Fourier domain OCT scans faster, reduces patient exam time

The imaging technology can be used for a variety of clinical situations.

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Accurate assessment of central and paracentral corneal thickness is essential in varied clinical settings. Correct assessment of central thickness is required in glaucoma evaluation and as indirect evidence of functionality of endothelial cells.

Anterior segment optical coherence tomography is a non-contact device that provides central and paracentral pachymetric data, along with biometric information, of the anterior segment and other details.

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Two principles

There are two principles of image acquisition and data processing in anterior segment OCT: time domain and Fourier domain algorithms.

In time domain OCT, there is a mechanical moving part that performs the A-scan, and the information along the longitudinal direction is accumulated over the course of the longitudinal scan time. Thus, the rate of the scan is limited by the movement of the part.

Recently, Fourier domain OCT has been introduced to ophthalmic practice. This device has a higher resolution than time domain OCT. In Fourier domain OCT, the information in an entire A-scan is acquired by a charge-coupled device (CCD) camera simultaneously. The A-scan acquisition rate is limited by the CCD camera frame transfer rate and the computer calculation time to perform the Fourier transform of the CCD acquired raw data into A-scan information. As there is no mechanical movement, the scan time in Fourier domain OCT is faster. This is an important advancement because faster acquisition time means lesser variability in the result due to the patient's eye movements.

Optovue

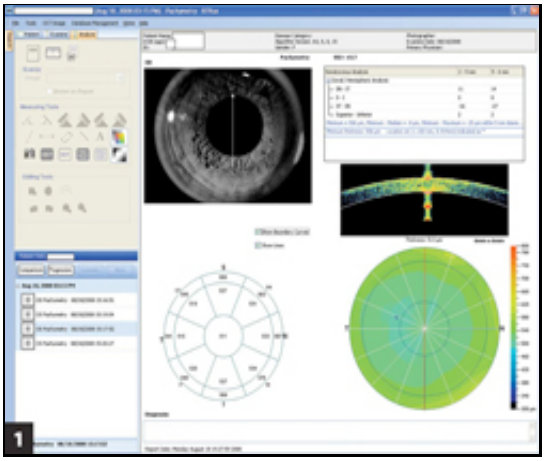
For Fourier domain OCT, RTVue (model RT 100, Optovue) has been approved by the U.S. Food and Drug Administration. It takes 26,000 A-scans per second, with a frame rate of 256 to 4,096 A-scans per frame. It has a depth resolution of 5 μm and a transverse resolution of 15 μm. The scan range is 2 mm to 2.3 mm in depth and 2 mm to 12 mm in transverse direction. The scan beam wavelength is 840 ± 10 nm, and the exposure power at the pupil is 750 μW. The cornea-anterior module (CAM) is additional software on the device, which helps in anterior segment imaging. The CAM L lens allows 6-mm-by-6-mm scans of the cornea for pachymetric analysis.

Examination

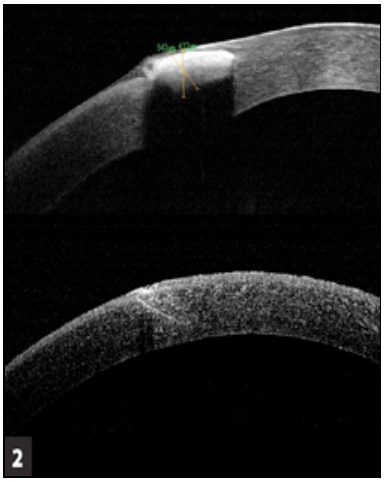
The patient is positioned on the headrest. The infrared image of the cornea is seen directly

on the examination screen. All scans are performed with the patient's eye wide open by his or her own effort. Scanning is done on visualization of a centered, bright infrared image of the central cornea. No topical anesthesia or lubricating drops are used. The scan is repeated if the first scan is not satisfactory — for example, if it is decentered due to patient eye movement or if there is poor corneal apex reflection.

The output screen consists of the infrared image of the cornea in the upper right, then, in clockwise direction, keratoconus analysis data, axial scan of the cornea, color-coded map of the corneal pachymetry and numerical data map divided into zones (Figure 1). The central zone of 2 mm is surrounded by zones subtending angles of 45· each in the 2- to 5-mm and 5- to 6-mm zone. The mean pachymetry for respective zones is given in the output.



Fourier domain anterior segment OCT output screen.

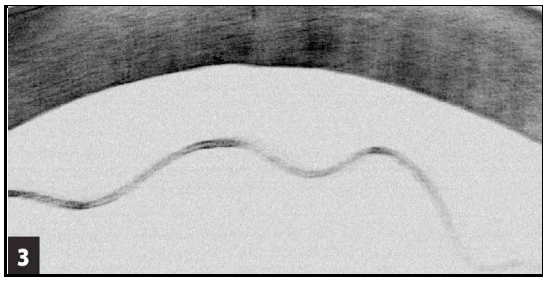


Fourier domain OCT of a foreign body in the cornea.

Clinical situations

Foreign body in the cornea: Figure 2 is a high-resolution spectral anterior segment OCT photo showing a foreign body in the anterior stroma of the cornea. The foreign body is a thorn with a size of 542 μm. There is surrounding corneal edema at the site of entry of the thorn. The bottom image was taken after the removal of the foreign body, and the wound healing line can be seen.

Descemet's stripping: Figure 3 is a high-resolution anterior segment OCT image showing Descemet's stripping in a patient after cataract surgery. This is clearly seen in Fourier domain OCT rather than in time domain OCT.



Fourier domain OCT of Descemet's stripping.

Fourier domain OCT of epithelial bullae.

Images: Agarwal A

Epithelial bullae: Figure 4 is a Fourier domain OCT of a case of epithelial bullae. This is

a patient with a history of gradual decrease in vision after penetrating keratoplasty. On slit lamp examination there was corneal edema with graft opacification. High-resolution spectral anterior segment OCT showed multiple epithelial bullae with increase in corneal thickness.

Conclusion

Fourier domain technology compensates for an important caveat in the current time domain systems. By faster capturing and acquisition processing, it reduces the examination time and therefore lessens the effect of the patient's eye movements.

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