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High-frequency ultrasound and vitreo-retinal imaging

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The ultrasound symposium organised by Quantel Medical and chaired by Dr Michel Puech as part of the first online conference of the French Ophthalmology Society (*Société Française d'Ophtalmologie*) took place on Sunday, 6 September 2020. The session considered the benefits of the annular 20-MHz high-frequency ultrasound probe (Absolu®, Quantel Medical) and the UBM probe (50 MHz) for the analysis of the posterior segment.

Posterior ocular wall imaging with the annular 20-MHz probe

Based on the presentation by
Dr P. Pégourié (Rives Ophthalmology Practice and Grenoble Alpes University Hospital)

Standard linear ultrasound probes (10 and 20 MHz) have a single transmitter and are focused at 20–25 mm, i.e. around the wall of the eyeball. The 10-MHz probe provides an overall view, with excellent visualisation of the vitreous and the orbit. This probe is a good all-rounder that can be used to guide the 20-MHz probe examination. Due to its high frequency, the 20-MHz probe offers superior resolution and allows for a more detailed assessment, particularly of parietal lesions. However, it cannot be used to visualise the vitreous, and the orbit is less easy to analyse.

Quantel Medical's Absolu® ultrasound platform has an annular 20-MHz probe that use five concentric transducers to generate alternating ultrasound waves, offering high-frequency resolution—including for transpalpebral use—and a depth of field that enables equally good visualisation of the vitreous and the orbit, as well as the posterior ocular wall. This new probe can therefore replace the two standard probes, reducing examination times while improving vitreous and orbit image quality.

Several examples of its clinical application were presented, in particular the diagnosis of tumours in the posterior segment.

>>> **Choroidal melanoma** is the most common type of malignant tumour. It can be fusiform, dome-shaped or even "mushroom"-shaped, if it passes through Bruch's membrane. It tends to be hypoechoic, with a decrease in echoes as the ultrasound passes through the lesion (negative kappa angle). Clinicians should look for choroidal excavation and scleral invasion. Measuring the base of the tumour, in particular its thickness, is valuable for diagnosis, treatment and monitoring purposes.

>>>**A choroidal naevus** is usually lenticular, isoechoic or slightly hyperechoic, and clearly defined. The ultrasound criteria indicative of a suspected naevus are tumour thickness of over 2 mm, a diameter of over 5 mm and hypoechoic tonality with choroidal excavation [1].

>>> **Circumscribed choroidal haemangioma** is a hyperechoic, lenticular or dome-shaped tumour, with no choroidal excavation.

>>> Finally, choroidal osteoma and idiopathic sclerochoroidal calcification are highly hyperechoic, with posterior acoustic shadowing.

A comparison of annular 20-MHz and linear 20-MHz ultrasound examination

Based on the presentation by
Dr M. Streho (Explore Vision Centre, Paris and Rueil-Malmaison, Hôpital Lariboisière, Paris and Bégin Military Teaching Hospital, Saint-Mandé)

Quantel Medical's Absolu® ultrasound platform has an annular 20-MHz probe with five concentric transducers that provide unique image depth, resolution and motion.

A study comparing the annular 20-MHz probe to the standard linear 20-MHz probe was conducted at the Explore Vision Centre in Paris. The aim was to analyse the differences between the information provided by the two probes based on various criteria (image quality, analysed area, ease of diagnosis) and to determine which probe was best for a given disease. Twenty-nine cases were examined with the two 20-MHz probes —the linear Quantel Medical Aviso S and the annular Quantel Medical Absolu®— at the same incidence level, by the same operator and with the same gain. The images were analysed blind by five ophthalmologists specialising in ocular ultrasound, in order to identify the benefits and limitations of each probe.

The annular 20-MHz probe can produce simultaneous images of the vitreous, hyaloid and posterior ocular wall with excellent resolution; whereas the linear 20-MHz probe does not reveal the vitreous. The annular 20-MHz probe is therefore better than the linear probe for analysing the vitreoretinal interface. With thick, large lesions, the signal quality rapidly decreases when using the linear probe, whereas the annular probe has a greater depth of field, meaning it can produce a very detailed image of these lesions in their totality (***Fig. 1 and 2***).

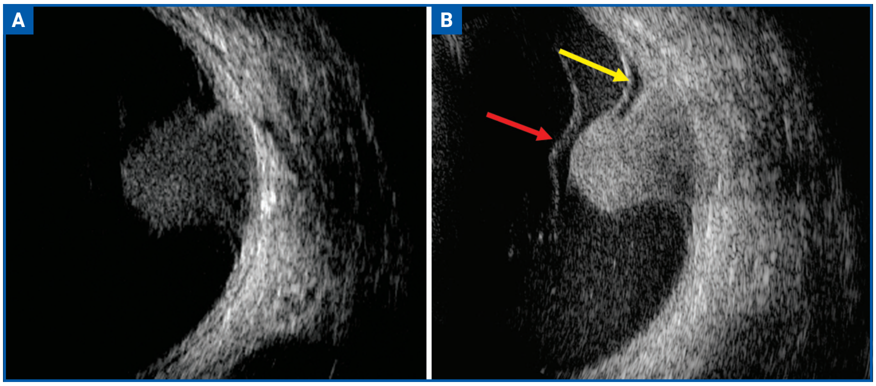

Fig. 1: Comparison of the standard 20-MHz probe (**A**) with the annular 20-MHz probe (**B**) on a typical, mushroom-shaped choroidal melanoma. The tumour is hard to see with the standard probe due to its significant thickness. With the annular 20-MHz probe, the contours of the tumour are perfectly identifiable and a peri-lesional exudative retinal detachment is visible (**yellow arrow**). The vitreous is also visible, with a posterior hyaloid detachment (**red arrow**) and fine retrohyaloid condensation.

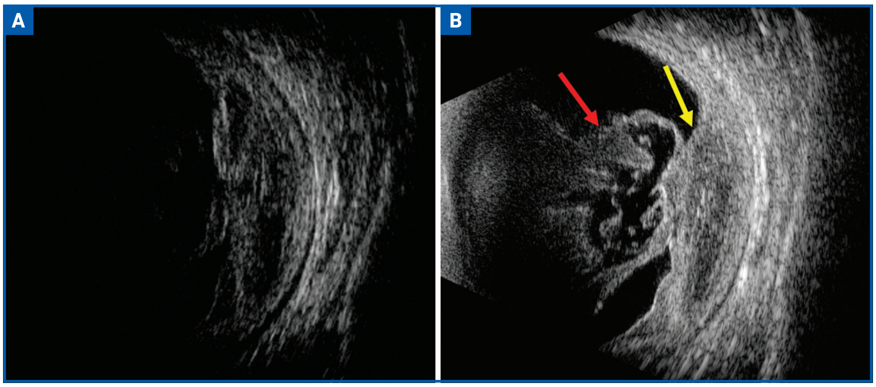

Fig. 2: Comparison of the standard 20-MHz probe (**A**) with the annular 20-MHz probe (**B**) on a parietal haematoma associated with decompensated neovascular AMD. The absorption of the signal with the standard probe, linked to the thickness of the lesion, reduces the image quality. With the annular probe, the parietal analysis is clearly more detailed, with significant heterogeneous thickening linked to the haematoma (**yellow arrow**). It also allows for simultaneous analysis of the vitreous, which reveals intravitreal haemorrhage (**red arrow**).

Vitreous imaging with the annular 20-MHz probe

Based on the presentation by
Dr V. Caillaux (Explore Vision Centre, Paris and Rueil-Malmaison, Hôpital Lariboisière, Paris)

Today, B-mode ocular ultrasound remains the best technique for examining the whole of the vitreous and the vitreoretinal interface. As we saw earlier, the new annular 20-MHz probe offers simultaneous analysis of the posterior ocular wall and the vitreous.

The normal vitreous is anechoic in childhood, after which floaters appear, in the form of fine vitreous condensation. When posterior vitreous detachment occurs, the posterior hyaloid is visible as a thin membrane, moving in an undulating fashion when the eyeball moves. Examination of the periphery will involve looking for vitreoretinal traction, an operculum on the posterior

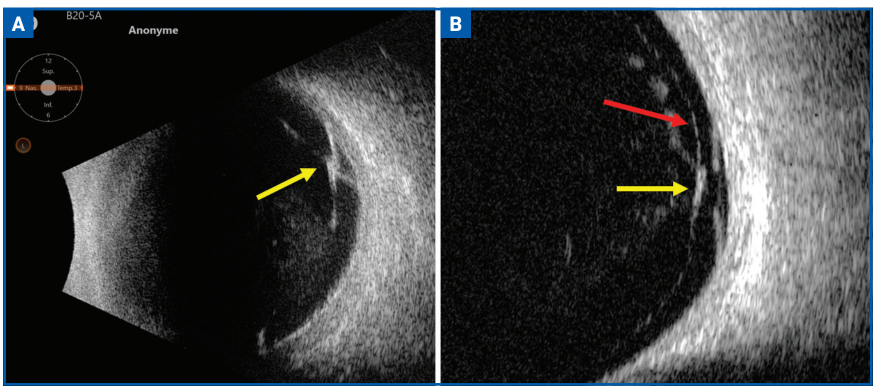

Fig. 3: Analysis of the vitreoretinal interface. **A:** proliferative diabetic retinopathy complicated by a thin intravitreal haemorrhage with "tented" tractional retinal detachment (**arrow**). The accelerometer located in the top left of the image automatically indicates the image plane: here, a longitudinal slice taken at 9 o'clock. **B:** horseshoe retinal tear (**yellow arrow**). The posterior hyaloid (**red arrow**) is attached to the flap. The retina is slightly raised along the tear.

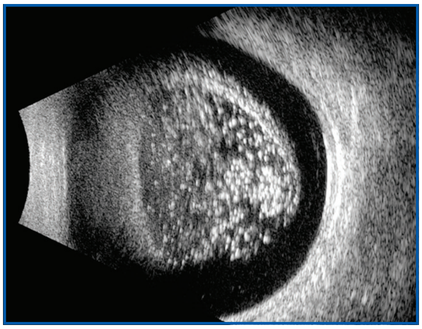

Fig. 4: Asteroid hyalosis visualised with the annular 20-MHz probe, allowing excellent simultaneous visualisation of the vitreous and the posterior ocular wall.

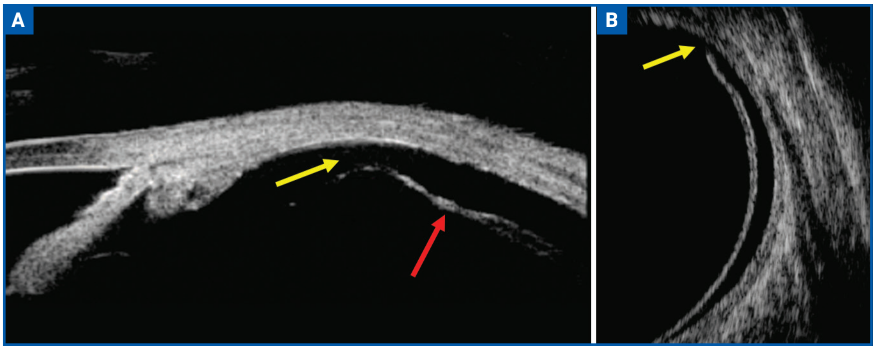

Fig. 5: UBM longitudinal slice (**A**) showing a retinal detachment (**red arrow**) with a dialysis at the ora (**yellow arrow**). Comparative analysis with a 20-MHz posterior segment probe (**B**) confirming the presence of a retinal detachment and showing the opening at the ora.

hyaloid (indicative of a retinal hole) or a retinal tear, the flap of which is attached to the posterior hyaloid (***Fig. 3***).

Intravitreal haemorrhage appears as vitreous condensation of varying density, often heterogeneous, since blood does not dilute fully in the vitreous gel. It may be associated with retrohyaloid haemorrhage, which will be more homogeneous due to the diluting effect of the aqueous humour.

The posterior hyaloid is often thickened due to haemorrhage. Ultrasound examination can be used to identify the cause of the intravitreal haemorrhage. Causes can include posterior vitreous detachment, peripheral retinal tear, preretinal neovascularisation (diabetic retinopathy or vein occlusion), peripheral choroidal neovascularisation and macular haematoma linked to age-related macular degeneration (AMD, ***Fig. 3***). Clinicians will also look for retinal detachment.

Asteroid hyalosis has a highly characteristic appearance in ultrasound images: very large numbers of very dense, highly hyperechoic dots moving within the vitreous, associated with a preretinal anechoic halo (***Fig. 4***). Ultrasound can be useful after retinal surgery, when the fundus is hard to access. A vitrectomised cavity is anechoic. If intracavitary haemorrhage is present, homogeneous intracavitary condensation will be observed. The presence of gas or silicone oil tamponade makes it difficult to examine the posterior ocular wall. Certain sectors may be accessible when the patient moves their head, but the analysis often remains incomplete.

The benefits of UBM for retinal periphery imaging

Based on the presentation by
Dr M. Puech (Explore Vision Centre, Paris and Rueil-Malmaison)

The value of UBM for iridocorneal angle analysis is well known. However, the very high frequency probe (50-MHz) can offer more than just angle analysis. It provides high-resolution direct access to the extreme retinal periphery. This enables the user to explore the vitreoretinal interface and visualise tears that are very small or very anterior. Some tears that can be difficult to access with posterior segment probes can be viewed more easily, such as retinal dialyses (***Fig. 5***).

UBM also helps with the differential diagnosis of retinal detachment versus peripheral retinoschisis. With the latter condition, it can be used to look for an opening in the internal or external layer. Pars plana cysts are relatively common. If these cysts are large, clinical examination of the fundus may suggest the presence of a solid parietal tumour. UBM can easily correct this diagnosis by revealing a cyst-like bubble of fluid behind the ciliary body.

Ciliochoroidal detachments can be easily visualised with UBM, showing the extension into the ciliary body.

UBM is also very useful for tumours located in the extreme retinal periphery and ciliary body. These highly anterior lesions cannot be viewed in their totality with B-mode ultrasound probes. UBM reveals the full extension of the tumour and any interaction with the iris and ciliary processes, and enables measurements to be taken.

Peripheral vascular lesions, such as peripheral exudative haemorrhagic chorioretinopathy and peripheral choroidal neovascularisation, are visible in UBM images as areas of hyperechoic parietal thickening, sometimes with heterogeneous tonality, with a bumpy or irregular surface. UBM enables the clinician to rule out ciliary body involvement and to take measurements in order to monitor progression.

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