

Original Article

Prevalence of keratoconus among patients seeking laser vision correction in Taif area of Saudi Arabia



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Abstract

Purpose: To determine the prevalence of keratoconus among patients seeking laser vision correction (LVC).

Methods: Retrospective study of 1374 eyes of 687 patients (335 males, 352 females) who underwent keratoconus screening as a part of routine preoperative evaluation prior to LVC at the Tadawi surgical centre, Taif, Saudi Arabia from January 2014 to June 2015. The diagnosis of keratoconus was based on evaluation of Pentacam derived parameters.

Results: Manifest keratoconus was found in 59 subjects (out of 687 subjects) representing a prevalence rate of 8.59%. Of the 687 subjects, 45 subjects (6.55%) had bilateral manifest keratoconus (manifest keratoconus in both eyes or manifest keratoconus in one eye and sub-clinical in contralateral eye) and remaining 14 patients (2.04%) had unilateral manifest keratoconus (with normal fellow eye). Sub-clinical keratoconus was diagnosed in 65 patients representing a prevalence rate of 9.46%. Of the 687 patients, 20 cases (2.91%) with subclinical keratoconus were bilateral and 45 (6.55%) were unilateral. Overall, 19.70% males (66/335) and 16.48% (58/352) females had either manifest or sub-clinical keratoconus, representing no statistically significant difference in the gender predisposition of the keratoconus disease process (Chi Square test; $p = .277$).

Conclusion: High prevalence of keratoconus was found among patients seeking LVC. Possible factors contributing to the high prevalence were recognized to be highly selective population (patients seeking LVC for myopia/hyperopia/astigmatism), ethnicity (high prevalence of consanguinity) and geographical location (high altitude) of the study subjects.

Keywords: Prevalence of keratoconus, Sub-clinical keratoconus, Saudi Arabia, Laser vision correction, Epidemiology

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Introduction

Keratoconus is a chronic, idiopathic and non-inflammatory corneal disorder, which is characterized by thinning and protrusion of central or paracentral portion of the cornea¹ resulting in irregular astigmatism, myopia and corneal scarring^{1,2} and reduction in visual acuity.^{3–5} The onset of

the keratoconus usually occurs at puberty with the progression until the third to fourth decade of the life in most of the cases.⁴

Several studies have evaluated the prevalence rate of the keratoconus. The prevalence rates reported in different studies range from 0.02 to 3333 cases per 100,000 population (0.00002 to 3.33%).^{1,3–13} The wide variation in the prevalence

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rate among different studies can be attributed to the differences in geographical area, ethnicity, presence of concomitant diseases (atopy e.g. eczema, asthma, hay fever), dissimilarity in study population (hospital based, general population, student population, age group), criteria used for diagnosis of keratoconus etc.^{4,12,14}

Geographical distribution and ethnicity are probably among the most important factors influencing the prevalence rate. Reports from different studies have indicated that the countries with warm climate such as Middle Eastern and Asian countries have high prevalence of keratoconus^{3,4,8,12} as compared to the countries with cold climate such as Russia, USA, UK etc.^{6,9,11} Genetic susceptibility in different ethnic groups, particularly the ones' with tradition of consanguinity, may also contribute to the high prevalence of keratoconus in some studies.^{11,15}

Studies reporting the epidemiology of keratoconus are limited in Saudi Arabia. We found only one such study which was carried out in Asir province. The authors found high incidence of keratoconus in this region compared to the other regions of the world.¹⁶ Thus, there is a need to carry out further studies evaluating the prevalence of keratoconus in Saudi Arabia. Moreover, with the increasing number of patients seeking laser vision correction (LVC), there is a need to determine prevalence rate of keratoconus among such patients as this will provide ophthalmologists with the direct estimation of the likelihood of finding keratoconus cases when screening the patients for LVC. In the current study, we examined the prevalence of keratoconus among patients seeking LVC at a refractive surgery centre in Saudi Arabia.

Material and methods

This observational case series included 1374 eyes of 687 patients who underwent keratoconus screening as a part of routine pre-operative evaluation prior to LVC at the Tadawi surgical centre, Taif, Saudi Arabia. Data were collected from January 2014 to June 2015. The exclusion criteria were age <18 years, corneal pathologies other than keratoconus and prior refractive or corneal surgery. The study followed the tenets of the Declaration of Helsinki and was approved by Taif University's institutional review board with waiver of consent.

The demographic data recorded were patient's age, sex and laterality of the eye. Out of 687 patients included in the study, 335 were males and 352 were females. The mean age of the patients was 27.6 ± 7.5 (range 18 to 65 years). The mean age of the male and female participants was 26.7 ± 7.5 (range 18 to 56 years) and 28.5 ± 7.5 years (range 18 to 65 years) respectively. All patients underwent complete ophthalmic examination, which included visual acuity measurement, refraction, pachymetry, keratometry, Pentacam evaluation, slit lamp biomicroscopy and fundus examination.

Visual acuity was tested in each eye with and without correction of refractive error using Snellen chart at a distance of 20 feet. The mean spherical equivalent (SE) of the included eyes was -3.11 ± 2.88 Dioptres (D). Of the total 1374 eyes, 91.85% (1262 eyes) were myopic ($SE \leq -0.50$ D), 4.73% (65 eyes) were hyperopic ($SE \geq +0.50$ D) and remaining 3.42% (47 eyes) had SE between $+0.50$ D and -0.50 D. Astigmatism (absolute cylinder ≥ 0.50 D) was present in 78.46%

(1078/1374) eyes of which 38.9% (419/1078) eyes had high astigmatism of ≥ 1.50 D.

The diagnosis of the keratoconus was made using Pentacam (Pentacam; Oculus, Inc, Wetzlar, Germany) based on the Belin-Ambrósio enhanced ectasia display (BAD) which evaluates elevation data (anterior and posterior), pachymetric distribution and keratometry. The parameters evaluated by BAD software are described elsewhere.¹⁷⁻²¹ The final D value is calculated performing a regression analysis against a standard database of normal and keratoconic corneas. The parameter is colour coded by the software based on the variation from the normal and classified as normal (<1.6 SD from the population mean, shown in white), suspicious (≥ 1.6 SD and <2.6 SD, shown in yellow), and pathologic (≥ 2.6 SD, shown in red).¹⁷⁻²¹

The prevalence rates of keratoconus in the study population were calculated as 'per patient' (i.e. based on the assessment of both the eyes). A patient was classified as having manifest keratoconus if he/she had bilateral manifest keratoconus or manifest keratoconus in one eye and sub-clinical/normal in the contralateral eye. To be classified as having subclinical keratoconus, patients should have either bilateral subclinical keratoconus or unilateral sub-clinical keratoconus with normal topography in fellow eye. The difference in the prevalence of keratoconus by gender was examined using Chi square test. The $p \leq 0.05$ was considered significant.

Results

Overall, the prevalence rate of the manifest keratoconus was 8.59% (59/687). Prevalence rate was 9.25% (31/335) in males and 7.95% in females (28/352). Of the 687 subjects, 45 subjects (6.55%) had bilateral manifest keratoconus (manifest keratoconus in both eyes or manifest keratoconus in one eye and sub-clinical in contralateral eye) and remaining 14 subjects (2.04%) had unilateral manifest keratoconus (with normal fellow eye) (Fig. 1).

Sub-clinical keratoconus was diagnosed in 65 patients representing a prevalence rate of 9.46%. Prevalence rates of sub-clinical keratoconus in males and females were 10.45% (35/335) and 8.52% (30/352) respectively. Out of 687 subjects, 20 subjects (2.91%) had bilateral and 45 (6.55%) had unilateral sub-clinical keratoconus (Fig. 1).

Overall (manifest + subclinical keratoconus cases), 19.70% males (66/335) and 8.44% females (58/352) had either manifest or sub-clinical keratoconus. No statistically significant difference was found between male and female patients with respect to the prevalence rate of the keratoconus (Chi Square Test; $p = .277$).

Discussion

Studies carried out in different regions of the world have reported wide variation in the prevalence rates^{1,3-13} and identified several factors that may contribute to these variations; e.g., geographical area, ethnicity, selected cohort of the patients (number of patients, age, sex, population type), methods and criteria for diagnosing keratoconus etc.^{22,23}

Geographical distribution of the individuals in regions with differing weather conditions, UV exposure, altitude etc. may contribute to the variance in prevalence rates.⁴ Review of literature shows high prevalence of keratoconus in India, Saudi

Arabia and Israel (range: 2340 to 3333 persons/100,000 population);^{3,4,13} and low prevalence in North America and Russia (range: 0.2 to 54 persons/100,000 population).^{6,9,24} Apart from the geographical distribution, the prevalence of keratoconus also varies by ethnicity depending upon the genetic pre-disposition of the ethnic group.²³ Evidence of genetic etiology of keratoconus include familial inheritance, concordance between monozygotic twins, and the association of the keratoconus to the other known genetic disorders such as Down's syndrome, Leber's congenital amaurosis, Marfan syndrome, Ehlers-Danlos syndrome etc.^{12,14,23} Further, high prevalence of consanguinity has been associated with high prevalence of the keratoconus.²² In a study from a district hospital in United Kingdom, authors found statistically significantly higher incidence of keratoconus for Asians (25/100000/year) as compared with white people (3.3/100000/year), notwithstanding the fact of similarity in geographical area.¹⁵ The authors concluded that the higher incidence in Asian population was highly suggestive of a genetic factor being dominant in this population as most of the Asian patients were of Northern Pakistani origin and this community has a tradition of consanguineous marriages.

LVC is generally contraindicated in keratoconus patients or suspects because excimer laser ablation may reduce the biomechanical strength of the cornea potentially leading to the progression of the ectasia.^{23,25} Therefore, routine screening of the patients is undertaken prior to the refractive surgery to help identify ectatic changes in asymptomatic subjects and make further decisions accordingly.²³ In the current study, we attempted to determine the prevalence rate of keratoconus and sub-clinical keratoconus among the patients who came for refractive surgery work-up. We found the prevalence rate of keratoconus to be 8.59% and sub-clinical keratoconus to be 9.46% in Taif area of Saudi Arabia in the patients who came for refractive surgery work-up. In a study carried out in Asir province of Saudi Arabia, Assiri et al. found the high incidence of keratoconus (20 cases per 100000 population).¹⁶ However, the study did not report the prevalence rate. Prevalence rate reported in the current study is higher than the prevalence rate previously reported in the different studies worldwide. Here, it is noteworthy that in the current study, the prevalence rate was calculated among the patients seeking LVC. Therefore, the reported prevalence rate is not representative of keratoconus prevalence in the general population of this area.

As compared with general population, myopic and astigmatic patients are likely to have a higher risk of developing keratoconus. In a study carried out by Xu et al., keratoconus was found significantly associated with more myopic refractive error, higher cylindrical refractive errors, lower best corrected visual acuity and smaller inter-pupillary distance.⁵ All patients/eyes in this study had at least some refractive error; (91.85% eyes were myopic, 4.73% were hyperopic). Overall, 78.46% eyes had astigmatism of which 38.9% eyes had high astigmatism of ≥ 1.50 D). Undoubtedly, the population of the current study was highly selected, therefore was expected to have a higher prevalence than reported in population-based studies.

Very few studies have analysed the epidemiology of keratoconus in a population similar to the current study. In a study

carried out by Wilson et al. (1994), 33% subjects, who sought an opinion regarding refractive surgery for the correction of myopia, were found to have abnormal corneal topography; however, 5.7% subjects were classified to have definite keratoconus.²⁶ Different outcomes of this study from ours could be attributed to the ethnic, geographical and environmental differences. This study was carried out in Dallas (Texas, US); however, the current study was carried out in Taif area of Saudi Arabia: a region with high altitude and high prevalence of consanguinity. The prevalence of consanguinity as high as ~57% has been reported in Saudi Arabia.^{27,28} As we discussed earlier, consanguinity is a factor responsible for genetic predisposition for developing keratoconus. Further, positive correlation between altitude and keratoconus has been reported.¹⁶ The altitude of Dallas is <150 meters; however, Taif area is situated 1700–2500 m above the sea level. With every 1000 meter increase in altitude, there is a 10% increase in the level of UV radiation.¹⁶ The higher exposure to the UV radiations of the sun is thought to be a risk factor in the development of the keratoconus.⁴ This hypothesis is supported by the evidence that keratoconic cornea lacks the ability to process reactive oxygen species, thereby producing oxidative stress on the cornea upon UV exposure.⁴ Additionally, differences in the diagnostic criteria (computed topographic analysis versus Pentacam derived parameters) could also be the reason for the differences in the epidemiology numbers.

Keratoconus is usually a bilateral disorder, although it develops asymmetrically.¹ A review of literature reveals 69% to 88.8% bilateral cases of the keratoconus compared to 11.8% to 31% unilateral cases.^{1,8,10} With 76.27% bilateral and 23.73% unilateral cases among manifest keratoconus patients, the trend in the current study was found to be similar; however, the presentation in sub-clinical keratoconus was contrasting (30.77% bilateral and 69.23% unilateral). This may be expected because subclinical keratoconus represents an earlier stage of the ectatic disease process compared to that of manifest keratoconus, which is well known to present in an asymmetric bilateral manner in most of the cases.

Concerning the gender distribution, there is no consensus between the studies regarding male or female dominance of keratoconus. While some studies show that keratoconus is more prevalent in females,^{1,3} other represent the higher prevalence of keratoconus in male patients.⁴ A study carried out in Mexico, reported the prevalence of keratoconus in females to be twice as compared to the male patients (66.6% versus 33.3%).^{1,3} Further, in a population-based study, the authors reported approximately five times higher prevalence of keratoconus in males compared to females (4.91% versus 1.07%).⁴ There are also studies which show that keratoconus is a disease with no gender predominance.^{24,29} In the current study as well, the prevalence of keratoconus in females was comparable to the male patients.

Conclusion

High prevalence of subclinical (9.46%) and manifest (8.59%) keratoconus was found among patients seeking LVC. The potential factors contributing to the high preva-

lence of the keratoconus among study subjects were recognized to be highly selective population (patients seeking LVC for myopia/hyperopia/astigmatism), ethnicity (particularly due to high prevalence of consanguinity) and geographical location (high altitude). Epidemiology numbers from the current study will serve as direct reference for the clinical ophthalmologist of our region while screening patients for refractive surgery. There is a need to carry out similar studies globally in different regions to guide the clinical ophthalmologists with the expected epidemiology of subclinical and manifest keratoconus for screening patients for LVC.

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Conflicts of interest

The authors declared that there is no conflict of interest.

Appendix A

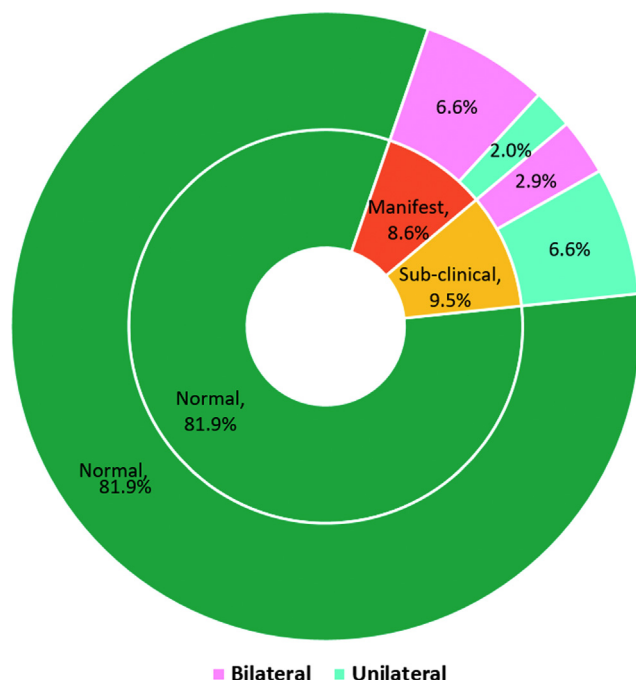


Fig. 1. Inner circle: Prevalence of manifest and sub-clinical keratoconus patients in the overall study population (n = 687, 100%); Outer circle: Prevalence of unilateral and bilateral manifest and sub-clinical keratoconus patients in the overall study population (n = 687, 100%).

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