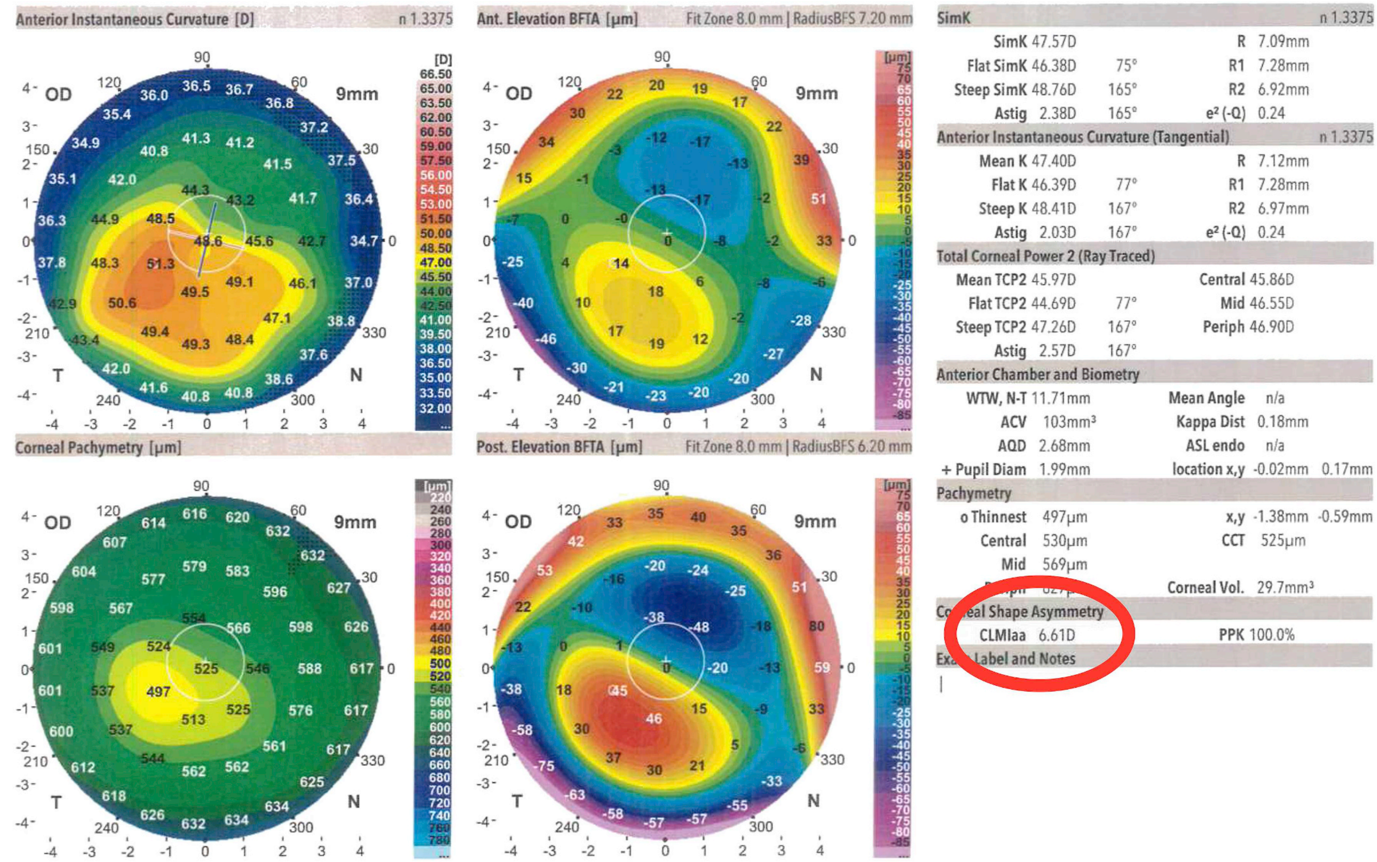


Fig. 1. *Pre and Post Intacs Keratometry Readings*: Pre and Post Intacs Asymmetry Indices show a net decrease of 3.14 D (from 5.04 D to 1.90 D) in corneal asymmetry.

this option is.[5–8] To our knowledge, we are not aware of reports of concurrent correction of presbyopia and astigmatism in cataractous patients with keratoconus.

In this case series, we present the management of three cases of corneal ectasia in two cataractous patients by (1) intacs placement to normalize corneal contour/asymmetry and permit more regular keratometry measurements (2) correction of astigmatism and presbyopia by placement of the Trulign toric pseudoaccommodating IOL after cataract extraction.

2. Findings

2.1. Case presentation 1

A 75 y/o Caucasian male presented to clinic with a prior diagnosis of keratoconus, with no prior surgery. Patient complained of decreased, distorted vision, constant haziness, and trouble seeing street signs. Vision was 20/60, PH 20/30 OD, 20/50 PH 20/40 OS with spectacles. Near vision was J5 OD, J1 OS. Glare testing demonstrated 20/400 OD, 20/150 OS. Slit-lamp examination was significant for 3+ nuclear sclerosis and cortical spoking OU. Topography showed keratoconus. (Fig. 1). Treatment plan to target both bilateral keratoconus and bilateral cataracts was discussed. Femtosecond laser-assisted single-segment Intacs of thickness 350 µm OD was performed. Depth of segment was set at 70% of depth of pachymetry at a 7 mm optical zone. Slit incision placement was placed at 147° in the superotemporal quadrant to facilitate insertion. The manufacturer's nomogram (Addition Technology, Lombard, IL) was used to guide Intacs planning. This was followed by cataract extraction with implantation of a toric pseudoaccommodating Trulign lens BL1UT SE: 17.50D, CYL: 2.00D OD. The same process was repeated with OS (single-segment Intacs of thickness 450 µm placed at 80° followed by Trulign lens BL1UT SE: 18.00D CYL: 2.75D). Pre-intacs and pre-cataract surgery keratometry readings/ asymmetry reports showed a decrease in corneal shape asymmetry (CLMIaa) of 3.14 D (from 5.04 D to 1.90 D) OD (Fig. 1) and 5.99 D (from 9.24 D to 3.25 D) OS (Fig. 2). Patient tolerated all procedures well, and 4 months post-operatively final vision was 20/30 OU, J2 sc OU.

2.2. Case presentation 2

A 53 y/o Caucasian Type II Diabetic male presented to clinic with a 15-year history of wearing rigid gas permeable contact lenses for longstanding diagnosis of keratoconus. In his left eye, patient had an additional piggy back lens Air Optix soft lens under RGP. The patient reported a 1 year duration of change in distance vision. Vision was 20/25 OD. Near vision was J1+ OD,. Slit-lamp examination was significant for 1+ NS OU, moderate keratoconus, ectasia with inferior decentration of cone OD. Topography showed extensive irregular astigmatism OU. Treatment plan to target both bilateral keratoconus and bilateral cataracts was discussed. For the right eye, femtosecond laser-assisted single-segment Intacs of thickness 450 µm was performed to normalize

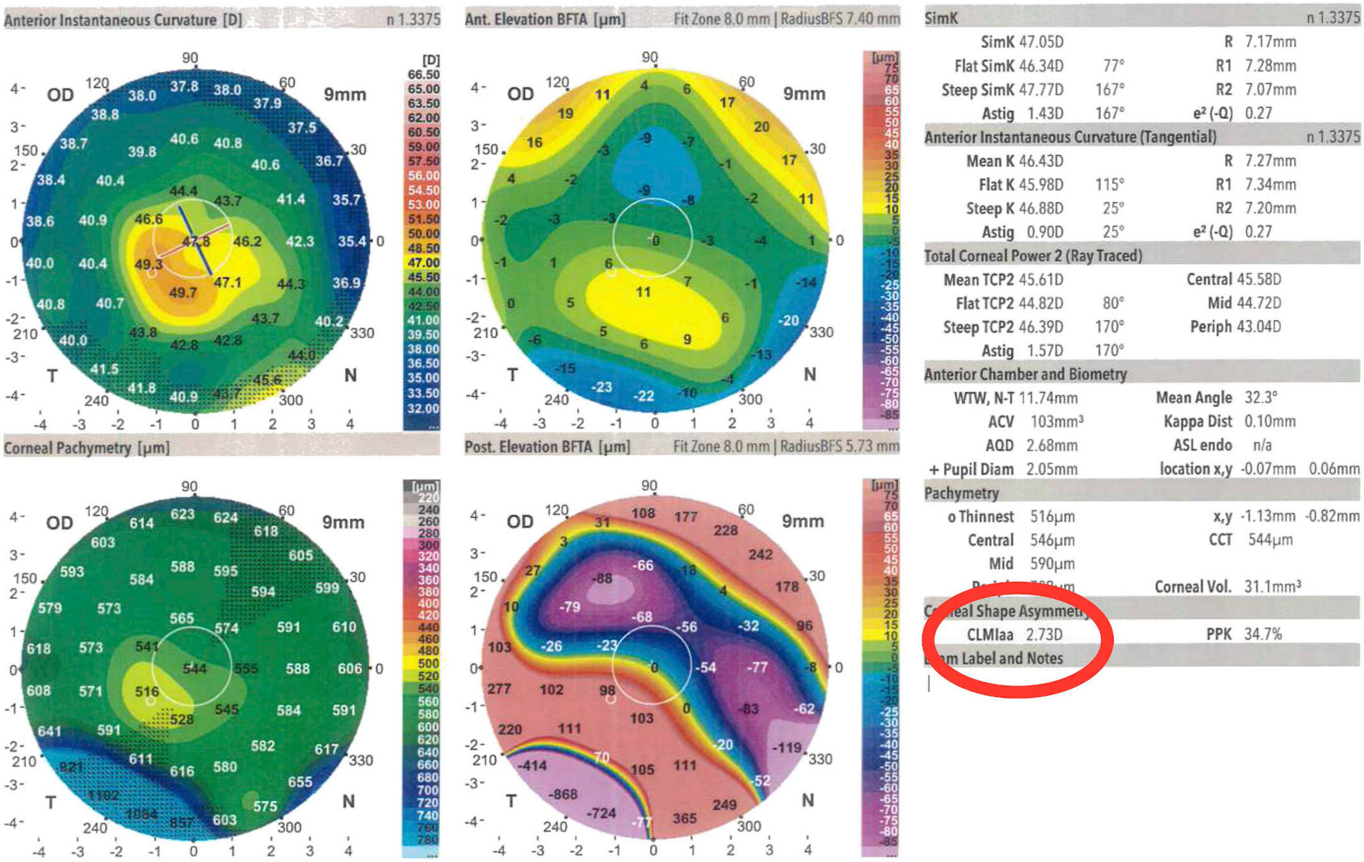
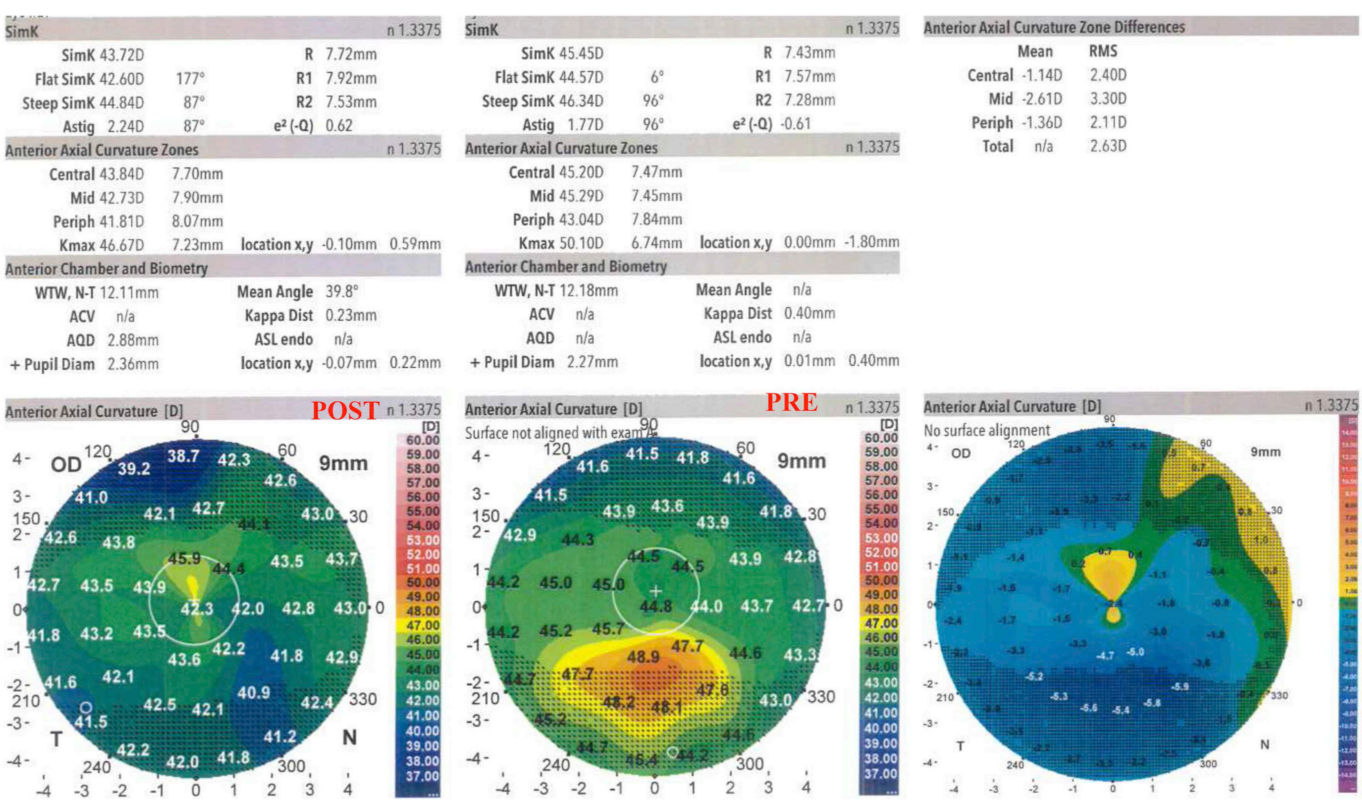


Fig. 1. (*continued*)



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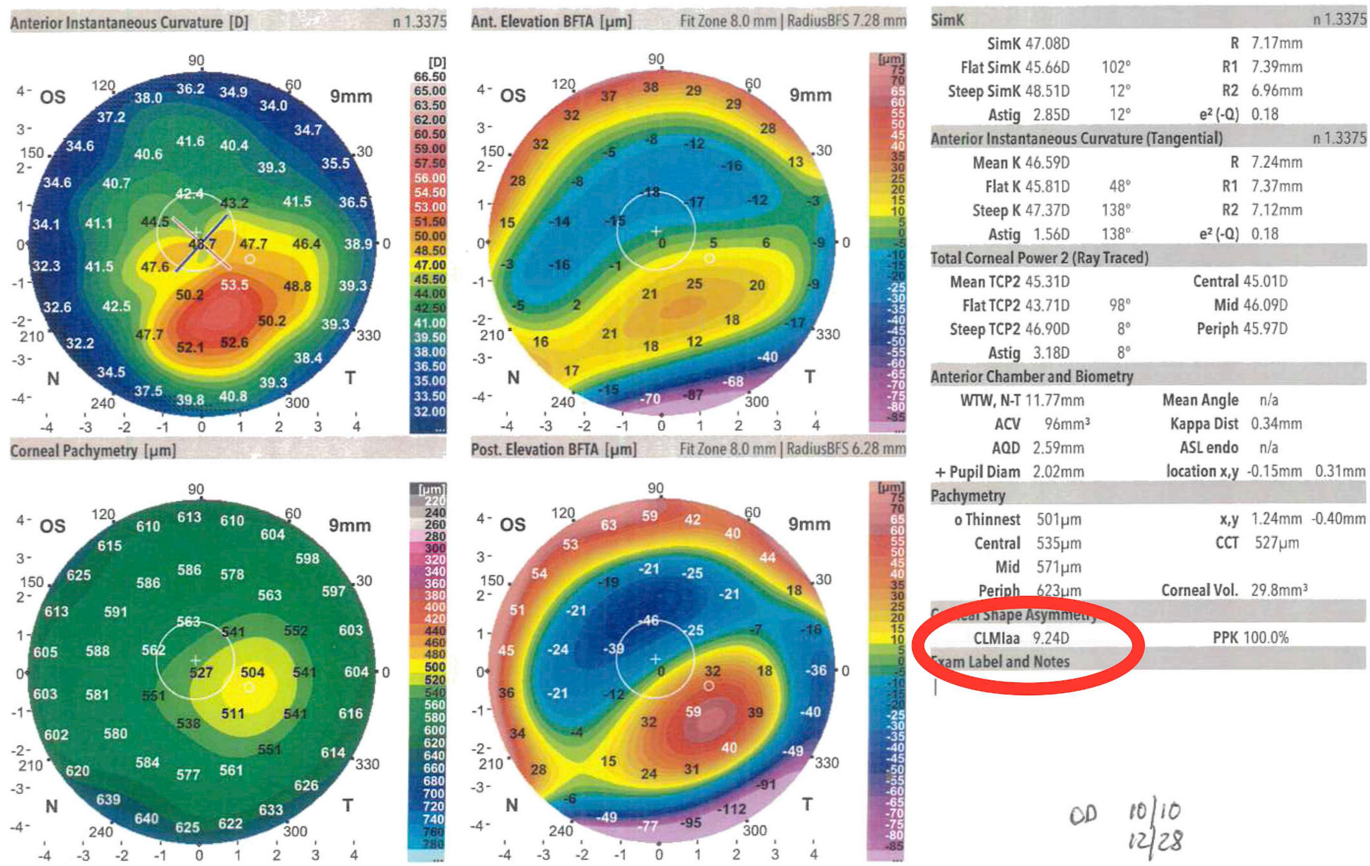


Fig. 2. *Pre and Post Intacs Keratometry Readings*; Pre and Post Intacs Asymmetry Indices show a net decrease of 5.99 D (from 9.24 D to 3.25 D) in corneal asymmetry.

the corneal contour. Segment size, location, depth and meridian of intacs placement was selected as described in Case 1; slit incision was placed at 170°. This was followed by cataract extraction with implantation of a toric pseudoaccommodating Trulign lens BL1UT SE: 18.50D, CYL: 2.75D OD 3 months later. Pre-intacs and pre-cataract surgery reports showed a decrease in corneal shape asymmetry (CLMIaa) of 3.88 D (from 5.04 D to 1.90D) OD (Fig. 3). Patient tolerated all procedures well, and final vision 4 months post-operatively was 20/30, J2 sc OD.

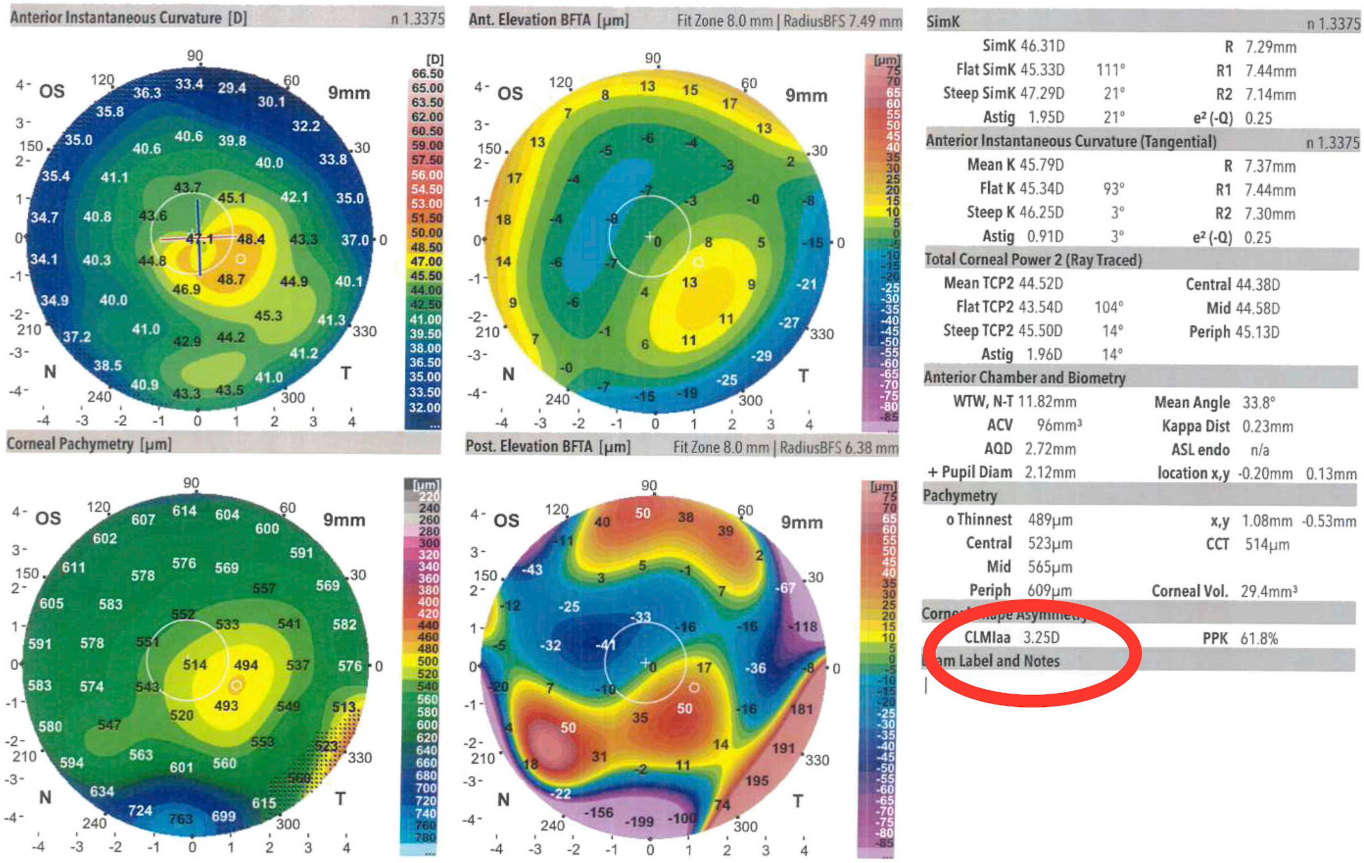
3. Discussion

All three eyes with concomitant corneal ectasia and cataracts were treated successfully with Intacs placement followed by toric pseudoaccommodating intraocular lens implantation. Pre and post intacs keratometries showed stabilization of the corneal surface and decreased asymmetry across corneal topography. This allowed for more precise IOL calculation and resultant improvement in visual acuity without the need for spectacles, contact lenses or rigid gas permeable lenses. No complications or adverse effects were noted in any of the three cases. While combining intracorneal ring segments with posterior phakic toric ICL has been described,[9–11] to our knowledge, this is first description of use of intracorneal ring segments and toric pseudoaccommodating intraocular lenses (Trualign) for the management of concurrent keratoconus and cataract.

Anterior and posterior measurements of corneal properties, presence of keratoconus and comparative stabilization of the corneal symmetry pre and post intacs implantation were performed via the Asymmetry Indices Report on the Ziemer Galilei G4. The Cone Location and Magnitude Index (CLMI) is an index used by the machine to identify the presence of a keratoconic pattern and axis of the posterior cone to guide single segment intracorneal ring segment placement. The machine software searches for the steepest area local region within the mapped area and determines whether the local maximum region is consistent with the corneal asymmetric keratoconus region.[12] In comparing asymmetry indices pre and post intacs, there was a mean net decrease of 4.34D across the three cases.

Intacs were first proposed in 1978 as a possible modality to alter corneal contour and induce corneal refractive stability. It was FDA approved in 2004 and has since been reported in literature to achieve statistically significant corneal keratometric flattening, reduction in astigmatism, and improvement in visual acuity.[13,14] While its efficacy in treating keratoconus and improving contact lens tolerance has been well documented in literature, there have been limited reports documenting its use in conjunction with toric ICL implantation (posterior phakic toric ICL following Intacs has been described[9–11]) to manage both progressive keratoconus and myopia.

Crosslinking is also a newer modality for treating keratoconus that



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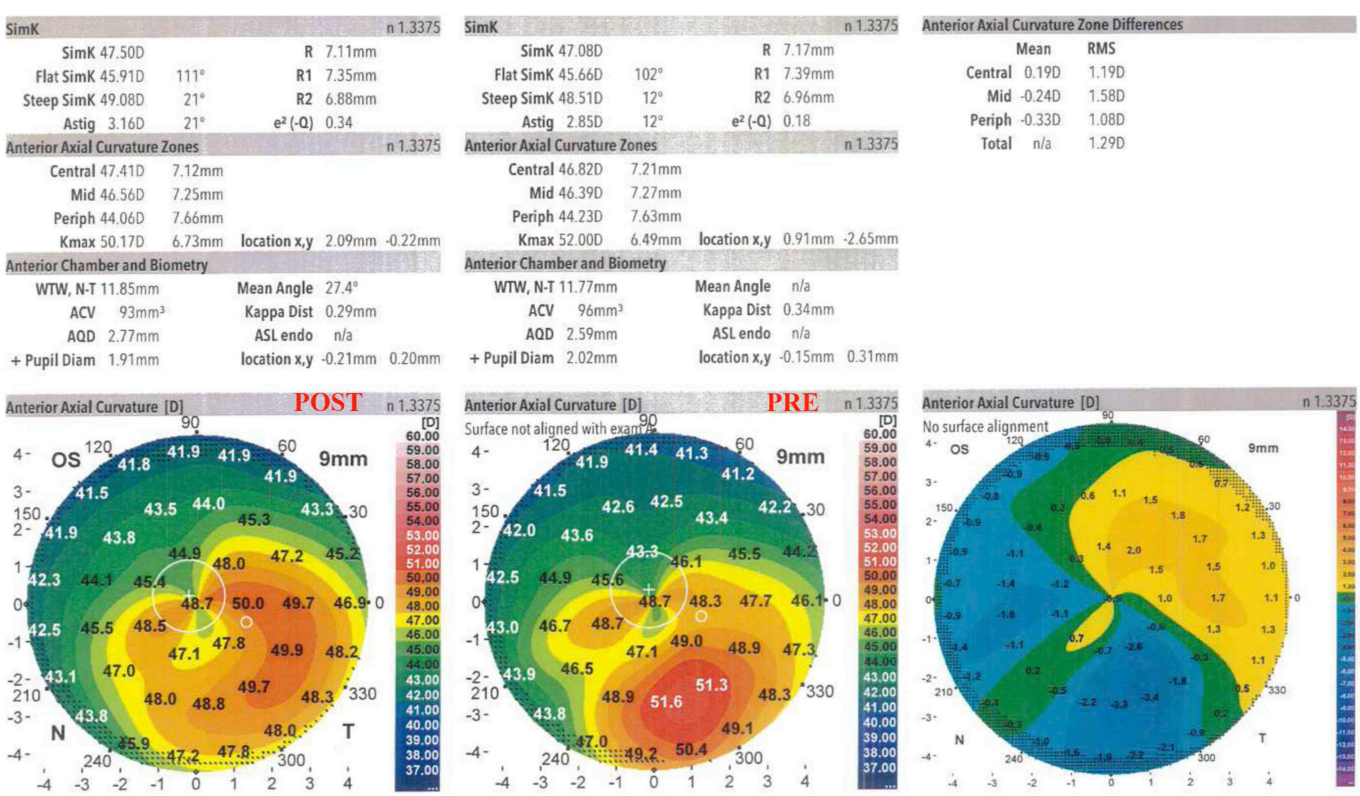

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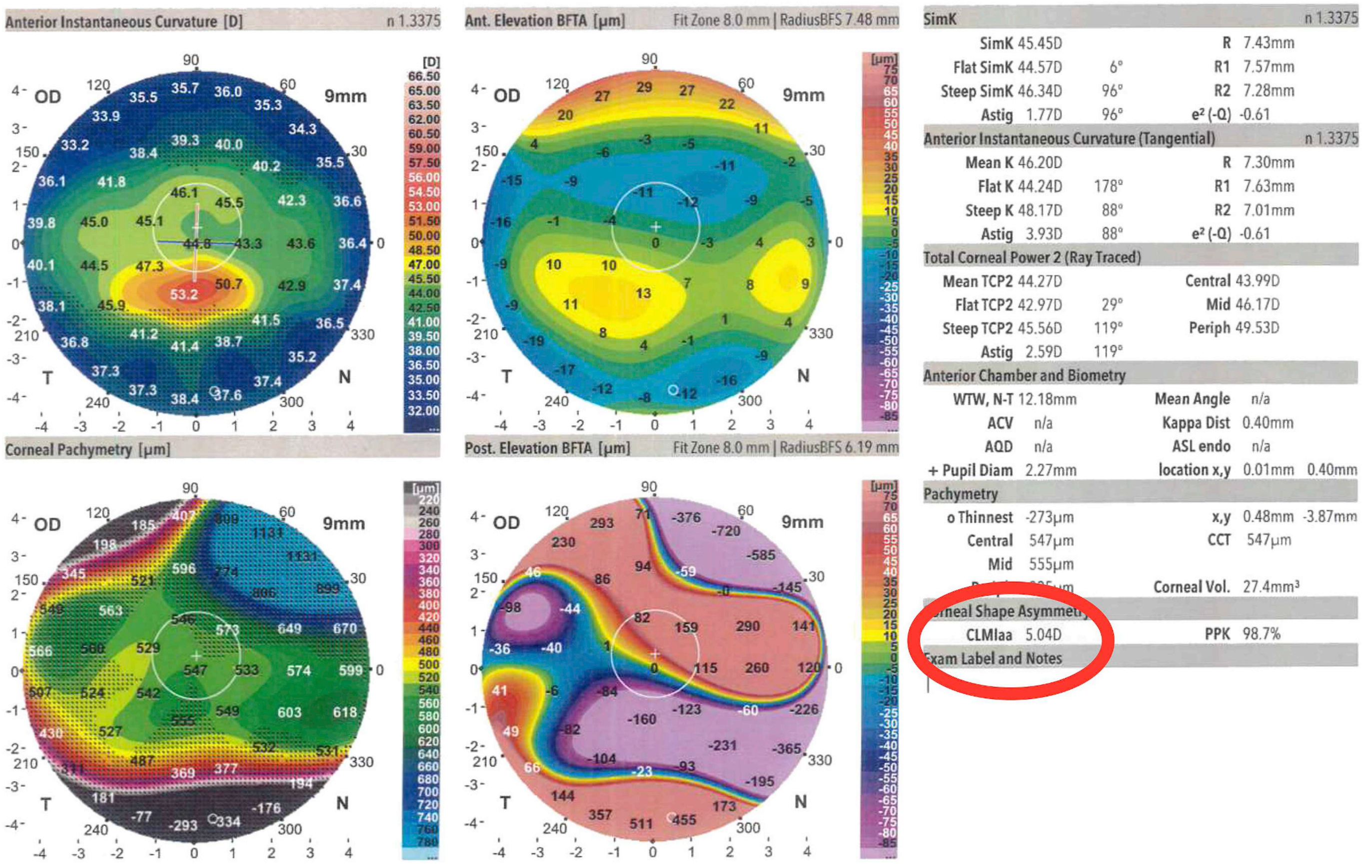

Fig. 3. *Pre and Post Intacs Keratometry Readings*: Pre and Post Intacs Asymmetry Indices show a net decrease of 3.88 D (from 5.04 D to 1.90D) in corneal asymmetry.

can be done alone, in conjunction with intacs or topography guided ablation to stabilize the cornea. However, its value in older stable patients with keratoconus remains to be defined. In contrast, intracorneal ring segments reshape the corneal curvature itself by buttressing the weakened area with the physical insertion of a crescent-shaped ring, with potential for significant reductions in astigmatism. Combination of both surgical modalities have been described in literature: Coskunseven et al. reports a sequence of crosslinking, Intacs and toric ICL implantation in a case series of 14 eyes to manage progressive keratoconus,[9] as well as combined intracorneal ring segments with posterior phakic toric ICL implantation to manage keratoconus with extreme myopia.[10] In a more recent study, Coskunseven et al. describes a 4-stage procedure—Intacs, Crosslinking, Toric ICL and PRK—in 11 eyes.[11,15] Again however, the invasiveness and cumulative length of these approaches may not be feasible or desirable in older, more stable patients.

Studies have reported an approximate flattening of 1.5 to 2D with crosslinking alone, with more flattening of up to 5D with Intacs.[16–19] Given that spherical error can be corrected fairly easily with adjustments in IOL spherical power, the extra corneal flattening afforded by crosslinking may not be relevant to management of cataract patients. In contrast, single-segment intracorneal ring segments reduce astigmatism far more than double segment placement.[20,21] Sharma et al. reports a greater improvement in visual acuity (9 lines vs 2.5 lines), steep K values (2.76 D vs .93D), and cylinder decrease (5.69D vs 1.58D) in single-segment vs double-segment subject groups.[21] Other studies report a reduction in astigmatism of up to 4 diopters with single segment intacs.[22–25] This theoretically affords the treating physician the option to debulk corneal astigmatism to a range that can be treated by a toric pseudoaccommodating intraocular lens.

4. Conclusions

Presence of progressive keratoconus and cataracts requires a multidimensional approach—corneal irregularity can complicate and confound intraocular lens calculations, making standard measurements inexact and equivocal. Corneal asymmetry and corresponding flattening/steepening of corneal topography can overestimate or sometimes underestimate corneal power, and hence directly influence final lens power parameters. It is thus paramount to ensure reduction of corneal irregularity and flattening of keratometric values prior to attempting cataract extraction and IOL implantation. This case series proposes the successful management of the above paradigm by normalizing corneal contour with Intacs, use of asymmetry indices to measure change/normalization in corneal contour, re-measurement of IOL parameters, and significant improvement in visual acuity without need for additional correction after cataract extraction/toric lens implantation.

Patient consent

Informed consent was obtained from the patients for the use of their health information.

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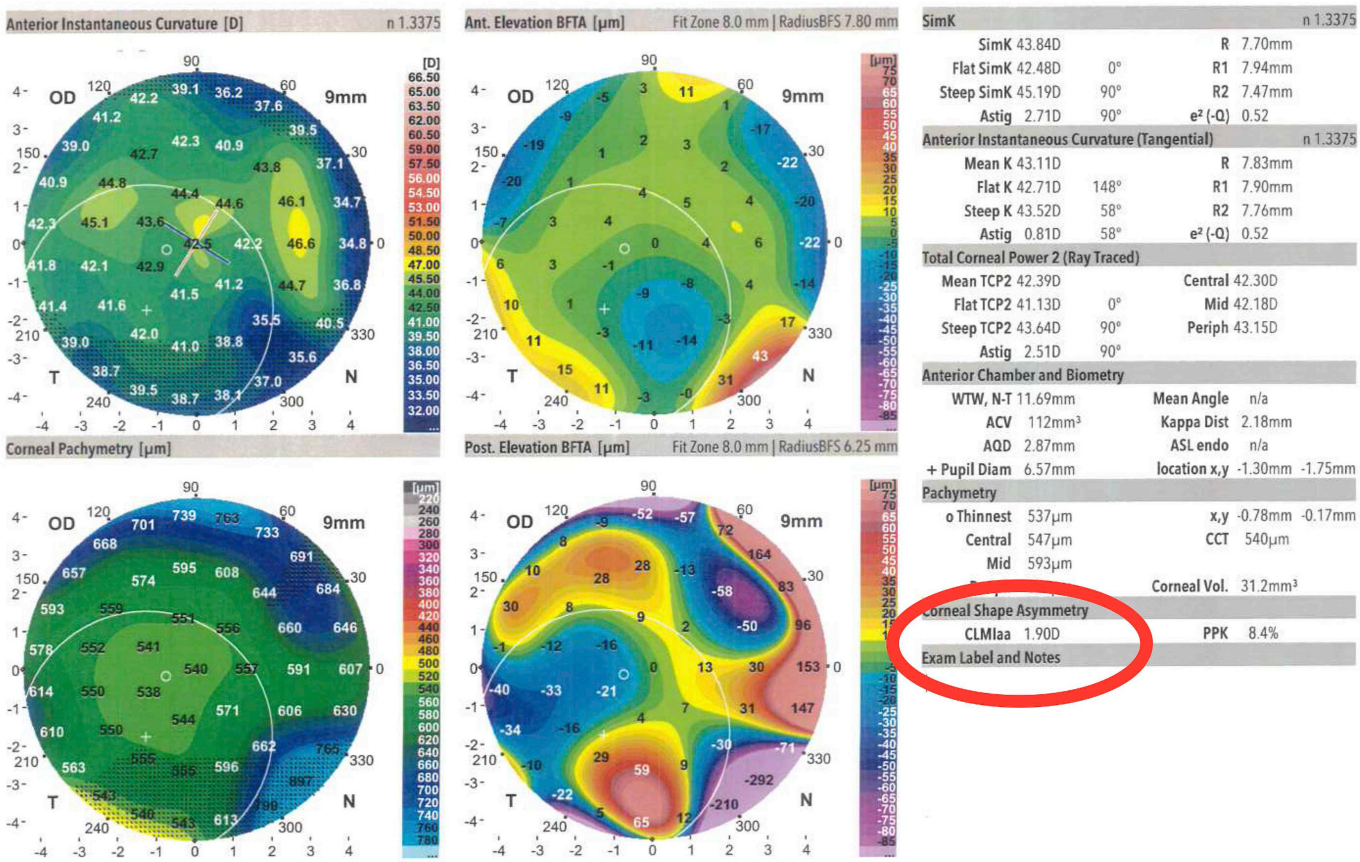

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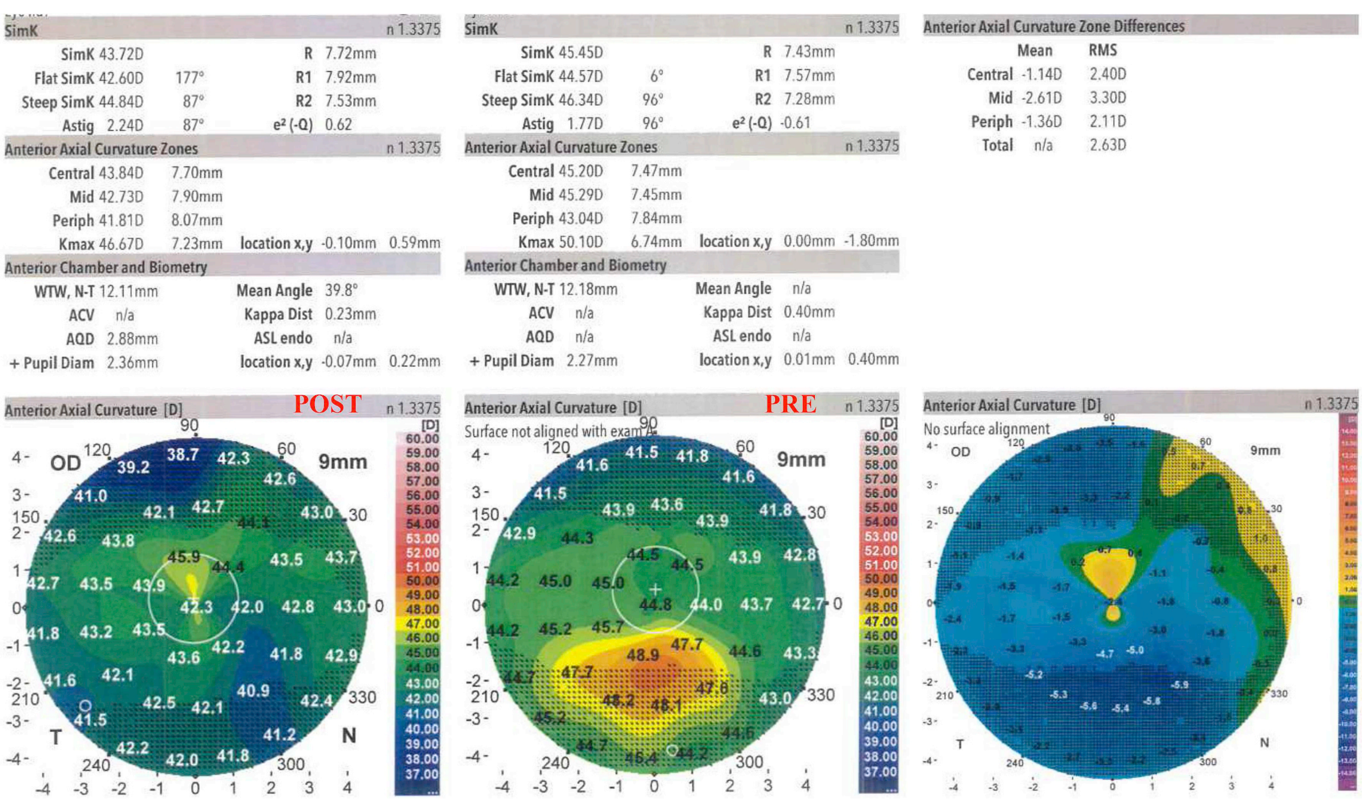

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Authorship

All authors attest that they meet the current ICMJE criteria for Authorship.

Declaration of competing interest

Neither author has any financial disclosures: SK, BKA.

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