Evaluation of the iridocorneal angle with accommodation using optical coherence tomography

Daniel Monsálvez-Romín, Antonio Del Águila-Carrasco, Teresa Ferrer-Blasco, José J. Esteve-Taboada, Robert Montés-Micó

Optics and Optometry and Vision Sciences Department, University of Valencia, Burjassot 46100, Spain
Correspondence to: José J. Esteve-Taboada. Optics and Optometry and Vision Sciences Department, C/ Dr. Moliner, 50 - 46100 - Burjassot, Spain. josejuan.esteve@uv.es
Received: 2016-11-08 Accepted: 2017-07-19

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
DOI:10.18240/ijo.2017.10.21


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 mm²), 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
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% CI for the different parameters that were evaluated.

<table>
<thead>
<tr>
<th>Angle parameters</th>
<th>Non-accommodated state</th>
<th>1.5 D of accommodation</th>
<th>3.0 D of accommodation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean±SD</td>
<td>95% CI</td>
<td>Mean±SD</td>
</tr>
<tr>
<td>Nasal AOD500 (mm)</td>
<td>0.50±0.25 (0.35, 0.65)</td>
<td>0.51±0.24 (0.36, 0.66)</td>
<td>0.52±0.26 (0.37, 0.68)</td>
</tr>
<tr>
<td>AOD750 (mm)</td>
<td>0.66±0.28 (0.49, 0.83)</td>
<td>0.69±0.29 (0.51, 0.86)</td>
<td>0.70±0.29 (0.52, 0.88)</td>
</tr>
<tr>
<td>TISA500 (mm²)</td>
<td>0.18±0.10 (0.12, 0.24)</td>
<td>0.18±0.10 (0.12, 0.24)</td>
<td>0.19±0.10 (0.12, 0.25)</td>
</tr>
<tr>
<td>TISA750 (mm²)</td>
<td>0.32±0.16 (0.23, 0.42)</td>
<td>0.33±0.17 (0.23, 0.43)</td>
<td>0.34±0.17 (0.23, 0.44)</td>
</tr>
<tr>
<td>SPA (°)</td>
<td>42.2±11.3 (35.4, 49.0)</td>
<td>42.8±11.3 (36.0, 49.6)</td>
<td>43.5±11.3 (36.6, 50.3)</td>
</tr>
<tr>
<td>Temporal AOD500 (mm)</td>
<td>0.45±0.19 (0.34, 0.57)</td>
<td>0.44±0.19 (0.32, 0.55)</td>
<td>0.45±0.21 (0.32, 0.58)</td>
</tr>
<tr>
<td>AOD750 (mm)</td>
<td>0.62±0.24 (0.48, 0.77)</td>
<td>0.63±0.26 (0.47, 0.78)</td>
<td>0.64±0.26 (0.48, 0.80)</td>
</tr>
<tr>
<td>TISA500 (mm²)</td>
<td>0.15±0.07 (0.11, 0.19)</td>
<td>0.14±0.07 (0.10, 0.18)</td>
<td>0.15±0.07 (0.10, 0.19)</td>
</tr>
<tr>
<td>TISA750 (mm²)</td>
<td>0.28±0.12 (0.21, 0.36)</td>
<td>0.27±0.12 (0.20, 0.35)</td>
<td>0.28±0.13 (0.21, 0.36)</td>
</tr>
<tr>
<td>SPA (°)</td>
<td>40.0±10.3 (33.8, 46.3)</td>
<td>39.0±10.7 (32.5, 45.5)</td>
<td>39.4±12.3 (32.0, 46.9)</td>
</tr>
</tbody>
</table>

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.

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.
Iridocorneal angle assessment with accommodation

in these measurements, which is in accordance with our work. Liu et al. 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. 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.

ACKNOWLEDGEMENTS

Foundations: Support by the Ministerio de Economía y Competitividad [Research project SAF2013-44510-R with ERDF (European Regional Development Funds) from European Union]. Daniel Monsálvez-Romín has a “Formación de Profesorado Universitario” Grant (FPU13/05332, Ministerio de Educación, Cultura y Deporte) and Antonio Del Águila-Carrasco has an “Atracció de talent” research scholarship (Universitat de València UV-INV-PREDOC14-179135).

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


