Comparison of Anterior Segment Parameters between Cases with Refractive Error and Emmetropia

Suleyman Gunaydin[1], Emine Malkoc Sen[2], Kemal Tekin[3], Ufuk Elgin[2]

ABSTRACT

Purpose: It was aimed to compare the anterior segment findings between the cases with refractive error and the emmetropic cases without refractive error.

Materials and Methods: Overall, 311 eyes of 311 participants were included in this cross-sectional study. In all participants, the parameters including flat keratometry (K1), step keratometry (K2), mean keratometry (Km), maximum keratometry (Kmax), central corneal thickness (CCT), apex corneal thickness (ACT), thinnest corneal thickness (TCT), cornea volume (CV), anterior chamber volume (ACV), anterior chamber depth (ACD) and anterior chamber angle (ACA) were measured using Pentacam HR.

Results: Of the participants, 81 (26%) were emmetropic (Group 1) while 71 (22.8%) had myopia (Group 2), 74 (23.8%) had hypermetropia (Group 3), 67 (21.5%) had myopic astigmatism (Group 4), and 18 (5.8%) had hypermetropic astigmatism (Group 5). Significant differences were found in anterior chamber parameters (ACA, ACV, ACD) between groups ($p<0.001$, for all). Regarding corneal parameters, there were significant differences in K2, Kmax and KV ($p<0.001$, $p<0.001$, $p<0.003$; respectively) while there were no significant differences K1 and Km values ($p=0.590$, $p=0.140$; respectively) between groups.

Conclusion: Myopic eyes had higher ACA, ACV, and ACD values compared to hyperopic and emmetropic eyes. ACV and ACD parameters were significantly lower in hyperopic eyes than emmetropic eyes.

Keywords: refractive error, cornea, anterior segment, pentacam HR.

INTRODUCTION

In different populations, refractive errors can show wide variations according to factors such as race, genetics, nutrition and culture. In Turkey, it was reported that 39% of refractive errors were myopia; 26% were hypermetropia; and 35% were astigmatism.[1] In a study on young adults in Turkey, it was reported that high myopia was more common than high hypermetropia.[2] It was also reported that astigmatism was more common and associated with higher degrees in patients with myopia.[2] In children at elementary school age, refractive error has been detected by 8.3-12.8%.[3-5] In another study at this age group, refractive error incidence was found as 25% for myopia, 27% for myopic astigmatism, 24% for hypermetropia, 20% for hypermetropic astigmatism and 4% for mix astigmatism.[6]

The cornea accounts for 70% of total refractive power in an eye at resting state (without accommodation).[1] Anterior segment parameters are important for estimation of intraocular lens (IOL) power in excimer laser, refractive surgeries such as phakic IOL and cataract surgery as well as diagnosis and follow-up of ocular disorders such as keratoconus. Pentacam Scheimpflug imaging is a non-contact, rapid, reproducible and reliable method for anterior segment imaging.[7-11] This system includes a rotational Scheimpflug camera and monochromatic slit lamp.[7-11] It captures images via rotating 180º around optical axis of eye. By rotational Scheimpflug camera, it can capture 50 anterior segment slit image and 500 measurements within 2 seconds. Three-dimensional image can be constructed by reformatting slit images. A second camera makes appropriate corrections by capturing eye movements.[7-11] Pentacam device provides these images as a map so-called "smart maps". In particular, it can provide information about previous corneal surgery as it can assess whole corneal diameter. It has major advantages such as refractive

1- Antakya Eye Hospital, Hatay, Turkey

2- University of Health Science, Ulucanlar Eye Education and Research Hospital, Ankara, Türkiye, Ankara

Received: 12.05.2021
Accepted: 04.12.2021
Glo-Kat 2022; 17: 84-89
DOİ: 10.37844/glauc.cat.2022.17.13

Correspondence Adress:
Emine Malkoç Şen
SBÜ, Ulucanlar Göz SUAM, Göz, Ankara, Türkiye
Phone:
E-mail: eminesentr@yahoo.com

power mapping, elevation display and tangential corneal mapping and assessment of anterior and posterior corneal topography.[7-11] In addition, corneal wave front data can be acquired from anterior and posterior surface of cornea by Zernicke polynomials in newly developed module, which can accurately determine spherical aberration originating from cornea, allowing more accurate calculation of IOL power. The anterior chamber depth (ACD) measurement is important in patients undergoing phakic IOL implantation. It is also possible to phakic IOL and estimated postoperative localization of IOL using high-resolution camera in Pentacam HR.[7-11]

The understanding of refractive errors on anterior segment parameters will help better assessment of the patients before and after anterior segment surgery by taking these differences into account. In our study, it was aimed to assess cornea and anterior segment parameters including flat keratometry (K1), step keratometry (K2), mean keratometry (Km), maximum keratometry (Kmax), central corneal thickness (CCT), apex corneal thickness (ACT), thinnest corneal thickness (TCT), cornea volume (CV), anterior chamber volume (ACV), anterior chamber depth (ACD) and anterior chamber angle (ACA) and to evaluate differences between emmetropic patients and those with refractive error and their relationship with refractive error.

MATERIALS AND METHODS

The study included 311 eyes of 311 patients who consecutively presented to ophthalmology outpatient clinic. The study was approved by Ethics Committee of Dışkapi Yıldırım Beyazıt Research and Training Hospital (approval# 15/04). All patients gave informed consent. The study was conducted in accordance to tenets of Helsinki Declaration. The patients included were categorized into groups according to refractive error: group 1, emmetropia; group 2, myopia; group 3, hypermetropia; group 4, myopic astigmatism; and group 5, hypermetropic astigmatism. Analyses included 81 eyes of 81 emmetropic patients (refraction between -0.50 and +0.50 diopter [D]) in group 1, 71 eyes of 71 myopic patients (spherical error between -0.75 and -5.00 D) in group 2, 74 eyes of 74 hypermetropic patients (spherical refractive between +0.75 and +3.00 D) in group 3, 67 eyes of 67 patients with myopic astigmatism (cylindrical refractive error between -1.00 and -3.00) in group 4 and 18 eyes of 18 patients with hypermetropic astigmatism (cylindrical refractive error between +1 and +3.00 D) in group 5. The patients with cylindrical refractive error>0.50 D among those with spherical refractive error and the patients with spherical refractive error >0.50 D among those with cylindrical refractive error were excluded.

In addition, the patients aged <18 years and >60 years, those with congenital or acquired eye disorder other than refractive error, those with history of previous ocular surgery, those with active ocular infection or inflammation, those with intraocular pressure (IOP) >21 mmHg or those with glaucomatous optic nerve findings and those with history of ocular trauma were excluded.

In all participants, refraction was measured using Huvitz HRK 7000 A auto-refractometry; followed by IOP measurements using Canon pneumatic tonometry. The best-corrected visual acuity was measured using Snellen charts. Fundus examination was performed using slit lamp biomicroscopy and 90 D lens. The cornea and anterior segment parameters were analyzed using Pentacam HR (Oculus Inc. Lynnwood,WA, USA). These measurements were performed in the same dark examination room by same operator blinded to group assignment. The measurements were performed at sitting position using Pentacam HR device while patient looking at illumination system of device after positioning his/her mandible on device at appropriate position. The ACA, ACD, ACV, K_1, K_2, K_{max}, KV, CCT, TCT and ACT values were recorded.

The statistical analyses were performed using SPSS version 18.0 (Statistical Package for Social Sciences, SPSSS Inc., Chicago, IL, USA). The normal distribution for continuous variables were assessed using Kolmogorov-Smirnov test. The correlation of ACA, ACD, ACV, K_2, K_{max}, KV, CCT, ACT and TCT values with normal distribution ($p>0.05$) between right and left eyes were assessed using Pearson's correlation analysis, , revealing strong correlation between right and left eyes ($r>0.750$ and $p<0.05$); thus, only values from right eyes were included to the statistical analysis. The difference between groups for these variables were assessed using ANOVA test. The correlation of Km and K_1 with skewed distribution between right and left eye were assessed using Spearman's correlation analysis, revealing a significant correlation between right and left eyes ($r>0.750$ and $p>0.05$). The difference between groups for Km and K_1 was assessed using Kruskal-Wallis test. For continuous variables, descriptive statistics are presented as mean±standard deviation

RESULTS

The study included 311 eyes from 311 patients. Of these, 184 (59.2% were women and 127 (40.2%) were men. Of the patients, 81 (26%) were emmetropic while 71 (22.8%) had myopia, 74 (23.8%) had hypermetropia, 67 (21.5%) had myopic astigmatism, and 18 (5.8%) had hypermetropic astigmatism. Mean age was 39.8±13.7 years. Myopic patients were younger while hypermetropic patients were older when compared to remaining groups. Table 1 presents mean age and gender distribution according to groups.

Table 1: *Demographic data.*

Group (N)	Emmetropia N= 81	Myopia N= 71	Hypermetropia N= 74	Myopic astigmatism N= 67	Hypermetropic astigmatism N= 18	p
Age (year) (mean ±SD)	41.2±11.2	28.8±10.9	50.4± 12.6	35.9±12.6	48.7± 13.6	**0.001***
Gender Female Male	 54 27	 47 24	 36 38	 37 30	 10 8	0.123**
Spherical value (Diopter)	+0.08 ±0.2	-1.99±1.1	+1.60±0.7	+0.02 ±0.1	+0.02±0.2	**0.001***
Cylindrical value (Diopter)	0.02±0.1	-0.03±0.1	0.04±0.1	-1.57±0.9	1.44±0.7	**0.001***

N= count, SS: standard deviation, *: Anova test; **: chi-square test, Significant values are presented as bold .

Mean spherical refractive error was +0.08±0.2 D in group 1, -1.99±1.1 D in group 2, +1.60±0.7 D in group 3, +0.02±0.1 D in group 4 and +0.02±0.2 D in group 5. Mean cylindrical error was 0.02±0.1 D in group 1, -0.03±0.1 D in group 2, 0.04±0.1 D in group 3, -1.57±0.9 D in group 4 and 1.44±0.7 D in group 5. Table 1 presents refractive error in groups.

There was a significant difference in maximum keratometry (Kmax) between group 1 and group 4 ($p<0.001$). However, there was no significant difference between group 1 and groups 2, 3 and 5 ($p=1.00$; $p=0.990$; $p=0.680$, respectively). There was significant difference between group 4 and groups 1, 2 and 3 ($p<0.001$; $p<0.001$; $p<0.001$, respectively) while no significant difference was detected between group 4 and 5 ($p=0.670$). No significant difference was detected in flat keratometry (K_1) values across groups ($p=0.530$). Although there were significant differences between group 4 and groups 1, 2 and 3 ($p<0.001$; $p=0.018$; $p<0.001$, respectively), no significant difference was found between group 4 and 5 ($p=0.688$). No significant difference was detected between remaining groups ($p>0.05$). Similarly, there were no significant differences in mean keratometry (Km) values between groups ($p=0.141$). (Table 2)

No significant difference was detected in central corneal thickness (CCT) between groups ($p=0.108$). No significant difference was detected in apical corneal thickness (ACT) between groups ($p=0.177$). Similarly, no significant difference was detected in thinnest corneal thickness (TCT) between groups ($p=0.090$). There were significant differences in corneal volume (CV) between group 2 and groups 3 and 5 ($p=0.040$, $p=0.002$, respectively). No significant difference was detected between remaining groups ($p>0.05$). Table 2 presents distribution of corneal parameters in groups.

There was significant difference in anterior chamber angle (ACA) between group 1 and groups 2 and 4 ($p<0.001$ and $p=0.012$, respectively). No significant difference was detected between group 1 and groups 3 and 5 ($p=0.158$ and $p=0.358$, respectively). Again, there were significant differences between group 2 and groups 1, 3 and 5 ($p<0.001$; $p<0.001$; $p<0.001$, respectively) while there was no significant difference between group 2 and 4 ($p=0.640$). There were significant differences between group 3 and groups 2 and 4 ($p<0.001$ and $p<0.001$, respectively) while there was no significant difference between group 3 and groups 1 and 5 ($p=0.150$ and $p=0.990$, respectively).

There were significant differences in anterior chamber depth (ACD) between group 1 and remaining groups ($p<0.001$; $p=0.018$; $p<0.001$ and $p=0.030$, respectively). Again, significant differences were detected between group 2 and remaining groups (1, 3, 4, 5) ($p<0,001$; $p<0,001$; $p<0,001$ and $p<0,001$, respectively). Although there were significant differences between group 3 and groups 1, 2 and 4 ($p=0.180$; $p<0.001$ and $p<0.001$, respectively) while there was no significant difference between group 3 and 5 ($p=0.853$).

Significant differences were detected in anterior chamber volume (ACV) between group 1 and groups 2, 3 and 4 ($p<0.001$; $p=0.009$ and $p=0.003$, respectively) while no significant difference was detected between group 1 and 5 ($p=0.110$). There were significant differences between group 2 and remaining groups ($p<0.001$). Again, there were significant differences between group 3 and groups 1, 2 and 4 ($p=0.009$; $p<0.001$ and $p<0.001$, respectively) while there was no significant difference between group 3 and 5 ($p=0.990$). Table 3 presents distribution of anterior chamber parameters across groups.

Table 2: *Distribution of corneal parameters according to groups.*

	Group 1 (N= 81)	Group 2 (N= 71)	Group 3 (N= 74)	Group 4 (N= 67)	Group 5 (N= 18)	p
Kmax (D) Mean±SD	44.2±1.4	44.3±1.4	44.2±1.4	45.3±1.8	44.8±1.6	**0.001***
KV (mm^3) Mean±SD	60.1±3.6	61.2±4.0	59.6±2.7	60.1±3.9	57.7±3.4	**0.003***
K_1 (D) Mean±SD	43.0±1.3	43.1±1.3	42.9±1.3	43.0±1.4	42.6±1.3	0.59**
K_2 (D) Mean±SD	43.6±1.4	43.8±1.3	43.5±1.4	44.6±1.4	44.1±1.4	**0.001***
Km (D) Mean±SD	43.3±1.3	43.5±1.3	43.0±1.4	43.2±4.9	43.3±1.3	0.14**
CCT (µm) Mean±SD	543.1±29.1	550.8±37.6	547.0±27.6	541.4±32.6	530.3±26.5	0.10*
ACT (µm) Mean±SD	545.3±29.6	551.8±37.6	549.0±27.8	544.3±35.5	532.0±26.6	0.17*
TCT (µm) Mean±SD	538.0±29.1	546.1± 38.0	542.3±28.0	535.6±33.0	525.8±26.1	0.09*

*: Anova Test, **: Kruskal Wallis Test, Significant p values are presented as bold.
Kmax: Maximum keratometry, KV: Cornea volume, K_1: Flat keratometry K_2: Steep Keratometry, Km: Mean keratometry, CCT: Central corneal thickness, ACT: Apical corneal thicknesss, TCT: Thinnest corneal thickness: D: diopter, µm: micrometer, SD: standard deviation.

Table 3: *Comparison of anterior chamber parameters between groups.*

	Emmetrope	Myopia	Hypermetropia	Myopic astigmatism	Hypermetropic astigmatism	p
ACA (º)	34.0± 6.5	40.0±5.85	31.8±5.6	37.3± 6.4	31.1± 5.9	**0.0001***
ACD (mm)	2.7±0.3	3.2±0.28	2.6±0.3	2.9±0.2	2.5± 0.2	**0.0001***
ACV (mm^3)	150.6±32.8	198.6±33.3	132.8±30.6	170.6± 38.0	129.5± 26.5	**0.0001***

*: Anova test, Significant p values are presented as bold.
ACA: Anterior chamber angle, ACD: anterior chamber depth, ACV: Anterior chamber volume, SD: standard deviation, º: angle.

DISCUSSION

Refractive errors are one of the most common causes of presentations to ophthalmology outpatient clinics worldwide. The understanding of cornea and anterior segment parameters according to refractive errors is important in the diagnosis and treatment of many ocular diseases. Currently, Pentacam device, one of the methods for assessment of anterior chamber parameters, allows non-contact anterior segment evaluation from anterior corneal surface to posterior lens surface by a single measurement.[8-11] In our study, we aimed to evaluate differences in cornea and other anterior segment parameters of patients with refractive errors when compared to emmetropic individuals.

The central corneal thickness is a major factor which leads inaccuracy in the assessment of IOP, the most important risk factor in the pathogenesis of glaucoma.[12] In addition, it also plays role in the assessment of whether patients candidate for reactive surgery are eligible for surgery and in the diagnosis of subclinical keratoconus.[13-15] In previous studies, contradictory results were reported regarding differences in corneal thickness among refractive errors.[15-18] In a study including 149 patients, Murata et al. reported that corneal thickness was higher in patients with hypermetropia when compared to those myopia.[15] While

Uçakhan et al.[18] and Hashemi et al.[19] found no significant differences in corneal thickness according to refractive errors in agreement with our study. Given the corneal thicknesses, it can be suggested the type of refractive error is not a significant factor for eligibility to reactive surgery.

Cornea volume is an important parameter for keratoconus progression and intra-corneal ring implantation.[20, 21] Ambrósio et al.[20] reported that corneal volume was significantly lower in patients with moderate and severe keratoconus when compared to normal population. Emre et al.[22] showed that corneal volume decreased progressively by increasing severity of keratoconus. In addition, Murata et al.[15] reported that cornea volume was lower in myopic patients when compared to hypermetropic patients. In a study including 283 patients, Hashemi et al.[19] found no significant difference in corneal volume between cases with myopia and those with hypermetropia. On contrary, total cornea volume was found to be significantly higher in myopic patients when compared to those with hypermetropia and hypermetropic astigmatism in our study. This difference may be due to younger population in our study.

Keratometry values are important corneal parameters used in both IOL power calculation in cataract surgery and in the diagnosis and follow-up of ocular disorders such as keratoconus. There are inconsistent results regarding relationship between keratometry values and refractive errors. Parssin et al.[23] reported that there was no relationship between degree of myopia and corneal curvature. On the other hand, there are studies reporting that cornea power was approximately 1 D higher in patients with myopia when compared to those with hypermetropia.[18, 24-26] In some studies, Km values were reported to be lower in hypermetropic patients when compared to myopic patients.[18, 19, 27, 28] In our study, although no significant difference was detected in mean keratometry (Km) and flat keratometry (K_1) values between groups, steep keratometry (K_2) value was significantly higher in myopic astigmatism group than emmetropia, myopia and hypermetropia groups. However, this difference did not reach statistical significance in hypermetropic astigmatism group. There was no significant difference in keratometry measurements between patients with hypermetropic astigmatism and emmetropic participants. This may be due to limited number of patients with hypermetropia.

Anterior chamber parameters have clinical relevance in both IOL implantation in cataract surgery and phakic IOL calculation in refractive surgeries.[29,31] In addition, hypermetropia is a major risk factor in the pathogenesis of angle closure glaucoma.[34, 35] In previous studies, it was shown that myopia was associated with deeper anterior chamber,, wider ACA and higher ACV.[15, 32, 33] In our study, emmetropic patients had significantly higher ACD when compared to hypermetropia and hypermetropic astigmatism groups while they had significantly lower ACD when compared to myopia and myopic astigmatism groups. There was no significant difference in ACD between hypermetropia and hypermetropic astigmatism groups. The lowest ACD value was detected in hypermetropic astigmatism group. This may be due to older age in hypermetropic astigmatism group. In addition, patients with hypermetropic astigmatism may have higher risk for angle closure.

Murata et al.[15] and Hashemi et al.[19] reported that ACV and ACD values were significantly higher in patients with low-myopia when compared to those high-myopia. On contrary, in a study including 246 cases, Uçakhan et al.[18] showed higher ACV and ACD values in patients with high-myopia. In our study, ACV was significantly lower in emmetropia group when compared to myopia and myopic astigmatism groups while significantly higher in hypermetropia group. Although emmetropia group had higher ACV values when compared to hypermetropic astigmatism group, the difference did not reach statistical significance. In addition, no significant difference was found in ACV between hypermetropia group and hypermetropic astigmatism group. The lowest ACV was detected in hypermetropic astigmatism group. This may be due to higher mean age in hypermetropic cases. However, this is a finding supporting that clinicians should be more cautious regarding risk for angle closure in patients with hypermetropic astigmatism. In the literature, Pentacam can be used in the detection of cases with angle closure.[36-39] It was reported that ACV had highest sensitivity (85%) among ACA, ACV and ACD measured by Pentacam.[38] Globally, primary angle closure accounts for more than 50% of blindness caused by glaucoma. Thus, early detection of the angle tended to close is important in these patients.[40]

The patients with myopia had significantly higher anterior chamber angle (ACA) when compared to emmetropic patients, those with hypermetropia and hypermetropic astigmatism, no significant difference was detected when compared to patients with myopic astigmatism in our study. Although mean ACA was wider in emmetropia group than hypermetropia and hypermetropic astigmatism groups, the difference did not reach statistical significance. This imaging modality can be used for screening as it allows non-contact, reproducible and rapid assessment by a technician without need for experience. In a review including 47 studies (9 using Pentacam) on non-contact angle measurement for detection of angle-closure glaucoma, it was found that these devices can detect angle-closure at rate higher than standard clinical examination.[40] Thus, gonioscopy, a time-

consuming modality that requires clinical experience and eye contact, can be performed in suspected cases with low ACV and narrow ACA by Pentacam.

In our study, the lower ACV, ACD and ACA detected in hypermetropia and hypermetropic astigmatism groups can be associated with degree of hypermetropia as well as higher mean age in hypermetropic cases. Thus, larger, prospective studies including age- and sex-matched cases with high hypermetropia are needed.

This study has some limitations including lack of age-matched groups and assessment of axial length. On the other hand, large study population and inclusion of all types of refractive errors are strengths of our study.

Based on our results, ACA, ACV and ACD was significantly higher in myopic patients when compared to emmetropic patients and those with hypermetropia. In addition, hypermetropia group had lower ACV and ACD when compared to emmetropic patients.

REFERENCES

1. Aydın P, Akova Y. Temel Göz Hastalıkları. Güneş Kitabevi, Ankara; 2001;93-102.
2. Erdoğan MG, Çelik Y, Durukan AH. Genç erişkin erkeklerde yüksek refraksiyon kusurları ve eşlik eden astigmatizma. MN Oftalmoloji 2007;14:271-5.
3. Işıklı B, Kalyoncu C. Eskişehir kırsal kesim ilk öğretim öğrencilerinde görme kusurları. Sürekli Tıp Eğitimi Dergisi (STED) 2007;16:95-9.
4. Toygar O, Öğüt MS, Kazokoğlu H. İstanbul'da ilköğretim çağı çocuklarında yapılan göz taraması sonuçları. T Oft Gaz. 2003;33:585-91.
5. Şahin HA, Sucaklı MH, Özdemir M. Van ili merkez ilköğretim öğrencilerinde refraksiyon kusuru ve diğer göz patolojilerinin prevalansı. Anadolu Tıp Dergisi 2003;5:106-10.
6. Öztürk F, Kurt E. Kayseri ve Manisa merkez ilkokullarında yapılan göz muayenesi sonuçları. MN Oftalmoloji 1999;6:77-9.
7. Rachel F, Chan TC, Prakash G, et al. Applications of corneal topography and tomography: a review. Clin Exp Ophthalmol. 2018;46:133-46.
8. Piñero DP, Saenz González C, Alió JL. Intraobserver and interobserver repeatability of curvature and aberrometric measurements of the posterior corneal surface in normal eyes using Scheimpflug photography. J Cataract Refract Surg 2009;35:113-20.
9. de Jong T, Sheehan MT, Koopmans SA, et al. Posterior corneal shape: Comparison of height data from 3 corneal topographers. J Cataract Refract Surg. 2017;43:518-24.
10. Shankar H, Taranath D, Santhirathelagan CT, et al. Anterior segment biometry with the Pentacam: Comprehensive assessment of repeatability of automated measurements. J Cataract Refract Surg 2008;34:103-13.
11. Kosekahya P, Koc M, Caglayan M, et al. Repeatability and reliability of ectasia display and topometric indices with the Scheimpflug system in normal and keratoconic eyes. J Cataract Refract Surg. 2018;44:63-70.
12. Beloway GW, Goldberg I. The thick and thin of the central corneal thickness in glaucoma. Eye (Lond). 2018;32:915-23.
13. Khachikian SS, Belin MW, Ciolino JB. Intrasubject corneal thickness asymmetry. J Refract Surg 2008;24:606-9.
14. Falavarjani KG, Modarres M, Joshaghani M, et al. Interocular differences of the Pentacam measurements in normal subjects. Clin Exp Optom 2010;93:26-30.
15. Murata C, Mallmann F, Yamazaki E, et al. Anterior ocular segment study with the Scheimpflug rotational camera in refractive surgery candidates. Arq Bras Oftalmol 2007;70:619-24.
16. Pedersen L, Hjortdal J, Ehlers N. Central corneal thickness in high myopia. Acta Ophthalmol Scand 2005;83:539-42.
35. Zuo C, Gong R, Chen W, et al. Investigation of Corneal Astigmatism in Chinese Patients With Primary Angle Closure Disease. J Glaucoma 2018;27:1131-5.
36. Kurita N, Mayama C, Tomidokoro A, et al. Potential of the Pentacam in screening for primary angle closure and primary angle closure suspect. J Glaucoma 2009;18:506-12.
37. Rossi GC, Scudeller L, Delfino A, et al. Pentacam sensitivity and specificity in detecting occludable angles. Eur J Ophthalmol 2012;22:701-8.
38. Dabasia PL, Edgar DF, Murdoch IE, et al. Noncontact Screening Methods for the Detection of Narrow Anterior Chamber Angles. Invest Ophthalmol Vis Sci 2015;5:3929-35.
39. Raluca M, Mircea F, Andrei F, et al. Old and new in exploring the anterior chamber angle. Rom J Ophthalmol 2015;59:208-16.
40. Jindal A, Ctori I, Virgili G, et al. Non-contact tests for identifying people at risk of primary angle closure glaucoma. Cochrane Database Syst Rev. 2020;5:CD012947.