• Brief Report •

Evaluation of the iridocorneal angle with accommodation using optical coherence tomography

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Abstract

• The changes in the iridocorneal angle structure during accommodation are assessed by means of anterior segment optical coherence tomography. Thirteen right eyes were included in the study. The device used for the measurement was the Visante® *omni* system. The stimuli were set up at different vergences (0.0 D, -1.5 D, and -3.0 D). The angle opening distance 500 and 750, the trabecular iris space area 500 and 750, and the scleral spur angle parameters were assessed at the nasal and temporal regions. The results in the iridotrabecular angle comparing the three accommodative states of the eye did not yield any statistically significant difference at nasal or temporal angle sections. In light of our results and in the conditions of our study, the structures of the iridocorneal angle are not significantly changed with accommodation.

• KEYWORDS: iridocorneal angle; accommodation; optical coherence tomography; anterior segment

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INTRODUCTION

The changes in the anterior segment structures with accommodation have been object of recent research. This is a matter of special interest since secondary anatomical changes take place during this process. This is because the crystalline lens, which takes the main role during accommodation, adjusts its refractive power by modifying its thickness and curvature in order to get a clear image on the retina. Several works have evaluated how different structures are affected by this mechanism, such as the anterior chamber depth (ACD), the crystalline lens thickness or its curvature[1-4]. The ACD is reduced due to the thickening of the lens, which makes its anterior surface get closer to the corneal endothelium. These variations could have a significant impact on whether a specific design of a phakic intraocular lens (pIOL) might be suitable or not depending on its nearness to the cornea. In this sense, the iridocorneal angle region would be a critical area in which the proximity of an anterior chamber pIOL to the corneal tissue or the push-up of the ocular structures by a posterior chamber lens could induce cell loss due to the possibility of peripheral contact[5]. Also, changes in the anterior chamber have been investigated with pseudophakic intraocular lenses (IOLs) after cataract surgery with induced contractions of the ciliary muscle[6]. Imaging techniques of the anterior eye, such as the anterior segment optical coherence tomography (AS-OCT), able to parametrize the anterior ocular structures[7-10]. This work was conducted to elucidate whether the iridocorneal angle structure undergoes any significant variation during accommodation.

METHODS

Thirteen right eyes were included. Mean age was 30.5±5.0y. Averaged refractive error was -0.73±2.12 dioptres (D). The subjects were included in the study if they had no ocular abnormality or systemic condition, no ocular surgery history, no apparent angle closure, and had enough amplitude of accommodation to focus on the target. The study followed the Declaration of Helsinki and was approved by the Ethics Committee of the University of Valencia. The patients were informed about the details of the study and provided a formal consent.

The Visante® *omni* system (Carl Zeiss, Germany) combines Placido disk and optical coherence tomography (OCT) technologies to obtain advanced corneal and anterior segment evaluation. Its software (v3.0) disposes of a set of different scan types. The "Enhanced Anterior Segment Single" mode, together with the Anterior Segment Irido-Corneal tool set, were used. This tool provide the angle opening distance 500 and 750 (AOD500, AOD750, in mm), the trabecular iris space area 500 and 750 (TISA500, TISA 750, in mm^2), and the scleral spur angle (SPA, in degrees). The device allows the examiner to adjust the vergence of the visual target by means of a set of internal lenses, which is useful to evaluate the changes with

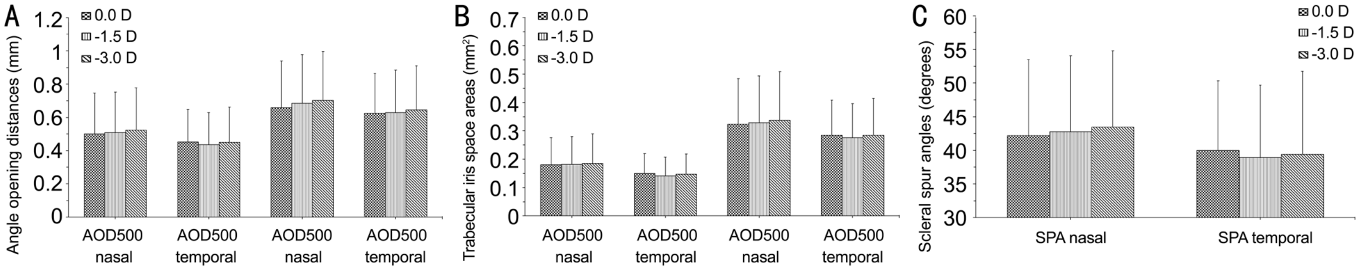

Figure 1 Changes with accommodation in the iridocorneal angle structures The different parameters are represented for nasal and temporal regions, as well as for the three evaluated vergences. A: AOD500 and AOD750 distances; B: TISA500 and TISA750 areas; C: Scleral spur angle. Error bars represent the value of one standard deviation.

Table 1 Mean values, standard deviations, and 95%CI for the different parameters that were evaluated

Angle parameters		Non-accommodated state		1.5 D of accommodation		3.0 D of accommodation	
		Mean±SD	95% CI	Mean±SD	95%CI	Mean±SD	95%CI
Nasal	AOD500 (mm)	0.50±0.25	(0.35, 0.65)	0.51±0.24	(0.36, 0.66)	0.52±0.26	(0.37, 0.68)
	AOD750 (mm)	0.66±0.28	(0.49, 0.83)	0.69±0.29	(0.51, 0.86)	0.70±0.29	(0.52, 0.88)
	TISA500 (mm^2)	0.18±0.10	(0.12, 0.24)	0.18±0.10	(0.12, 0.24)	0.19±0.10	(0.12, 0.25)
	TISA750 (mm^2)	0.32±0.16	(0.23, 0.42)	0.33±0.17	(0.23, 0.43)	0.34±0.17	(0.23, 0.44)
	SPA (°)	42.2±11.3	(35.4, 49.0)	42.8±11.3	(36.0, 49.6)	43.5±11.3	(36.6, 50.3)
Temporal	AOD500 (mm)	0.45±0.19	(0.34, 0.57)	0.44±0.19	(0.32, 0.55)	0.45±0.21	(0.32, 0.58)
	AOD750 (mm)	0.62±0.24	(0.48, 0.77)	0.63±0.26	(0.47, 0.78)	0.64±0.26	(0.48, 0.80)
	TISA500 (mm^2)	0.15±0.07	(0.11, 0.19)	0.14±0.07	(0.10, 0.18)	0.15±0.07	(0.10, 0.19)
	TISA750 (mm^2)	0.28±0.12	(0.21, 0.36)	0.27±0.12	(0.20, 0.35)	0.28±0.13	(0.21, 0.36)
	SPA (°)	40.0±10.3	(33.8, 46.3)	39.0±10.7	(32.5, 45.5)	39.4±12.3	(32.0, 46.9)

accommodation. All the measurements were randomly taken at 0.0 D (unaccommodated state), -1.5 D, and -3.0 D stimulus vergences. The parameters being evaluated were those related to the nasal (0 degrees) and temporal (180 degrees) angles, and they were captured three times for every accommodative state. The illumination in the room was controlled to avoid any significant pupil diameter variations.

The statistical analysis was performed with SPSS (v22.0, SPSS Inc., USA). The Kolmogorov-Smirnov test was used to check normality. The non-parametric Friedman test was employed to compare the groups, with statistical significance defined as $P<0.05$.

RESULTS AND DISCUSSION

Table 1 shows mean values, standard deviations, and 95% confidence intervals (CI) for the different parameters that were evaluated.

Concerning the AOD500 and AOD750, Figure 1A shows the results for the three vergences. There was not found any statistically significant difference either at nasal or temporal angles for any accommodative state ($P\geq0.199$). Nevertheless, a slight increase of these parameters is observed for AOD500 and AOD750. As for the TISA500 and TISA750, results are shown in Figure 1B. There was also not found a statistically significant difference when comparing values between the three accommodative states ($P\geq0.116$). Finally, the SPA, shown in Figure 1C, did not either show any significant variation when comparing values between the different accommodative states ($P\geq0.292$), although a slight increase was observed at the nasal angle. In light of our results and in the conditions of our study, the accommodation did not statistically significantly change the values of the region of the angle in our sample. The slightly increasing variation of some parameters that were observed in our study can be in part due to the pupil constriction explained by the near triad or accommodation reflex, as pupil dynamic variations during accommodation can change the part in which the tool detects the iris surface.

The evaluation of the width of the iridocorneal angle is crucial in determining the risk of angle closure due to iridotrabecular contact. Some works have suggested that the angle characteristics are related to age, race/ethnicity, refraction, illumination, *etc*. All these factors have an impact on the susceptibility of the angle becoming closed, and thus, leading to glaucoma[11]. Although there are other techniques for the angle evaluation which are also commonly used in the clinical practice, such as gonioscopy, they do not let quantify this structure.

A recent work, in which a rotating Scheimpflug camera was used, studied the changes in the anterior chamber angle with accommodation[12]. In this case, the value being analysed was represented as the mean anterior chamber angle of the eye in young patients. The stimuli ranged from +1.00 to -4.00 D. No significant accommodation-related changes were found in these measurements, which is in accordance with our work. Liu[13] examined the anatomical changes of the anterior chamber angle by AS-OCT. This work concluded that the risk of iridotrabecular contact depends on the height of the iris plane relative to the trabecular meshwork and on the degree of physiological pupillary dilation. Thus, narrow angles might become closed in dark lighting conditions, which could also lead to the diagnosis of angle-closure glaucoma being missed. Marchini *et al*[14] analysed anterior segment changes during accommodation in subjects implanted with monofocal pseudophakic IOLs after cataract surgery by means of high-frequency ultrasound biomicroscopy. The aim was to better understand anterior segment modifications during accommodation in pseudophakic eyes due to ciliary muscle contractions still present in these eyes. Nevertheless, the mean iridocorneal angle values did not show any significant variation either for the horizontal or the vertical cross-sectional images that were analysed, which is in accordance with our findings as well.

In our work, the light was carefully controlled so that it was the same for all patients, in order to make sure that all subjects were examined under the same conditions and no different illumination patterns could actually alter the results. The reduced sample size and the lack of pupillary diameter values are some of the limitations of this study. Therefore, it would be interesting to address future research on this matter with a bigger sample and to set up different groups depending on the total amount of ametropia, sex, age, *etc*.

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Conflicts of Interest: Monsálvez-Romín D, None; **Del Águila-Carrasco A,** None; **Ferrer-Blasco T,** None; **Esteve-Taboada JJ,** None; **Montés-Micó R,** None.

REFERENCES

1 Baikoff G, Lutun E, Ferraz C, Wei J. Static and dynamic analysis of the anterior segment with optical coherence tomography. *J Cataract Refract Surg* 2004;30(9):1843-1850.

2 Leng L, Yuan Y, Chen Q, Shen M, Ma Q, Lin B, Zhu D, Qu J, Lu F. Biometry of anterior segment of human eye on both horizontal and vertical meridians during accommodation imaged with extended scan depth optical coherence tomography. *PLoS One* 2014;9(8):e104775.

3 Richdale K, Bullimore MA, Zadnik K. Lens thickness with age and accommodation by optical coherence tomography. *Ophthalmic Physiol Opt* 2008;28(5):441-447.

4 Hamzeh N, Moghimi S, Latifi G, Mohammadi M, Khatibi N, Lin SC. Lens thickness assessment: anterior segment optical coherence tomography versus A-scan ultrasonography. *Int J Ophthalmol* 2015;8(6): 1151-1155.

5 Coullet J, Mahieu L, Malecaze F, Fournié P, Leparmentier A, Moalic S, Arné JL. Severe endothelial cell loss following uneventful angle-supported phakic intraocular lens implantation for high myopia. *J Cataract Refract Surg* 2007;33(8):1477-1481.

6 Lesiewska-Junk H, Kaluzny J. Intraocular lens movement and accommodation in eyes of young patients. *J Cataract Refract Surg* 2000; 26(4):562-565.

7 Ramos JL, Li Y, Huang D. Clinical and research applications of anterior segment optical coherence tomography - a review. *Clin Exp Ophthalmol* 2009;37(1):81-89.

8 Lim SH. Clinical applications of anterior segment optical coherence tomography. *J Ophthalmol* 2015;2015:605729.

9 Han SB, Liu YC, Noriega KM, Mehta JS. Applications of anterior segment optical coherence tomography in cornea and ocular surface diseases. *J Ophthalmol* 2016;2016:4971572.

10 Angmo D, Nongpiur ME, Sharma R, Sidhu T, Sihota R, Dada T. Clinical utility of anterior segment swept-source optical coherence tomography in glaucoma. *Oman J Ophthalmol* 2016;9(1):3-10.

11 Maruyama Y, Mori K, Ikeda Y, Ueno M, Kinoshita S. Morphological analysis of age-related iridocorneal angle changes in normal and glaucomatous cases using anterior segment optical coherence tomography. *Clin Ophthalmol* 2014;8:113-118.

12 Domínguez-Vicent A, Monsálvez-Romín D, Del Águila-Carrasco AJ, Ferrer-Blasco T, Montés-Micó R. Changes in the anterior chamber during accommodation assessed with a Scheimpflug system. *J Cataract Refract Surg* 2014;40(11):1790-1797.

13 Liu L. Anatomical changes of the anterior chamber angle with anterior-segment optical coherence tomography. *Arch Ophthalmol* 2008;126(12): 1682-1686.

14 Marchini G, Pedrotti E, Modesti M, Visentin S, Tosi R. Anterior segment changes during accommodation in eyes with a monofocal intraocular lens: high-frequency ultrasound study. *J Cataract Refract Surg* 2008;34(6):949-956.