Keratoconus detected by corneal topography in patients seeking refractive surgery in Jazan region, Saudi Arabia: A retrospective cross-sectional study

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ABSTRACT

Background: Keratoconus is a non-inflammatory, chronic, idiopathic, corneal disease characterized by thinning of the core or paracentral part of the cornea. In this study, we demonstrate the prevalence of keratoconus among patients seeking refractive surgery using laser vision correction (LVC) at the Department of Ophthalmology, Private Eye Center, Jazan, Saudi Arabia.

Materials and methods: A retrospective cross-sectional study was undertaken with the data from January 1, 2019 to December 31, 2019 in the ophthalmology department of Jazan city. This study included 1068 eyes of 534 patients of which 56.8% were men. The mean patient age was 28.5 (SD = 8.3) years. The analyst performed chi-square tests for the report. Prevalence was calculated at a 95% confidence interval at specified times in the year (CI).

Results: The prevalence of manifest unilateral keratoconus was 3% and that of bilateral keratoconus was 18.72%; on the other hand prevalence rates of suspected unilateral KC was 16.48% and of bilateral KC 9.36%. Significant differences between eyes were noted and recorded.

Conclusion: The occurrence and spread of this condition are on the rise in the city of Jazan and on the outskirts. Terminology: eyelid disorder (keratoconus), prevalence, risk factors, treatment of the disorder (vision).

1. Introduction

Keratoconus is an idiopathic chronic non-inflammatory corneal disease that presents with degeneration of the eye structure within the cornea, thereby shrinking and thinning of the eyeball [1–4]. Normally, the disorder begins at a tender age and may last longer, extending to 40 years of age. Variations in geography, race, concurrent disorders, and infections, such as atopy, fever, and asthma, among others, are contributing factors to the onset of keratoconus. Incidentally, poor research methods in different medical facilities and poor diagnosis and treatment methods perpetuate its prevalence and spread. Such cases explain the tendency to infect [2,3,5,6]. Research on the keratoconus disorder and its prevalence is challenging because of the geographical distribution of patients and their differences limiting the scope of their studies. However, reports state that geographical areas predisposed to warm climates, such as the Middle East and great Asia, recorded relatively large numbers of infections compared to countries experiencing cold climates, such as the United States, the United Kingdom, and Russia [7,8]. Genetic predisposition could also contribute to its occurrence, especially in ethnic groups with a designated way of life, as was found in a certain Asian province. Significant data on the higher rate of infections in this Asian province indicate the need for research on keratoconus

Abbreviations: N, number; Sd, standard deviation; KC, keratoconus; OD, oculus dexter (right eye); OS, oculus sinister (left eye); K ma, kc max (the maximum keratometric power); Thin, thinnest location; Is A, asymmetry; Ante, anterior elevation map; Post, posterior elevation map; Thick, the thickness location; K d, Kc diagram; BAD, Belin-Ambrosio Enhanced ectasia Display.

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diagnosis and infection in the Middle East population [7]. Additionally, there is an urge to evaluate the occurrence and spread rate in locations with a growing number of patients seeking laser vision correction (LVC), as this might provide ophthalmologists with a means of finding cases of keratoconus while screening patients for LVC. The current study investigated the patients of keratoconus in Saudi Arabia who sought LVC services in the refractive surgery centers (1078/1374). Notably, approximately 38.9% of eyes showed an average of 1.50 D astigmatism. The diagnosis process applied a pentagram to measure anterior and posterior tachymetric distribution and keratometry data in human eyes. D values were determined by analyzing the regression versus the standard count of normal and infected individuals. The (BAD) software packages. The chi-square test was used to compute the presence of keratoconus for those seeking LVC services. Frequency and prevalence data were obtained: age, sex, corneal thickness the maximum kerato metric power thinnest location, anterior elevation map, posterior elevation map, KC diagram, to evaluate the keratocouns status, subclinical or manifest, and unilateral or bilateral. Demography was computed according to the patient age, sex, and laterality. After data collection, manual verification was performed, and then the entry into an Excel spreadsheet was analyzed statistically using social science packages. The chi-square test was used to compute the presence of keratoconus for those seeking LVC services. Frequency and prevalence data are presented as percentages (%). Statistical significance was set at p-value ≤ 0.05. The research findings met the guideline of STROCS [17] and was registered with Research Registry (UIN) 7511 [18]. The research method adhered to declaration of Helsinki and provisions in the Scientific Research Ethics Committee reference code (REC 42/1/118) by Jazan University.

3. Result

We included 534 patients at the Department of Ophthalmology in a private hospital (Magrabi Eye center) in Jazan. A total of 1068 eyes of 534 patients who underwent complete ophthalmic examination, which include visual acuity, refraction, pachometry, keratometry, slit lamp bio microscopy and fundus examination as well as pentacam (Oculus Optikgeraete GmbH Wetzlar Germany using the belin-Ambrosio enhanced ectasia (BAD) in the period January 1, 2019 to December 31, 2019 were included. The following data were obtained: age, sex, corneal thickness the maximum kerato metric power thinnest location, anterior elevation map, posterior elevation map, KC diagram, to evaluate the keratoconus status, subclinical or manifest, and unilateral or bilateral. Demography was computed according to the patient age, sex, and laterality. After data collection, manual verification was performed, and then the entry into an Excel spreadsheet was analyzed statistically using social science packages. The chi-square test was used to compute the presence of keratoconus for those seeking LVC services. Frequency and prevalence data are presented as percentages (%). Statistical significance was set at p-value ≤ 0.05. The research findings met the guideline of STROCS [17] and was registered with Research Registry (UIN) 7511 [18]. The research method adhered to declaration of Helsinki and provisions in the Scientific Research Ethics Committee reference code (REC 42/1/118) by Jazan University.

### Table 1

Prevalence of keratoconus.

| Variable            | N (%)/mean (sd)* |
|---------------------|------------------|
| Gender              |                  |
| Male                | (56.9%)304       |
| Female              | (43.1%)230       |
| Total               | (100%)534        |
| Age                 | (8.3)28.6        |
| Diagnosis           |                  |
| Normal              | (52.4%)280       |
| Suspect unilateral  | (16.4%)88        |
| Bilateral           | (9.36%)50        |
| Manifest unilateral | (3%)16           |
| Bilateral           | (18.7%)1100      |
| Total               | (100%)534        |

### Table 2

Prevalence of keratoconus according to age and gender.

| Variable | normal | Suspect (KC) | Manifest (KC) | p.value |
|----------|--------|--------------|---------------|---------|
| Age      |        |              |               |         |
| 20 y or less |       |              |               | 0.265   |
| Male     | 20     | 10           | 13            |         |
| female   | 12     | 8            | 3             |         |
| 21-25 y  |        |              |               | 0.081   |
| Male     | 70     | 16           | 16            |         |
| female   | 36     | 18           | 6             |         |
| 26-30 y  |        |              |               | 0.209   |
| Male     | 41     | 19           | 26            |         |
| female   | 21     | 16           | 9             |         |
| 31-35 y  |        |              |               | 0.052   |
| Male     | 17     | 6            | 12            |         |
| female   | 25     | 17           | 7             |         |
| 36-40 y  |        |              |               | 0.243   |
| Male     | 9      | 8            | 7             |         |
| female   | 13     | 5            | 3             |         |
| 41-45 y  |        |              |               | 0.117   |
| Male     | 5      | 1            | 6             |         |
| female   | 5      | 5            | 4             |         |
| 46-50 y  |        |              |               | 0.683   |
| Male     | 1      | 2            | 1             |         |
| female   | 2      | 4            | 6             |         |
| 51 y or more |      |              |               | 0.091   |
| Male     | 0      | 1            | 2             |         |
| female   | 2      | 3            | 5             |         |
| Total    |        |              |               | 0.001   |
| Male     | 164    | 62           | 78            |         |
| Female   | 116    | 76           | 38            |         |

This retrospective case study was conducted in a city in Saudi Arabia. The study included all patients who underwent pre-examination for vision correction at the Department of Ophthalmology in a private hospital in Jazan. A total of 1068 eyes of 534 patients who underwent complete ophthalmic examination, which include visual acuity, refraction, pachometry, keratometry, slit lamp bio microscopy and fundus examination as well as pentacam (Oculus Optikgeraete GmbH Wetzlar Germany using the belin-Ambrosio enhanced ectasia (BAD) in the period January 1, 2019 to December 31, 2019 were included. The following data were obtained: age, sex, corneal thickness the maximum kerato metric power thinnest location, anterior elevation map, posterior elevation map, KC diagram, to evaluate the keratoconus status, subclinical or manifest, and unilateral or bilateral. Demography was computed according to the patient age, sex, and laterality. After data collection, manual verification was performed, and then the entry into an Excel spreadsheet was analyzed statistically using social science packages. The chi-square test was used to compute the presence of keratoconus for those seeking LVC services. Frequency and prevalence data are presented as percentages (%). Statistical significance was set at p-value ≤ 0.05. The research findings met the guideline of STROCS [17] and was registered with Research Registry (UIN) 7511 [18]. The research method adhered to declaration of Helsinki and provisions in the Scientific Research Ethics Committee reference code (REC 42/1/118) by Jazan University.

2. Materials & methods

This retrospective case study was conducted in a city in Saudi Arabia.
rate of manifest and suspect keratoconus (P.value = 0.001).

There were no statistically significant associations between the different age groups and prevalence of keratoconus (Table 2, Fig. 2).

There were significant differences in the right eye or left eye in the following variables: k max, thinnest location, asymmetry, anterior elevation map, posterior elevation map, and Kc diagram among normal and suspect keratoconus and manifest keratoconus (P.value < 0.001), and thickness map elevation (P.value = 0.021) (Table 3).

Logistic regression age significantly affected the diagnosis of keratoconus or subclinical keratoconus (suspect) in both eyes; nevertheless, sex was not associated with diagnosis (Table 4).

Logistic regression analysis revealed that age, K max, thinnest location, asymmetry, thickness, and KC diagram in the right eye significantly affected the likelihood that the participants had keratoconus or subclinical keratoconus (suspect) in the left eye. In addition, asymmetry, thickness, and KC diagrams in the left eye were found to significantly affect the likelihood that participants had keratoconus or subclinical keratoconus (suspect) in the right eye (Tables 5–7).

5. Strengths and limitations

To the best of our knowledge, few studies have analyzed suspected cases, especially in adults. In addition, our cohort was relatively large, sex was well-balanced, and age was normally distributed. However, the retrospective cross-sectional design of our study is a limitation. The patients were from one private hospital in Jazan City; therefore, they may not be representative of the entire population. The use of a clinical sample rather than a population-based sample introduced an additional constraint on the validity of our results.

6. Conclusions

We report a high prevalence of keratoconus: 3% manifest unilateral KC, 18.72% manifest bilateral KC, 16.48% suspected unilateral KC, and 9.36% suspected bilateral KC. Therefore, we recommend using social media websites, malls, and television to raise awareness about keratoconus. In addition, we recommend screening programs to detect keratoconus early to avoid complications. In addition, future studies that include a larger number of hospitals to estimate the prevalence of keratoconus in the Jazan region are warranted.

Provenance and peer review

Not commissioned, externally peer-reviewed.

Author contributions

Study concept: Mohammed W. Bosaily, Aisha A. Majrashi, Wassem Zakri, and Asma Abdulazim. Design: Mohammed O. Shami, Mohammed W. Bosaily, Majd H. Moafa, and Wassem Zakri. Data collection: Ahmed A. Ageeli, Mohammed O. Shami, Shahad K. Shabaan, and Walid Barakat. Data analysis: I. Abuallut, Ahmed A. Ageeli, Majd H. Moafa, and Walid Barakat. Writing: Ismail I. Abuallut, Aisha A. Majrashi, Shahad K. Shabaan, and A. Abdulazim.

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Submission declaration and verification

All the authors confirm that this manuscript has not been previously published and is not currently under consideration by any other journal. Additionally, all authors have approved the contents of this paper and have agreed to the journal submission policies.
Table 3
Topographic data of normal group compared to suspect or manifest KC group.

| Variable | normal | Suspect (KC) | (KC) manifest | P.value |
|----------|--------|--------------|---------------|---------|
| K ma (OD) |        |              |               | <0.001  |
| Normal   | 253    | 105          | 43            |         |
| Suspected | 16     | 33           | 29            |         |
| Manifest  | 1      | 0            | 44            |         |
| Thin (OD) |        |              |               | <0.001  |
| Normal   | 253    | 98           | 29            |         |
| Suspected | 26     | 33           | 32            |         |
| Manifest  | 1      | 7            | 55            |         |
| IS A (OD) |        |              |               | <0.001  |
| Normal   | 265    | 111          | 42            |         |
| Manifest  | 15     | 27           | 74            |         |
| Ante (OD) |        |              |               | <0.001  |
| Normal   | 260    | 110          | 50            |         |
| Manifest  | 20     | 28           | 66            |         |
| Post (OD) |        |              |               | <0.001  |
| Normal   | 268    | 113          | 56            |         |
| Manifest  | 12     | 25           | 60            |         |
| Thick (OD) |        |              |               | 0.021   |
| Normal   | 60     | 23           | 36            |         |
| Suspected | 220    | 115          | 80            |         |
| Kc d (OD) |        |              |               | <0.001  |
| Normal   | 277    | 70           | 6             |         |
| Suspected | 3      | 68           | 13            |         |
| manifast | 0      | 0            | 97            |         |
| K ma (OS) |        |              |               | <0.001  |
| Normal   | 268    | 114          | 42            |         |
| Suspected | 11     | 24           | 29            |         |
| manifest  | 1      | 0            | 45            |         |
| Thin (OS) |        |              |               | <0.001  |
| Normal   | 255    | 102          | 36            |         |
| Suspected | 23     | 31           | 19            |         |
| manifest  | 2      | 5            | 61            |         |
| IS A (OS) |        |              |               | <0.001  |
| Normal   | 255    | 121          | 47            |         |
| manifast | 25     | 17           | 69            |         |
| Ante (OS) |        |              |               | <0.001  |
| Normal   | 260    | 121          | 58            |         |
| manifast | 20     | 17           | 58            |         |
| Post (OS) |        |              |               | <0.001  |
| Normal   | 262    | 125          | 63            |         |
| manifast | 18     | 13           | 53            |         |
| Thick (OS) |        |              |               | 0.012   |
| Normal   | 134    | 45           | 52            |         |
| Suspected | 146    | 93           | 64            |         |
| Kc d (OS) |        |              |               | <0.001  |
| Normal   | 280    | 45           | 13            |         |
| Suspected | 0      | 92           | 11            |         |
| manifest  | 0      | 1            | 92            |         |

KC = keratoconus, OD = oculus dexter (right eye), OS = oculus sinister (left eye), K ma = kc max (the maximum keratometric power), Thin = thinnest location, IS A = asymmetry, Ante = anterior elevation map, Post = posterior elevation map, Thick = the thickness location, K d = Kc diagram.

Table 4
Logistic regression of total diagnosis in both eyes.

|         | B     | S.E.  | Wald  | df | Sig.  | Exp(B) | 95% C.I.for EXP(B) |
|---------|-------|-------|-------|----|-------|--------|--------------------|
|         |       |       |       |    |       |        |                   |
|         | Lowe  | Upper |       |    |       |        |                   |
| Age     | 0.033 | 0.011 | 8.967 | 1  | 0.003 | 1.034  | 1.012  1.057      |
| gender  | -0.036| 0.180 | 0.041 | 1  | 0.84  | 0.964  | 0.678  1.371      |

a Variable(s) entered on step 1: Age and gender.
Informed consent statement
Waived since it’s retrospective data.

Data availability statement
The datasets generated and analyzed during the current study are available from the corresponding author upon reasonable request.

Declaration of competing interest
The authors declare that there is no conflict of interests.

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Table 5
Logistic regression of diagnosis of left eye according to variables or right eye.

| Variable(s) entered on step 1: | B | S.E. | Wald | df | Sig. | Exp(B) | 95% C.I.for EXP(B) |
|--------------------------------|---|-----|------|----|------|---------|-------------------|
| Age                           | -0.001 | 0.015 | 0.004 | 1 | 0.948 | 0.999 | 0.970 | 1.029 |
| K max (OD)                    | -0.023 | 0.01 | 5.514 | 1 | 0.019 | 0.977 | 0.959 | 0.996 |
| Thin (OD)                     | -0.02 | 0.004 | 21.435 | 1 | 0.000 | 0.980 | 0.971 | 0.988 |
| IS (OD)                       | -0.472 | 0.126 | 13.893 | 1 | 0.000 | 0.623 | 0.487 | 0.799 |
| Ante (OD)                     | 0.061 | 0.044 | 1.893 | 1 | 0.169 | 1.063 | 0.974 | 1.160 |
| Post (OD)                     | 0.017 | 0.023 | 0.518 | 1 | 0.472 | 1.017 | 0.972 | 1.064 |
| Thick (OD)                    | -0.01 | 0.005 | 4.915 | 1 | 0.027 | 0.990 | 0.981 | 0.999 |
| KC d (OD)                     | 1.304 | 0.203 | 41.423 | 1 | 0.000 | 3.683 | 2.476 | 5.479 |

Table 6
Logistic regression of diagnosis of right eye according to variables of left eye.

| Variable(s) entered on step 1: | B | S.E. | Wald | df | Sig. | Exp(B) | 95% C.I.for EXP(B) |
|--------------------------------|---|-----|------|----|------|---------|-------------------|
| Age                           | 0.029 | 0.015 | 3.799 | 1 | 0.051 | 1.029 | 1 | 1.060 |
| K max (OS)                    | 0.068 | 0.080 | 0.723 | 1 | 0.395 | 1.070 | 0.915 | 1.253 |
| Thin (OS)                     | 0.000 | 0.004 | 0.001 | 1 | 0.972 | 1 | 0.993 | 1.007 |
| IS (OS)                       | 0.354 | 0.172 | 4.240 | 1 | 0.039 | 1.424 | 1.017 | 1.995 |
| Ante (OS)                     | 0.055 | 0.045 | 1.522 | 1 | 0.217 | 1.057 | 0.968 | 1.154 |
| Post (OS)                     | -0.002 | 0.008 | 0.068 | 1 | 0.794 | 0.998 | 0.981 | 1.014 |
| Thick (OS)                    | -0.010 | 0.005 | 3.725 | 1 | 0.054 | 0.991 | 0.981 | 1 |
| KC d (OS)                     | 1.751 | 0.252 | 48.157 | 1 | 0.000 | 5.761 | 3.513 | 9.447 |

Prevalence rate of keratoconus in previous studies worldwide.

| Study | Data collection period | Country | Study type | Sample size | Prevalence rate of KC |
|-------|------------------------|---------|------------|-------------|-----------------------|
| Netto et al. [8] | 2017 | Saudi Arabia | Hospital based | 219 | 303 | 4.79% |
| Caputo et al. [9] | 2012–2013 | Italy | Hospital based | 754 | 397 | 0.77% |
| Totan et al. [10] | 1998–1999 | Turkey | Hospital based | 62 | 20 | 26.2% |
| Dantas et al. [11] | 2000 | Brazil | Hospital based | 118 | 55 | 22.53% |
| Ahmed et al. [12] | 2017–2018 | Egypt | Hospital based | 66 | 34 | 7% |
| Feng et al. [13] | 2013–2018 | China | Hospital based | 40 | 131 | 73% |
| Sidky et al. [14] | 2017 | Egypt | Hospital based | 265 | 282 | 4.8% |
| Omar et al. [15] | 2015–2018 | Egypt | Hospital based | 47 | 40 | 9.2% |
| Mugho et al. [16] | 2016 | Kenya | Hospital based | 63 | 60 | 30.89% |

Appendix A. Supplementary data
Supplementary data related to this article can be found at https://doi.org/10.1016/j.amsu.2022.103890.

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