Original Article
Cukurova Anestezi ve Cerrahi Bilimler Dergisi

Effects of Pterygium Surgery on Holladay Equivalent Keratometry Readings

Aynura Sariyeva Aydamirov [1], Berkay Kızıltaş [2], Ayna Sariyeva Ismayilov [3]

1 Alanya Alaaddin Keykubat University Training and Research Hospital, Department of Ophthalmology, Antalya, Türkiye
2 Health Sciences University, Adana City Training and Research Hospital, Department of Ophthalmology, Adana, Türkiye
3 Health Sciences University, Yüksek ihtisas Training and Research Hospital, Department of Ophthalmology, Bursa, Türkiye

Abstract

Aim: To investigate and compare the effects of pterygium surgery on the mean anterior surface Simulated Keratometry (SimK) and Holladay Equivalent Keratometry Readings-65 (EKR65) detail report.

Methods: For this prospective study, patients who underwent pterygium surgery between August 2022 and January 2023 were examined. All surgeries were performed under local anesthesia with conjunctival autograft method. Pentacam topography was performed after detailed ophthalmological examination before and 3 months after surgery. The mean anterior SimK, EKR65 report results in all zones, mean anterior corneal radius (rfront) and mean posterior corneal radius (rback) parameters were investigated preoperatively and at 3 months. In addition, postoperative change amounts (Δ) of SimK and EKR65 data were calculated.

Results: Twenty-four eyes of 24 patients were included in the study. The mean age of the patients was 51.50±9.48 (36-75) years. Mean anterior corneal surface SimK increased from 40.85±3.30 D, to 42.57±2.53 D at the postoperative 3rd month (p=0.003). Both rfront and rback values decreased significantly (8.30±0.66 mm vs. 7.95±0.49 mm, p=0.004, and 6.56±0.56 mm vs. 6.50±0.54 mm, p=0.001, respectively). A general increase in EKR65 report values was observed in the postoperative period. Increases in EKR65 values at 4.5, 5, 6 and 7 mm were significant (p<0.05 for all). Both ΔEKR65 at 2mm and ΔEKR65 at 3mm were found to correlate with ΔSimK (r=0.371, p=0.044 and r=0.347, p= 0.046, respectively).

Conclusions: Conventional keratometry calculations may be insufficient due to the irregularity of the cornea caused by pterygium surgery. For this purpose, the use of the results of the Holladay EKR65 detail report for irregular corneas can be considered.

Keywords: *Pterygium surgery, simulated keratometry, EKR65, corneal radius*

1. Introduction

In the Pentacam topography/tomography system with Scheimpflug camera technology, detailed and various analyzes of keratometry calculation are made. Simulated keratometry (SimK) and The Holladay Equivalent Keratometry Readings-65 (EKR65) detail report are some of them. For SimK measurement, the device calculates the anterior corneal radius and determines corneal power using the standard keratometric index (n=1.3375)[1,2]. As in other topography systems, posterior corneal curvature cannot be measured directly, and calculations are made by assuming a constant ratio of anterior and posterior curvature[1-3]. In the Holladay EKR65 detail report, posterior corneal curvature is also measured besides anterior corneal curvature[1,4,5]. It is argued that it gives more accurate results due to the change in the anterior/posterior curvature ratio in patients undergoing refractive surgery or other irregular corneas[2,3,6]. Pterygium occurs with the progression of the bulbar conjunctiva on to the cornea in the form of fibrovascular tissue[7,8]. It has been reported to cause significant changes in corneal shape and curvature[7-9]. The effects of corneal irregularity caused by pterygium and its surgery on curvature changes and keratometry calculations are a matter of curiosity. Therefore, in this study, it was aimed to examine and compare the effects of pterygium surgery on the SimK and EKR65 report. As far as we know, there is no study evaluating the effect of pterygium surgery on the results of the EKR65 report.

2. Materials and methods

For this prospective study, patients who underwent pterygium surgery between August 2022 and January 2023 were examined. Patients with nasal and primary pterygium were included. Patients

* *Corresponding Author: Aynura Sariyeva Aydamirov*
e-mail: aynuresariyeva91@gmail.com
Received: 31.07.2023, Accepted: 10.08.2023, Available Online Date: 31.08.2023, Cite this article as: Aydamirov SA, Kiziltas B, Ismayilov AS. Effects of Pterygium Surgery on Holladay Eqiuvalent Keratometry Readings. J Cukurova Anesth Surg. 2023; 6(1): 296-9. doi: 10.36516/jocass.1334962

with a previous history of ocular trauma or surgery, ocular infection or inflammation, corneal scarring, pseudopterygium, recurrent or temporal pterygium were excluded from the study. Pterygium are divided into 3 types according to their size. Small pterygium infiltrating the cornea less than 2 mm were classified as type 1, those infiltrating the cornea 2-4 mm were classified as type 2, and those infiltrating more than 4 mm were classified as type 3[10].This research adhered to the principles outlined in the Declaration of Helsinki and was approved by the local institutional ethics committee. Informed consent was obtained from each patient.

All surgeries were performed under local anesthesia with conjunctival autograft method. Pterygium borders marked. Subconjunctival lidocaine hydrochloride (1%) was applied for local anesthesia. The head of the pterygium was separated from the cornea by blunt dissection. Then, the pterygium body and subconjunctival fibrovascular tissue were excised. The dimensions of the exposed nasal sclera were measured. Upper conjunctival graft in required sizes was taken after local anesthesia. In the bare area, the graft was sutured to the conjunctiva approximately 1 mm behind the limbus. Absorbable interrupted 8.0 Vicryl (8-mm 0.5-c spatula double-armed violet braided; Ethicon) suture material was used for conjunctival sutures. In the postoperative period, drops containing a combination of 0.5% concentration of moxifloxacin and 0.1% concentration of dexamethasone to be used 5 times a day for 4 weeks were prescribed to all patients. In the postoperative period, follow-up was recommended for the patients on the 1st day, 1st week, 4th week, 3rd month and 6th month.

Pentacam topography was performed after detailed ophthalmological examination before and 3 months after surgery. The test was performed in a sitting position and in a dark room. Measurements were repeated until reproducible data were obtained. Only the measurements of patients who could meet the reliability parameter (Quality specification: Ok) were included.

The Holladay EKR 65 detail report divides the cornea into zones starting from the central 1 mm diameter up to 7 mm peripheral at 1 mm intervals. Total corneal power is calculated in all zones. The mean anterior SimK, EKR65 report results in all zones, mean anterior corneal radius (r_{front}) and mean posterior corneal radius (r_{back}) parameters were investigated preoperatively and at 3 months postoperatively. In addition, postoperative change amounts (Δ) of SimK and EKR65 data were calculated. The Δ value for the variables was found by subtracting the mean of the preoperative values from the mean of the postoperative values.

2.1 Statistical Analysis

Continuous variables were presented as mean±standard deviation. Data normality was confirmed using the Shapiro-Wilk test. Paired-sample t-test was used in dependent groups. The correlation between the variables was analyzed by Spearman analysis. SPSS (IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp.) software was used for statistical analysis and a p value of <0.05 was considered statistically significant.

3. Results

Twenty-four eyes of 24 patients were included in the study. The mean age of the patients was 51.50±9.48 (36-75) years. Type 2 pterygium was present in 10 patients and type 3 pterygium in 14 patients. The demographic data of the patients are summarized in Table 1. Mean anterior corneal surface SimK increased from 40.85±3.30, to 42.57±2.53 at the postoperative 3rd month (p=0.003). The mean radius of curvature values on both anterior and posterior corneal surfaces decreased significantly (8.30±0.66 vs. 7.95±0.49, p=0.004, and 6.56±0.56 vs. 6.50±0.54, p=0.001, respectively).

Table 1
Demographic characteristics of patients

	n=24
Age (years)	51.50±9.48 (36-75)
Sex (female/male)	9/15
Laterality (right/left)	12/12
Pterygium type	
Type 1	-
Type 2	10
Type 3	14
Preoperative SE (D)	0.65±1.74 (-2-(+3))
Postoperative SE (D)	0.55±1.11 (-2-(+3.5)
Preoperative BCVA (Snellen)	0.73±0.21 (0.4-1)
Postoperative BCVA (Snellen)	0.8±0.14 (0.6-1)
Preoperative CA-front (D)	3.23±2.41 (0.76-6.4)
Postoperative CA-front (D)	1.81±1.29 (0.2-4.3)
Preoperative CA-back (D)	0.48±0.74 (0-2.3)
Postoperative CA- back (D)	0.33±0.33 (0.1-1.1)

SE: Spherical equivalent, BCVA: Best corrected visual acuity, CA: Corneal astigmatism, D: Diopter

Table 2
Comparison of mean anterior SimK, mean rfront, mean rback and EKR65 values in the preoperative and postoperative period

	Preoperative (Mean ± SD)	Postoperative 3rd month (Mean ± SD)	p
Mean anterior SimK (D)	40.85±3.30	42.57±2.53	0.003
Mean rfront (mm)	8.30±0.66	7.95±0.49	0.004
Mean rback (mm)	6.56±0.56	6.50±0.54	0.001
EKR65 at 1 mm (D)	42.26±3.31	42.24±2.39	0.951
EKR65 at 2 mm (D)	42.47±2.40	42.59±1.89	0.445
EKR65 at 3 mm (D)	42.64±2.11	42.84±1.90	0.066
EKR65 at 4 mm (D)	42.86±2.21	43.00±2.10	0.119
EKR65 at 4.5 mm (D)	42.86±2.23	43.06±2.12	0.036
EKR65 at 5 mm (D)	42.52±1.90	43.13±2.14	0.022
EKR65 at 6 mm (D)	43.10±2.10	43.26±2.17	0.006
EKR65 at 7 mm (D)	43.22±2.14	43.51±1.99	<0.001

*Paired samples t-test, p < 0.05 statistically significant. Results are denoted as mean ± standard deviation (SD). SimK: Simulated keratometry, rfront: radius of curvature at the front corneal surface, rback: radius of curvature at the back corneal surface, EKR: Equivalent keratometry reading

A general increase in EKR65 report values was observed in the postoperative period. Increases in EKR65 values at 4.5, 5, 6 and 7 mm were significant (p<0.05 for all) (Table 2).

The postoperative mean changes in SimK and EKR65 data are given in Table 3. ΔSimK and ΔEKR65 values were positive, denoting a postoperative mean increase in SimK and EKR65 values.

Both ΔEKR65 at 2mm and ΔEKR65 at 3mm were found to correlate with ΔSimK (r=0.371, p=0.044 and r=0.347, p= 0.046, respectively) (Table 4).

Table 3
Mean differences in SimK and EKR65 values

ΔSimK (D)	1.47±1.92 (-2-5.7)
ΔEKR65 at 1 mm (D)	0.30±1.54 (-2.56-2.74)
ΔEKR65 at 2 mm (D)	0.12±0.75 (-0.95-1.25)
ΔEKR65 at 3 mm (D)	0.20±0.50 (-0.43-1.18
ΔEKR65 at 4.5 mm (D)	0.20±0.45 (-0.73-0.73)
ΔEKR65 at 5 mm (D)	0.61±1.23 (-0.59-3.64)
ΔEKR65 at 6 mm (D)	0.16±0.26 (-0.17-0.59)
ΔEKR65 at 7 mm (D)	0.31±0.33 (-0.10-0.96)

Δ: Mean differences (Mean of the postoperative values- mean of the preoperative values), SimK: Simulated keratometry, EKR: Equivalent keratometry reading. Results are denoted as mean ± standard deviation.

Table 4
Correlation analysis results of ΔSimK and ΔEKR65 values

	ΔSimK
ΔEKR65 at 1 mm	r=0.218 p=0.306
ΔEKR65 at 2 mm	r=0.371 p=0.044
ΔEKR65 at 3 mm	r=0.347 p=0.046
ΔEKR65 at 4 mm	r=-0.024 p=0.912
ΔEKR65 at 4.5 mm	r=0.205 p=0.337
ΔEKR at 5mm	r=0.048 p=0.824
ΔEKR65 at 6 mm	r=-0.048 p=0.824
ΔEKR65 at 7 mm	r=0.084 p=0.697

Spearman Correlation Analysis, the cells contain the correlation coefficient and the corresponding P-value. Δ: Mean differences (Mean of the postoperative values- mean of the preoperative values), SimK: Simulated keratometry, EKR: Equivalent keratometry reading.

4. Discussion

In conventional topographic SimK, the central 3 mm of the cornea is used, it is assumed that there is a constant ratio between the anterior and posterior radius and the cornea consists of a single refractive surface[4, 5]. In the Holladay EKR65 report, posterior corneal curvature is also measured and the effect of the posterior cornea is taken into account[4, 5]. In this report, the cornea is divided into zones from central 1mm to 7mm. 65% of the mean of the keratometry values in each examined zone is calculated. For irregular corneas such as postrefactive, postkeratoplasty, and scarred corneas, this report makes it possible to obtain a mean K value from a larger surface[6, 11]. In addition, another advantage of EKR65 data is that it can be used directly in biometric measurements[4]. In the literature, it has been reported that EKR65 at 4.5 mm gives more accurate refractive results in cataract surgery than conventional SimK in eyes undergoing refractive surgery[2, 3]. Accurate measurement of keratometry is very important for optimum refractive results after cataract surgery. Considering that pterygium patients are generally elderly and have accompanying cataracts, accurate measurement of keratometry becomes very important in cataract surgery after pterygium excision. Therefore, in this study, it was aimed to compare the results of conventional SimK and EKR65 report in eyes with pterygium excision. There is no other study in the literature on the effect of pterygium surgery on the EKR65 report.

In this prospective study, mean anterior SimK increased significantly after pterygium surgery. There are other studies reporting significant steeping in the front cornea after pterygium surgery[12-17]. One of the hypotheses is that the meridian where the pterygium is located is flattened by the effect of its mechanical compression[14, 17, 18]. Another hypothesis is that the tear meniscus pooling between the corneal apex and the pterygium causes flatter results[14, 18]. In this study, postoperative increases were detected in the EKR65 report, similar to SimK. The increases were statistically significant in the 4.5 mm and above zones. From this result, it can be interpreted that the flattering effect of the pterygium is more dominant in the peripheral cornea close to the limbus.

Significant reductions in anterior and posterior corneal radius were detected in this study. There are studies in the literature showing that pterygium surgery causes anterior and posterior corneal radius changes[7, 8]. Based on these findings, it comes to the fore that the anterior/posterior radius ratio, which is assumed to be constant in SimK measurement, may change as a result of pterygium surgery and SimK may be insufficient in the calculation of intraocular lens power. Considering the EKR65 report in this group of patients may be more beneficial in this respect. However, there is a need for larger studies including the results of cataract surgery on this subject.

Holladay EKR65 detail report has been developed especially for intraocular lens calculation in corneas undergoing refractive surgery and with irregularities[1, 6, 19]. The comparison of conventional keratometry measurements with EKR65 report data has been made in the literature. Symes et al.[4]reported that EKR65 at 3 mm data was most compatible with Scheimpflug keratometry reading in terms of cataract surgery results in eyes that had not undergone refractive surgery. Holladay et al. [2] reported that the most accurate refractive results were obtained with EKR65 at 4.5 mm data in eyes undergoing corneal refractive surgery. Achiron et al.[20] examined EKR65 at 2mm data in terms of refractive prediction in irregular corneas and found that the results were similar to conventional keratometry but better than Scheimpflug keratometry reading.

It is a matter of curiosity which EKR65 measurement is best agreed with SimK. For this purpose, the correlations of postoperative change amounts were examined in this study. A weak correlation was found with the change in SimK and the change in the EKR65 report at 2 and 3 mm. The information that corneal central 3 mm was used in SimK measurement may support this result.

5. Conclusions

Keratometry measurements based on the conventional hypothesis may be insufficient in the calculation of intraocular lens power due to the distortion and irregularity of the cornea caused by the pterygium and its surgery. The use of the EKR65 report recommended for irregular corneas in this patient group may be considered. For this purpose, more comprehensive and long-term studies are needed.

Acknowledgements

None.

Statement of ethics

The study was compliant with the Declaration of Helsinki and additional approval was obtained from the Adana City Training and Research Hospital ethics committee (2022- 109, number of decision: 2030).

Conflict of interest statement

The authors declare that they have no financial conflict of interest with regard to the content of this report.

Funding source

The authors received no financial support for the research, authorship, and/or publication of this article.

Author contributions

ASA: Concept, design, surgical practice, data analysis, literature search, manuscript preparation and manuscript review. BK: Concept, design, surgical practice, data acquisition and manuscript review. ASI: Concept, design, statistical analysis, literature search and manuscript review.

All authors read and approved the final manuscript.

References

1.Saglik A, Celik H. Comparison of Holladay equivalent keratometry readings and anterior corneal surface keratometry measurements in keratoconus. Int Ophthalmol. 2019; 39(7): 1501-9.
https://doi.org/10.1007/s10792-018-0967-2

2.Holladay JT, Hill WE, Steinmueller A. Corneal power measurements using scheimpflug imaging in eyes with prior corneal refractive surgery. J Refract Surg. 2009; 25(10): 862-8.
https://doi.org/10.3928/1081597X-20090917-07

3.Aksoy M, Asena L, Güngör SG, et al. Comparison of refractive outcomes using Scheimpflug Holladay equivalent keratometry or IOLMaster 700 keratometry for IOL power calculation. Int Ophthalmol. 2021; 41(6): 2205-12.
https://doi.org/10.1007/s10792-021-01781-6

4.Symes RJ, Ursell PG. Automated keratometry in routine cataract surgery: comparison of Scheimpflug and conventional values. J Cataract Refract Surg. 2011; 37(2): 295-301.
https://doi.org/10.1016/j.jcrs.2010.08.050

5.Woodmass J, Rocha G. A comparison of Scheimpflug imaging simulated and Holladay equivalent keratometry values with partial coherence interferometry keratometry measurements in phakic eyes. Can J Ophthalmol. 2009; 44(6): 700-4.
https://doi.org/10.3129/i09-172

6.Symes RJ, Say MJ, Ursell PG. Scheimpflug keratometry versus conventional automated keratometry in routine cataract surgery. J Cataract Refract Surg. 2010; 36(7): 1107-14.
https://doi.org/10.1016/j.jcrs.2009.11.026

7.Kheirkhah A, Safi H, Nazari R, et al. Effects of pterygium surgery on front and back corneal surfaces and anterior segment parameters. Int Ophthalmol. 2012; 32(3): 251-7.
https://doi.org/10.1007/s10792-012-9560-2

8.Levinger E, Sorkin N, Sella S, et al. Posterior Corneal Surface Changes After Pterygium Excision Surgery. Cornea. 2020; 39(7): 823-6.
https://doi.org/10.1097/ICO.0000000000002325

9.Kheirkhah A, Safi H, Molaei S, et al. Effects of pterygium surgery on front and back corneal astigmatism. Can J Ophthalmol. 2012; 47(5): 423-8.
https://doi.org/10.1016/j.jcjo.2012.07.002

10.O'Dwyer PA, Akova YA. Temel Göz Hastalıkları. 3rd ed., İstanbul, Güneş Tıp Kitabevleri, 2015.

11.Saraç Ö. Pratik Kornea Topografisi. 1st ed., Ankara, Anadolu Kitabevi, 2022.

12.Cinal A, Yasar T, Demirok A, et al. The effect of pterygium surgery on corneal topography. Ophthalmic Surg Lasers. 2001; 32(1): 35-40.

13.Ozdemir M, Cinal A. Early and late effects of pterygium surgery on corneal topography. Ophthalmic Surg Lasers Imaging. 2005; 36(6): 451-6.

14.Maheshwari S. Pterygium-induced corneal refractive changes. Indian J Ophthalmol. 2007; 55(5): 383-6.
https://doi.org/10.4103/0301-4738.33829

15.Yilmaz S, Yuksel T, Maden A. Corneal topographic changes after four types of pterygium surgery. J Refract Surg. 2008; 24(2): 160-5.
https://doi.org/10.3928/1081597X-20080201-06

16.Errais K, Bouden J, Mili-Boussen I, et al. Effect of pterygium surgery on corneal topography. Eur J Ophthalmol. 2008; 18(2): 177-81.
https://doi.org/10.1177/112067210801800203

17.Oh JY, Wee WR. The effect of pterygium surgery on contrast sensitivity and corneal topographic changes. Clin Ophthalmol. 2010; 4: 315-9.
https://doi.org/10.2147/opth.s9870

18.Yasar T, Ozdemir M, Cinal A, et al. Effects of fibrovascular traction and pooling of tears on corneal topographic changes induced by pterygium. Eye (Lond). 2003; 17(4): 492-6.
https://doi.org/10.1038/sj.eye.6700377

19.Saglik A, Celik H, Aksoy M. An Analysis of Scheimpflug Holladay-Equivalent Keratometry Readings Following Corneal Collagen Cross-Linking. Beyoglu Eye J. 2019; 4(2): 62-8.
https://doi.org/10.14744/bej.2019.35220

20.Achiron A, Elhaddad O, Leadbetter D, et al. Intraocular lens power calculation in patients with irregular astigmatism. Graefes Arch Clin Exp Ophthalmol. 2022; 260(12): 3889-95.
https://doi.org/10.1007/s00417-022-05729-z