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Ultrasound Biomicroscopy – Enduring Clinical Value After a Quarter Century

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The technique of ultrasound biomicroscopy (UBM) was described by Pavlin in *Ophthalmology Rounds* 10 years after the introduction of this important imaging technology. Despite the development of newer imaging technology, UBM remains the mainstay of anterior-segment imaging in that sound energy is able to penetrate structures that limit light transmission. In this issue of *Ophthalmology Rounds*, UBM technology is described to outline the enduring benefits of this form of imaging.

Imaging the human eye continues to play an indispensable role in the diagnosis and management of ocular abnormality and disease. Both light- and sound-based technologies have achieved impressive levels of structural definition and are used extensively throughout all aspects of ophthalmic practice. Ultrasound has provided unique advantages in this regard by employing B-scan, 2-dimensional, cross-sectional views of the intraocular space and orbit, particularly when anterior-segment pathology prevents adequate light penetration or when views of more peripheral posterior abnormalities are required. The capacity to view the anterior segment has been challenging both for light- and ultrasound-based devices due to the loss of light transmission with pigment absorption for light-based technology and the limitation of image resolution at high frequencies for ultrasound techniques. Ultrasound biomicroscopy (UBM), developed by Drs. Stuart Foster and Charles Pavlin 25 years ago in Toronto,[1] has provided a unique tool to evaluate the anterior segment of the eye which, at microscopic resolution, allows imaging of living structure in a noninvasive and relatively uncomplicated procedure. Dr. Pavlin described the technique and its clinical benefits in a 2004 issue of *Ophthalmology Rounds*.[2]

Since then, another technique of imaging the anterior segment of the eye, anterior segment optical coherence tomography (AS-OCT), has been developed. OCT employs the time delays of light waves reflected from the various depths of the target sample to reconstruct a 3-dimensional image. Despite the introduction and refinement of AS-OCT, UBM continues to be the mainstay of anterior-segment imaging.[3]

Basics for Imaging

Ultrasound employs the region of sound waves in the acoustic spectrum above the limits of human audibility. The frequency of sound waves determines its tone or pitch; low frequencies produce low tones and high frequencies produce high tones. Ultrasound produces vibrations with a pitch so high that it is not audible to the human ear, and frequencies above 18 kHz are usually considered to be ultrasonic. Higher image resolution suffers the penalty of limited penetration into tissue. The maximum penetration achievable for a 10-MHz system is about 50 mm, but for a 60-MHz system (a range employed in some UBM systems) the image resolution is reduced to about 5 mm. Posterior pole imaging is therefore impossible with high-frequency ultrasound; however, anterior-segment definition can be resolved in a manner to be clinically valuable. Although laboratory systems have achieved frequencies of 100 MHz, currently available instrumentation employs between 20 MHz and 50 MHz to provide more than satisfactory resolution for analysis of the anterior segment.

A Noninvasive Procedure

Examination of the eye by UBM uses a fluid immersion technique, similar to that of conventional B-scan imaging. This allows sufficient standoff from the structures being examined to avoid image distortion close to the transducer as well as prevention of the transducer from coming into contact with the ocular surface. Figure 1 shows the patient positioned supine, with the probe held

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