

The Development of Criteria for Identifying Keratoconus Risk Group During the Initial Ophthalmic Examination

Milana Solomatina¹, Guna Laganovska², Jana Gertnere³

Affiliation: ¹Riga Stradiņš University, Faculty of Medicine, Latvia,

²Pauls Stradiņš University hospital, Department of Ophthalmology, Latvia,

³Dr. Solomatin Eye Center, Latvia

E-mail: milanasolo@gmail.com

Summary

Introduction. There has been an increase in the number of patients diagnosed with keratoconus in Latvia in recent years. This disease must be timely diagnosed and managed to prevent some severe complications that may require a corneal transplantation.

Aim of the study. The objective of the research was to understand if it's possible to develop specific criteria, by using data from anamnesis and measurements provided by autorefractor, that would help to identify a risk group which requires more specific and detailed examination.

Methods. A retrospective case-control and analytical study included 100 patients with keratoconus diagnosis and a control group of 100 patients who had myopia. Data about autorefractometer measurements and accompanying conditions were obtained from the outpatient medical records. Calculations were performed using Excel. Data were analysed using IBM SPSS 29.0.0.0

Results. The study revealed a statistically significant difference in astigmatism ($p < 0.001$), mean keratometry ($p < 0.001$), and delta keratometry ($p < 0.001$) distribution between the keratoconus and control groups. Study did not show statistically significant association between keratoconus and endocrinological diseases (Fisher's exact test, $p = 0.065$), keratoconus and dermatological diseases, Chi-square test, $\chi^2(1, N = 200) = 1.418$, $p = 0.234$), keratoconus and asthma $\chi^2(1, N = 200) = 3.191$, $p = 0.074$), keratoconus and allergy $\chi^2(1, N = 200) = 2.098$, $p = 0.147$).

Conclusion. Astigmatism, delta keratometry and mean keratometry values appeared to be a statistically significant, so these parameters may serve as diagnostic criteria. Accompanying conditions didn't show statistically significant association with keratoconus.

Keywords. Keratoconus, astigmatism, mean keratometry, delta keratometry, allergy, asthma, dermatitis.

Introduction

There has been an increase in the number of patients diagnosed with keratoconus in Latvia in recent years. Keratoconus – a pathology from the list of rare diseases – must be timely diagnosed in order to prevent further progression which sometimes may end up with a keratoplasty. The objective of this research was to understand if it is possible to develop specific criteria by using data from analysis and measurements provided by autorefractometer, for example during the mandatory health check, that would help to identify a keratoconus risk group, which further requires more specific and detailed examination.

Keratoconus is an uncommon corneal disorder where the central or paracentral cornea

undergoes progressive thinning and steepening causing irregular astigmatism, and the cornea acquires conic shape which also gives the name for this pathology (Asbell et al., 2023). Risk factors include systemic diseases, familial, eye rubbing, and other environmental factors. The risk is higher if there is a family history of keratoconus. Among the environmental risk factors eye-rubbing should be highlighted as one of the main factors. Some other important risk factors are eczema, asthma, and allergy (Armia et al., 2022). An attempt to find a statistically significant association between keratoconus and these conditions has become a part of the study.

There are also some early signs of keratoconus which can be noticed even without special equipment, for example, keratometry showing high and irregular astigmatism, (the axis that does not add to 180°), asymmetric refractive error with high or progressive astigmatism (1). In early disease, the condition may go undiagnosed unless assessments of the posterior and anterior corneal surface are undertaken using corneal tomography, and, also, topography to visualize corneal surface (Mas Tur et al., 2017).

Aim of the study: to understand if it is possible to create some criteria for identifying the keratoconus risk group during the initial ophthalmic examination, even in the absence of specific technical equipment used for keratoconus screening.

Materials and methods

This is a retrospective case-control, analytical study that included 100 patients with keratoconus (76 men and 24 women (male to female ratio 3.17:1), mean age of patients was 34 ± 10.5 years) and a control group of 100 patients who had myopia (the group consisted of 63 men and 37 women (male to female ratio 1.7:1) mean age 31 ± 6.4). Data about autorefractometer measurements and accompanying conditions were obtained from the outpatient medical records in the eye clinic "Acu rehabilitācijas un redzes korekcijas centrs". Calculations for delta keratometry and mean keratometry were performed using Excel, comparison of autorefractometer measurements of patients from both groups was made using the Mann-Whitney U Test. Chi-square or Fisher's test was used to find out if there is an association between keratoconus and accompanying conditions. All statistical analyses were performed using IBM SPSS 29.0.0.0.

Results

Result No.1 shows us the difference in mean keratometry between right and left eyes (Figure 1).

In the keratoconus patient group, values are in the interquartile range from 0.7 to 4.22 mm and the difference in mean keratometry between right eye (OD) and left eye (OS) is quite significant. The median is 1.63mm. The boxplots show that there is quite a small difference in mean keratometry between OD and OS in the control group, and the values are mostly in the interquartile range from 0.1 to 0.3 mm. The median is 0.2mm.

The distribution of difference in Km between OD and OS ($p < 0.001$) between the keratoconus and control groups appeared to be statistically significant.

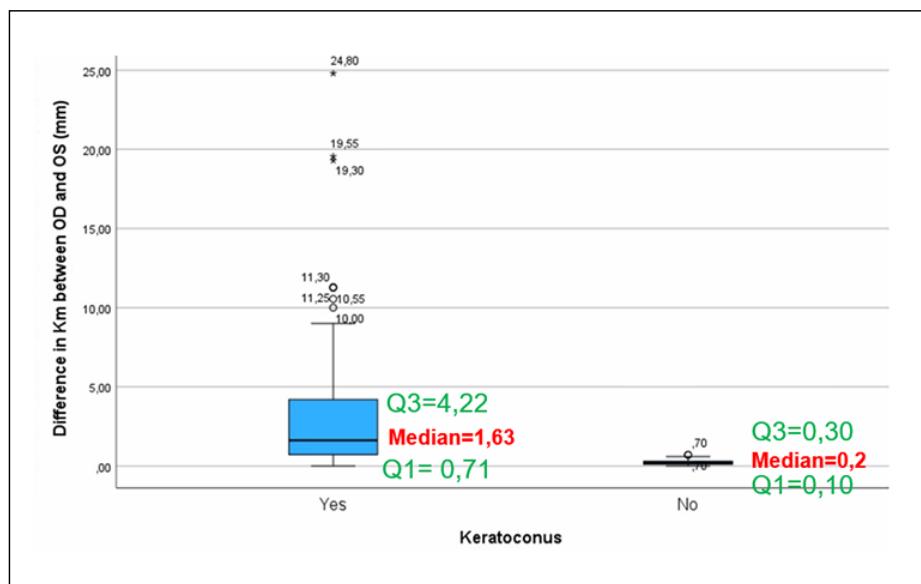


Figure 1.

Result No. 2 shows the distribution of mean keratometry (Figure 2). The interquartile range of values in the keratoconus group is 43.66–47.16 mm, with a median of 45.1 mm. The interquartile range of values of the control group is 42.23–44.48 mm, with a median of 43.30 mm.

The study revealed a statistically significant difference in the mean keratometry distribution between the keratoconus and control groups ($p < 0.001$).

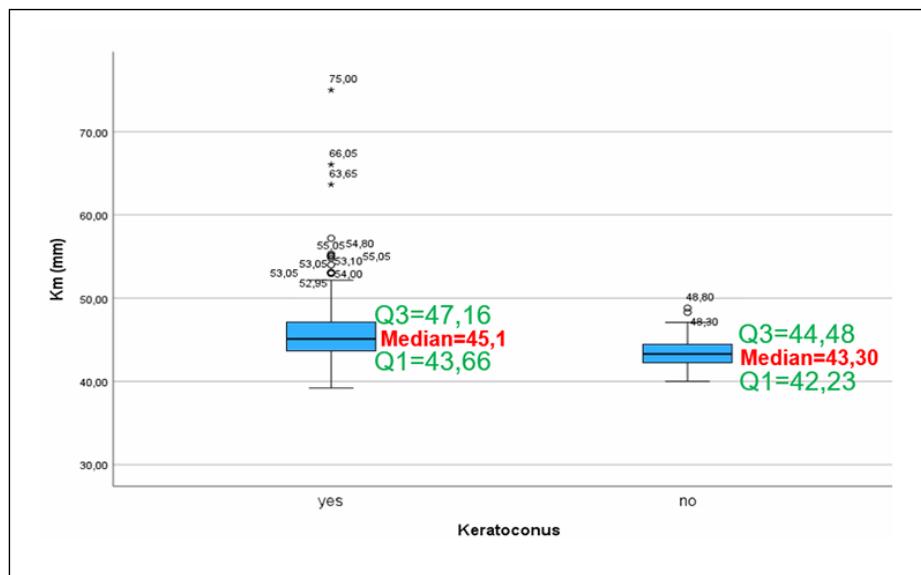


Figure 2.

Result No. 3 shows the distribution of astigmatism in both groups of patients (Figure 3). Interquartile range varies from 1.1 to 3.6 D in the keratoconus group and from 0.6 to 1.3 D in the control group. The study revealed a statistically significant difference in the distribution of astigmatism between the keratoconus group and the control group ($p < 0.001$).

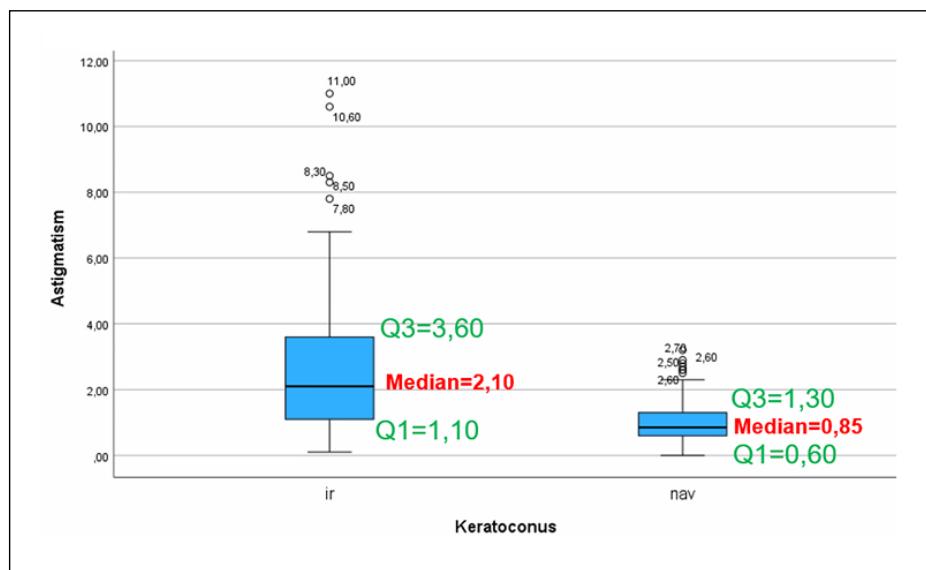


Figure 3.

Result No. 4 (Table 1). Finding if there is a statistically significant association between keratoconus and some accompanying conditions that are present in the patient's anamnesis also was a part of the study. During the research there hasn't been found any statistically significant association between keratoconus and endocrinological diseases (Fisher's exact test, $p=0.065$), keratoconus and dermatological diseases, Chi-square test, $\chi^2(1, N=200)=1.418$, $p=0.234$), keratoconus and asthma $\chi^2(1, N=200)=3.191$, $p=0.074$), keratoconus and allergy $\chi^2(1, N=200)=2.098$, $p=0.147$). Even though the table shows that the number of cases of allergy, asthma, and endocrinological diseases in the keratoconus group is bigger than in controls.

Table 1.

Accompanying conditions	Number of cases	Number of controls	p value*
Endocrinological diseases	7	1	0.065
Dermatological diseases	4	8	0.234
Asthma	9	3	3.191
Allergy	17	10	0.147

Discussion

The study was made to understand, which parameters may become specific criteria for suspecting keratoconus pathology. These criteria are intended for use in optics and during mandatory health checks, where usually a corneal topographer is absent, and where the only technical tools available are a slit lamp and an autorefractometer.

The difference in the distribution of the values of astigmatism and mean keratometry, in both groups appeared to be impressive, so these parameters may be helpful during the diagnostic process. One parameter that should be calculated manually, and is not commonly used, is a difference in mean keratometry between OD and OS. It may become a supportive factor, which proves the asymmetry of the disease course in each eye. Compared to the control group, the results appeared to be statistically significant. Asymmetry in visual acuity between both eyes is a common feature of keratoconus. Unfortunately, values of dioptres provided by autorefractometer may be inaccurate when there is a severe stage of the disease, making the subjective assessment of vision necessary for diagnostics. The results of the statistical analysis, that were obtained

during the research, coincided with data from reference literature.

It is estimated that approximately one out of three patients with KC have an underlying atopic disorder, although the prevalence of atopy varies between 1.8 and 57 % amongst different studies (4). Some allergies and atopies may be included and evaluated in one study and ignored in others. The conflicting evidence in the published literature may be due to different definitions of atopy/allergy and a lack of standardized classification (Khor et al., 2011).

An absence of association between environmental factors and keratoconus could be also because some patients did not provide full information about themselves. Patients often forget to mention in the questionnaire that they have seasonal allergies, hay fever and atopic dermatitis, some forget that have suffered from asthma attacks (especially if they were in childhood). Patients usually deny having any chronic diseases unless they are asked about a specific one. Additionally, it was not clarified which dermatological and endocrinological pathologies patients had. The study evaluated a group of conditions that affected a specific organ/organ system.

There was no data about eye rubbing in outpatient records, but many international studies had previously found a strong association between eye rubbing and keratoconus development. One case-control study revealed that the rate of keratoconus patients, who were rubbing their eyes, reached 56.6 %, while among the controls only 22.9 % had that habit (Almusawi et al., 2021). One more study showed that the main rubbing characteristic leading to keratoconus in the eye rubbing population was high frequency rather than intensity or duration of rubbing (Debourdeau et al., 2022).

This study did not include some specific clinical features that might be pathognomonic for keratoconus. Some specific signs appear even in the early stages of the disease, for example, retinoscopy may show a "Scissor" reflex and a direct ophthalmoscopy – a fairly well-delineated "oil droplet" reflex (Santodomingo-Rubido et al., 2022). As the disease severity increases, Fleischer's ring, Vogt's striae, and breaks in Bowman's membrane (Figure 4). can be observed during the examination with a slit lamp (Santodomingo-Rubido et al., 2022). Hydrops and Munson's sign are common in severe stages of keratoconus. A nonspecific sign of keratoconus may be seen on the screen of the autorefractometer as asymmetric concentric rings (Figure 5). Such irregular rings appear when there are significant changes in the corneal curvature. They might also be present if there are other corneal pathologies or traumas but still should be considered.

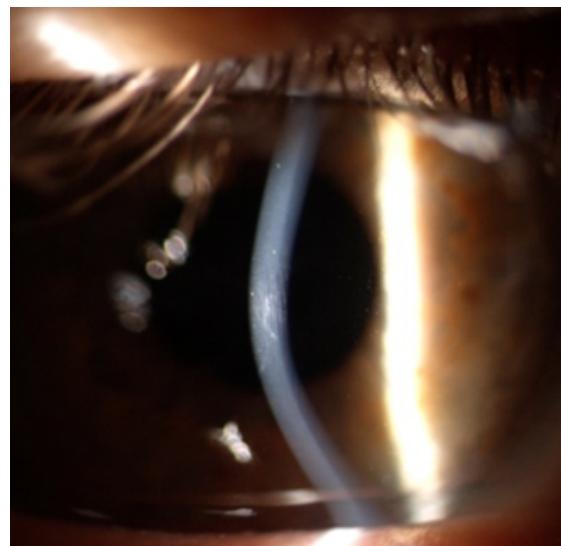


Figure 4. Keratoconus with stromal striae.
From Dr. Gertnere's archive.



Figure 5. Keratoconus signs on the screen of the autorefractometer.
From Dr. Gertnere's archive.

Conclusions

The difference in the distribution of astigmatism, mean keratometry and mean keratometry between OD and OS between the keratoconus group and the control group appeared to be a statistically significant, so these parameters may serve as diagnostic criteria. Accompanying conditions did not show statistically significant association with keratoconus due to a lack of information about all environmental risk factors patients may be exposed. One more possible reason for statistically insignificant results could be the insufficient sample size.

The suggestion would be to modify questionnaires for patients with suspected keratoconus. For example, questions about family history, some specific conditions (such as eye rubbing, allergy, asthma, etc.), and sleeping position should be added to get more precise information about the patient's health status. Data from anamnesis could help not only in diagnostics but also in further research about keratoconus risk factors and etiological mechanisms which are still not fully understood.

References

1. Asbell, P.A., Petratos, T. and Karakus, S., 2023. *Keratoconus*. American Academy of Ophthalmology. [online] Available at: <https://eyewiki.org/Keratoconus>
2. Armia, A. and Mazzotta, C., 2022. Keratoconus. In: *Current and Future State-of-the-Art*, pp. 23–53. [online] Available at: [doi: 10.1007/978-3-030-84506-3](https://doi.org/10.1007/978-3-030-84506-3)
3. Mas Tur, V., MacGregor, C., Jayaswal, R., O'Brart, D. and Maycock, N., 2017. A review of keratoconus: Diagnosis, pathophysiology, and genetics. *Survey of Ophthalmology*, [online] pp. 770–783. Available at: [doi: 10.1016/j.survophthal.2017.06.009](https://doi.org/10.1016/j.survophthal.2017.06.009)
4. Khor, W.B., Wei, R.H., Lim, L., Chan, C.M. and Tan, D.T., 2011. Keratoconus in Asians: demographics, clinical characteristics and visual function in a hospital-based population. *Clinical and Experimental Ophthalmology*, 39, pp. 299–307.
5. Owens, H. and Gamble, G., 2003. A profile of keratoconus in New Zealand. *Cornea*, 22, pp. 122–125. (Quoted in Armia, A. and Mazzotta, C., 2022. *Current and Future State-of-the-Art*, pp.23–53. Available at: [doi: 10.1007/978-3-030-84506-3](https://doi.org/10.1007/978-3-030-84506-3)
6. Almusawi, L.A. and Hamied, F.M., 2021. Risk Factors for Development of Keratoconus: A Matched Pair Case-Control Study. *Clinical Ophthalmology (Auckland, N.Z.)*, 15, pp. 3473–3479. [online] Available at: [doi: 10.2147/OPTH.S248724](https://doi.org/10.2147/OPTH.S248724) [Accessed 14 July 2025].
7. Debourdeau, E., Planells, G., Chamard, C., Touboul, D., Villain, M., Demoly, P., Babeau, F., Fournie, P. and Daien, V., 2022. New Keratoconus Risk Factors: A Cross-Sectional Case-Control Study. *Journal of Ophthalmology*, 2022, Article ID 6605771. [online] Available at: [doi: 10.1155/2022/6605771](https://doi.org/10.1155/2022/6605771)
8. Santodomingo-Rubido, J., Carracedo, G., Suzaki, A., Villa-Collar, C., Vincent, S.J. and Wolffsohn, J.S., 2022. Keratoconus: An updated review. *Contact Lens & Anterior Eye*, 45(3), Article 101559. [online] Available at: [doi: 10.1016/j.clae.2021.101559](https://doi.org/10.1016/j.clae.2021.101559)