ROSE K2 Contact Lens Rehabilitation in Keratoconic Corneas

Sneha Aggarwal, M Vanathi, Vinay Gupta, Noopur Gupta, Radhika Tandon

Cornea, Lens & Refractive Surgery Services, Dr. R. P. Centre, AIIMS, New Delhi, India.

Purpose: *To evaluate the modifications required in ROSE K2 contact lens (CL) fitting in keratoconic corneas.*

Methods: *A retrospective study with ROSE K2 CL wear in keratoconic corneas was done. Study data noted stage of keratoconus, Uncorrected Visual Acuity (UCVA), Best Spectacle Corrected Visual Acuity (BSCVA) and the Best CL Corrected Visual Acuity (BCLCVA), type of ROSE K2 CL, base curve (BC), overall diameter (OD), edge fit and modifications, Asymmetric Corneal Technology (ACT) & Toric Periphery (TP) design, lens exchanges, and follow ups. Data was analyzed based on the fitting guidelines of ROSE K2 CL [BC Kmean of ≤5.99mm (group 1), 6.0mm to 6.99mm (group 2), >7.0 Group 3)] and in accordance to the keratoconus staging.*

Results: *92 eyes of 64 patients of mean age 22.12 ± 5.57years [(range 11 to 36 years) (males 50, females 14)], which had undergone prior collagen crosslinking, were recruited into the study. Mean logMAR UCVA was 1.01 ± 0.41, mean logMAR BCVA with spectacles was 0.52 ± 0.31 and mean logMAR BCVA with ROSE K2 contact lenses was 0.12 ± 0.09. The difference between the recommended and prescribed CL BC was 0.33 ± 0.34 mm in group 1, 0.19 ± 0.17 mm in group 2 and 0.18 ± 0.16 in group 3. Edge modification was required in 90%, 58.7% and 45.5% in group 1, 2 & 3 respectively. Eyes of advanced keratoconus required mean change of 0.26 ± 0.24 mm in BC from recommended trial, with a mean difference from K-max of 1.02 ± 0.44 mm, and change in overall lens diameter by 0.21 ± 0.14 mm.*

Conclusion: *Advanced corneal ectasias of keratoconus staging IV and with mean K base curve values of < 6 mm require more fitting modifications from recommended manufacturer's guidelines in order to achieve an optimal CL fitting. Our experience provides guidance on the fitting modifications in parameters required for achieving better customization of ROSE K2 CL in post C3R keratoconic corneas with advanced ectasias.*

Abstract

Introduction

Visual rehabilitation in keratoconus patients is optimally achieved with multicurve lenses such as ROSE K2 CL as compared to spectacles, soft, mono-curve or bi-curve GP lenses.[1] Studies have also reflected the use of ROSE K2 lenses for the enhancement of binocular resolution and three-dimensional depth perception in keratoconic eyes as compared to spectacles.[2] Literature has shown that visual rehabilitation with RGP or multicurve contact lenses help in restoring vision and improving the quality of lives with better comfort and satisfaction in patients with keratoconus eyes. (3-5) The higher magnitude of irregular astigmatism is optimally corrected with these contact lens systems, thereby avoiding, or postponing the need for surgical intervention.[6] CL fitting in post collagen crosslinked (C3R) keratoconic corneas is performed after stabilization of the corneal topography for an invariable contact lens fit in the long term.[7]

Lens fitting parameters protocol offered by the manufacturer needs to be modified according to the fitting characteristics and fluorescein pattern observed on a custom basis, in order to achieve a tailored fit.[8] Post C3R corneas were included in order to avoid the probable risk of lens parameter change due to altered corneal topography if the corneal ectasia progresses. (9-10) Unlike the conventional RGP lenses, ROSE K2 lenses are multicurve, which are designed by utilizing computerized digital lathes that compensate the parameters such as base curve, diameter, power, center thickness and paracentral fitting curves whenever a change is made to the central or peripheral parameters of CL.[1] The aim for this adjustment is to maintain the optimum posterior lens touch (sagittal height) when a change in edge lift is required.

The ROSE K2 lens applies very small changes to the curves on both the anterior and posterior surface which help in focusing the light within the pupil zone to a single point providing better sight with minimum aberrations.[11-13] The expected primary measure outcome was to analyze the modifications required in fitting parameters of ROSE K2 contact lenses in post collagen crosslinked keratoconic corneas to achieve optimal and successful fitting.

Materials & Methods

A retrospective observational study of all patients of keratoconus following collagen crosslinking treatment who were referred to the Low vision services – cornea, of our centre for contact lens fitting. This study was performed to analyze the fitting parameters of ROSE K2 contact lenses (CL). Institutional ethics clearance was obtained.

Cases records of patients of post C3R treated keratoconic corneas on ROSE K2 contact lens wear between the period of March 2015 – April 2018 and on follow-up for a minimum of three months were included for analysis. All eyes had undergone CL fitting on documenting stable corneal topography after C3R treatment (Figure 1). Data of those patients of keratoconus using other contact lens systems, or those with other ocular morbidities was excluded. Data included demographic details (stage of keratoconus, time following collagen crosslinking treatment of ROSE K2 CL fitting, laterality, uncorrected visual acuity (UVCA), best corrected visual acuity (BCVA) with spectacles, BCVA with ROSE K2 CL, refraction details, details of ROSE K2 contact lens fitting parameters, duration of ROSE K2 contact lens wear, lens exchanges, post wear problems, Scheimpflug
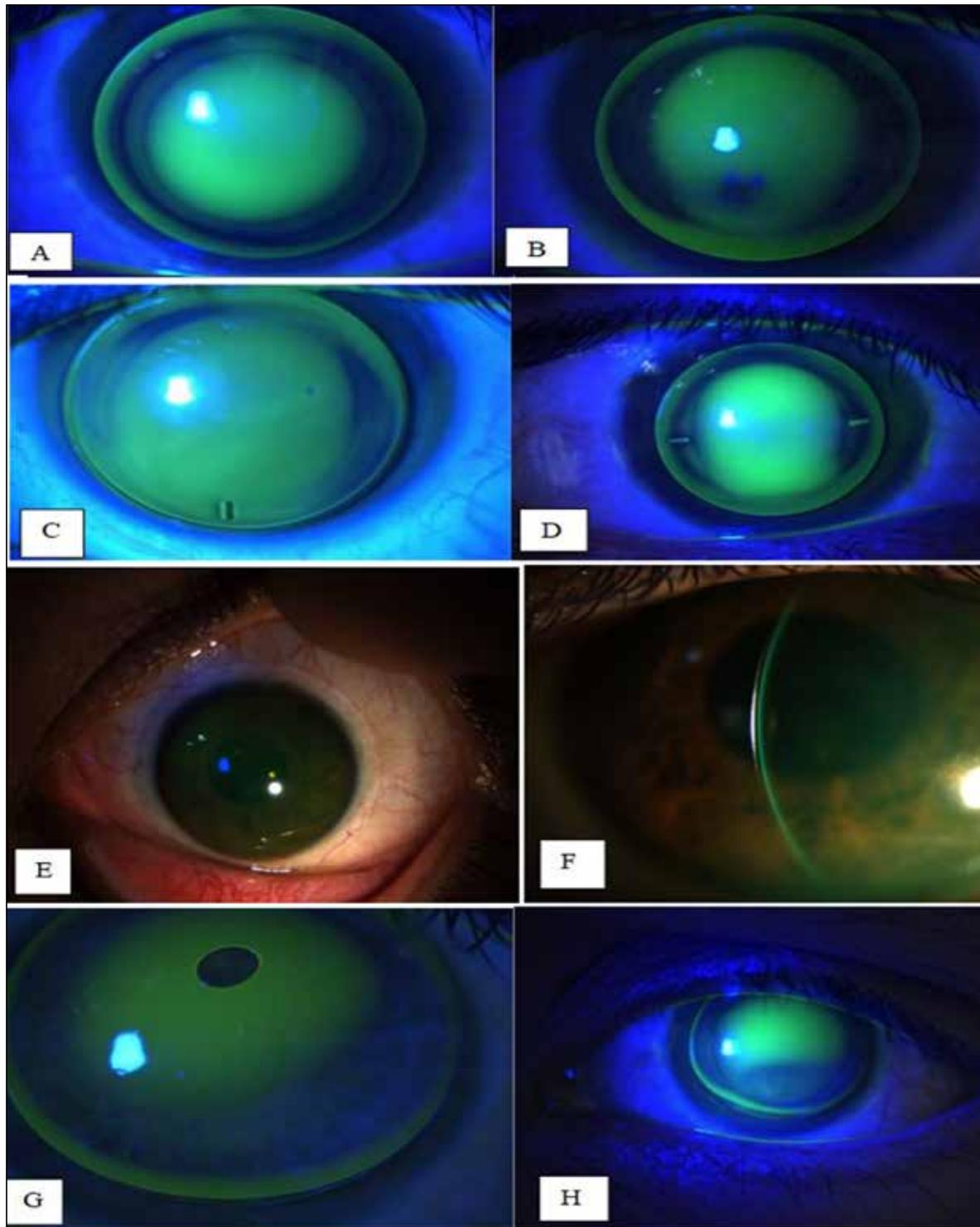
Figure 1: *Clinical Photograph showing the contact lens fit evaluation*
(A) ROSE K2 Lenses with fluorescein staining in post collagen crosslinked keratoconic cornea showing the desired "3-point touch"
(B) Nipple cone design
(C) Toric periphery (TP) incorporation
(D) Asymmetric Corneal Technology (ACT) incorporation
(E) Proper coverage of Rose K2 XL Miniscleral on the sclera without any impingement of vessels
(F) Desired tear vault without any apical touch in ROSE K2 XL Mini Scleral
(G) Figure depicting a conventional RGP lens with good central fit, but flat edge at 6 O'clock leading to edge stand-off and bubbles to trap, no tuck is possible in a conventional RGP lens

(H)- fluorescein-stained ROSE K2 lens with good feather touch at the steepest point having a good diameter and flat edge at 6O'clock, ACT incorporation recommendation is desirable in this lens from 0.8 to 1.3 mm depending upon the edge lift.

corneal topography (for corneal curvature of anterior surface – K1 & K2, K-max, average K, thinnest pachymetry). The ROSE K2 contact lens fitting parameters included ROSE K2 CL initial trial (base curve, overall diameter, edge fit) and prescribed CL fitting parameters and modifications (BC, lens diameter, edge lift, Asymmetrical Corneal Technology (ACT) and Toric Periphery (TP) designs), lens exchanges, time duration of daily wear, period of follow up, and post CL fitting problems.

As per manufacturer's recommendations, the first trial lens was selected and inserted on the patient's eye. After approximately 20 minutes, sodium fluorescein dye was instilled in the eye for contact lens fitting assessment. Static and dynamic fit of the lens were assessed. The Back Optic Zone Radius (BOZR) was evaluated for apical feather touch, if attained other CL fitting parameters were evaluated otherwise trial lens was changed. Depending on the central staining, the BOZR of the lens was flattened or steepened in 0.10 mm steps until an apical feather touch was obtained. Once the CL achieves feather touch, the overall diameter and edge fitting were assessed to ensure that the lens was well centered and has a proper lens movement and the lens facilitates tear exchange. Lens Diameter and Edge lift were empirically modified by observing trial lens and visual acuity with the trial contact lens was noted and CL was prescribed to the patient after over-refraction.

Optimal fit was adjudged with that contact lens which achieved the following for lens parameters:

- Optimal Base Curve: An approximate 20 microns fluorescein-stained tear film was desired over the steepest point on the cornea for a small feather touch.
- Optimal Diameter: Assessment was done according to lens type, stage of keratoconus, palpebral aperture and lens coverage and centration. The lens should hang off the top lid and clear of the limbus. Central cones require small diameter while decentered and early cones need larger diameter.
- Optimal lens centration: Assessment was done on the basis of base curve, diameter and lens edge lift.
- Optimal Edge Lift: A fluorescein tear film band of 0.6 to 0.8 mm width facilitating tear exchange at the lens edge was desired for comfortable peripheral edge.
- Optimal lens movement: 1 to 2mm of lens movement on blink was necessitated to facilitate proper tear exchange (mainly influenced by the edge lift).
- Asymmetric Corneal Technology (ACT) was advocated in cases of inferior lens edge standoff with pooling (approximately from 5 o' to 8 o'clock) to steepen the inferior quadrant of the lens. (ACT is incorporated in an asymmetric cornea; where the inferior corneal quadrant is significantly steeper than the superior, causing the standard RGP lens to lift off inferiorly, allowing bubbles to trap and break-up of tear meniscus. ACT is a CL design which tucks the inferior quadrant giving a good and comfortable inferior edge along with 3, 9 and 12 O'clock and better stability).
- Toric Periphery (TP) was recommended where the central optical zone was spherical having feather touch

but approximately the last 1mm of peripheral curve was toric; resulting in differential pooling. It is variably dependent on lens diameter which shows good edge lift at one meridian and thin pooling of edges at the other meridian indicating steep or tight edges.

- Incorporating toric periphery eliminated edge toricity (TP is preferred where the central fit is good, but the peripheral curves are toric where one meridian is steeper than the other resulting in variable pooling and affecting tear exchange. This modification serves optimal peripheral configuration when fluorescein assessment shows toric edges.

The available designs include ROSE K2, ROSE K2 Irregular Cornea (IC), ROSE K2 Nipple Cone (NC), ROSE K2 Post Graft (PG) and ROSE K2 XL (XtraLimbal) Mini Scleral (Table 1). All detailed ROSE K2 lens parameters available in trial inventory and for dispensing are mentioned in table 1 (a) (b). All required details of contact lens fitting, and assessment were entered in to a predesigned proforma for analysis. All the parameters that were modified for the optimum ROSE K2 CL fit were also recorded and evaluated.

Results

Case records of 92 eyes of 64 patients (mean age 22.12 ± 5.57 years, range 11 to 36 years) having keratoconic corneas who were fitted with ROSE K2 CL were analyzed. There were 50 male (mean age 21.52 ± 5.59 years) and 14 female (mean age 24.11 ± 5.95 years) patients. The mean age of the patients at the time of collagen crosslinking was 19.46 + 7.42 year (range 11 to 26 years). The time interval between collagen crosslinking and CL fitting was 24.08 ± 24.91 months; (range 2 to 110 months) (Figure 2).
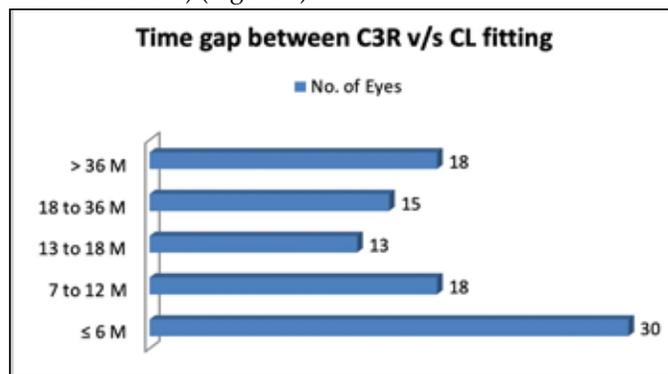
Figure 2: The time interval between collagen crosslinking and CL fitting in the study eyes

Table 1(a): Availability of Inventory of ROSE K2 contact lenses

CL Type	Base Curve (mm)	Overall Diameter (mm)	Edge Lift
ROSE K2 (26 lenses)	5.10 to 7.60	Variable, 8.50 to 9.20	Standard
ROSE K2 IC (18 lenses)	6.00 to 8.40	Standard, 11.4	Standard
ROSE K2 NC (25 Lenses)	4.60 to 7.40	Variable, 8.10 to 8.90	Standard
ROSE K2 PG (22 Lenses)	6.00 to 9.00	Standard, 10.4	Standard
ROSE K2 XL Mini Scleral (16 Lenses)	6.00 to 8.00	Standard, 14.6	Standard

Table 1(b): Range of available Lens parameters for Dispensing

CL Type	Base Curve (mm)	Overall Diameter (mm)	Edge Lift
ROSE K2	4.30 to 8.59	7.90 to 10.40	Standard, standard flat, standard steep
ROSE K2 IC	5.70 to 9.30	9.40 to 12.00	Standard, standard flat, standard steep, double flat, double steep Standard
ROSE K2 NC	4.30 to 7.69	7.60 to 9.00	Standard, standard flat, standard steep
ROSE K2 PG	5.70 to 9.30	9.40 to 12.00	Standard, standard flat, standard steep, double flat, double steep
ROSE K2 XL Mini Scleral	5.70 to 8.40	13.6 to 16.00	13 options in 0.5 steps from -3.0 decreased lift to +3.0 increased lift.
Special lens design and parameters for customization			
Asymmetric Corneal Technology (ACT)	ACT is available from 0.4mm to 1.5mm, in single steps, Standard is 0.8, ACT Grade 1# 0.7, ACT Grade 2# 1 and ACT Grade 3# 1.3mm		
Toric Periphery (TP)	Toric periphery (range from 0.4 to 1.3mm) creates difference in the meridians, eliminating tighter areas resulting in better fitting of edges, and standard TP is 0.8mm.		

(a)

(b)

Figure 3: *Pie charts representing study eye characteristics of eyes reflecting*
(a) *Distribution of amount of Astigmatism*
(b) *History of contact lens use.*

Table 2: Characteristics of the Study eye parameters

Study eye characteristics	Mean ± Std Dev (Min to Max)
UCVA	1.01 ± 0.41 (0.16 to 1.8)
BSCVA	0.52 ± 0.32 (0.08 to 1.56)
BCVA with ROSE K2 CL	0.12 ± 0.09 (0 to 0.54)
Manifest Refractive Spherical Equivalent	-4.2 ± 1.9 (-22 to +16)
Pachymetry	401 ± 40.2 (267 to 496)
Kmax	5.61 ± 0.69 (4.55 to 7.23)
Kmean	6.42 ± 0.63 (4.81 to 7.98)

The characteristics of study eye patients is shown is table 2, the amount of astigmatism in the study subjects is represented in Figure 3(a) and history of contact lens use (type and drop-outs) is shown in Figure 3(b).

The mean follow-up time of our patients was 15.60 + 9.84 months (range 3 to 34 months). The mean logMAR UCVA, BCVA with spectacles and BCVA with ROSE-K2 CL of all study subjects is depicted in (Table 2). The visual outcomes are analyzed in accordance to the base curve of the eyes and stages of keratoconus (Table 4 and Figure 4).

The mean difference of K-mean and the K-max in the entire study group was 0.97 + 0.32 mm (range 0.13 to 1.98 mm), 0.99 ± 0.37 mm in stage I, 1.02 ± 0.34 mm in stage II, 0.94 ± 0.40 mm in stage III and 0.89 ± 0.22 mm in stage IV keratoconus eyes. The distribution of K-max, K-mean, the recommended BC and the prescribed BC in the study eyes is depicted in (Figure 5).

The mean difference between the manufacturer's recommended base curve and final prescribed base curve in eyes with K-mean < 6mm was 0.33 ± 0.34mm; (range 0.25 to 0.5 mm) (p=<0.001, one-sample t-test), 6 to 6.99 mm was 0.19 ± 0.17 mm; (range -0.6 to 0.6 mm) and for and ≥ 7 mm 0.18 ± 0.16 mm (range -0.35 to 0.6 mm) as shown in table 5, figure 6a. The mean difference between the trial fit assessment and final prescribed overall diameter in eyes with K-mean < 6.0mm was 0.17 ± 0.11 mm; (range 0 to 0.6 mm), 6.0 to 6.99 mm was 0.19 ± 0.14 mm (range 0 to 0.5 mm) and ≥ 7.0 mm was 0.16 ± 0.12 mm; (range -0.2 to 0.3 mm), table5, figure

Table 3: Characteristics of the Contact lens parameters in the study eyes

| Contact Lens parameters		Group 1 (Mean K< 6.0mm) Mean + SD (range)	Group 2 (Mean K 6 to 6.99 mm) Mean + SD (range)	Group 3 (Mean K ≥ 7.0 mm) Mean + SD (range)
Base Curve	Recommended	5.94 ± 0.18 (5.5 to 6.3)	6.44 ± 0.38 (6.0 to 7.0)	7.13 ± 0.25 (6.8 to 7.8)
	Prescribed	5.71 ± 0.34 (5.1 to 6.3)	6.47 ± 0.34 (5.7 to 7.15)	7.09 ± 0.25 6.6 to 7.5
Overall Diameter	Trial CL	8.45 ± 0.12 (8.3 to 8.9)	8.88 ± 0.85 (8.7 to 8.9)	9.06 ± 0.84 (8.9 to 9.1)
	Prescribed CL	8.82 ± 0.28 8.5 to 9.1	8.90 ±0.3 8.7 to 9.2	8.84 ± 0.22 (8.7to 9)
Prescribed CL Power		-15.8 ±5.98 (0 to -25.5)	-9.45 ± 4.12 (7.75 to -17.5)	-6.73 ± 3.95 (-1.25 to -15.5)
Prescribed CL Edge Lift		0.73 ± 0.43 (-0.5 to 1.5)	0.21 ± 0.46 (-1.3 to 1.3)	0.03 ± 0.47 (-1.3 to 1)
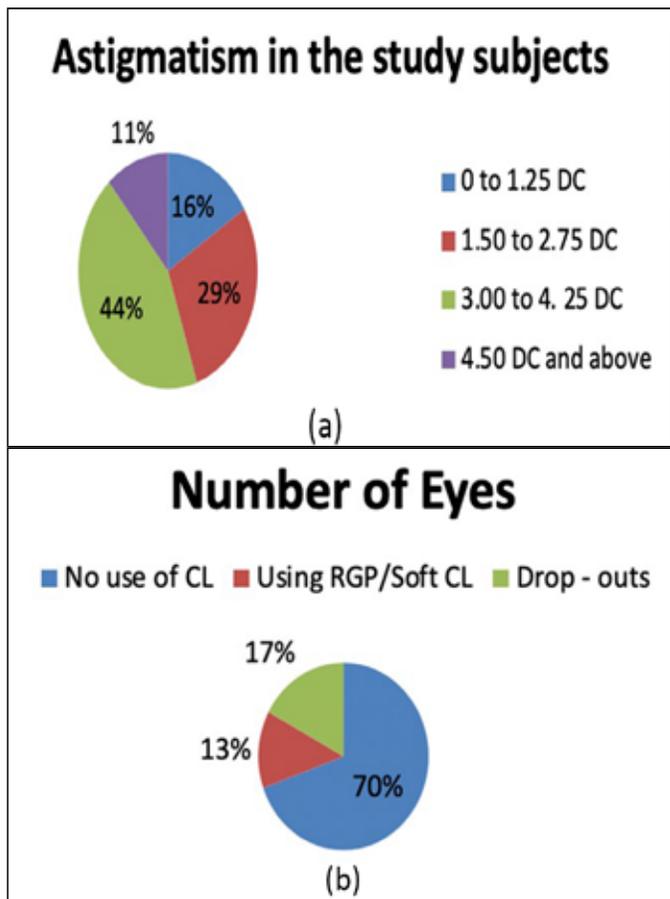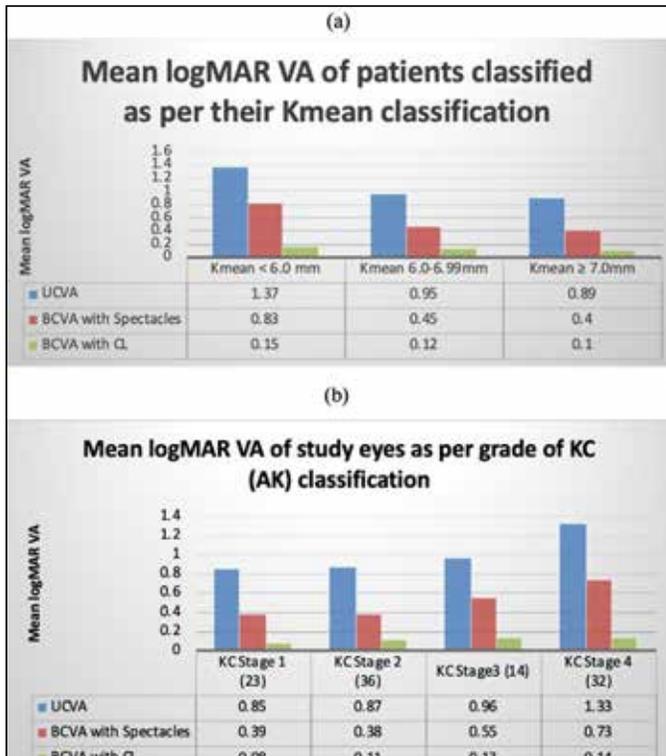
Figure 4: *Mean logMAR UCVA, mean logMAR BCVA with spectacles and contact lenses in accordance to the base curve of the study eyes and in accordance to the grade of keratoconus (Amsler Krumeich classification) respectively.*

Table 4: Details of visual acuity correction achieved in the study eyes

Keratoconus	Mean Spectacle BCVA (range)	Mean CL BCVA (range)	*p value
In accordance to Keratoconus grading			
Grade I	0.39 ± 0.21 (0.08 ± 0.86)	0.08 ± 0.09 (0 to 0.3)	p< 0.001
Grade II	0.38 ± 0.17 (0.08 ± 0.76)	0.11 ± 0.09 (0 to 0.54)	p< 0.001
Grade III	0.55 ± 0.37 (0.16± 1.56)	0.13 ± 0.06 (0 to 0.2)	p< 0.001
Grade IV	0.73 ± 0.37 (0.2 ± 1.56)	0.14 ± 0.09 (0 to 0.4)	p< 0.001
In accordance to base curve			
< 6 mm	0.79 ± 0.37 (0.2 ± 1.56)	0.15 ± 0.09 (0 to 0.4)	p< 0.001
6 – 6.99 mm	0.45 ± 0.27 (0.08 ± 1.56)	0.12 ± 0.08 (0 to 0.54)	p< 0.001
>7 mm	0.40 ± 0.21 (0.08 ±0.86)	1.1± 0.09 (0 to 0.3)	p< 0.001
*Dunn's Pairwise Comparison			

6b. In analysis as per severity of the keratoconus, the mean change from manufacturer's recommendation in CL fitting parameters were mentioned in (Table 5).

Overall Modification: Modifications in overall ROSE K2 CL fitting parameters as against the manufacturer's recommendations were required in 21 eyes with mean K base curve of < 6mm, 58 eyes with mean K base curve of 6 to 6.99mm and 19 eyes with mean K base curve of ≥ 7 mm.
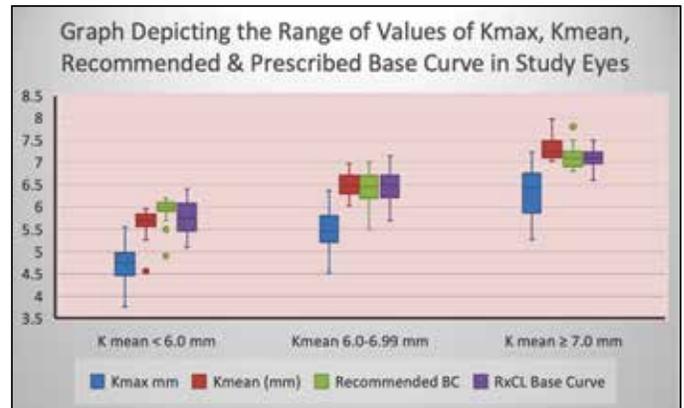

Figure 5: *The distribution of Kmax, Kmean with respect to recommended and prescribed contact lens in the eyes with base curve < 6.0 mm, 6.0 – 6.99.0 mm, ≥ 7.0 mm.*

Table 5: Mean Change in fitting parameters from manufacturer's recommendation

	In accordance to Base Cure		
CL Parameters	Group 1 K Mean (< 6mm)	Group 2 K Mean (6 to 6.99 mm)	Group 3 K Mean (≥ 7mm)
Base Curve	0.33 ± 0.34	0.19 ± 0.17	0.18 ± 0.16
Diameter	0.17 ± 0.11	0.19 ±0.14	0.16 ± 0.12
Edge lift	0.64 ± 0.50	0.35 ± 0.42	0.34 ± 0.42
In accordance to Keratoconus Staging			
CL Parameters	KC Stage 1	KC Stage 2	KC Stage 3 / KC Stage 4
Base Curve	0.17 ± 0.16	0.21 ±0.20	0.23 ± 0.18 / 0.29 ± 0.24
Diameter	0.16 ±0.12	0.17 ±0.14	0.23 ±0.14 / 0.19 ±0.13
Edge lift	0.37 ±0.42	0.37 ± 0.39	0.44 ± 0.40 / 0.63 ± 0.44

Table 6: Details of study eyes requiring fitting parameters modifications

	Base Curve Changes eyes (%)	Diameter Changes eyes (%)	Edge lift Changes eyes (%)
Group 1 (< 6.0mm) (n=17 eyes)	16 (94%)	14 (82%)	15 (83.3%)
Group 2 (6 to 6.99 mm) (n = 58 eyes)	49 (84.4%)	48 (83%)	34 (58.7 %)
Group 3 (≥ 7.0 mm) (n = 17 eyes)	14 (82%)	9 (53%)	8 (47%)

ROSE K2 CL base curve modifications were required in 19 eyes, in ROSE K2 diameter in 16 eyes and edge lift modifications in 18 eyes of those keratoconic eyes with mean K < 6mm; ROSE K2 CL base curve modifications were required in 53 eyes, in ROSE K2 diameter in 53 eyes and edge lift modifications in 37 eyes of those keratoconic eyes with mean K 6- 6.99mm; ROSE K2 CL base curve modifications were required in 18 eyes, in ROSE K2 diameter in 13 eyes and edge lift modifications in 10 eyes of those keratoconic eyes with mean K ≥ 7.0 mm; (Table 6). ACT and TP were prescribed in 20 eyes (one eye in Kmean < 6 mm, 16 eyes in 6 – 6.99 mm, three eyes >7 mm) and 5 eyes (one eye in Kmean > 6 mm, three eyes in 6 – 6.99 mm, two eyes > 7 mm) respectively which ensured a better and comfortable lens fit.
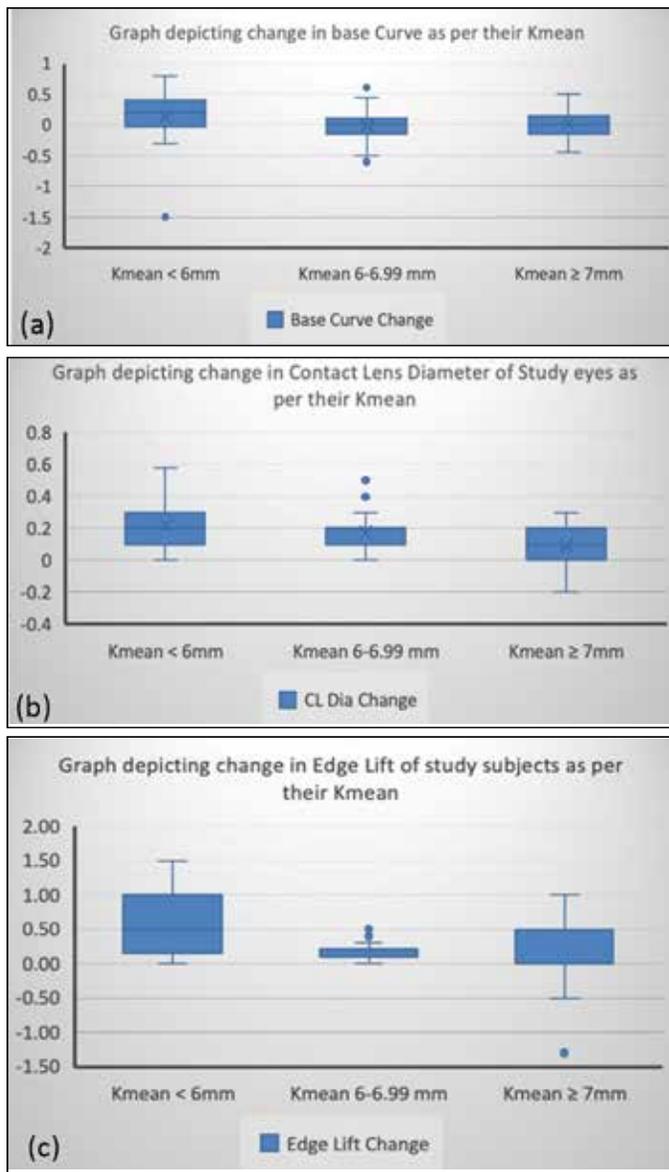
Figure 6: *Box and Whisker's plots depicting*
(a)Mean change in recommended and prescribed base curve of contact lenses as per their base curve
(b)Mean change in contact lens diameter in final contact lens trial v/s prescribed contact lens diameter
(c)Mean change in contact lens edge lift in the final contact lens trial v/s prescribed contact lens edge lift

Discussion

This study describes clinical evaluation of ROSE K lens fitting for the visual rehabilitation of post C3R keratoconic corneas. The ROSE K2 CL for keratoconus is a proprietary design. It is a multi-spherical posterior design with aberration control aspheric optics across the front and back optic zone diameters. The ROSE K2 contact lens design being effective in providing good comfort, better quality of vision with less chair time for fitting has been described to have a greater acceptability in the management of corneal ectasias.[12] As per the earlier study, first definite apical clearance lens (FDACL) was chosen as a starting point in oval and nipple cones and the result showed that an average of 2.3 trial ROSE K2

lenses were required to achieve an optimal lens fit. Study also mentioned that eye care practitioners should anticipate higher optimal lens fit rates when using three-point-touch (83%) in comparison with apical touch contact lens fittings .(71%) [14] Another study reflected that two to four diagnostic trial lenses were required to determine the best fitted base curve for a desired three-point touch fitting on a keratoconic eye [2]). An Indian retrospective study reported that a mean of 1.73 ± 0.9 (range 1-5) ROSE K trial lenses were required to lens base curve parameters to achieve desired fit .[1]

This retrospective study describes the results of our experience of ROSE K2 CL fitting in post collagen crosslinked keratoconic corneas. The standard manufacturer's recommendations may require modifications in several cases of advanced keratoconus depending on the severity or the stage of the corneal ectasia being dealt with. In several instances, custom modifications need to be adopted upon observing the static and dynamic fluorescein fitting characteristics in order to achieve an optimal contact lens fit. All our patients were referred for CL fitting after a minimum period of three months of collagen crosslinking treatment the trend observed in stabilization of collagen crosslinking treated corneas was immediate worsening between baseline and 1 month, resolution at approximately 3 months, and improvement thereafter.[15] The relatively varying interval between the time of collagen crosslinking and contact lens fitting is due to the late reporting of patients (in accordance to their convenience for reporting), as most of our patients were referred and come to our clinics from areas located far away from our centre. Analysis of our contact lens fitting experience in 105 post collagen-crosslinked keratoconic corneas in this study observed that the optimal contact lens fit concurred well with manufacturer's recommendations in eyes with where the mean K values ranged between 6.0 to 6.99 mm (56.25 to 48.12 D) and mean K ≥ 7mm (≥48.21 D).

The mean difference between the recommended and final prescribed CL base curve in cases of Kmean < 6.00 mm was found to be statistically significant. In Kmean <6.0mm, 95% of study eyes required modification in lens base curve, 80% in lens diameter and 90% of eyes required modification in edge lift as compared to those study eyes in group 2 and 3 (Table 7).

The Box and Whiskers plots (figure 4) clearly demonstrate

Table 7: Details of the number of fitting parameters modifications that were required in the study eyes

KC Grade	No modification eyes (%)	1 parameter modified eyes (%)	2 Parameters modified eyes (%)	3 Parameters modified eyes (%)	4 Parameters modified eyes (%)
1 (n= 23 eyes)	3 (13.04%)	9 (39.13%)	7 (30.43%)	3 (13.04%)	1 (4.35%)
2 (n=36 eyes)	2 (5.56%)	9 (25%)	13 (36.11%)	12 (33.33%)	0
3 (n= 14 eyes)	1 (7.14%)	0	8 (57.14%)	3 (21.43%)	2 (14.29%)
4 (n= 32 eyes)	4 (3.13%)	8 (25%)	14 (43.75%)	8 (25%)	1 (3.13%)

that recommended BC and prescribed BC are in alignment with each other in group 2 of Kmean 6 - 6.99mm and group 3 of Kmean ≥ 7.0mm whereas prescribed BC in group 1 of Kmean < 6.0mm shows deviation with preponderance towards steeper side.

A greater deviation from the recommended BC is noted in eyes with advanced ectasia (of Kmean < 6.0mm). The recommended base curve of contact lens in group 1 was noted to be slightly flatter than the mean K, concurring with the manufacturer guidelines i.e., 0.3 mm flatter than the Kmean, but prescribed CL BC is even steeper than mean K, shifting towards K-max Figure 5(a). In eyes with advanced keratoconus (stage IV), the deviation of K-mean from K-max is (0.89 ± 0.22 mm). Analysis of the overall diameter and lens edge modifications noted that the mean difference between these fitting parameters of Kmean <6.00mm group corelated with study eyes of KC stage IV, Kmean 6 to 6.99mm aligned well with study eyes KC stage II and III and Kmean ≥7.00 mm was in proportionate to the modification of KC stage 1 as depicted in (Figure 5). This highlights that the steeper radii of curvature of advanced keratoconic corneas necessitated modifications in the base curve fitting parameters as compared to recommended guidelines, leading to more amount of change in lens diameter and edge lift.

As the available steepest base curve option with the trial lens set of ROSE K2 lens is 5.0 mm, in those corneas where the trial CL was assessed to have less than desirable fit parameters, we proceeded with adopting modifications in the final prescription, based on the fitting observations in our experience. Achieving an optimal base curve fitting is paramount in being able to fit these irregular corneal contours and influences the overall diameter requirements and edge lift modifications. ROSE K2 multicurve lenses do provide a custom fit to mask the irregularities where the modification in one parameter is independent of the other and allows a wide range of modifications to facilitate the desired modification in lens diameter and edge lift.

Asymmetric Corneal Technology (ACT) and Toric Periphery (TP) incorporations in the final lens fit prescriptions were prescribed in 20 study eyes (1, e in Kmean group <6mm, 16 in 6 to 6.99mm, 3 in ≥7mm) and 5 study eyes (1 in Kmean group <6mm, 3 in 6 to 6.99mm, and 1 in ≥7mm) for better and stabilized lens fit. Our protocol recommendation that was followed in prescribing ACT incorporation in the final lens fit prescription is in those cases where an edge stand-off was noted with heavy pool at inferior lens quadrant. The amount of ACT prescribed depended directly on the quantity of edge lift at 6 O'clock. TP incorporation in the final lens fit prescription was in those cases where toric periphery was asymmetrical. This served appropriately for all our patients with all accepting their final prescribed contact lens well. None of our patients required any CL exchange.

The number of modifications, i.e., whether only one of the three (base curve, overall diameter, edge lift) or more was required was also analyzed and it was observed that 3, 15, 8 eyes required one parameter modification, 11, 21, 10 eyes required two parameters modification and 12, 15, 3 eyes

require three or more parameters modification in cornea with Kmean <6mm, Kmean 6 to 6.99mm, Kmean ≥7mm respectively. Corneas with advanced keratoconus with base curve < 6.0 mm seem to require more modifications in terms of adjustments required for optimal base curve fit, overall diameter and edge lift fitting.

Our experience can serve to guide ophthalmologist and optometrist dealing with contact lens fitting about the optimal modifications which can affect better customization of multicurve contact lens fits achieved based on base curve parameters. It is imperative for health care personnel dealing with contact lens fitting to understand the corneal topography of each cornea that is being dealt with in order to plan an optimal fitting that would minimize chair time and patient discomfort during the fitting trials. Patients with advanced corneal ectasia present with significant low and distorted vision as vision correction with spectacles and conventional rigid gas permeable contact lenses is not successful. Visual rehabilitation is best achieved in these eyes with the use of multicurve and cornea-scleral /scleral contact lens. These patients tend to over wear their contact lenses for long periods of time during the day due to the better quality of vision afforded by these and hence get dependent on these contact lenses. Comprehension of the optimal fitting parameter changes required to achieve ideal contact fits will result in enhancing the comfort of contact lens wear and alleviate the need for to look for options of corneo-scleral / scleral lens in these scenarios.

References

1. Jain AK, Sukhija J, ROSE K2 contact lens for keratoconus, Indian J Ophthalmol 2007; 55: 121-125
2. Nilagiri VK, Metapally S, Kalaiselvan p, Schor CM, Bharadwaj SR. LogMAR and Stereoacuity in Keratoconus Corrected with Spectacles and Rigid Gas-permeable Contact Lenses. Optometry and Vision Science 2018; 95: 391-398.
3. S, Jung G, Lee HK. Comparison of Contact Lens Corrected Quality of Vision and Life of Keratoconus and Myopic Patients. Korean J Ophthalmol. 2017; 31: 489-496.
4. Abou Samra WA, Badawi AE, Kishk H, Abd El Ghafar A, Elwan MM, Abouelkheir HY. Fitting Tips and Visual Rehabilitation of Irregular Cornea with a New Design of Corneoscleral Contact Lens: Objective and Subjective Evaluation. J Ophthalmol. 2018: 3923170. doi: 10.1155/2018/3923170. eCollection 2018.
5. Smiddy WE1, Hamburg TR, Kracher GP, Stark WJ. Keratoconus. Contact lens or keratoplasty? Ophthalmology 1988; 95: 487-92.
6. Mandathara Sudharman P, Rathi V, Dumapati S. Rose K lenses for keratoconus: An Indian experience
7. O'Brart DP, Kwong TQ, Patel P, McDonald RJ, O'Brart NA. Long-term follow-up of riboflavin/ultraviolet A (370 nm) corneal collagen Crosslinking to halt the progression of keratoconus. Br J Ophthalmol. 2013; 97: 433-437.
8. https://cdn.menicon.nl/uk/pdfs/ML014_V4_Rose-K2-Practitioners-Fitting-Guide.pdf
9. Hashemi H, Seyedian MA, Miraftab M, Fotouhi A, Asgari S. Corneal collagen cross-linking with riboflavin and ultraviolet a irradiation for keratoconus: long-term results. Ophthalmology. 2013; 120: 1515-1520
10. Asri D, Touboul D, Fournie P, et al. Corneal collagen crosslinking in progressive keratoconus: multicenter results from the French National Reference Center for Keratoconus. J Cataract Refract Surg. 2011; 37: 2137-2143.
11. Gupta R, Sinha R, Singh P, Sharma N, Tandon R, J S Titiyal. ROSE

K2 versus Soper Contact Lens in Keratoconus: A Randomized Comparative Trial. Middle East African J Ophthalmol 2014; 21: 50–55.

12. Betts AM, Mitchell GL, Zadnik K. Visual performance and comfort with the ROSE K lens for Keratoconus. Optometry and Vision Science 2002; 79: 493-501.

13. Rico-Del-Viejo L, Garcia-Montero M, Hernández-Verdejo JL, García-Lázaro S, Gómez-Sanz FJ, Lorente-Velázquez A. Nonsurgical Procedures for Keratoconus Management. J Ophthalmol.2017; 9707650.

14. Romero-Jiménez M1, Santodomingo-Rubido J, González-Méijome JM. An assessment of the optimal lens fit rate in keratoconus subjects using three-point-touch and apical touch fitting approaches with the ROSE K2 lens, Eye Contact Lens. 2013; 39: 269-272.

15. Chang CY, Hersh PS. Corneal collagen cross-linking: a review of 1-year outcomes. Eye Contact Lens. 2014 Nov;40(6):345-52.

Address for correspondence

M Vanathi, MD,
Prof of Ophthalmology,
Cornea, Lens & Refractive Surgery Services,
Dr. R. P. Centre, AIIMS, New Delhi, India.
Email : mvanathi.rpc@gmail.com

Quick Response Code