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How Ultrasound and OCT can be used as complimentary applications in 2021?

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The Quantel Medical symposium was held during the 127th congress of the French Society of Ophthalmology at the Palais des Congrès in Paris, with many participants present and many more joining by remote video link. The meeting "*What complementarity can we expect between ultrasound and OCT in 2021?*" was held on Sunday 9 May 2021. This topic raised questions concerning indications for ultrasound given the latest technical developments, with the Absolu ultrasound equipment featuring the annular probe, and OCT. We heard three presentations, on comparisons of analyses of the anterior segment, on the vitreoretinal interface, and on tumoural pathologies. Overall it was clear that technical developments in ultrasound are likely to see this technology retain a predominant place in these indications throughout 2021, in complementarity to OCT rather than competing with it.

Imaging of the anterior segment: the place of UBM

Communication given by Dr M. Puech (Explore Vision Centre, Paris and Rueil-Malmaison)

A large, illustrated and comprehensive presentation of the anterior segment, analysed by Ultrasound BioMicroscopy (UBM) in various indications and pathologies, privileging the analysis of the iridocorneal angle.

The UBM probe (very high frequency, short focal length, here 50 MHz) allows an excellent cross-sectional visualisation of the structures of the iridocorneal angle, but also of the structures behind the iris and the ciliary body. The examination can be carried out even in the event of loss of transparency (due to the principle of the ultrasound source), unlike OCT which can present defects, in particular in the visualisation of the structures of the posterior chamber (***fig. 1***). A study carried out at the Explore Vision

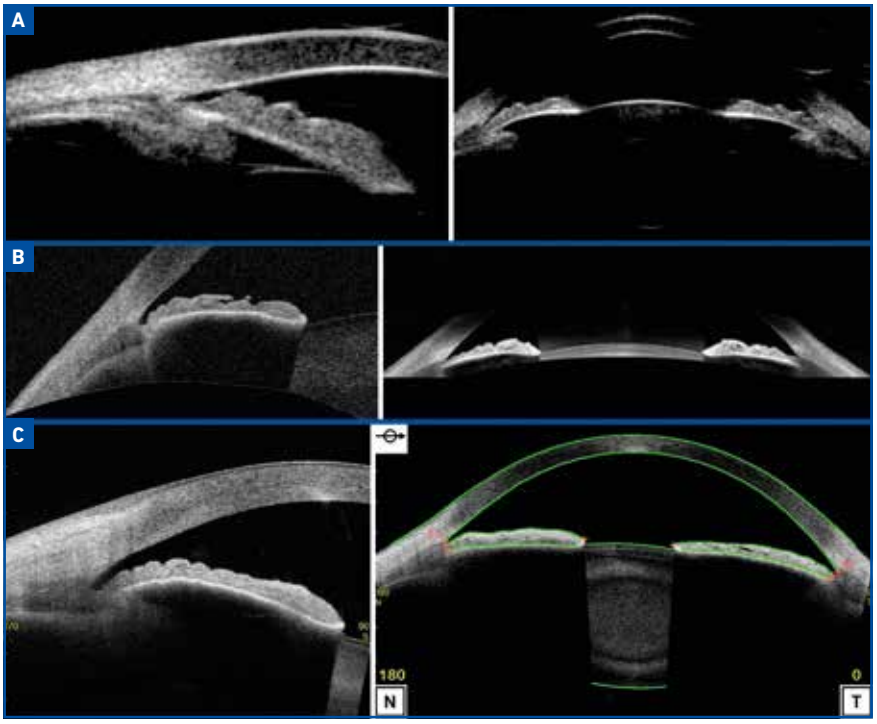

Fig. 1A: Ultrasound sections in UBM showing the perfect visualisation of the structures of the anterior segment and, in particular, of structures behind the iris. **B:** sections of the anterior segment in retinal OCT with anterior segment modulus. Note the high quality of the images at the cornea but the absence of visualisation of structures behind the iris. **C:** sections of the anterior segment from an OCT of the anterior segment (with specific wavelength) giving even higher precision at the cornea but still with absence of visualisation behind the iris.

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centre showed only partial visualisation of the structures of the posterior chamber during OCT of the anterior segment (even in swept source) in 42% of cases and a complete absence of visualisation in 58% of cases.

UBM makes it possible to make both qualitative and quantitative analyses, with biometric measurements of the anterior segment, in all cases. These measurements can be carried out with a perfect visualisation of the structures. It is thus possible to analyse the iridocorneal angle and to proceed with biometry of the anterior segment in preparation for surgical intervention. The lens vault gives a reflection of the resonance of the lens in front of the iris, which can help to inform surgical indications for the lens. The examination can shed light on the mechanisms of angle closure and allows the analysis of lesions and tumours, assessment in the case of trauma, and a detailed analysis of implants (anterior and posterior chamber, phakic or pseudophakic).

UBM is a dynamic examination with cross sections possible under photopic and scotopic conditions to analyse the closure of the angle in physiological mydriasis. As a reminder, there is always a gradation of angle closure — it appears more open in gonioscopy than in OCT, and in UBM than in OCT. This is essentially a result of the lighting necessary, which induces a slight residual miosis. Among the different angle closure mechanisms, we may find plateau iris, lens factors, iridociliary cysts, pupillary block or anterior insertion of the iris root, for example. Plateau iris is defined by ultrasound as follows: angle closure, anterior position of the ciliary processes and absence of a ciliary sulcus.

UBM can be used post-iridotomy to analyse the therapeutic effect. We should then be able to see a reopening of the angle or, conversely, an absence of reopening linked to a non-transfixing iridotomy or related to an anatomical configuration such as synechiae, anterior insertion of the iris or plateau iris. Iris curvature is an excellent indication under UBM in analysing the cause, with a fine tissue analysis giving a diagnostic orientation in the event of benign or fluid lesions, or where there is a suspicion of a malignant lesion, with very distinct echographical criteria. In the event of trauma, it is possible to perfectly visualise the structures of the angle and the lens, even in the presence of hyphema or total corneal opacity.

Finally, precision measurements can used for safety in the case of anterior chamber phakic implantation, in particular for determining the distance from the endothelium, and for visualisation of the ciliary processes in the case of phakic implantation in the posterior chamber, in order to avoid poor implant positioning in patients with plateau iris anatomy or iridociliary cysts.

To conclude, the main advantages of the UBM are its perfect visualisation behind the iris, the possibility of clear analysis even in the event of loss of transparency, with precise measurements making it possible to determine the mechanisms of angle closure, analysis of lesions, analysis of trauma and precise preoperative assessment for phakic implantation.

Applications of the annular probe in vitreoretinal pathologies

Communication given by Dr M. Streho
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Saint-Mandé)

The objective of this presentation was to highlight the major interest of ultrasound in the analysis of the vitreoretinal interface, as a complement to OCT, and to show the contribution in terms of image quality of the new 20 MHz annular probe used with the Absolu ultrasound machine (Quantel Medical).

Ultrasound is a "cross sectional" imaging technique, ideal for analysing the vitreoretinal relationship and distinguishing physiological vitreous detachment from pathological detachment, which can have extremely serious consequences. In comparison to OCT, ultrasound offers a wide examination window (more than 25 mm), regardless of any disorders of the transparent media that may be present. Analysis is possible even in the presence of total cataract, hyphema or intravitreal haemorrhage. The resolution is clearly lower than OCT but largely sufficient for the precise analysis of the vitreoretinal interface (***fig. 2***). In addition, the penetration of ultrasound allows analysis of the vitreoretinal interface at the posterior pole, both in the middle and at the extreme periphery. Ultrasound makes it possible to visualise tractions, tears and detachments of the retina, even in the extreme periphery.

To carry out a high quality examination, it is advisable to remember the two golden rules of ultrasound: perpendicularity to the structure analysed, and always examining an area of interest using two perpendicular views. The examination must be systematic and dynamic to analyse the hyaloid canal correctly. This will be well visualised on an ultrasound section as a fine, undulatory membrane with ample mobility, free of traction. Ultrasound can also analyse the vitreous for floaters and identify their number, size and location. Analysis of the periphery in symptomatic cases can verify the absence of traction, operculum or tearing. Retinal detachment presents as a thicker, less mobile membrane with a "spring" movement. In case of retinal detachment, the location of the detachment and the mechanism should be determined, the axial length measured and the contralateral eye examined.

In order to analyse the performance of the annular probe, we anonymously submitted 29 ultrasound sections to 5 experts at the Explore Vision centres, comparing the classic 20 MHz probe to

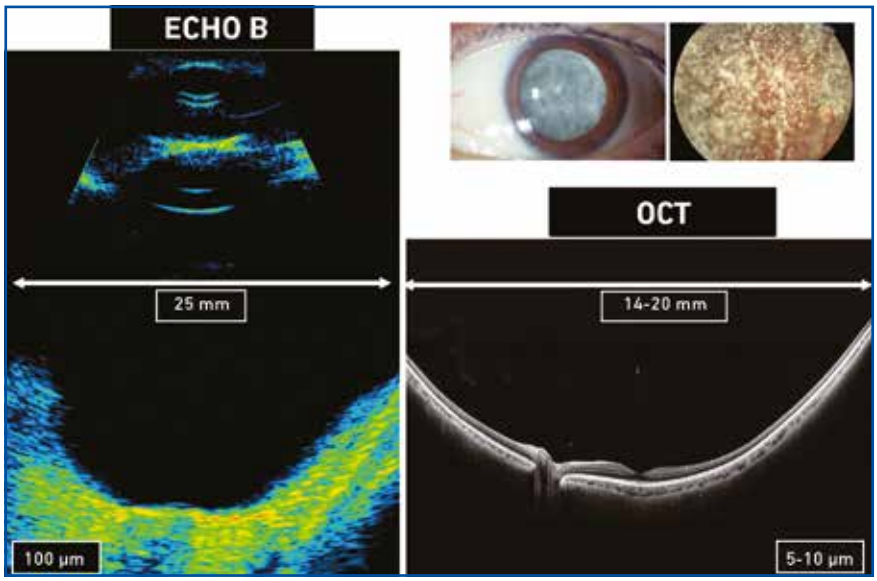

Fig. 2: Comparison of an ultrasound section and an OCT section. Note the lower resolution but wider examination window for the ultrasound, possible even in the event of disturbances of the transparent media.

the 20 MHz annular probe. It appears that we have more than an 80% preference for the annular probe in 65.5% of cases, in particular for the analysis of the vitreous humour, the vitreo-retinal interface and large parietal lesions. These results are primarily due to the technical properties of the annular probe, which appears to give better depth of field, better resolution and higher quality images.

As we have seen, recent technical developments in ultrasound have placed this imaging technique at the forefront for analysis of the vitreo-retinal interface. It is clearly complementary to OCT, with different indications and informational content.

Complementarity of ultrasound and OCT in imaging of posterior pole tumours

Communication given by Dr L. Rosier (Centre Rétine Gallien, Bordeaux)

This presentation began with a reminder that the diagnosis of choroidal tumours is essentially based on clinical examination, although multimodal imaging is clearly playing an increasingly important role, first and foremost with ultrasound and OCT. Dr Rosier also reminded us of the advantages of ultrasound: exploration of the eye whatever disturbances of transparency are present (with the exception of silicone oil), giving a quantitative and qualitative analysis with a diagnostic orientation. The best analysis is performed with the 20 MHz probe with a resolution of 100 µm.

Choroidal naevus is the most frequent tumour type (prevalence 5%). It may be flat or mildly protruding, less than 2 mm in height and some 5 mm in diameter. On the ultrasound image, ideally acquired using the 20 MHz annular probe, the lesion surface is hyper-reflective with homogeneous internal reflectivity (***fig. 3***). OCT, ideally acquired in Enhanced Depth Imaging mode, gives a typical appearance, sometimes with a neovascular complication, testifying to the chronic (and therefore benign) nature of this lesion type. The naevus is most often stable, but requires regular monitoring given the rare risk of malignant transformation.

A suspected choroidal naevus should indicate a search for a small melanoma. As a rule of thumb, each millimetre of lesion growth increases the risk of metastasis by 10%. The criteria for Shields tumour growth are clinical and echographic: "*To Find Small Ocular Melanoma Using Helpful Hints Daily*" is a mnemonic for the six growth criteria: T, thickness over 2 mm; F, fluid; S, symptoms; O, orange pigment; M, margin within 3 mm of the optic disc; UH, ultrasound hollow; H, halo absent; and D, drusen absent. In the presence of three or more of these criteria, the risk of malignant transformation is greater than 50%. Ultrasound is therefore the reference examination in case of a suspicious naevus, with thickness and diameter measurements used to document progression and to analyse the echoic structure of the lesion.

Choroidal melanomas give a typical appearance on the ultrasound image with a hypoechoic lenticular, domed

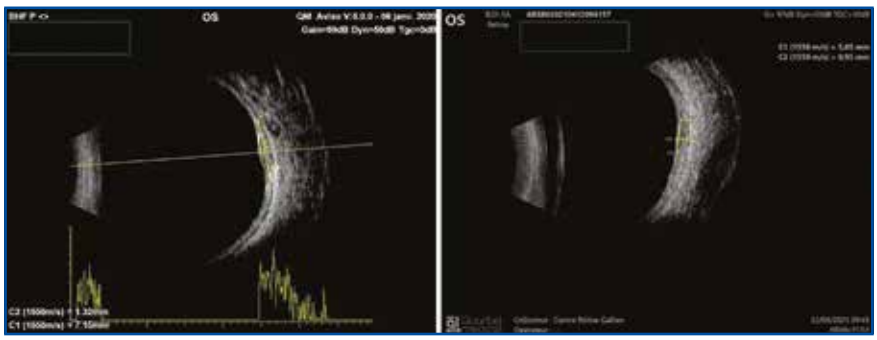

Fig. 3: Ultrasound sections of a choroidal naevus using the 20 MHz annular probe. Note the typical isoechoic character, with no associated choroidal excavation

or mushroom shape, with signal attenuation, choroidal excavation, scleral invasion and sometimes an associated retinal detachment. Ultrasound can be used for diagnosis, but also for the planning of proton therapy. The diagnosis is therefore based on both clinical and ultrasound examinations. OCT is invaluable in evaluating the impact of radiotherapy on the macula (post-radiation maculopathy).

Among the rarer tumours, melanocytoma is a highly pigmented, usually papillary, benign tumour which gives a hyperechoic appearance on the ultrasound image. Choroidal metastases are most often located retro-equatorially, near the posterior pole. Echographically, the lesions have an irregular dome shape which may be more or less poly-lobed, with rather hypoechoic or heterogeneous echogenicity and, commonly, exudation which can lead to retinal detachment. Circumscribed choroidal haemangiomas are rare, benign tumours (15 times less common than choroidal melanoma). The ultrasound section shows a hyperechoic biconvex lesion which may be associated with a fine hyperechoic membrane corresponding to an exudative detachment of the retina. Within the rarer lesions, retinoma is a localised hyperechoic lesion with a large posterior shadow cone. Calcifications such as osteoma or episcleral calcification also give a highly hyperechoic wall with a posterior shadow cone. In secondary uveal lymphomas (marginal zone B-cell lymphoma of mucosa-associated lymphoid tissue (MALT) type or metastatic dissemination of lymph node lymphoma), a diffuse choroidal thickening is observed, often associated with retinal detachment and, commonly, extra-scleral invasion.

In summary, ultrasound remains an examination of primary importance in the differential diagnosis and follow-up of choroidal tumours. Analysis in mode A allows a tissular approach, while analysis at 20 MHz and with an annular probe allows higher resolution. The interest is very high in case of disturbance of the ocular media. The principal limitation of ultrasound is its operator-dependent character and the non-dedicated profession. Ultrasound and OCT are complementary techniques, each with their respective indications.

The author declares to have no conflict of interest regarding the data published in this article.