EXPLORATION OF THE ANTERIOR SEGMENT BY OPTICAL COHERENCE TOMOGRAPHY-3

EXPLORACIÓN DEL SEGMENTO ANTERIOR MEDIANTE TOMOGRAFÍA ÓPTICA DE COHERENCIA 3

LARA-MEDINA FJ, ISPA-CALLÉN MC, NÚÑEZ A, LÓPEZ-ROMERO S, LÓPEZ-MONDÉJAR E, ZARCO JM, GONZÁLEZ DEL VALLE F

ABSTRACT

Purpose: To show the utility of optical coherence tomography (OCT) for studying the anterior segment and to explain its potential advantages as compared to ultrasonic biomicroscopy (UBM).

Materials and methods: We have described the findings in 5 patients with different pathologies of the anterior segment, all of whom were studied with UBM and OCT-3 adjusted for the anterior segment. There were 2 cases of an acute attack of closed angle glaucoma, 1 case of rubeosis iridis, 1 case of penetrating ocular trauma and 1 case of a primary stromal iris cyst.

Results: OCT was found to be as useful as UBM in detecting angle closure in patients affected by an acute attack of glaucoma. In addition, OCT was more comfortable for the patient and faster than UBM in obtaining images, with the exploration mean time using OCT being less than five minutes while that with UBM was over ten minutes. OCT has also been demonstrated to be a safe and valuable non-contact examination in other iris pathologies such as rubeosis iridis, for checking the permeability of iridotomies and even for studying iris masses such as primary stromal iris cysts. In these entities OCT may reach a higher resolution than ultrasonic biomicroscopy.

ORIGINAL ARTICLE

RESUMEN

Objetivo: Dar a conocer la utilidad de la Tomografía de Coherencia Óptica (OCT) para el estudio de patología del segmento anterior así como presentar sus posibles ventajas frente a la biomicroscopía ultrasonica (BMU).

Material y métodos: Presentamos 5 pacientes con diversas patologías del segmento anterior estudiados mediante OCT: 2 pacientes con ataque agudo de glaucoma de ángulo estrecho, 1 paciente con rubeosis iridis, 1 paciente con un traumatismo ocular penetrante y un paciente con un quiste estromal primario del iris.

Resultados: En los pacientes con ataque agudo de glaucoma, el OCT ha mostrado ser una herramienta tan útil como la BMU para la detección del cierre angular. Además, la tomografía óptica fue más cómoda y rápida en la obtención de las imágenes que la BMU, así la el tiempo medio de exploración con OCT suele ser inferior a 5 minutos, a diferencia de la BMU cuyo tiempo suele ser superior a 10 minutos. El OCT también ha demostrado ser una prueba útil para el estudio de otras patologías del iris, permitiendo valorar la permeabilidad de las iridotomías, mostrar neovascularización iridiana e incluso estudiar masas iridianas como el quiste estromal.
Conclusion: OCT-3, with an adjustable focus, can obtain images from the scleral angle, as well as from other ocular structures like the iris, thus assisting in the diagnosis of numerous pathologies (Arch Soc Esp Oftalmol 2006; 81: 647-652).

Key words: Acute glaucoma, closure angle, ultrasonic biomicroscopy (UBM), optical coherence tomography (OCT), iridotomy, primary iris stromal cyst.

INTRODUCTION

The assessment of the scleral angle is essential in the exploration of glaucoma patients. At present, gonioscopy is considered to be the choice test for studying the anatomy and morphology of the scleral-corneal angle.

In recent years, the appearance of Ultrasound Biomicroscopy (UBM) has brought about improvements in viewing the anterior chamber, allowing for a high level of spatial resolution and objective measuring capacity of the angle structures (1).

UBM is a contact exploration technique with an immersion system which requires patients to be in recumbent position. The technique can be slightly uncomfortable for some patients and not very well tolerated in some cases. In addition, the position of the echography sound and the patient eye can vary in the course of the test and this involves a potential increase in the variability of the measurements. In fact, the reliability of the test largely depends on the collaboration of the patient and the experience of the operator (2,3).

Optic Coherence Tomography (OCT) is a non-invasive technique which was initially proposed for studying posterior pole disorders. However, some authors have suggested the possibility of utilizing it for studying the structures of the scleral-corneal angle, thus proving to be a comfortable technique with high spatial resolution at this anatomic level (4).

In this paper we describe the use of OCT 3 for visualizing the anterior segment by adjusting the focus of the image on the anterior pole structures.

SUBJECTS, MATERIAL AND METHODS

The study was made on 5 patients with a variety of anterior segment pathologies: 2 with closed angle acute glaucoma, 1 with rubeosis iridis, 1 with penetrating ocular traumatism which caused an iridectomy and 1 with a primary iris stromal cyst. In all cases, we obtained images of the anterior segment by means of UBM (OTI Systems® 35 Mhz probe) and Stratus OCT 3 with diagnostic purposes and for controlling the evolution. It was possible to obtain images with the OCT due to the optical properties of the anterior segment structures. To obtain said images with the OCT the corneal limbus must be focused by means of the refractive defect wheel (tending towards positive levels) to obtain a clear image of the area to be studied. After focusing the area, the «Line» protocol is selected and the scanning is carried out. At all times, the area being scanned by the OCT is shown in the real-time camera of the device, allowing for a modification at any time of the area to be studied. Captures can be made at all clock positions, with the nasal and temporal horizontal areas being easier.

RESULTS

Case 1

A 58-year old woman who visited the urgency section due to unilateral ocular pain which started a few earlier, together with a slight reduction in her
visual acuity. The exploration revealed ciliar injection, non-reactive middle midriasis and intraocular pressure of 53 mm Hg. Accordingly, the preliminary diagnosis of small angle acute glaucoma attack is given and images are taken by means of UBM and OCT. The latter revealed an angular closure with contact between the trabecular mesh and the peripheral area of the iris in all 4 quadrants (fig. 1). Also, the UBM showed a similar arrangement of the angle at 360° (fig. 2). The appropriate medical treatment is established, subsequently carrying out bilateral iridotomies with YAG laser. Thereafter an anterior chamber OCT is done, which shows that the iridotomy in the eye of the acute glaucoma attack is not pervious, thus making it necessary to apply new impacts to the area (fig. 3). After said second treatment a new OCT is performed which showed permeability in the iridotomy, opening of the angle and deepening of the anterior chamber (fig. 3).

Case 2

A 45-year old woman referred by Internal Medicine for eye fundus study due to bilateral middle midriasis with headaches, loss of vision, nausea and vomiting which started 12 hours earlier. Exploration reveals a visual acuity of 0.8 in both eyes and a non-reactive bilateral midriasis. The remainder of the exploration, including the papillae, gave normal results with the exception of small anterior chambers and intra-ocular pressure of 65 and 58 mm Hg in each eye. Accordingly, anterior pole images are taken with OCT (fig. 4) and UBM (fig. 5), which revealed an angle closure in 360° and bilaterally. The diagnostic of acute bilateral glaucoma attack is established, prescribing appropriate medical treatment. Bilateral iridotomies are carried out, which show permeability as seen in the OCT images, with scleral depth increasing in both eyes (fig. 6).

Case 3

45 year-old male, diabetic type I since 14 years ago, diagnosed with non-proliferative diabetic retinopathy in the last ophthalmological checkup.
He visits the practice for the usual checkup exhibiting an intense *rubeosis iridis* in the left eye. Photographs are taken of the anterior segment and an iris OCT is done, which shows a hyper-reflecting sign in the external iris surface corresponding to the neovessels area (fig. 7). In this case, the OCT reveals that the configuration of the scleral-corneal angle is open. Subsequently the patient is treated with retinal panphotocoagulation.

**Case 4**

A 38 year-old woman who visited the urgency section due to penetrating traumatism in the eye caused by a clothespin fragment. The patient exhibits a perforation at the corneal level with involvement of the iris and lens. She is operated on to remove the fragment and close the cornea, with subsequent lens phacoemulsification and insertion of an intra-sac lens. A subsequent checkup, 5 months after the lesion, involving OCT images of the anterior segment (fig. 8) clearly revealed the traumatic iridectomy area as well as the arrangement of the intraocular lens.

**Case 5**

A 34 year-old man who attended the practice referred by an optometrist to assess a tumoration at the iridian level without functional repercussions. The exploration exhibited a raised formation, similar to a cyst, with milky content at the level of the iris, close to the pupil edge. The patient does not refer any relevant ophthalmological history. Images are obtained with UBM and OCT and the diagnostic is of primary iris stromal cyst (figs. 9 and 10).

In all the above cases, the mean exploration time utilizing both instruments varied considerably. Accordingly, by means of OCT complete explorations of the anterior segment were made in under 5 minutes. However and mainly due to the prior preparations required by UBM as well as the difficulty in locating the lesions to be studied, the exploration times with this tool required over 10 minutes.

**DISCUSSION**

Acute small angle glaucoma constitutes the main expression of glaucoma in the Asian population. However, it is not as frequent in Caucasian patients.

At present, gonioscopy continues to be the technique of choice for visualizing the angle, and is essential for exploring glaucomatous patients.

In the past decade, the development of UBM has facilitated an improved visualization of the scleral-corneal structures by providing images with high spatial resolution. However, UBM continues to be a method which is not widely extended, partly because it is not very comfortable for the operator.

*Fig. 6: Permeable iridotomies (white arrows) and enlargement of the anterior chamber (case 2).*

*Fig. 7: Iridian hyper-reflectiveness in neovessels area (white arrow).*

*Fig. 8: OCT showing a traumatic iridectomy (white arrow), as well as opacification of the posterior capsule.*
and the patient as well as a considerable degree of variability in non-expert hands.

In contrast with UBM, Optic Coherence Tomography is a widely extended non-invasive diagnostic method due to its multiple applications for studying retinal diseases.

However, the use of OCT for obtaining anterior segment images is not well researched in the literature, with very few references to its usefulness.

In cases of narrow angle acute glaucoma (cases 1 and 2), OCT allows a rapid assessment of the degree of angular occlusion and of the iris morphology by facilitating quick images at any meridian. Previously, other authors (5) have proved that the smaller is the angle, the better it can be seen with OCT, to the extent that the root of the iris can be seen in occluded angle cases. In our cases, this is clearly evidenced so that, when the angle is closed, the root of the iris can be seen as well as its contact with the trabecular mesh. However, after performing the corresponding iridotomies, the anterior chamber is enlarged and a non-reflective area appears at that level, indicating the opening of the angle. In addition, in patients with angular closure, OCT allows for a quick assessment of the condition of the performed iridotomies because the real-time camera can easily locate and scan them. With OCT we can obtain information about the degree of depth and permeability and depth of iridotomies as well as the degree of angular opening after same. Thus, it can be seen that in case 1, OCT allowed us to determine that the first iridotomy was incomplete due to the very narrow anterior chamber, seeing the root of the iris. In this case it was necessary to carry out a second treatment which widened the anterior chamber and gave it an open configuration confirmed with the OCT. Apart from the assessment of the scleral-corneal angle, OCT can be utilized for studying and assessing various iris pathologies. In this way, cases 3, 4 and 5 provide different examples wherein OCT was employed to analyze the iris.

Case 3 is a clear example of rubeosis iridis due to proliferative diabetic retinopathy. Here, the OCT shows a hyper-refractivity in the anterior face of the iris which corresponds to neovessels, together with an open position of the angle. In case 4, the OCT study allows for an easy visualization of the traumatic iridectomy caused by the entrance of a fragment of a clothespin in the eye. It also shows a hyper-refrangent line in the area of the posterior edge of the intraocular lens due to the opacification the posterior capsule of the lens.

In turn, case 5 shows a patient diagnosed with primary iris stromal cyst. This cyst usually exhibits a slowly progressive growth towards the anterior chamber which may even occlude the pupil axis (6). Traditionally, this condition has been called «iris stromal cyst» due to its anatomic location, although in fact it comprises a conjunctiva-type epithelium wall and therefore the term «stromal», from the histological point of view, seems hardly adequate (7). This cyst is usually diagnosed in childhood and can be located in any quadrant. The cyst usually contains a semi-transparent fluid through which the iridian epithelium posterior to the lesion can be clearly seen.

In this case we studied the lesion by means of UBM which allowed us to verify the aspect and content of the cyst as well as determine its size. The OCT study also allowed us to analyze the anatomy of the cyst, reaching a structural detail which was superior to that obtained with UBM. However, the lack of adequate software for the anterior pole prevented us from measuring the actual size of the lesion. Even so, this does not preclude the identifi-
ocation of any growth in successive checkups provided that the scan line is placed in the same location.

OCT produces high resolution images (<10 µm), even higher than those obtained by ultrasound microscopy (25 µm). On the other hand, the time for generating the images is much shorter with OCT (400 scans per second) than with conventional UBM (8 images per second) (4).

However, the main advantage of OCT vis-à-vis conventional UBM lies in that tomography is non-contact method which does not require the patient to be in recumbent position. This makes for the procedure to be much better tolerated by patients and more comfortable than conventional UBM.

One disadvantage of OCT against UBM is that it cannot obtain images of the ciliar body, the zonule and the lens because the iris pigmentary epithelium has a screen effect for the laser beam, thus preventing it from scanning said structures. At present, the 820 nm laser of the OCT 3 cannot display the ciliar body, although devices are being developed with different wavelengths which may display it (8). UBM also features other advantages over OCT when studying the scleral-corneal angle in patients with opacity of the medium at the corneal and limbar level. In these cases, the OCT laser is unable to penetrate the anterior chamber and scan structures of the scleral-corneal angle and iris.

To conclude, even though OCT 3 was not specifically designed for this use, it can serve to obtain images of the scleral-corneal angle as well as of other anterior segment structures, constituting a non-invasive, relatively comfortable and safe exploration for the patient.

REFERENCES