Intraocular pressure variation and quantitative assessment of the anterior chamber pre- and post-iridotomy in primary angle-closure suspects

Variación de la presión intraocular y medidas cuantitativas del segmento anterior pre y postiridotomía en pacientes sospechosos de cierre angular primario

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Abstract

Objectives: To evaluate the short-term changes that occur after laser peripheral iridotomy on intraocular pressure (IOP) and chamber angle by anterior segment optical coherence tomography in primary angle-closure suspects (PACS). **Methods:** Prospective, observational, comparative study. PACS were included according to the classification proposed by Foster. The parameters evaluated before and after the iridotomy were IOP, anterior chamber depth, trabecular-iris angle (TIA), angle opening distance (AOD500) and trabecular-iris space area (TISA500) using anterior segment tomography. **Results:** We analyzed 28 eyes of 14 patients and found a decrease in IOP from 16.6 ± 3.1 to 14.4 ± 4.3 mmHg ($p = 0.001$) pre- and post-iridotomy. We also found a statistically significant increase ($p = 0.001$) in TIA, TISA500 and AOD500 values ($p = 0.032$). **Conclusion:** This study confirms that, in PACS, peripheral laser iridotomy results in a significant increase in the anterior chamber angle amplitude, as well as a significant decrease in IOP.

Key words: Primary angle-closure suspect. Laser peripheral iridotomy. Anterior chamber depth. Anterior segment optical coherence tomography.

Resumen

Objetivos: Evaluar los cambios a corto plazo que acontecen después de una iridotomía láser periférica en la presión intraocular (PIO) y el ángulo camerular mediante tomografía de coherencia óptica de segmento anterior en pacientes sospechosos de cierre angular primario (PACS). **Métodos:** Estudio prospectivo, observacional, comparativo. Se incluyeron individuos PACS según la Clasificación de Foster. Los parámetros evaluados antes y después de la iridotomía fueron PIO, profundidad de cámara anterior, ángulo trabecular iris (TIA), distancia de apertura angular (AOD500) y área del espacio trabecular iris (TISA500) con tomografía de segmento anterior. **Resultados:** Se analizaron 28 ojos de 14 pacientes, se encontró una disminución de la PIO de 16.6 ± 3.1 a 14.4 ± 4.3 mmHg ($p = 0.001$) pre y postiridotomía. También se encontró un incremento estadísticamente significativo ($p = 0.001$) en los valores de TIA, TISA500 y AOD500 ($p = 0.032$). **Conclusiones:** Este estudio

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confirma que, en pacientes con sospecha de cierre angular, la iridotomía láser periférica resulta en un incremento significativo de la amplitud del ángulo de la cámara anterior, así como una disminución significativa de la PIO.

Palabras claves: Sospechosos de cierre angular primario. Iridotomía láser periférica. Profundidad de cámara anterior. Tomografía de coherencia óptica del segmento anterior.

Introduction

Primary angle-closure glaucoma (PACG) is estimated to be responsible for about half of blindness worldwide¹. Approximately 22% of Asian primary angle-closure suspects (PACS) will evolve to primary angle-closure (PAC) in 5 years and 28% of these will develop PACG². The knowledge of the anterior chamber angle configuration is an essential part of the diagnosis and management of glaucoma patients³. Gonioscopy is the reference technique for its evaluation^{4,5}, since it allows the assessment of details such as the presence of pigment, deposits, pseudoexfoliative material, as well as the differentiation between appositional or synechial closure; although it has drawbacks, such as its subjectivity, which makes it very dependent on the examiner, and the consequent low reproducibility, in addition to the skill required by the evaluator and an adequate collaboration of the patient^{3,6}.

There are some alternatives for angle assessment, including optical coherence tomography of the anterior segment (OCT-AS), which has shown to be comfortable and to have a high spatial resolution at this anatomic level⁷⁻⁹.

Peripheral laser iridotomy (PLI) is the procedure of choice in PACS and PAC, since it causes a significant increase in the opening of the anterior chamber angle^{10,11}. The aim of this study is to evaluate the short-term changes on intraocular pressure (IOP) and on the chamber angle after an iridotomy using OCT-AS in PACS.

Methodology

Prospective, observational, comparative study in 31 eyes of 17 patients who attended the Centro Diagnóstico Oftalmológico de Oriente y Unidad Oftalmológica Dra. Mirna Hernández from May 2016 to May 2017. Previously, the patients signed the informed consent, the approval of the ethics committee of the medical school of Anzoátegui state was obtained and the guidelines of the declaration of Helsinki were followed.

Patients older than 18 years and younger than 78 years were included, with a spherical ametropia of -3.00 to +6.00 diopters and cylinders less than 3

diopters, with normal IOP <21 mmHg and diagnosis of PACS according to the Foster Classification¹².

Patients with a history of previous intraocular surgery, ocular trauma, presence of peripheral anterior synechiae, intumescent lens, uveitis, who were receiving hypotensive medical treatment or who presented alterations suggestive of glaucomatous optic neuropathy were excluded.

All participants underwent complete ophthalmologic evaluation, including: visual acuity (Snellen chart), biomicroscopy, Goldmann applanation tonometry, gonioscopy, funduscopy (78D lens), ultrasonic contact pachymetry (Tomey model SP-100). The biometric parameters, anterior chamber depth (ACD) and axial length (AL), were taken with the IOL master non-contact biometry (Carl Zeiss). All the examinations were carried out by the same ophthalmologist.

Gonioscopic evaluation was performed with a 4-mirror ophthalmic lens, after instillation of 0.5% topical proparacaine and using low ambient lighting. With the patient seated in the slit lamp, in the primary position of the gaze, the 1 mm light beam was oriented horizontally to evaluate the nasal and temporal angle; while to evaluate the superior and inferior angle, the light beam was directed vertically. If the pigmented portion of the trabecular meshwork was not visible at 270°, the eye was considered a PACS according to Foster¹².

The equipment used to acquire images of the anterior segment was the RTVue® OCT (Optovue Inc., Fremont, CA), and the lens used to measure them was the CAM-L. The nasal and temporal quadrants (angle 0° and 180°) were evaluated under mesopic conditions. Images were captured with the patient sitting with the eyes facing the opposite side of the angle to be explored. Only quality images that indicated a signal strength greater than 30 were accepted. Each quadrant was scanned twice, choosing the image that had the best quality, the least noise and where the greatest number of anatomical structures were identified.

The measurements taken into consideration were trabecular-iris angle (TIA), angular opening distance (AOD500) and the trabecular-iris space area (TISA500), these last two taken at 500 microns from the scleral spur.

The TIA was defined drawing a line from the angle recess to the Schwalbe's line and another line on the iris surface to the perpendicular point on Schwalbe's line. The AOD500 was determined as the perpendicular distance from the trabecular meshwork, 500 microns anteriorly from the scleral spur to the anterior surface of the iris. The TISA500 was defined as the area between the AOD 500, the surface of the iris, the corneal endothelium and a perpendicular line that starts from the scleral spur to the iris^{3,13}.

After taking the basal measurements, the iridotomy was performed. For the procedures 2% pilocarpine was instilled, and after 30 minutes, 0.5% topical proparacaine was applied, and the Abraham lens was used with a coupling gel. A crypt was selected in the outer third of the peripheral iris located in the upper sector, preferably in the nasal quadrant, until outflow of aqueous humor and pigment was observed. For the procedure, a YAG (yttrium-aluminum-garnet) laser model LIGHT-Las YAG from LIGHTMED Corporation was used. The power was adjusted between 3 to 6 mJ. The IOP was re-evaluated 1 hour after the procedure and 1% topical prednisolone was started, 1 drop every 8 hours for 6 days with follow-up in 1 week. The IOP, biometric parameters and OCT-AS were reevaluated 1 to 4 weeks after the iridotomy.

Statistical analysis

The arithmetic mean, and standard deviation of the continuous variables were calculated: age, sphere, cylinder, pachymetry, AL, IOP, ACD, TIA, TISA500 and AOD500. When comparing the averages, the Student's t-test of paired data on age by gender, TIA, TISA500 and AOD500 was applied in the pre- and post-iridotomy groups. The Shapiro-Wilk test determined the parametric behavior ($p > 0.05$) of these variables. For comparing the means of the variables IOP and ACD between the pre- and post-iridotomy groups, the Wilcoxon test was applied because the data showed nonparametric trends according to the Shapiro-Wilk test ($p < 0.05$). Frequency and percentage of the categorical variable as well as patient's gender were computed. The data were analyzed with the computerized statistical package SPSS version 21.0. Statistical significance was assigned at a level of $p < 0.05$.

Results

Twenty-eight eyes were analyzed, both eyes of 14 patients. The mean age was 56.4 ± 11.1 years, with an

Table 1. Measurements of intraocular pressure and anterior chamber depth pre- and post-iridotomy

Variable	Pre-iridotomy	Post-iridotomy	p
IOP (mmHg)	16.6 ± 3.1	14.4 ± 4.3	0.001
ACD (mm)	2.7 ± 0.3	2.8 ± 0.03	0.401

The values are arithmetic means plus/minus standard deviation. ACD: anterior chamber depth; IOP: intraocular pressure.

age range between 39 and 78 years. There was no statistical difference between male and female ($p = 0.106$). Nine patients (64.3%) of the sample were female. Regarding the refractive error, the mean sphere was 1.84 ± 1.8 diopters, with a range of -1 to 6, and the mean cylinder was -0.49 ± 0.50 diopters, with a range of -1.5 to 0.

Of the 28 eyes evaluated, the mean central corneal thickness was 543.2 ± 45.9 μ m, with a range of 416 to 620 μ m; the mean of the axial length was 22.7 ± 0.65 mm, with a range of 21.5 to 24.1.

The IOP variation was 16.6 ± 3.1 to 14.4 ± 4.3 mmHg ($p = 0.001$) pre- and post-iridotomy, respectively, which represents a statistically significant decrease. The ACD average before and 4 weeks after the iridotomy increased from 2.7 ± 0.3 to 2.8 ± 0.2 mm ($p = 0.401$). This was not statistically significant (Table 1).

Table 2 shows the TIA, TISA500 and AOD500 values measured both in the nasal and temporal angle, before and after the iridotomy. The TIA, TISA500 and AOD500 values showed a statistically significant increase ($p = 0.001$), except the TISA500 in the nasal angle, which did not show statistical significance ($p = 0.032$).

Discussion

The aim of this study was to evaluate the short-term changes on IOP and on the chamber angle after iridotomy using OCT-AS in PACS. In addition, the effect of iridotomy on ACD was examined, using non-contact biometry. The OCT-AS is a non-contact technique of excellent resolution, and easy to use. Despite the wide acceptance of gonioscopy as the gold standard in the evaluation of the chamber angle, the measurements by OCT-AS have the advantage of carrying out quantitative analyses, being able to measure through opaque corneas, in sitting position and with uncooperative patients, besides being highly reproducible¹⁴⁻¹⁶.

The results obtained in this study show that after the iridotomy, there was a significant increase in the

Table 2. Angle parameters changes before and after peripheral laser iridotomy

Variable	Nasal angle		p	Temporal angle		p
	Pre-iridotomy	Post-iridotomy		Pre-iridotomy	Post-iridotomy	
TIA (°)	12.0 ± 5.1	18.2 ± 6.9	0.001	11.2 ± 6.3	18.2 ± 6.4	0.001
TISA500 (mm ²)	0.107 ± 0.19	0.117 ± 0.20	0.032	0.055 ± 0.03	0.086 ± 0.04	0.001
AOD500 (μm)	136.8 ± 81.0	208.0 ± 103.3	0.001	143.9 ± 80.1	221.3 ± 105.4	0.001

The values are arithmetic means plus/minus standard deviation.
AOD: angle opening distance; TIA: trabecular iris angle; TISA: trabecular iris space area.

chamber angle, which was evidenced by an increase in the TIA, TISA500 and AOD500, similar to that reported by several authors who have published their results after studying different races of patients and using different imaging equipment to measure the anterior chamber angle parameters¹⁷⁻¹⁹.

How, et al.¹⁹ evaluated 176 eyes confirming an increase in AOD and TISA after PLI measured by the OCT Visante. Ang et al., on the other hand, evaluated 71 eyes of Caucasian patients and reported a significant opening of the peripheral chamber angle measured by OCT-AS Slit lamp¹⁷. Lee, et al.²⁰ obtained similar results in 32 eyes of PACS. This study confirms data published by previous investigations¹⁷⁻²¹, that the chamber angle widens in PACS after an iridotomy.

In this study, the measurement of nasal TISA did not show any significant change, like that reported by Jiang, et al.²² who found that 25% of the eyes had closed-angle persistence after the iridotomy. The possible reasons for these findings can be explained by the existence of other factors that affect the angle opening other than the degree of pupillary block, such as the position or thickness of the iris, the ciliary body and the lens, among others, whose measurement was not in the scope of this study²².

There is controversy about the effect of iridotomy on ACD^{21,23-25}. This study showed that, in PACS, iridotomy has no significant effect on ACD, as was shown by Faramarzi, et al. who evaluated 40 eyes of PACS by Lemstar²⁶ biometry.

A study with Pentacam of 20 eyes of PACS showed a significant difference in the volume of the anterior chamber, TIA and peripheral ACD, but not in the central ACD, after performing an iridotomy²³.

Regarding the effect of iridotomy on intraocular pressure, in this study the pressure decreased significantly after the procedure, unlike the data reported by Vryonis et al.²⁷, who studied 46 eyes of PACS, PAC and PACG and did not demonstrate a statistically significant

decrease in IOP. Probably, this difference is because in their sample they included patients with PAC and PACG, whereas for this study only PACS were included, which have normal intraocular pressure levels.

The limitations of this work include, first, the size of the sample, which prevents the generalization of the results obtained; second, the difficulty in identifying the scleral spur in some eyes, either because it is anatomically unclear, or because of reflectivity or contrast, and third, not having considered other parameters such as the lens volume and iris thickness in the measures used, which would have allowed us to better understand the reasons why in some patients the procedure did not obtain the desired effect of angle opening.

With the results obtained it can be concluded that iridotomy produces a significant angle increase in PACS and a significant decrease in IOP.

Ethical disclosures

Protection of human and animal subjects. The authors declare that the procedures followed were in accordance with the regulations of the relevant clinical research ethics committee and with those of the Code of Ethics of the World Medical Association (Declaration of Helsinki).

Confidentiality of data. The authors declare that they have followed the protocols of their work center on the publication of patient data.

Right to privacy and informed consent. The authors have obtained the written informed consent of the patients or subjects mentioned in the article. The corresponding author is in possession of this document.

Conflicts of interest

The authors declare that they have no conflicts of interest with any of the manufacturers of the instruments and equipment used for the study.

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