

Clinical Profile, Risk factors and Topographic Characteristics of Keratoconus at a Tertiary Eye Hospital: An Observational Study

Poonam Shrestha,¹ Bibhuti Thapa,¹ Lazza Singh,¹ Santosh Paudel¹

¹Department of Cornea and External Eye Disease, Nepal Eye Hospital, Tirpureshwor, Kathmandu, Nepal.

ABSTRACT

Introduction: Keratoconus is a non-inflammatory, progressive thinning, most commonly bilateral condition of the cornea involving the central two-thirds of the cornea. The study aimed to assess the clinical profile, risk factors, and topographic parameters.

Methods: An observational study was conducted from March to November 2024 among patients with clinically and topographically diagnosed keratoconus. Corneal topography-800 and the Amsler-Krumeich classification were used for diagnosis and grading. Binary variables were summarized as frequencies and percentages, while continuous variables were expressed as mean, standard deviation, and coefficient of variation.

Results: Among the 82 keratoconus patients 120 eyes were evaluated, the mean age of presentation was 22.37 ± 8.7 years. The study population included 64 (78.05%) males and 18 females (21.95%). Reported risk factor were eye rubbing 52 (37.96%), ocular allergy 44 (32.12%). Unilateral keratoconus was seen in 46 (56.10%) cases. The observed clinical sign was scissor reflex 62 (75.61%), stromal thinning 50 (60.98%) and Vogt's striae 36 (43.90%). Refractive parameters showed considerable variation, with spherical power averaging -1.16 ± 2.05 D and cylindrical power at -4.16 ± 2.88 D, confirming significant myopia and astigmatism. Corneal curvature was increased, with a mean K value of 47.30 ± 5.50 D, and the surface asymmetry index was 2.44 ± 2.19 , indicating variations in corneal topography.

Conclusions: In this study, majority of the patients were in early twenty's age group. The most early sign for the detection of keratoconus was scissor reflex and as the severity of keratoconus increased the central corneal thickness and best corrected visual acuity decreased.



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Correspondence:

Name: Dr Poonam Shrestha

Affiliation: Department of Cornea and External Eye Disease, Nepal Eye Hospital, Tirpureshwor, Kathmandu, Nepal.

Email: mepoonam120@gmail.com

Phone: +977-9851131431.



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INTRODUCTION

Keratoconus is a progressive, non-inflammatory condition that primarily affects both eyes, leading to thinning of the central two-thirds of the cornea.¹ It is characterized by irregular myopic astigmatism with corneal thinning, protrusion and corneal scar.²

Earlier studies have reported that compared to Caucasian eyes, Asians had 4-fold increase in incidence of keratoconus with relative high incidence in the Mediterranean and Middle eastern areas.³ Studies have shown the risk factors for keratoconus are atopy or allergic diseases, frequent eye rubbing, positive family history of keratoconus and consanguinity.⁴ Clinical and topographic indices of keratoconus are important in the process

of early diagnosis and its management.¹

Despite the rising incidence of keratoconus, there is lack of clinical profile, causes of risk factors and topographic pattern in Nepal. The study aimed to find the clinical profile, risk factors and topographic characteristics of keratoconus patients in our population will help to prepare a standard diagnostic protocol and proper management.

METHODS

This was a descriptive observational study conducted among 82 keratoconus patients at Nepal eye Hospital which is a tertiary

care hospital located at Kathmandu. The study was conducted from March 2024 to November 2024 after ethical clearance from Nepal Health Research Council (NHRC), Kathmandu (Reference Number: 1182). Keratoconus was diagnosed with the presence of clinical signs and corneal topographic changes both. Patients with history of any intraocular surgery, refractive surgery on any other corneal surgery in the past, patients with active corneal diseases, contact lens users and patients not willing to participate in the study were excluded from the study. The data was collected with the help of structured performa and consecutive sampling technique was done. A detailed clinical profile, risk factors and topographic data were recorded. Visual acuity was recorded in Log Mar chart. Topographical diagnosis and grading of keratoconus was done with the topographic and keratometry variables obtained by the corneal topographer CA- 800. The CA-800 topographer takes into the account of the KPI (Keratoconus Prediction Index) calculated by the combination of 8 topographic indices and uses discriminant function; the S-I(Superior-Inferior asymmetry); the AGC(Anterior Geometry Curve) and the apex curvature. The following criteria will be used to diagnosis of keratoconus: KPI - > 0.23 is indicative of keratoconus S-I asymmetry - > 1.40 D is indicative of keratoconus AGC- > 2.00 D/mm is diagnosis of keratoconus

The above corneal topography results for keratoconus also follows keratoconus Rabinowitz criteria will be diagnosed on the basis of: Central K-value > 47.20 and Inferior- Superior asymmetry (I-S value) > 1.40 D.⁵

Keratoconus was classified according to the Amsler-Krumeich Classification.⁶ Grade 1 was characterised by eccentric steepening, myopia and astigmatism of < 5.00 D, and a mean central keratometry (K) reading of < 48.00 D. Grade 2 was defined by myopia and astigmatism ranging from 5.00 to 8.00 D, a mean central K reading of < 53.00 D, absence of corneal scarring, and a minimum corneal thickness of > 400 μ m. Grade 3 included myopia and astigmatism ranging from 8.00 to 10.00 D, a mean central K reading of > 53.00 D, absence of corneal scarring, and a minimum corneal thickness of 300–400 μ m. Grade 4 was characterised by unmeasurable refraction, a mean central K reading of > 55.00 D, the presence of central corneal scarring, and a minimum corneal thickness of 200 μ m.⁶ To calculate the necessary sample size for this study, we had used formula designed for descriptive studies. This formula takes into account the level of confidence, the standard deviation of the data (denoted as "SD"), and the desired margin of error (abbreviated as "E"). $(Z^2(\alpha/2) \times SD^2)/E^2 = (1.96)^2 \times (4.58)^2/1^2 = 80.582$

So, the final sample size required for this study, based on the mean keratometry reading as a key diagnostic factor for Keratoconus (KCN) and using a standard deviation of 4.58 from a previous study conducted at the Tilganga Institute of Ophthalmology and taking precision at 1%, is approximately 82 patients.⁷

Data analysis was performed using SPSS Statistics for Windows, version 26.0 (SPSS Inc., Chicago, Ill., USA). The frequency and percentage were reported for binary data, and mean with

standard deviation and coefficient of variation was used.

RESULTS

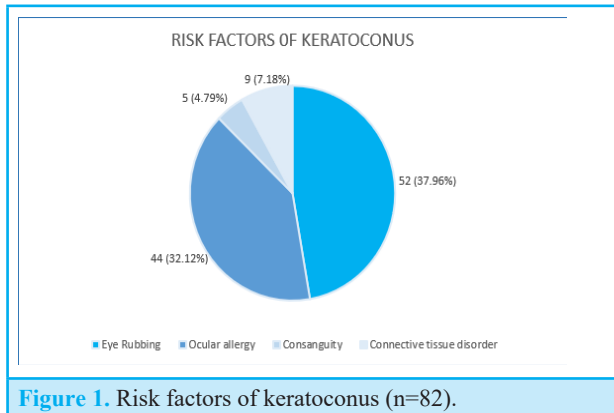
The study included a total of 82 keratoconus patients, with a mean age of 22.37 ± 8.7 years (range: 8 to 48 years). There were 64 (78.05%) males and 18 (21.95%) females patients affected with keratoconus.

Table 1. Baseline characteristics of keratoconus patients (n=82).

Variables	n(%)
Age	
< 20	40(48.78)
20- 30	27(32.92)
31- 40	10(12.20)
>40	5(6.10)
Gender	
Male	64(78.05)
Female	18(21.95)
Screen exposure	
< 2 hours	19(23.17)
2- 6 hours	43(52.44)
>6 hours	20(24.39)
Smoking	
Yes	12(14.63)
No	70(85.37)
Laterality of Keratoconus	
Unilateral	46(56.10)
Bilateral	36(43.90)
Symptoms	
Decreased vision	81(98.78)
Frequent change of glasses	32(39.02)
Headache	10(12.20)
Clinical signs	
Scissor reflex	62(75.61)
Stromal thinning	50(60.98)
Vogt's striae	36(43.90)
Apical scar	6(7.32)
Fleischer ring	9(10.98)
Best corrected Visual acuity with glasses	
0 to 0.6	36(43.90)
>0.6 to 1	28(34.15)
>1	18(21.95)
Severity of keratoconus	
Grade 1	58(70.73)
Grade 2	16(19.51)
Grade 3	6(7.32)
Grade 4	2(2.44)

Among the ocular complaints, decreased vision was reported by 81 (98.78%) participants, and frequent changes of glasses were reported by 32 (39.02%) participants. The observed clinical sign was scissor reflex 62 (75.61%), stromal thinning 50 (60.98%) and Vogt's striae 36 (43.90%). Regarding lifestyle characteristics, 70 (85.37%) participants were non-smokers, and 43 (52.44%) reported screen usage of 2–6 hours per day. Best-corrected visual acuity of 0–0.6 was observed in 36

(43.90%) participants, while best-corrected visual acuity of >0.6 – 1.0 was observed in 28 (34.15%) participants. Regarding the severity of keratoconus, 58 (70.73%) participants had Grade 1 disease, characterised by a mean central keratometry reading of <48.00 D, while 2 (2.44%) participants had Grade 4 disease, characterised by a mean central keratometry reading of >55.00 D and the presence of central corneal scarring.



Eye rubbing was reported by 52 (38.0%) participants, and ocular allergy was reported by 44 (32.1%) participants (Figure 1).

Table 2. Descriptive Statistics for study variables (n=82).

Variable	Mean $\pm$ SD
BCVA	0.38 $\pm$ 0.33
Spherical Power	-1.16 $\pm$ 2.05
Cylinder Power	-4.16 $\pm$ 2.88
Mean K	47.30 $\pm$ 5.50
AK	54.43 $\pm$ 7.25
AGC	6.15 $\pm$ 3.83
SI	3.11 $\pm$ 2.92
KPI	87.49 $\pm$ 15.66
SAI	2.44 $\pm$ 2.19
CCT	492.18 $\pm$ 47.58

Note: BCVA: Best-corrected visual acuity; K: Keratometer; AK: Anterior keratometry; AGC: Anterior global curvature; SI: Surface Irregularity Index; KPI: Keratoconus Prediction Index; SAI: Surface Asymmetry Index; CCT: Central Corneal Thickness.

The mean values of the ophthalmic and topographic parameters are presented in Table 2. The best-corrected visual acuity (BCVA) had a mean of 0.38 ± 0.33 , with a median of 0.30 indicating moderate visual impairment. The mean refractive parameters included a spherical power of -1.16 ± 2.05 D and a cylindrical power of -4.16 ± 2.88 D. The mean K value was 47.30 ± 5.50 D, and the mean anterior keratometry (AK) was 54.43 ± 7.25 D. The mean surface asymmetry index (SAI) was 2.44 ± 2.19 . The mean central corneal thickness (CCT) was 492.18 ± 47.58 μ m, with values ranging from 268 to 620 μ m (Table 2).

DISCUSSION

Keratoconus is a bilateral, corneal, non-inflammatory condition characterized by gradual thinning and apical protrusion, which results in a significant decrease in vision. The prevalence

of keratoconus varies widely across different populations depending on many factors, such as geographic location, genetic factors, diagnostic criteria used in different countries, and study methodologies. Studies have shown a range from 9 per 100,000 in Japan to 2,300 per 100,000 in India.⁴ Our study included 82 keratoconus patients, with male predominance observed, which is similar to other studies.⁸ The exact reason for the gender difference in the distribution of keratoconus is not clear, although there are hypotheses involving the role of sex hormones; anatomical, physiological susceptibility, and environmental exposures may also contribute to a higher prevalence of keratoconus in men.⁹ The mean age of the participants in our study was 22.37 ± 8.7 years, which falls within the early twenties. According to previous studies, the mean age of KCN patients was 23–28 years in European countries and 18–24 years in Asian countries.^{9, 10} The younger age at diagnosis in our study and studies from Asian countries compared to European countries reflects that keratoconus has earlier and faster progression in the Asian population, showing variability in the disease process.

Keratoconus usually involves both eyes but can affect one eye earlier than the other. This study reported that 56.1% of cases had unilateral keratoconus, while 43.9% had bilateral keratoconus, whereas a study conducted in Malaysia showed that around 77% of cases had bilateral keratoconus.¹¹ Population-based studies have reported a higher percentage of unilateral keratoconus in the Asian population.¹² The variation in the results from other studies may be due to differences in the diagnostic methods used. In this study, the central corneal curvature values measured by keratometry following the Amsler-Krumeich grading system were selected for grading keratoconus, where we found 58 mild (70.73%), 18 moderate (21.90%), and 6 severe (7.3%) grades of keratoconus. The study conducted by Vinay et al. showed mild keratoconus was 12.04%, moderate keratoconus was 72.26%, and severe keratoconus was 15.69%, which shows that in our study, we were able to detect keratoconus at an early stage.¹³ A study conducted by Rafati et al. found that 15.2%, 56.4%, and 28.4% of the patients had mild, moderate, and severe keratoconus, respectively.¹⁴ The frequency of moderate and severe keratoconus in this study was similar to its frequency in Asian populations but higher than in other ethnic populations, especially European populations.¹⁰ Many factors, such as the use of newer techniques and protocols for diagnosis and increasing awareness about refractive errors, may have played a role in detecting the disease at an early stage.

Our study findings showed that 81 (98.7%) cases had complaints of decreased vision, and other studies also suggest that keratoconus significantly affects vision-related quality of life.¹⁵ Studies have found that allergic conjunctivitis leads to forceful eye rubbing, which causes an increase in protease activity, contributing to the development and progression of keratoconus.¹⁶ We also found that the common risk factor was eye rubbing, 52 (37.96%), followed by ocular allergy, 44 (32.12%). There are many theories that explain the correlation between eye rubbing and the development of keratoconus, such

as a decrease in keratocyte density and changes in intraocular pressure as a result of forceful eye rubbing, which leads to keratoconus.¹⁷ Among the keratoconus patients in the study, the mean CCT was $492.18 \pm 47.58 \mu\text{m}$, and it ranged from 268 to $620 \mu\text{m}$, which was similar to the findings of another study.⁷ With regard to best corrected visual acuity and refractive status, the results of our study resemble those of a study conducted in Sudan, which showed that visual acuity was 0.43 ± 0.27 , the mean spherical amount of refraction was -5.59 ± 4.14 , and the mean cylindrical amount of refraction was -4.34 ± 2.77 .¹⁸ Awareness of the relationship between demographic factors, clinical characteristics, and topographic indices will help in planning a regular management protocol that is not only important for diagnosis but also for organizing an effective early detection and screening program.¹²

This study adds data on the clinical profile patterns of keratoconus, associated risk factors, and topographic patterns in our population, which will help in the prevention and early diagnosis of the disease, thereby reducing its overall impact. However, this was a single-center, hospital-based study, which could limit the generalizability of the findings and its ability to predict the prevalence of keratoconus. This study only included patients with keratoconus who visited this particular hospital, reducing the generalizability of the results and increasing selection bias. Future research should focus on conducting large-scale, multicentric studies to improve the reliability and applicability of the findings.

CONCLUSION

In this study, majority of the patients were in 20- 24 years age group, males were more affected than female and most of the patients had mild grade of keratoconus. The most early sign for the detection of keratoconus was scissor reflex and as this can be detected by simple retinoscopy can be used in simple setting also. Ocular allergy and eye rubbing were the most common risk factors for keratoconus. As the severity of keratoconus increased the central corneal thickness and best corrected visual acuity decreased.

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