Ultrasound proves worth in screening for keratoconus

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in London

VERY high-frequency digital ultrasound imaging is a valuable clinical tool that may help to identify eyes at risk for developing ectasia after refractive surgery, according to Dan Z Reinstein MD.

“Our studies have shown that epithelial profiles derived from ultrasound scans (Artemis, Ultralink LLC) can help in differentiating true keratoconus from apparent keratoconus as well as in cases of so-called forme fruste keratoconus,” said Dr Reinstein, speaking at a special Clinical Research Symposium on ‘What needs to be measured in refractive surgery?’ held during the XXIV Congress of the ESCRS.

He noted that the Artemis device is also valuable in excluding keratoconus in certain cases where the topography implies keratoconus is present – hence enabling surgery in a patient who may have otherwise been denied treatment.

Dr Reinstein, one of the co-inventors of the Artemis technology, said that there is a clear need for surgeons to be able to improve the diagnosis of keratoconus given that there is confusion as to what exactly form fruste keratoconus actually is. “Some believe that you can do surface treatments on these patients, some disagree. The truth lies under the surface,” said Dr Reinstein.

“I developed a particular interest in detecting keratoconus early because in my opinion it is perhaps the one variable that can potentially stump even the most careful refractive surgeon when assessing patients for corneal refractive surgery,” he said.

Dr Reinstein noted that back surface changes become apparent before front surface changes because the epithelium can absorb certain changes in the stroma anteriorly.

Looking at the characteristics of the Artemis 2 device, Dr Reinstein said that the FDA- and CE-approved device uses 50 MHz scanning with digital signalling processing to deliver very high-resolution imaging and high precision biometry of the anterior segment and the entire cornea.

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“The data obtained is essentially a full B-scan of the cornea showing clear delineation of the epithelial surface, Bowman’s surface, the flap interface and the back surface of the cornea. Unlike analog high-frequency ultrasound systems, the measurements are not made from the B-scan, or the A-scan trace, but rather from the digitally signal processed raw data. Each of these interfaces can be detected to less than 1.0 micron precision,” he said.

Dr Reinstein said that his recent studies seem to imply that examination of epithelial and stromal thickness profiles within the cornea enable the Artemis 2 to identify telltale features of early keratoconus, even before it is detectable by topography.

“Detection of keratoconus before it expresses itself on front surface topography is done by observing back surface asymmetry accompanied by coincident thinning of the epithelium. The thinning over the anterior stromal cone is accompanied by thickening of the epithelium circumferentially to the cone. In some cases, the front surface topography is absolutely symmetrical due to the full compensation afforded by the epithelial remodelling around the anterior stromal cone,” he said.

Illustrating the clinical utility of Artemis scans, Dr Reinstein described the case of a 33-year-old female patient, with -4.75 D
sphere and -0.75 D cylinder in one eye and -4.00 D sphere and -0.50 D cylinder in the other. The patient had normal keratometric values and normal pachymetry. However, WASCA aberrometry showed a very high degree of coma (9 microns of Sediel Coma) and one eye had a displaced back surface on Orbscan with anterior surface inferior steepening. Another cause for concern was the fact that her brother had keratoconus, said Dr Reinstein.

Comparing the patient's epithelial thickness profile with the wavefront pattern, it was found that the asymmetric elevation in the higher-order optics—which would have designated the 'cone' of keratoconus—did not correspond with thinning of the epithelium, with thickening of the epithelium surrounding.

"We found instead a concentric-to-the-centre pattern, showing that there was no cone on the anterior surface of the cornea. We knew therefore that we were not dealing with a case of keratoconus and could proceed with surgery," he said. (Figure 1B)

"One year after wavefront guided LASIK with the Carl Zeiss Meditec MEL80, the patient's coma was reduced to 1.0 micron (Seidel coma), she gained a line of best-corrected visual acuity, and her refraction has been stable since the one-month visit," reported Dr Reinstein, "supporting the exclusion of keratoconus that was made by Artemis despite the topographic and wavefront warning signs present preoperatively."

He then discussed the case of an 18-year-old female, with -3.25 D sphere in both eyes and -0.25 D of cylinder in one eye, who wanted to undergo LASIK before attending university. The keratometry and corneal thickness measures were standard in both eyes and the patient seemed to be a good candidate for surgery. However, her epithelial thickness profile on the Artemis scan showed a thinning of the epithelium corresponding to a displaced posterior surface apex, thereby masking the bulging of the anterior stromal surface. (Figure 2C)

"This was a patient who may have gone on to develop ectasia had we proceeded with the surgery. We believe that we were actually detecting keratoconus before it was evident on the front surface thanks to the analysis of the epithelial thickness profile provided by the Artemis," he said.

Dr Reinstein also described the case of an Australian professional cricket player who had requested refractive surgery. The patient's refraction had been stable for about 20 years, and he had normal keratometric and corneal thickness measurements. His wavefront also showed normal RMS values and very low coma. While the patient seemed a good candidate for surgery, an Artemis scan showed an epithelial thickness profile with a thinning of the epithelium corresponding to an inferiorly displaced posterior surface apex in both eyes. (Figure 3L)

"In this case we opted not to proceed with refractive surgery despite the fact that there was very low coma and normal topography," he said.

Summing up, Dr Reinstein said that epithelial thickness profiles obtained with the Artemis not only enables the identification of patients in whom corneal ablative procedures are contraindicated, but can also identify patients who are suitable for surgery despite topographic findings suggestive of keratoconus.

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