Prevalence of Keratoconus in Refractive Surgery Cases in Western India

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Abstract:

Purpose: To report the prevalence of keratoconus (KCN) in patients presenting for refractive surgery in western India.

METHODS: A cross-sectional, observational, retrospective study performed at a tertiary eye care center. A total of 2902 cases, aged 18–40 years who presented in the refractive surgery department between January 2014 and December 2018 were included. Records of all the included cases were reviewed. Patients showing KCN pattern on topography were noted and divided into KCN and KCN suspects. Annual and overall 5-year prevalence were calculated at 95% confidence interval (CI). Demographic details of KCN and non-KCN participants were compared.

RESULTS: Of the 2902 cases, 25 (0.86%) had clinical KCN and 22 (0.76%) were KCN suspects. The combined 5-year prevalence of all these 47 KCN cases was 1.61% (95% CI: 1.15%–2.07%), with an annual prevalence range of 0.97%–2.43%. The mean age of non-KCN cases was 24.60 ± 4.91 years and KCN cases was 24.62 ± 5.37 years (P = 0.98). Among the KCN cases, there were more females (30; 63.83%), and the gender ratio was significantly different than non-KCN cases (P = 0.004).

CONCLUSION: The prevalence of KCN in refractive surgery cases was 1.61% which is higher than those found in the western population and lower than those found in the Middle East (Saudi Arabia and Iran). Furthermore, topographic examination performed during the routine screening of patients for refractive surgery can be a useful tool to diagnose new cases of KCN in asymptomatic patients.

Keywords:
Keratoconus, prevalence, refractive surgery

Introduction

Keratoconus (KCN) is a bilateral, progressive, noninflammatory corneal disorder characterized by ectasia and thinning of the central or paracentral cornea.[¹] Patients usually present with decrease in visual quality or quantity or both. There are well-defined biomicroscopic, ophthalmoscopic, and retinoscopic signs, but topography is the gold standard for diagnosis of early disease.[¹]

Another area in ophthalmology where topography plays a key role is the field of refractive surgery.[²,³] Aiming for a spectacle-free vision, the surgeon and the patient both have high expectations following the laser vision corrective procedures. To avoid the risk of postoperative complications and achieve a good visual outcome (early and late), proper patient selection is of paramount importance. Topography is an indispensable tool for preoperative workup and decision-making.[²,³] Patients with topographic abnormalities suggestive of KCN or suspect KCN are excluded from the
procedure, as these abnormalities increase the risk of postoperative corneal ectasia.\cite{4}

The prevalence of KCN varies widely with geographical location and ranges from 0.0003% to 4%.\cite{8-11} It also depends on the diagnostic method and criteria used in the study. The study done on KCN prevalence from India has reported a prevalence of 2.3% in general population.\cite{7} Their study is not based on topography, and instead, they have used keratometry >48 diopters (D) as criteria for labeling as KCN. The paucity of data prompted us for this study which we conducted to find the prevalence of KCN in patients who presented for refractive surgery at a tertiary care center in western India.

**Methods**

This was a cross-sectional, retrospective, observational study conducted at a tertiary eye care center in western India. Ethical clearance was obtained from the institutional review board (NHL Institutional Review Board), and the study adhered to the tenets of the Declaration of Helsinki. We included all individuals aged 18–40 years who presented in the refractive surgery department of our hospital from January 2014 to December 2018. Patients who had previously undergone any ocular surgery, those with any known ocular or systemic disorder, and pregnant or lactating females were excluded. A total of 2902 individuals were included in the study. Records of all these 2902 individuals were reviewed which included history, anterior and posterior segment examination, manifest and cycloplegic refraction with postmydriatic testing results, thinnest pachymetry, and topography. Contact lens users were asked to discontinue the lens use for 2 weeks before the examination. Pachymetry data were taken from Galilei dual Scheimpflug system (Ziemer Ophthalmic Systems AG, Port, Switzerland), and topography data were taken from Atlas 9000 Corneal Topography System, a Placido-based topographer (software version 3.0.0.39. Carl Zeiss Meditec AG, Jena, Germany).

Atlas topographer has optional software known as Pathfinder II Corneal Analysis Software that classifies the cornea into normal, abnormal, and pathologic based on anterior corneal topography. The software analyzes 12 different corneal parameters and compares them to a comprehensive clinical database that contains reference values for normal, KCN pattern, and myopic or hyperopic laser vision correction. KCN pattern category includes established KCN, suspect KCN, and pellucid marginal degeneration (PMD).

All those patients whose topography analysis by Pathfinder II showed a KCN pattern in either eye were noted and divided into clinical KCN and KCN suspects based on topographic and clinical findings. Patients who had at least one of the biomicroscopic signs consistent with KCN (Vogt’s striae, Fleischer’s ring, or corneal scarring), distorted keratometric mires, or distortion of the retinoscopic or ophthalmoscopic red reflex along with the topographic abnormalities were classified as clinical KCN. Others with a least one or more of the following signs: inferior or central steepening on topography with inferior-superior asymmetry ≥1.4 D, keratometry >48 D, corneal thinning corresponding to the area of steepening, distorted keratometric mires, or distortion of the retinoscopic or ophthalmoscopic red reflex, but without any biomicroscopic signs, were classified as KCN suspects. Patients with clinical KCN in one eye and suspect KCN in the other were kept in the clinical KCN group. Patients with isolated steep cornea or thinnest pachymetry <500 µwithout any KCN pattern on topography were not taken into consideration. The demographic details of all the patients were recorded.

Statistical analysis was done using SPSS software (version 20.0, SPSS Inc. Armonk, NY: IBM corp.). Quantitative data were analyzed using Student’s t-test. \( P < 0.05 \) was considered statistically significant. The prevalence of KCN in patients for refractive surgery was calculated annually from 2014 to 2018 and overall for 5 years and assessed within 95% confidence interval (CI).

**Results**

In our study, of a total of 2902 individuals who were included, 25 cases (0.86%; 95% CI: 0.52%–1.2%) had clinical KCN and 22 cases (0.76%; 95% CI: 0.44%–1.08%) were KCN suspects. Hence, the combined 5-year prevalence of all these 47 KCN cases (clinical and suspect) was 1.61% (95% CI: 1.15%–2.07%). The annual prevalence ranged from 0.97% in 2015 to 2.43% in 2017 [Table 1].

The mean age of non-KCN cases was 24.60 ± 4.91 years and that of KCN cases was 24.62 ± 5.37 years (P = 0.98). Among the total KCN cases, there were 17 (36.17%) males and 30 (63.83%) females. The gender ratio was significantly different than non-KCN cases (P = 0.004) [Table 2].

**Discussion**

Topographic abnormalities such as KCN and suspect KCN are absolute contraindications for refractive surgery. Proper diagnosis of these cases is a must during evaluation of patients keen for spectacle-free vision. We conducted this study to find the prevalence of these cases in patients presenting for refractive surgery in India.

The incidence and prevalence of KCN varies with the geographical distribution. Studies have
reported incidence ranging from 1.3 cases/100,000 in Denmark\cite{12} to 22.3-24.9 cases/100,000 in Iran\cite{13}. The prevalence of KCN also varies widely ranging from 0.3-100,000 (0.0003%) in Russia\cite{8} to 4000/100,000 (4%) in Iran.\cite{6} Countries with hotter climate such as Iran,\cite{4} India,\cite{7} and Lebanon\cite{8} have reported higher prevalence compared to countries with cooler climate such as Denmark,\cite{12} the United Kingdom,\cite{9} the United States,\cite{10} and The Netherlands.\cite{11} A possible explanation could be the ultraviolet light-induced oxidative stress in hotter countries that increases the risk of KCN.

The prevalence of KCN in patients presenting for refractive surgery is reported to be higher than in the general population because these patients are often dissatisfied with glasses and contact lenses and seek refractive treatment. Studies from Saudi Arabia (KCN: 18.7% and suspect KCN: 17.5%)\cite{14} and Yemen (KCN: 17.9% and suspect KCN: 10.4%)\cite{15} have reported a much higher prevalence and incidence, respectively. Ambrósio and Klyce have reported a combined prevalence of 0.9% for KCN, KCN suspects, and PMD in the United States.\cite{2} El-Sayed and Ali found an incidence of 1.7% for KCN and 2.1% for KCN suspects in Egypt.\cite{16} In our study, the combined prevalence of all KCN cases was 1.61%, with 0.86% for clinical KCN and 0.76% for KCN suspects. The prevalence in our study is less than the studies on refractive surgery patients from Saudi Arabia and Yemen. This may be because of the fact that the mean age of KCN patients is younger in India as reported by Saini et al. (20.2 ± 6.4 years)\cite{17} and Agrawal (20.1 ± 3.5 years),\cite{18} and therefore, many cases of KCN would have been diagnosed at an earlier age (<18 years) because of visual symptoms. Another possible explanation of higher prevalence in those countries compared to India could be the increased incidence of consanguineous marriage in the Middle East countries. The lesser prevalence in our study compared to previous Indian study can be explained by the fact that the previous study has used only keratometry >48 D as a criterion for KCN which might have led to an overdiagnosis of KCN.\cite{17} Furthermore, the age group is not similar to our study as they have included patients aged 30 years and above.

The mean age of KCN patients in our study was 24.62 ± 5.37 years. This was similar to the previous studies from India.\cite{17,18} There was no significant difference in age between the KCN and non-KCN cases. In our study, we found a female preponderance in the KCN cases with 63.83% of females. Previous studies have shown varied results with few reporting greater prevalence in females\cite{19} and few in males.\cite{9,20,21} Some studies have reported no gender predisposition.\cite{10,22} Studies from India also report male preponderance in some\cite{23,24} and female preponderance in others.\cite{17,18} The female preponderance in our study could be because of the small number of KCN patients.

### Conclusion

We found a KCN prevalence of 1.61% in refractive surgery population in western India. This prevalence is higher than that found in the western world and lower

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**Table 1: Annual and overall 5-year prevalence of keratoconus in patients presenting for refractive surgery**

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of new cases</th>
<th>Number of KCN suspect</th>
<th>Number of clinical KCN</th>
<th>Total number of new KCN patients (clinical and suspect)</th>
<th>Prevalence of KCN (clinical and suspect) in patients for refractive surgery (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014</td>
<td>746</td>
<td>4</td>
<td>5</td>
<td>9</td>
<td>1.20 (0.42-1.98)</td>
</tr>
<tr>
<td>2015</td>
<td>823</td>
<td>5</td>
<td>3</td>
<td>8</td>
<td>0.97 (0.3-1.64)</td>
</tr>
<tr>
<td>2016</td>
<td>413</td>
<td>4</td>
<td>6</td>
<td>10</td>
<td>2.42 (0.94-3.9)</td>
</tr>
<tr>
<td>2017</td>
<td>411</td>
<td>5</td>
<td>5</td>
<td>10</td>
<td>2.43 (0.94-3.94)</td>
</tr>
<tr>
<td>2018</td>
<td>509</td>
<td>4</td>
<td>6</td>
<td>10</td>
<td>1.96 (0.76-3.16)</td>
</tr>
<tr>
<td>Total</td>
<td>2902</td>
<td>22</td>
<td>25</td>
<td>47</td>
<td>1.61 (1.15-2.07)</td>
</tr>
</tbody>
</table>

KCN: Keratoconus, CI: Confidence interval

**Table 2: Age and gender distribution of nonkeratoconus cases and total keratoconus (clinical and suspect) cases**

<table>
<thead>
<tr>
<th>Year</th>
<th>Non-KCN cases (n=2855)</th>
<th>Age in years (mean±SD)</th>
<th>Males (%)</th>
<th>Females (%)</th>
<th>KCN cases (clinical and suspect) (n=47)</th>
<th>Age in years (mean±SD)</th>
<th>Males (%)</th>
<th>Females (%)</th>
<th>P for age</th>
<th>P for gender</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014</td>
<td></td>
<td>24.71±5.05</td>
<td>402 (54.55)</td>
<td>335 (45.45)</td>
<td>24.66±4.08</td>
<td>2 (22.22)</td>
<td>7 (77.78)</td>
<td>0.98</td>
<td>0.05</td>
<td></td>
</tr>
<tr>
<td>2015</td>
<td></td>
<td>24.83±4.99</td>
<td>461 (56.56)</td>
<td>354 (43.44)</td>
<td>28.25±5.39</td>
<td>2 (25)</td>
<td>5 (75)</td>
<td>0.05</td>
<td>0.07</td>
<td></td>
</tr>
<tr>
<td>2016</td>
<td></td>
<td>24.66±5.08</td>
<td>237 (58.81)</td>
<td>166 (41.19)</td>
<td>23.80±5.51</td>
<td>5 (50)</td>
<td>5 (50)</td>
<td>0.60</td>
<td>0.58</td>
<td></td>
</tr>
<tr>
<td>2017</td>
<td></td>
<td>24.14±4.50</td>
<td>229 (57.11)</td>
<td>172 (42.89)</td>
<td>23.20±3.54</td>
<td>5 (50)</td>
<td>5 (50)</td>
<td>0.51</td>
<td>0.65</td>
<td></td>
</tr>
<tr>
<td>2018</td>
<td></td>
<td>24.40±4.68</td>
<td>291 (58.32)</td>
<td>208 (41.68)</td>
<td>23.90±6.36</td>
<td>3 (30)</td>
<td>7 (70)</td>
<td>0.74</td>
<td>0.07</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>24.60±4.91</td>
<td>1620 (56.74)</td>
<td>1235 (43.26)</td>
<td>24.62±5.37</td>
<td>17 (36.17)</td>
<td>30 (63.83)</td>
<td>0.98</td>
<td>0.004</td>
<td></td>
</tr>
</tbody>
</table>
than that found in the countries in the Middle East (Saudi Arabia and Iran). Furthermore, topographic examination performed during the routine screening of patients for refractive surgery can be a useful tool to diagnose new cases of KCN in asymptomatic patients. Further studies with a larger sample size can be done in the future.

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Nil.

Conflicts of interest
There are no conflicts of interest.

References