Light versus sound

Bill Harvey compares a new ultrasound pachymeter with an anterior OCT capture technique and finds they correlate nicely

A measurement of corneal thickness is important as it qualifies a tonometer reading (a thick cornea will result in a higher value tonometry measurement, a thinner cornea a lower value). Serial measurements of corneal thickness may also be useful in monitoring the progression of ectasias such as keratoconus. Accurate pachymetry readings are increasingly important to eye care practitioners, not least in glaucoma referral refinement schemes. Typically this is done using hand-held pachymeters which use ultrasound when in contact with the anaesthetised cornea to offer an accurate averaged value of thickness wherever the probe has been applied.

As more practitioners obtain OCT devices, many will have access to anterior OCT measurement capability. As well as offering a view of the cornea in cross-section (along with the pre-tear film and contact lens if present) and views of the filtration angle, such measurements are also able to give pachymetry readings. In essence, instead of bouncing sound off reflecting layers perpendicular to the sound wave transmission and therefore calculating the thickness of any structure by analysis of the difference in time between receiving the echo from the front and the back surface, an OCT will measure the thickness by looking at the reflection of light from the two surfaces and calculating thickness in terms of the reflection delay from the more distant surface. I was interested to see if there was any significant difference between the two techniques.

OCT versus hand-held pachymeter

I measured 28 eyes using the new iPac pachymeter (reviewed in *Optician* 09.03.12) and compared the results with values gained using the corneal capture programmes of the new OPKO Spectral OCT SLO (launched in the UK by Optos. A full review of this instrument will appear in *Optician* in the coming weeks). This OCT requires a supplementary lens to be screwed over the instrument lens. Once the patient data has been uploaded, there is a choice of anterior measurement options. The angle may be viewed or alternatively there is the option of a line scan or a 3D corneal map. The line scan offers the highest resolution image of the cornea cross-section. It is then possible to use the measuring programme by selecting the caliper tool and drawing a line between the two outer surfaces of the cornea. This then gives a measurement of the thickness to the nearest 10 microns (Figure 1). The process is very easy to carry out with a few provisos. The image needs to be crisp. It is also important to start at the anterior corneal surface and not at the outer edge of the tear film, the brighter rim to the corneal image. The measurement needs to be of the central cornea to match the iPac area of assessment. Finally, to minimise any error due to subtle 'mouse movement', in each case I made three measurements and, unless consistent, went with the median. The 3D corneal map analyses several raster sweeps of the cornea allowing a full thickness map across the central area. The resolution will not be as good but here there are pachymetry readings reported as to the nearest micron (Figure 2).

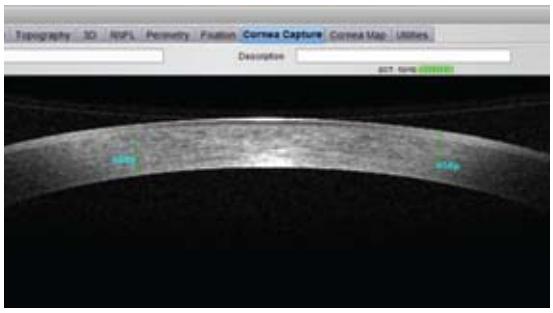

Figure 1 Line scan allows measurement of thickness with the mouse

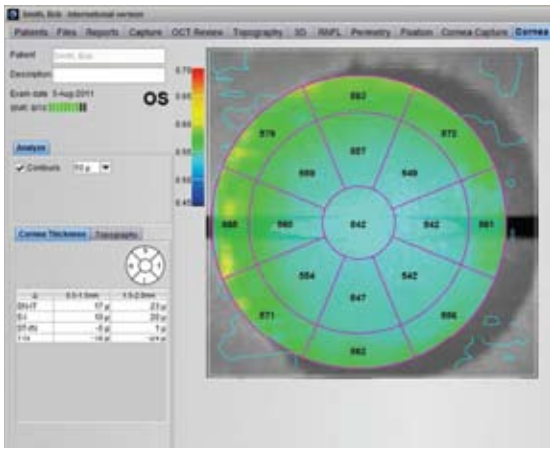

Figure 2 A pachymetry map displays regional thicknesses

Results

The results correlated well between the three techniques (Table 1). For the line scan the correlation coefficient with the iPac was 0.979 ± 0.008 and for the 3D map 0.987 ± 0.004. The OCT measurement did not require any anaesthetic and, one might argue, allowed me to ensure the measurement was always from as central an area as possible. The hand-held probe does not allow this control, relying instead on your ability to position the probe as centrally as possible. The pachymeter does have the advantage of calculating the IOP adjustment for you, but many ophthalmologists merely ask for the reading rather than the adjustment and there are different views as to what is the best conversion algorithm. I would argue that OCT data should be considered as valid when citing corneal thickness values.

● Thanks to Carleton UK and Optos for loans of the instrumentation. Any comments to william.harvey@rbi.co.uk

TABLE 1

Thickness of 28 corneas (in microns). Pach = measurement with the iPac (in microns). OCT line = measurement with line scan. OCT 3D measurement from a corneal thickness map obtained using the 3D corneal map

Px	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Pach	572	579	546	531	590	589	630	632	601	599	554	561	551	550
OCT line	570	580	550	540	590	590	620	630	610	610	550	550	550	550
OCT 3D	574	582	544	528	594	588	624	621	603	606	558	555	548	540

Px	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Pach	549	553	557	574	557	546	548	569	491	502	609	608	594	590
OCT line	550	550	560	570	550	550	550	560	490	490	600	590	600	590
OCT 3D	555	554	562	568	546	547	551	562	488	496	612	614	596	594