

Comparison of Topographic and Biomicroscopic Features Among Symptomatic Keratoconic Eyes

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Aim and objectives: This study tries to estimate the relationship between biomicroscopic features and topographic features of keratoconus.

Design: Descriptive cross sectional study.

Materials and Methods: Symptomatic keratoconic patients between the age group of 10-30 years were included in this study. Biomicroscopic examination, retinoscopy and corneal topography were done for the patients and their correlation studied.

Abstract

Results: The study group included 92 keratoconic eyes having defective vision. The mean age of patients with keratoconus was 20.08 years (SD \pm 4.5), 59% (n=54) were males. This study showed a statistically significant positive correlation between anterior segment findings and corneal topographic features.

Conclusion: Along with biomicroscopic examination, corneal topographic examination is an important method for diagnosis of keratoconus.

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Keywords: Keratoconus, Corneal topography, KISA, Central K, SimK

Introduction

Keratoconus (KC), a bilaterally asymmetrical, progressive, non-inflammatory corneal ectatic disorder is characterised by cone-like steepening of the cornea with irregular stromal thinning, corneal protrusion and significant loss of vision.¹⁻⁶ The incidence of KC among Asian populations ranges from 1 in 4,000-5,100 persons per year.⁴ It is associated with image distortion and increased sensitivity to glare and light.^{1,5} The defective vision cannot be adequately corrected with spectacles because of the asymmetry.¹ Subclinical KC remains undetected and diagnosed as asymmetric oblique astigmatism.^{1,5,6} Corneal topography is considered as the main investigative modality to diagnose early KC. This study was undertaken to evaluate the correlation between the clinical features and corneal topographic parameters of diagnosed cases of KC.

Materials and methods

Subjects diagnosed with symptomatic KC in the age group of 10-30 years were recruited for the study. The study period was twelve months. The study was approved by institutional ethics committee. Cases with history of ocular trauma and surgery and outside the specified age group were excluded from the study. Age, gender and symptoms were noted. Distant visual acuity was assessed unilaterally with Snellen's visual acuity chart at a distance of six meters. Anterior segment examination including corneal topography was done. Cycloplegic retinoscopy was done after putting Homatropine bromide 2% eye drops or Tropicamide - Phenylephrine drops depending on their age (one drop every ten minutes apart thrice) and autorefractometry was done. Post mydriatic test was done after 4 days. Spherical equivalent was calculated by adding half of cylinder with the sphere. Shin Nippon corneal topographer CT-1000 was the instrument used for corneal topography. The topographic

parameters noted were Sim K1- the maximum keratometry value in dioptres, Sim K2 - the K value 90° away from the axis of Sim K1 in dioptres, Central K- the keratometry value of centre of cornea in dioptres, KISA index (%) [$K \times (I-S) \times (AST) \times (SRAX) \times 100 \div 300$ in percentage unit] and SRAX (skewing radial axis) = 180 - angle between the steep axis above and below the horizontal meridian. Statistical analysis was done with SPSS -18 version. Qualitative analysis was done with one way Anova test.

Result

The study group included 92 eyes of patients with KC between 10 and 30 years age. The mean age of patients with KC was 20.08 years (SD \pm 4.5). 36% (n=33) belonged to the age group 20 - 25 years.

12% (n=11) cases were unilateral KC, 73% (n=67) were bilateral KC and 15% (n=14) had myopic astigmatism in the other eye. All subjects had defective vision as their presenting complaint.

The mean spherical equivalent was 5.11 D (SD \pm 4.45), mean Sim K1 was 52.6 D (SD \pm 5.6), mean Sim K2 was 47.32 D (SD \pm 3.87), mean KISA was 6282.7 and the mean central K was 52.22 D (SD \pm 5.8). 39% (n=36) had Sim K1 between 45.00 - 50.00 D, 44% (n=40) had Sim K2 in the range of 45.00 - 50.00D. 33% (n=30) had central K between 45.00 - 50.00 D. 98% (n=90) has SRAX between 21 - 90°.

A total of 73% (n=66) cases had best corrected visual acuity (BCVA) better than 6/12. Distribution of cases based on their BCVA is given in Figure 1. Spectacle use was observed among 49% (n=45).

Ocular associations noted were VKC in one (1.1%) patient and type II Duane's retraction syndrome in one patient (1.1%). 2.2% (n=2) cases had family history of KC.

Subjects were grouped based on Sim K1, Sim K2, Central K, KISA and SRAX. Distribution of cases based on the Sim

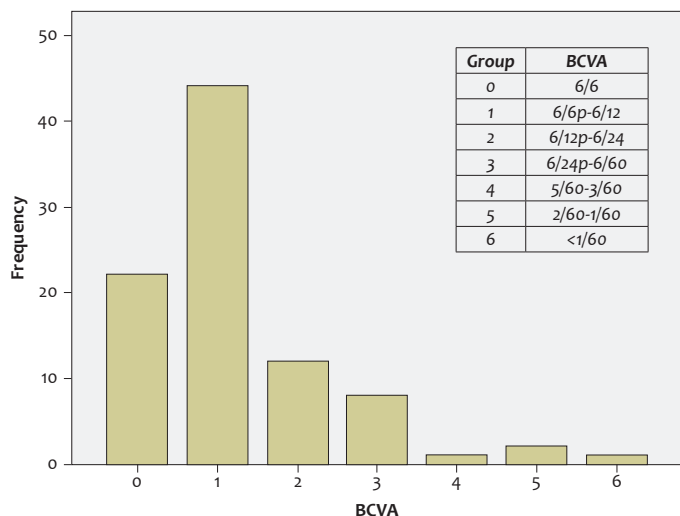


Figure 1: Distribution of cases based BCVA.

K1 values are given in Table 1. As Simk1 values increased, Sim K2, Central K, KISA also increased, however SRAX indicative of skewing of radial axis progressively decreased. These observations were statistically significant.

Distribution of cases based on the Sim K2 and central K values are given in Table 2 and 3 respectively. A positive correlation was observed between the keratometric values which were statistically significant. However the keratometric readings did not show association with SRAX.

89% (n=82) cases had anterior segment findings. The common anterior segment findings were positive Munson’s sign (60%), positive Rizutti’s sign (55%), abnormal pattern in Placido’s disc (55%), prominent corneal nerves (54%), Fleischer ring (48%) and Vogt’s striae (37%). Oil drop sign on retinoscopy was observed among 14% cases. Distribution of cases based on anterior segment findings is given in Table 4. No association was observed between the presence of anterior segment findings like Munson’s sign, Rizutti’s sign, prominence of corneal nerves and Fleicher’s ring with the topographic parameters. But those with distortions on Placido disc had a statistically significant higher central K values. Those with Vogt’s striae had a higher Sim K1, Sim K2 and KISA values. However, central K and skewing were less than those without Vogt’s striae. The association with Vogt’s striae and Sim K1, Sim K2 and central K were statistically significant.

Table 1: Subjects categorised based on Sim K1

Sim K1 Gp (D)	n	Sim K1		Sim K2		Central K		KISA		SRAX	
		D	SD	D	SD	D	SD	%	SD	Degrees	SD
40-45	5	44.51	0.65	42.86	1.31	43.70	2.79	249.80	126.04	80.80	9.78
45.01-50	36	48.35	2.03	44.96	1.48	48.38	2.05	921.75	1687.41	69.44	16.81
50.01-55	22	52.31	1.72	47.74	1.99	52.50	2.81	3544.95	3195.51	66.50	20.42
55.01-60	20	57.51	1.9	49.03	3.31	56.72	4.41	12220.6	8565.40	62.35	24.38
>60	9	63.84	3.09	54.42	4.62	61.65	5.19	24575.11	28840.43	47.56	24.20
		P=0.000		P=0.000		P=0.000		P=0.000		P=0.002	

Table 2: Categorised based on Sim K2

Sim K2 Gp (D)	n	Sim K1		Sim K2		Central K		KISA		SRAX	
		D	SD	D	SD	D	SD	%	SD	Degrees	SD
40-45	32	48.01	3.44	43.89	0.91	47.50	2.91	1127.38	2670.86	66.84	20.32
45.01-50	40	52.58	3.49	47.17	1.43	51.89	2.91	3920.38	5072.66	66.78	19.81
50.01-55	16	58.88	3.06	52.01	1.59	60.17	4.58	15624.81	11118.91	63.56	24.04
55.01-60	2	60.58	7.79	53.88	4.15	61.85	4.29	52155.50	56661.17	77.50	7.78
>60	2	68.01	0.68	61.20	0.05	60.77	7.05	15405.00	18046.78	30	7.07
		P=0.000		P=0.000		P=0.000		P=0.000			

Table 3: Categorisation based on central K

Central K(D)	n	Sim K1		Sim K2		Central K		KISA		SRAX	
		D	SD	D	SD	D	SD	%	SD	Degrees	SD
<40	1	43.47		40.9		38.95		434		74	
40.01-45	3	44.71	0.38	43.23	0.98	44.42	0.45	174.67	74.1	81.33	12.42
45.01-50	30	48.16	1.82	44.81	1.22	47.96	1.4	541.77	367.03	66.50	16.22
50.01-55	29	51.85	3.14	46.79	1.92	51.31	2.57	3464.83	3627.45	67.52	21.55
55.01-60	16	58.20	4.1	49.39	4.12	56.21	2.38	9994.44	6931.37	58.50	25.63
>60	12	60.83	3.51	53.78	3.0	62.78	4.03	24830.42	24567.03	64.17	25.78
		P=0.000		P=0.000		P=0.000		P=0.000			

Table 4: Categorisation based on anterior segment findings

		No:	Sim K1 (D)	SD	Sim K2 (D)	SD	Central K(D)	SD	KISA(%)	SD	SRAX(0)	SD
AS	no	10	50.63	2.57	46.66	1.94	49.87	2.73	2159	4224	62.30	23.13
	yes	82	52.84	5.9	47.40	4.04	52.51	4.02	6783	12722	66.09	26.77
MS	no	37	51.11	4.46	46.19	2.96	50.75	4.39	5738	15429	65.68	19.17
	yes	55	53.6	6.23	48.08	4.23	53.22	6.44	6649	9498	65.67	22.21
RS	no	41	50.56	4.43	45.98	2.49	49.89	3.93	4218	14451	64.39	18.55
	yes	51	54.24	6.1	48.40	4.42	54.04	6.38	7943	9790	66.71	22.79
			P<0.005		P<0.005		P<0.005					
PD	nl	41	51.19	5.42	46.21	3.01	50.11	5.11	4915	15191	63.32	22.3
	abnl	51	53.73	5.71	48.21	4.26	53.94	5.8	7382	9046	67.57	19.78
							P<0.005					
CN	no	42	51.95	5.28	46.95	3.38	51.59	5.72	6110	15387	64.48	21.93
	yes	50	53.14	6.62	47.63	4.24	52.75	5.87	6427	8748	66.68	20.23
FR	no	48	51.65	4.92	46.78	3.28	51.34	5.24	5774	14460	65.98	21.0
	yes	44	53.64	6.33	47.91	4.38	53.16	6.26	6838	9159	65.34	21.09
VS	no	58	51.29	4.66	46.51	2.93	56.84	4.77	4015	6553	67.14	21.00
	yes	34	54.83	6.62	48.7	9.82	54.63	6.67	10152	17586	63.18	20.87
			P<0.005		P<0.005		P<0.005					

AS: Anterior segment; MS: Munson's sign; RS: Rizutti's sign; PD: Placido's disc; CN: Corneal nerves; FR: Fleischer ring; VS: Vogt's striae

Discussion

In addition to slit-lamp biomicroscopic evaluation, corneal topography and pachymetry are the two important diagnostic tools of KC and early diagnosis is possible only with corneal topography.^{1,2} Topography can be used to document subtle corneal surface irregularity before other clinical or biomicroscopic signs appear.¹

Majority of the study population belonged to the age group 20 to 25 years. Zednik et al reported an average age of 37 years (range 10-89 years), with 84% between 20 and 49 years old in their clinic-based sample group.⁷ According to Agrawal et al, 43.3% cases belonged to the 20-30 year age group with the mean age of diagnosis of 20 years, similar to other Asian population.⁴ Naderan et al also report a similar age of diagnosis.⁸ Shanti et al reported a mean age of 23.3 years.⁹ Shetti et al reported a mean age of 21.5 years.¹⁰ KC occurs at puberty, progresses until third or fourth decade and remains stationary thereafter.^{1,5} Rarely, KC becomes manifest at a later age following an alteration in endocrinological status (eg pregnancy).^{1,11}

There was a male preponderance. Agrawal et al reported a male (68.9%) predominance in KC.⁴ It may be due to early diagnosis in males. Shanti et al reported equal preference in both sexes.⁹ Shetti et al reported 53% female predominance.¹⁰ Bilaterality was evident. But a significant subgroup with unilateral KC had myopic astigmatism in the other eye. Zednik et al reported 13% unilateral cases.⁷ Shanti et al reported 88.2% bilaterality in their study.⁹ Shetti et al reported 97% bilaterality and also reported unilateral

involvement on clinical examination had bilateral early KC or forme-fruste on topographical analysis.¹⁰ Agrawal et al reported 100% bilaterality.⁴ KC is an asymmetric disease.^{5,6} Even in the two eyes of the same patient, there will be asymmetric manifestation and progression.^{1,5,6}

Defective vision was the presenting complaint. Majority had a best corrected visual acuity better than 6/12. Spectacle use was not preferred by all of them due to intolerance. Shanti Y et al also reported a BCVA better than 6/12 in 71.5% cases.⁹ CLEK study reported BCVA 6/12 or better in 58% cases.¹² Agrawal et al reported that 30% had BCVA >6/12 and 15% were not using any vision correction and around 45% were using spectacles.⁴ Spectacle intolerance may be due to poor quality of corrected vision. Lack of awareness about KC and its treatment modalities, or the lack of access to appropriate care may also contribute to nonuse of contact lens in our study group.

Only 2 cases had a family history of KC. It may be due to lack of awareness about the ocular condition of relatives. Shetti et al reported 6.8% family history.¹⁰ Agrawal et al reported only 1.1% cases with family history in his study.⁴ Even though high prevalence of positive family history of KC in KC patients is well-known, the results regarding the association between family history of KC and disease severity are controversial. Naderan et al report 19.5% patients with a family history of KC and severity was more in families.¹³

Ocular associations noted were VKC and type II Duane's retraction syndrome. Gordon-Shaag et al reported eye rubbing as an important risk factor for ketratoconus.¹⁴ No

history of other ocular or systemic diseases were seen in the study by Agrawal et al.⁴ They suggested that this may be due to lack of detection, low level of penetration of associated diseases, an evolving disease process or different underlying mechanisms of KC in the Asian-Indian population.⁴ The risk factors of KC include rigid gas permeable (RGP) contact lens wear, chronic eye rubbing, Down syndrome, atopic disease, connective tissue disease, Leber congenital amaurosis, tapetoretinal degeneration, mitral valve prolapse and inheritance.^{1,2,3,10}

Keratometric values (Sim K1, Sim K2, Central K) showed significant positive correlation. As Sim K1 values increased, Sim K2, Central K, KISA also increased. However, the association between keratometric values and skewing of axis was poorly defined. A statistically significant decrease in the SRAX values was observed with progressive increase in Sim K1, Sim K2 and Central K.

Clinical findings were evident among the vast majority of the study group. The common anterior segment findings were positive Munson's sign (60%), positive Rizutti's sign (55%), abnormal pattern in Placido's disc (55%), prominent corneal nerves (54%), Fleischer ring (48%) and Vogt's striae (37%). Oil drop sign on retinoscopy was observed among 14% cases. Clinical findings of KC are the asymmetrical thinning of the corneal stroma, more inferotemporally, and the highly irregular corneal topography, Fleischer iron rings, Munson sign, Rizzuti sign, and/or Vogt striae.¹ Inferotemporal steepening is associated with superonasal flattening and higher order aberrations like coma.^{1,5} Naderan et al reported that corneal protrusion, scissoring reflex, corneal thinning, Fleischer's ring, and prominent nerve fibres were the most prevalent findings in the keratoconic corneas (71.7%, 64.2%, 56.6%, 55.5% and 54.7%, respectively).¹⁵ Agrawal et al reported that even though disease severity has a positive relation with anterior segment findings, KC can be diagnosed without AS findings (7%).⁴ 81% cases had Fleischer ring and Vogt's striae and corneal scarring were more prevalent in severe disease in the study by Agrawal et al.⁴ CLEK and DUSKS studies reported absence of AS findings in 14% and 15%, respectively.^{12,16} No association was observed between the presence of anterior segment findings like Munson's sign, Rizutti's sign, prominence of corneal nerves and Fleischer's ring with the topographic parameters. But those with distortions on Placido disc had a statistically significant higher topographic values. Those with Vogt's striae had a higher Sim K1, and Sim K2. However central K value, KISA and skewing were less than those without Vogt's striae. These observations were statistically significant. Agrawal et al claim that higher keratometric readings are associated with a higher prevalence of corneal signs of KC.⁴

Majority of the study group had keratometric values between 45 D to 50 D. Naderan et al reported the mean K reading of 48.8 ± 4.8 Diopters.⁸ Shanti et al reported that 62% cases had mild KC.⁹

Limitations

As the study was conducted in a tertiary eye care centre, the study population included those with nonimprovement of vision with spectacles or referred diagnosed cases of KC.

Thus more severe forms of the disease may have been over-represented due to selection bias. Placido based corneal topography was done which can assess only the anterior corneal surface. A characteristic asymmetry in posterior surface elevation is a specific and sensitive indicator for KC. So Scheimpflug-imaging devices, such as the Pentacam and scanning slit-scan such as the Orbscan would be more useful for diagnosis since they offer detailed pachymetry maps. Nowadays, anterior-segment optical coherence tomography (OCT), especially Fourier-domain OCT devices provide corneal epithelial thickness distribution, that can be a very sensitive and specific indicator for early KC.¹

Conclusion

Variations in the various Keratometric values (Sim K1, Sim K2, Central K) showed significant positive correlation. Skewing of axis reduced with progressive increase in Sim K1, Sim K2 and Central K. Munson's sign, Rizutti's sign prominence of corneal nerves and Fleischer's ring did not show any correlation with the topographic parameters. Distortions on Placido disc and Vogt's striae correlated with higher Sim K1 and Sim K2 values. Central K values, KISA and SRAX values were significantly less among those with Vogt's striae.

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