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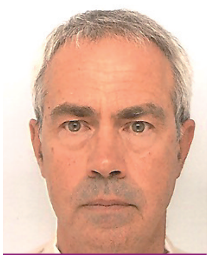
Ultrasound and iridial angle closure

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The importance of very high-frequency ultrasound in the study of primary angle-closure glaucoma is obvious. It often contributes to the diagnosis in several secondary angle-closure situations. It is a very thorough examination technique which requires training and practice.

Very high-frequency ultrasound (more commonly known by the name UBM) is one of the diagnostic tests that contributes the most to the study of iridial angle closure.

The examination uses ultrasound of a frequency higher than 30 MHz, providing for excellent definition, however offering very limited field depth of around a few millimetres.

The examination therefore takes place with the eyelids open and over a layer of a few millimetres fluid, or gel such as a tear substitute, which implies the eyelids have to be sufficiently wide open. An eye speculum may be required at times.

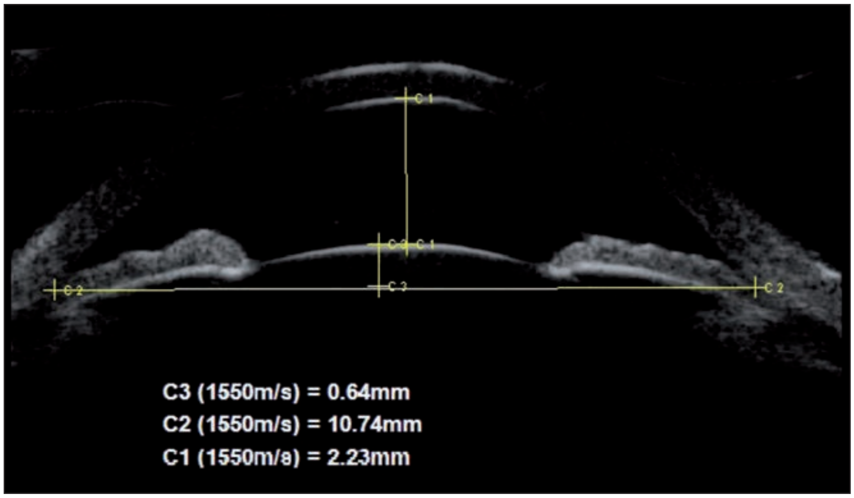


Figure 1. *Normal cross-section. Anterior chamber = 2.23 mm. Lens width = 0.64 mm. Barely convex iridial plane.*

The risk of an acute glaucoma flare-up from angle-closure is of course assessed first during the physical and gonioscopic examination. The role of ultrasound, in the early stage, is to assess atypical situations or angle non-reopening, after iridotomy.

Firstly, we will discuss the role of ultrasound in the study of primary angle-closure glaucoma, before illustrating several cases of secondary angle-closure, in which ultrasound often contributes to the diagnosis.

We will not address the use of ultrasound after physical or surgical treatment of chronic glaucoma.

Ultrasound examination procedure

The UBM ultrasound examination begins with a 3 o'clock-9 o'clock axial cross-section (*figure 1*).

We can therefore:

- measure the depth of the anterior chamber, a significant risk factor for angle-closure,
- measure lens width, reflection of intumescence or of lens anteroposition, showing the lens' contribution to narrowing of the anterior chamber,
- assess the iris curve, convex suggesting blockage of the pupil, flat, or concave but in a context of open angle with possible pigment dispersion.

The iridial angles are then analysed in cross-sections according to the four main meridians:

9 o'clock, 12 o'clock, 3 o'clock and 6 o'clock, to view the peripheral cornea, the iris from its root to the edge of the pupil, the ciliary processes and the ciliary body (*figure 2*).

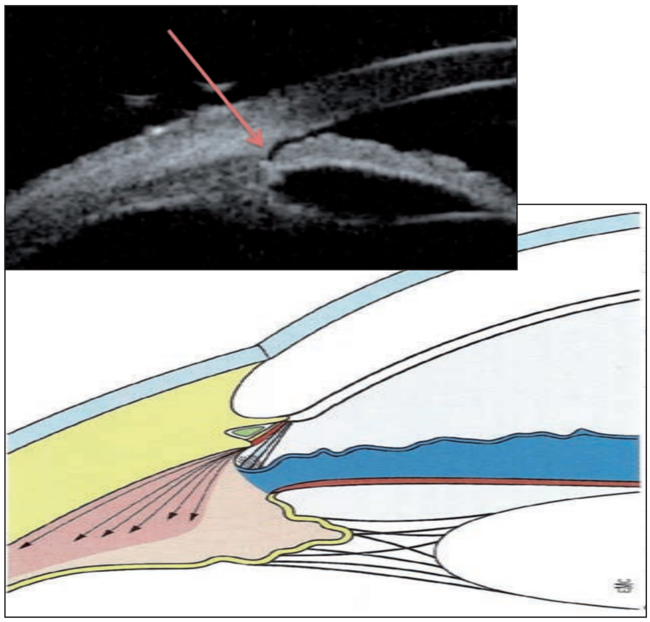


Figure 2. *Schlemm's canal and trabecular meshwork is not clear by UBM, is roughly sketched by OCT. The landmark remains its posterior limit: the scleral spur. On the ultrasound examination, the scleral spur is only seen by UBM on a meridian cross-section.*

The scleral spur is the only ultrasound landmark of the angle structures, and it is localised by the intersection of the internal curves of the cornea and of the sclera (*figure 3*).

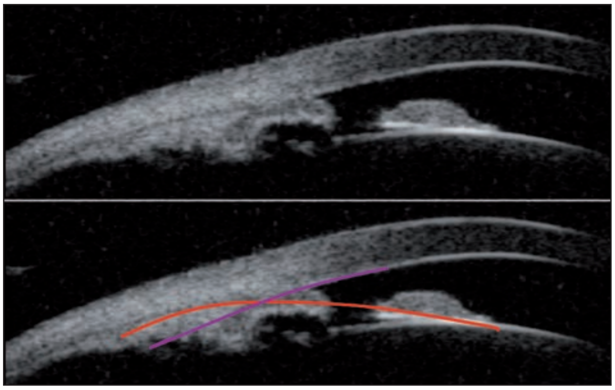


Figure 3. *When the angle is closed, the spur is located at the junction of the curves of the internal faces of the sclera and of the cornea. Note the closed angle despite penetrating iridotomy.*

We can therefore:

- again assess the curve of the plane of the iris, convex, flat or concave,
- evaluate iridial angle opening, open, narrow, flute mouthpiece or closed (the degree can be determined using special calipers), check changes in angle-closure according to light or dark conditions (*figure 4*),

Figure 4. ***A.*** *Open angle;* ***B.*** *Narrow flute mouthpiece angle;* ***C.*** *Closed angle, arrow showing spur.*

- note the position of the ciliary processes with respect to the perpendicular dropped from the scleral spur, and thus assess the potential anteroposition of the ciliary processes tipping the root and iris periphery forwards (*figure 5*).

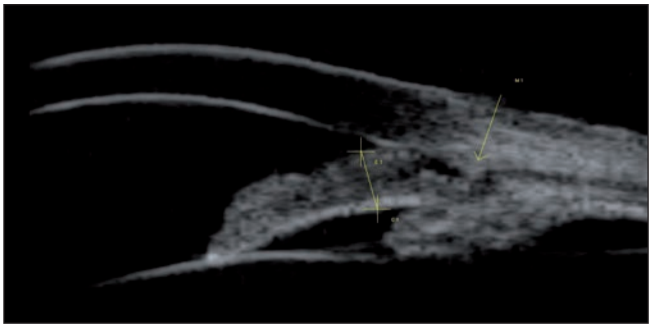


Figure 5. *The location of the scleral spur makes it possible to determine forward tipping of the ciliary bodies perpendicularly to the scleral spur and to point to a plateau iris configuration. Note the thick iris and the slightly convex iridial plane, along with a partially closed angle and persistent, discreet peripheral recess.*

Biometry of the eyeball in conventional B mode (10 MHz) provides the axial length and lens thickness. This examination in B mode can also be used to study the anatomy of the posterior segment (*figure 6*).

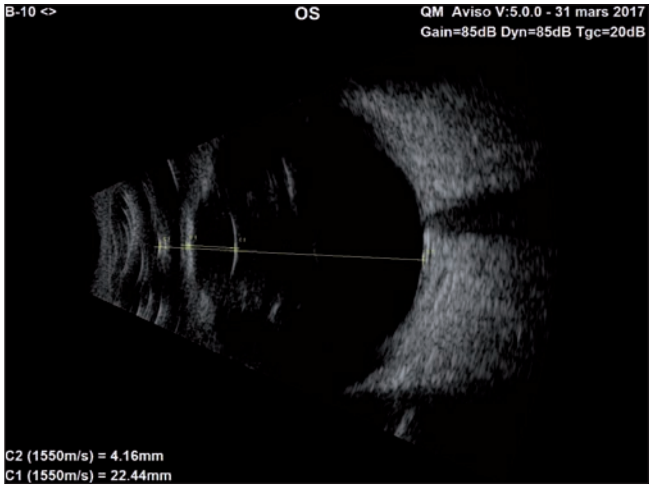


Figure 6. *Axial cross-section in B mode, 10 MHz: lens axial length and thickness measurement.*

Primary closure

All of this information points to the iridial angle-closure mechanism by pupil blockage, by plateau iris, and to post-iridotomy plateau iris syndrome.

Pupil blockage: the elements pointing to a pupil blockage picture are the narrow chamber, the high lens rise, and the protruding iris, without tipping of the ciliary processes. In this picture, if iridotomy is performed, the ultra-

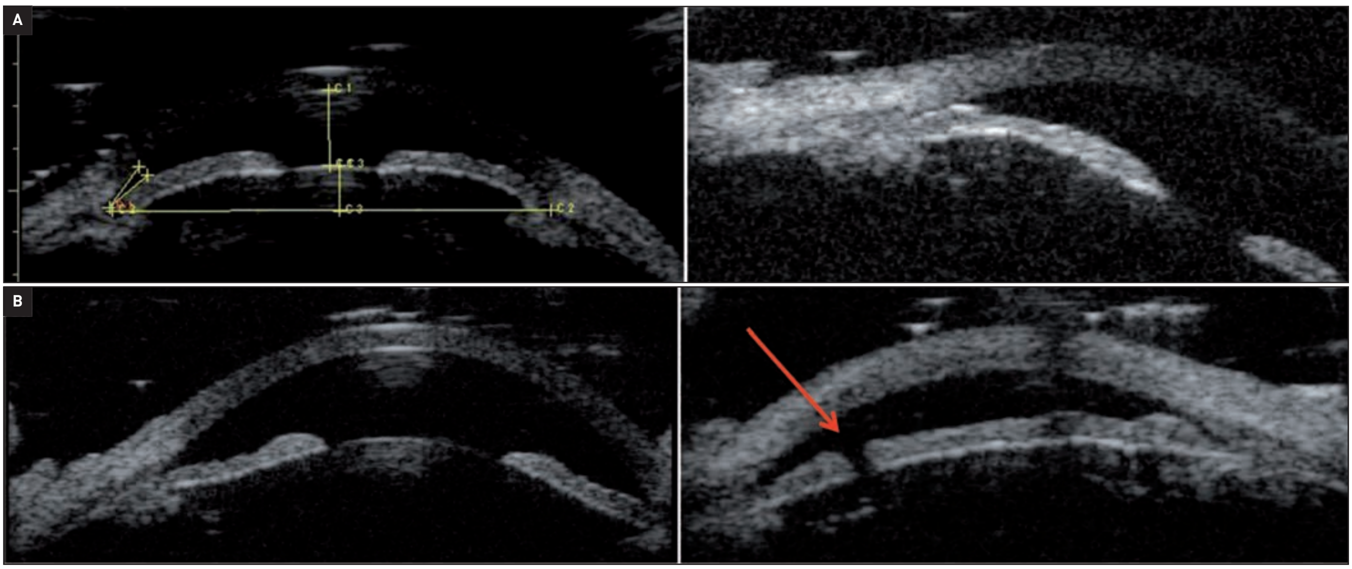
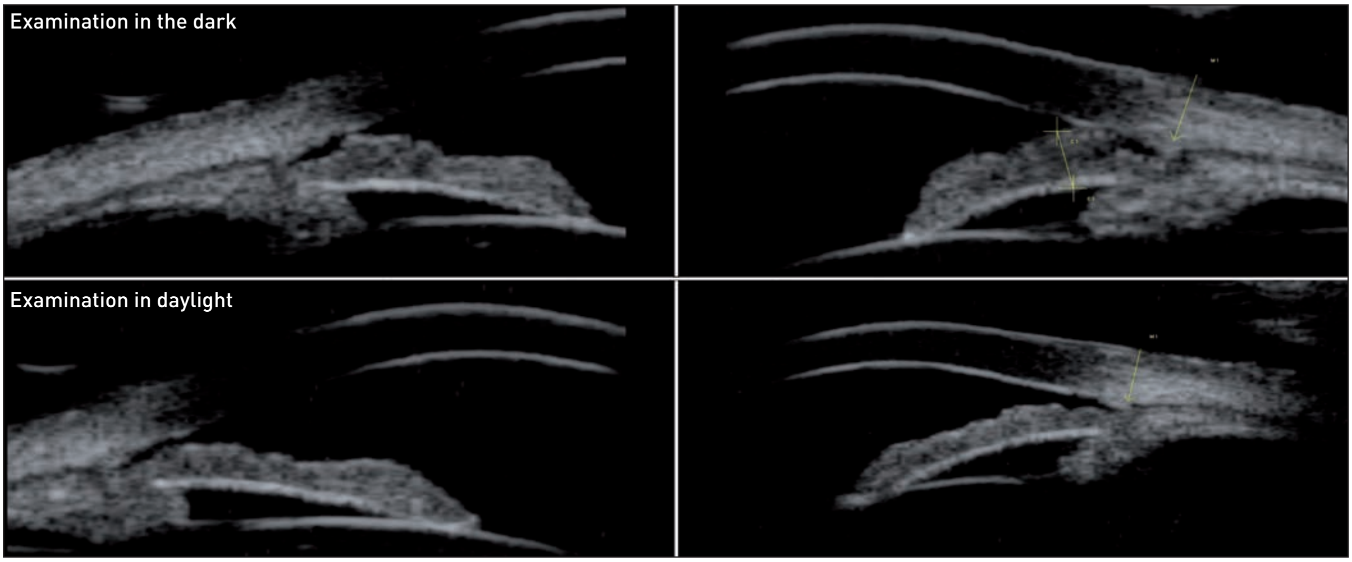


Figure 7. *Angle-closure picture by pupil blockage.* ***A.*** *Before iridotomy, iris convex, angle closed;* ***B.*** *After iridotomy, iris flat or even a little concave and widened angle. Arrow showing iridotomy.*

sound should confirm flattening of the iridial plane, widening of the angle, the potential presence of synechia, and the penetrating nature of the iridotomy (*figure 7*).

Plateau iris configuration: the elements pointing to plateau iris structure are an anterior chamber which may have a normal depth, a thick iris and especially forward tipping of the ciliary processes coming into contact with the posterior face of the peripheral iris, pushing it towards the peripheral cornea. The frequent association of this aspect with even relative pupil blockage, confirmed by a convex iris, means iridotomy is indicated to remove this potential additional element (*figure 8*).

Plateau iris syndrome: the determining elements of plateau iris syndrome is the absence of widening of the angle in a plateau iris configuration *after iridotomy* (*figure 9*). The ultrasound confirms the absence of reopening despite penetrating iridotomy.



▲ ***Figure 8.***
Plateau iris configuration is suggested given a 'closable' angle, according to dilatation of the iris (examination carried out in the dark then in light, ~~top images in the dark, bottom images in daylight~~).

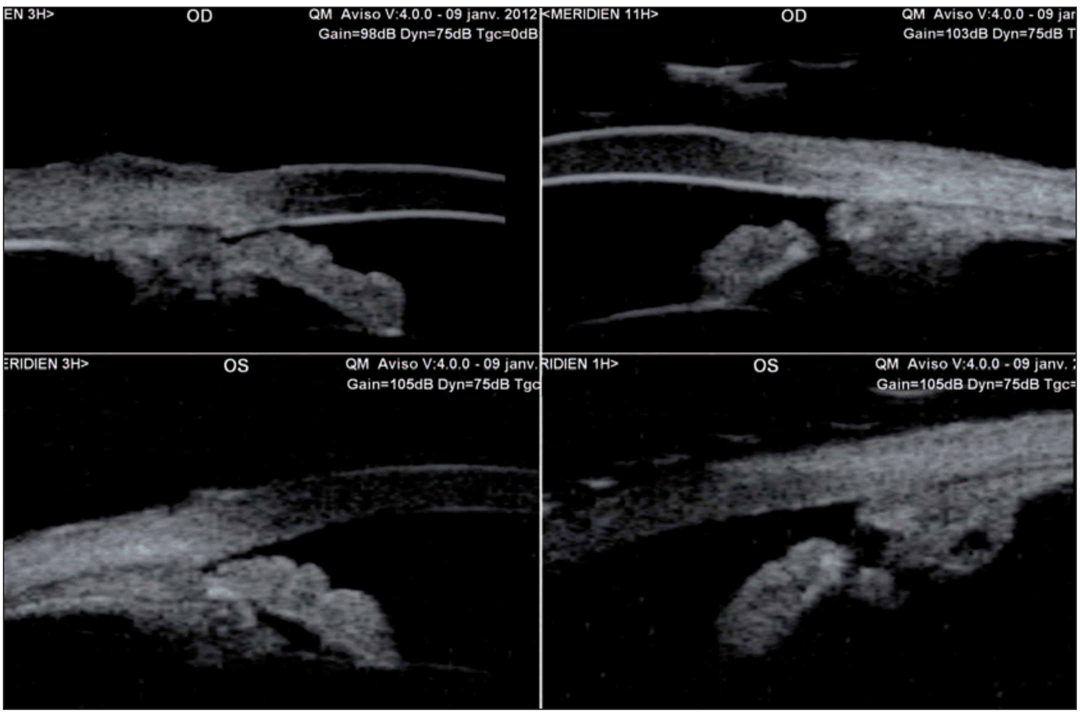


Figure 9.
Plateau iris syndrome is defined by persistent angle-closure in a plateau iris configuration despite iridotomy (right eye top, left eye bottom).

Secondary closure

These closures can be confined or diffuse, with numerous aetiologies: cysts, tumours, anterior chamber implants, injury, haemorrhages, inflammation, uveal effusion, malignant glaucoma, etc.

Ultrasound is therefore useful if the cornea is not transparent, but not only, as it is used to view the sclera and the ciliary region in all cases. Here are some illustrations (*figures 10-19*).

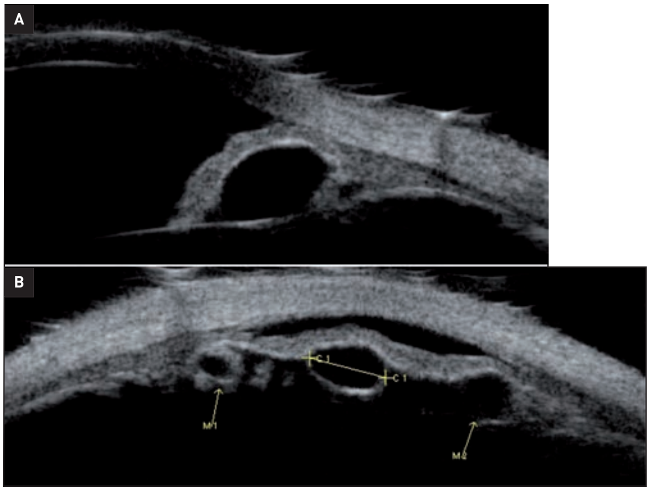


Figure 10. *Confined angle-closure:* ***A.*** *Ciliary cyst in the posterior chamber, isolated on the meridian cross-section, large (1.6 mm), it closes the angle, or* ***B.*** *multiple on the cross-section (tangential to the corneal margin).*

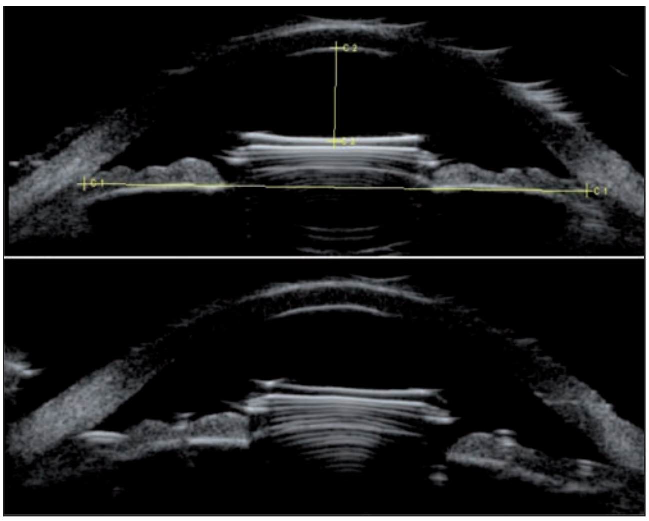


Figure 11. *Complications from anterior chamber implants. Cross-section not passing through the haptic: centred optic. Angle to angle diameter = 11.6 mm, endothelium ICA distance = 2.1 mm. Cross-section passing through the haptic: the haptic indents the iris to the back and presses on the bottom of the angle.*

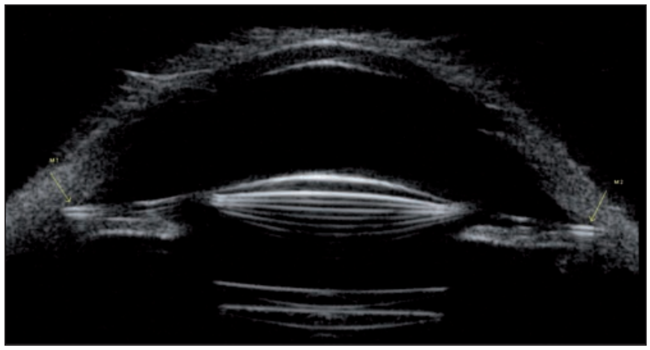
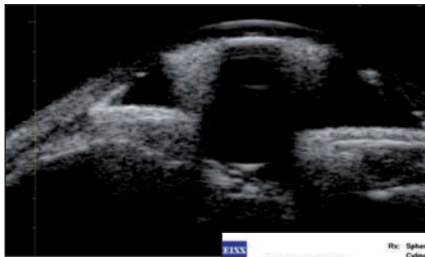


Figure 12. *Complication from anterior chamber implants. Other patient, hypertonia and eye pain. Cross-section passing through the haptic: the loops have penetrated the angle tissue (M1 and M2).*



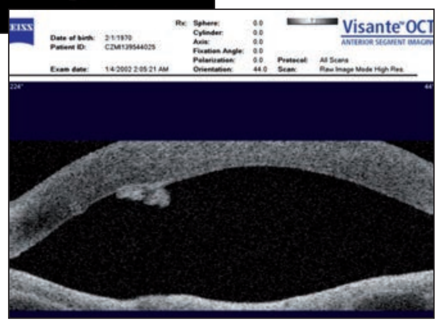


Figure 13. *Silicone in the anterior chamber. Presence of numerous artefacts meaning the ultrasound image cannot be interpreted. The image by OCT Visante is not affected.*

Figure 14. *Goniosynechia, and effect of cyclodestruction: meridian cross-section: M1 = angle opacification/goniosynechia; M2 = ciliary body atrophy; M3 = iris-lens synechia. Cross-section: marked ciliary process atrophy, the reliefs of which can be made out, and which have become echoic.*

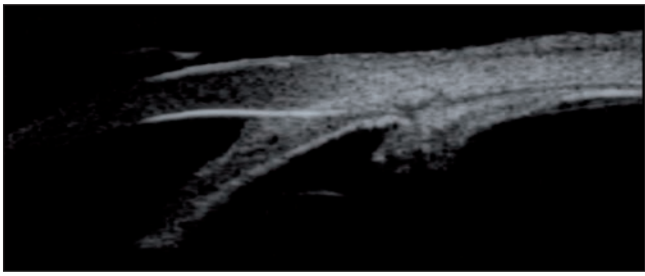


Figure 15. *Uveitis sequelae: extensive iridial-corneal adhesion obstructing the angle.*

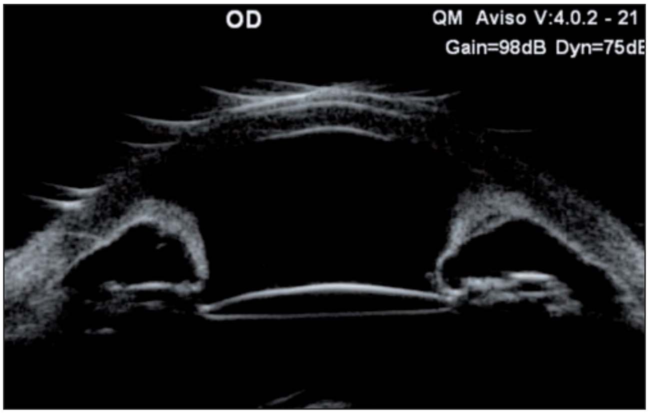


Figure 16. *Protruding iris: the peripheral iris is stretched, thinned and flattened against the cornea. The angle is closed. The edge of the pupil adheres to the anterior edge of the capsule, over 360°.*

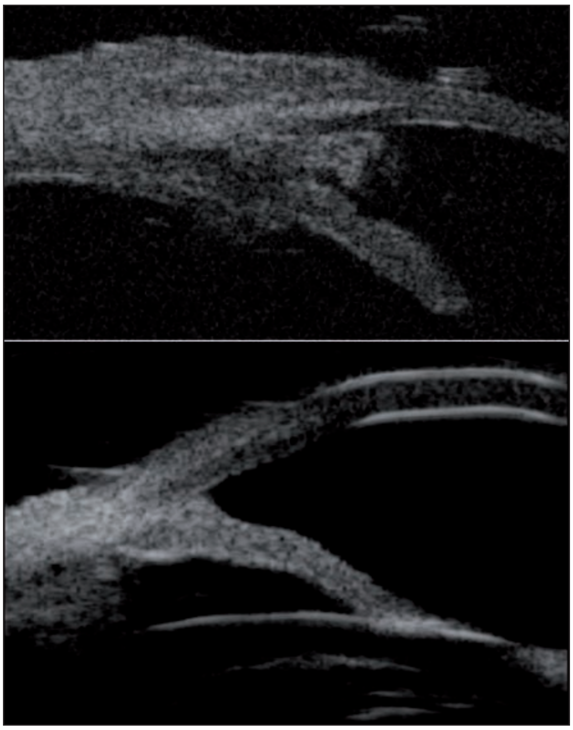


Figure 17. *Inflammatory hypertonia of tumoral origin. Conjunctival lymphoma: the angle is obstructed by a jumble of echoes. Conjunctival thickening to the front. After chemotherapy: on the same meridian, presence of peripheral iridial-corneal adhesion = goniosynechia.*

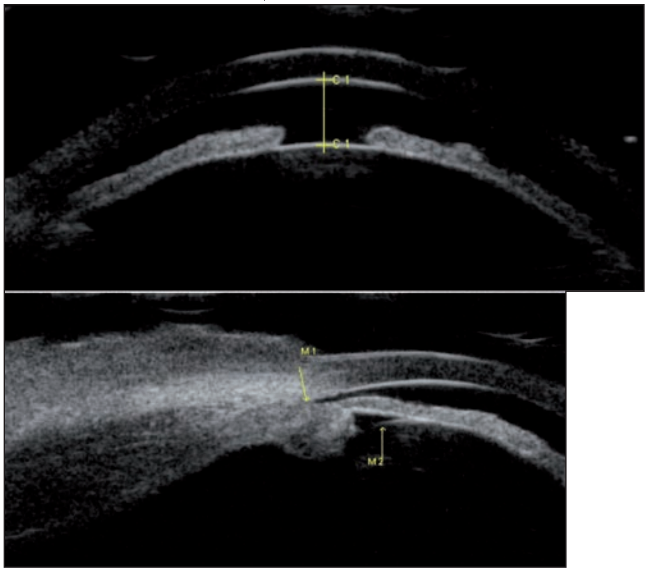


Figure 18. *Athalamia by uveal effusion. CA prof = 1.1 mm, lens width = 1.8 mm, the appearance is that of lens anterior subluxation. Very narrow and deep angle (scleral spur in M1). Double thickening of the wall by chemosis to the front and ciliary detachment to the back, inducing tipping of the ciliary process towards the cornea.*

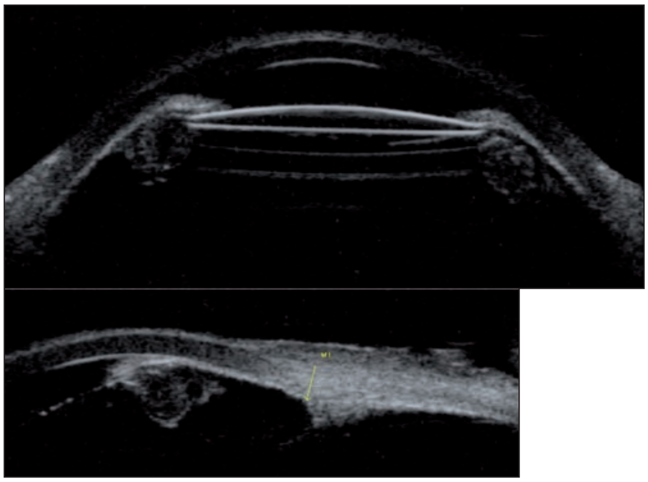


Figure 19. *Athalamia/malignant glaucoma: implant block + capsule + Sommering's ring (inter-capsular masses) are propelled into the CA. Meridian: the iris is stretched and flattened against the cornea from the scleral spur (arrow).*

Conclusion

Very high-frequency ultrasound is the most informative diagnostic test for studying the iridial angle. It can be used to view the ciliary bodies, along with the position of the iris in scotopic conditions. However, image quality depends on a highly accurate examination technique that only a trained and practised operator can achieve.