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Routine OCT and UBM of the anterior segment

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From information to specialist training

Routine OCT and UBM of the anterior segment

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Highlights

- OCT imaging performs well for corneal imaging
- OCT imaging performs well for anterior segment measurements
- UBM imaging performs well for visualising the ciliary body and identifying the risk of plateau iris mechanism

Key words

OCT
UBM
Sectional imaging of anterior segment
Tissue penetration

Introduction

Exploration of the anterior segment by OCT and UBM usefully complements slit lamp examination.
The particular feature of OCT and UBM instruments is their ability to provide sectional images of the cornea and anterior segment covering either a delimited area or the entire anterior segment.
These imaging systems allow the measurement of different anatomical values and distances. Another advantage they offer is access to structures that are difficult to see with the slit lamp, such as the iridocorneal angle or ciliary processes.
Greater resolution of imaging systems and their wider availability in ophthalmology centres offer practitioners not only an appreciable additional diagnostic aid, but also a didactic feature for patients.

Technical principles

OCT instruments

The exploration of the anterior segment by OCT can be performed with two different types of instruments:

- OCT instruments designed for the exploration of the anterior segment with a specific wavelength of about 1300 nm: this wavelength allows a better penetration through the different iris tissues. These instruments can also provide sectional images of the entire anterior segment.

However, this method involves the use of an infrared beam whose penetration is countered by the most highly pigmented tissues such as the iris: a good visualisation of the ciliary processes is thus impossible when the iris is dark-coloured.

- OCT instruments designed for macular exploration, which use wavelengths of about 850 nm, along with an evolution of OCT towards the use of spectral domain systems, allowing faster acquisition and better resolution than those obtained with time domain instruments.

Recent instruments allow the OCT beam to be focused on the anterior segment with a very high analytical resolution, but still with limited penetration owing to the wavelength used and a limited acquisition window, which most often precludes a complete sectional image of the entire anterior segment.

UBM instruments

Very high frequency ultrasonography applied to the anterior segment was described in the 1990s by Charles Pavlin, with the first demonstration of the utility of ultrasound biomicroscopy (UBM) instruments for glaucoma and iridociliary tumours. The principle of these instruments is to use very high-frequency ultrasonographic probes (higher than 20 MHz) with focusing between 10 and 12 mm so as to obtain better resolution on the anterior segment and the iris.

The resolution of UBM instruments is lower than that of recent OCT devices, but ultrasonography offers the advantage of a very high power of penetration through opaque tissues with, for example, a very good visualisation of ciliary processes, irrespective of iris pigmentation.

Routine use of OCT and UBM imaging

The use of these two types of imaging instruments for the anterior segment is optimised by using the very high resolution of weakly penetrating OCT when focusing on the cornea or the iridocorneal angle, and UBM preferentially for the analysis of structures lying behind the iris.

Corneal imaging

For corneal imaging, OCT outperforms UBM owing to its very high resolution, spectral domain OCT allowing the visualisation of different layers of the cornea and the specific identification of the reflectivity disturbances than can arise in corneal disorders, refractive surgery treatments or corneal grafts and trauma. It is thus possible to relocate the section plane of a Lasik procedure even several years post-operatively.
Measurement of the corneal section depth and the thickness of the residual stroma is an important factor in deciding on further treatment for an insufficient refractive effect ***(Figure 1)***. Determination of the depth of certain opacities also allows the guidance of ablative treatments intended to improve corneal transparency.

Anterior segment imaging and phakic implants

The exploration of the anterior segment by OCT or UBM allows the analysis of phakic implant surgery techniques.

- For anterior chamber implants, both OCT and UBM instruments allow the measurements of safe distances between the optical implant and the cornea, or between the optical implant and the lens ***(Figure 2)***.

The analysis of feet positioning in the iridocorneal angle offers another advantage in cases of pupillary ovalisation.

- For posterior chamber implants, only UBM imaging gives a good visualisation of the optical implant behind the iris and the position of the implant feet.

In some cases, this examination can reveal evidence of implant oversizing or mispositioning.

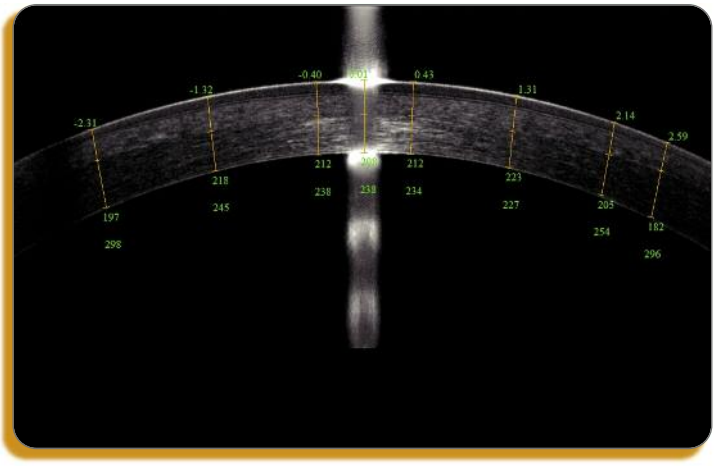

Figure 1 : *Very high resolution OCT sectional image (spectral domain) showing a Lasik microkeratome section, one year after surgery: the depth of the section and the thickness of the residual stroma can be measured to decide on any further additional treatment.*

Figure 2 : *Sectional image of an anterior segment (OCT Visante, Zeiss) in a patient after phakic implant surgery of the anterior chamber with safe distance measurements between the implant and the cornea and between the implant and the anterior lens capsule.*

Anterior segment imaging and glaucoma

The first applications of sectional imaging of the iridocorneal angle were described with UBM. The advent of recent OCT broadens our exploratory scope.

▸▸▸▸ Narrow-angle

The main indications are linked to the determination of glaucoma risk by angle closure with a very good visualisation of the scleral spur, which serves as a stable anatomical reference point relative to the iris and ciliary body, and whose shape can vary according to the pupillary diameter or accommodation. The analysis of a narrow iridocorneal angle and risk of glaucoma by angle closure can be carried out by either OCT or UBM, in light- or dark-adapted conditions to observe the behaviour of the angle with a secluded pupil comparable to our patients' night-time situation ***(Figure 3)***.

• Angle measurement

The current systems allow the measurement of either the iridocorneal angle opening or the peripheral depth of the anterior chamber (AOD 500 or AOD 750, which represents the angle opening distance at 500 microns or 750 microns from the scleral spur).

• Measurement of crystalline lens rise

The position of the anterior lens capsule relative to the straight line connecting the two iridocorneal angles determines the crystalline lens rise, which is used to assess the extent of the lens factor in the angle closure mechanism ***(Figure 4)***.

• Plateau iris

The limit of OCT is often set by the pigmentation of the ciliary body and the root of the iris, which restricts the analysis of the ciliary body, whereas UBM gives a very good visualisation of the position and dynamics of the ciliary processes. The routine use of UBM has found an appreciable proportion of patients presenting an anterior position of the ciliary processes. This picture, associated with a closed angle and no ciliary sulcus, forms the conditions for closed-angle glaucoma with a plateau iris mechanism ***(Figure 5)***.
In cases of iris root double hump sign diagnosed by gonioscopy, exploration by UBM provides very useful additional analytical data to support a therapeutic decision.

▸▸▸▸ Open-angle

Open-angle glaucoma can also benefit from imaging to show, for example, inversion of iris curvature in cases of pigmentary glaucoma. After surgery for chronic open-angle glaucoma, the site of filtration surgery (trabeculectomy or deep sclerectomy) can be analysed by OCT or UBM to observe, in cases of dysfunction, the mechanism of reduced filtration: apposition of the iris root, collapsed scleral flap with no decompression chamber, or fibrosed conjunctival filtering bleb.

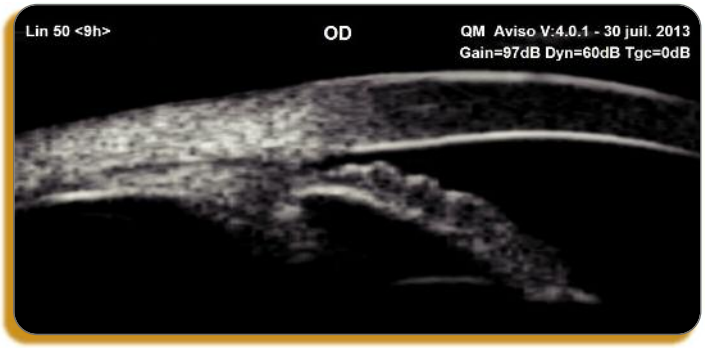

Figure 3 : UBM sectional image of a narrow iridocorneal angle that appears closed in dark-adapted conditions. In this patient, the ciliary body is located behind the scleral spur, showing the absence of plateau iris mechanism.

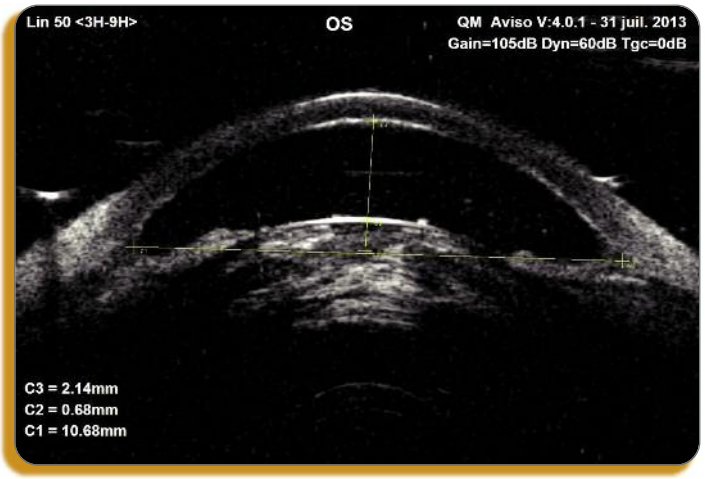

Figure 4 : Whole anterior segment sectional images obtained by UBM or OCT provide a measurement of crystalline lens rise: here measured at 1300 microns by Visante OCT, attesting a strong lens factor in the risk of angle closure.

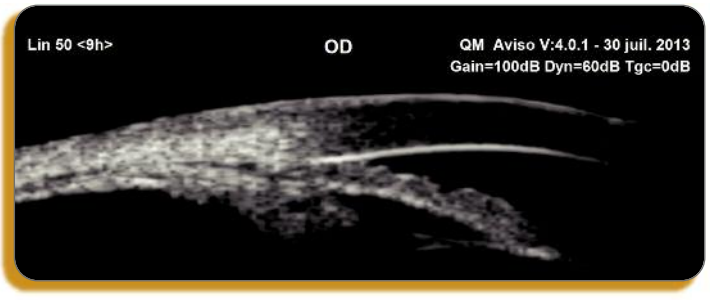

Figure 5 : UBM sectional image of a closed angle with plateau iris mechanism: the ciliary body is located in front of the scleral spur.

Anterior segment imaging and tumour

Exploration of the anterior segment with OCT and UBM instruments is another field of application for monitoring tumours of the iris and ciliary body. Here the OCT images provide a first approach, pointing to an iris relief or filling of the iridocorneal angle, but the better penetration of UBM makes it indispensable for this application.

Classical situations include diagnoses of iris vaulting, where both OCT and UBM instruments can identify iris relief, but where the appreciably better penetration of the UBM allows the presence of iridociliary cysts to be differentiated from solid lesions of the nevus or melanoma type.

Recourse to UBM to measure iridociliary tumours enhances the clinical follow-up of patients with diagnosis and conservative treatment of melanoma ***(Figure 6)***.

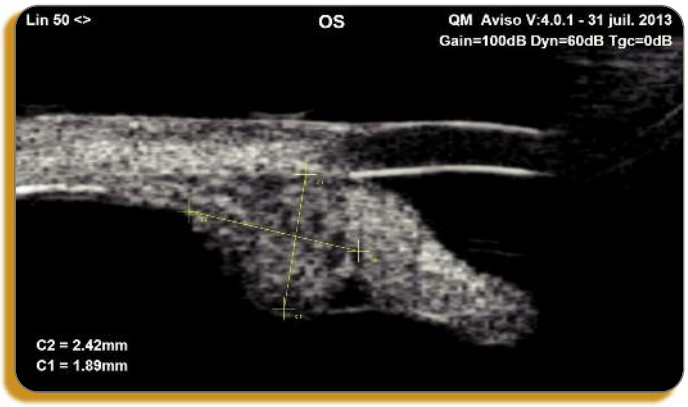

Figure 6 : *UBM meridian section of an iridociliary melanoma allowing a follow-up after conservative treatment by measuring the main dimensions: length, width and thickness.*

Anterior segment imaging and trauma

In cases of violent trauma with marked hyphema, exploration by UBM offers the possibility of a clinical appraisal of the anterior segment, with visualisation of the different anatomical structures to seek anomalies of the iridocorneal angle, such as traumatic angle recession or ciliary detachments.

Traumatic cataracts and lens subluxations can benefit from a clinical appraisal to support a therapeutic decision.

Conclusion

Progress in image quality through an appreciable improvement in the resolution of OCT and high-frequency ultrasonography instruments, associated with greater availability of these different devices, lends ever greater scope to anterior segment imaging in routine practice. This new approach to the anterior segment, which complements the slit lamp examination, provides further clinical information not only at the diagnosis stage, but also throughout medical or post-therapeutic follow-up.

Iridocorneal angle imaging can be performed with both OCT and UBM, with the recently improved resolution of the OCT instruments, but the better penetration of UBM allows an analysis of retroiridian structures.

In the current state of technology, the advantages of OCT for exploring the anterior segment are preponderant for sectional imaging of the cornea, for the different measurements of the anterior segment and for the follow-up of phakic anterior chamber implants.

UBM remains the method of choice for the diagnosis of angle closure by plateau iris mechanism, for the monitoring of posterior chamber phakic implants and for the diagnosis and follow-up of iridociliary tumours. ■

Conflicts of interest: none

REFERENCES

Pavlin CJ, Harasiewicz K, Foster FS-Ultrasound biomicroscopy of anterior segment structures in normal and glaucomatous eyes [see comments],1992, Am J Ophthalmol 113(4): 381-9.

Pavlin CJ, Harasiewicz K, Sherar MD, Foster FS. Clinical use of ultrasound biomicroscopy. Ophthalmology. 1991 Mar;98(3):287-95. Pavlin CJ, Foster FS.

Reinstein DZ, Srivannaboon S, Archer TJ, Silverman RH, et all Probability model of the inaccuracy of residual stromal thickness prediction to reduce the risk of ectasia after LASIK part I: quantifying individual risk. J Refract Surg. 2006 Nov;22(9):851-60.

Baïkoff G, Bourgeon G, Jodai HJ,et all. Pigment dispersion and Artisan phakic intraocular lenses: crystalline lens rise as a safety criterion. J Cataract Refract Surg. 2005 Apr;31(4):674-80.

Reinstein DZ, Archer TJ, Silverman RH, et all, Correlation of anterior chamber angle and ciliary sulcus diameters with white-to-white corneal diameter in high myopes using artemis VHF digital ultrasound. J Refract Surg. 2009 Feb;25(2):185-94.

Zhou SY, Wang CX, Cai XY, Huang D, Liu YZ.Optical Coherence Tomography and Ultrasound Biomicroscopy Imaging of Opaque Corneas. : Cornea. 2012 Oct 15.

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