Update on corneal topographers and their use in CL practice

Dr Shehzad Naroo and **Alejandro Cervino** describe the potential for topography in general clinical practice and refer to a case where the data obtained was essential for accurate contact lens fitting

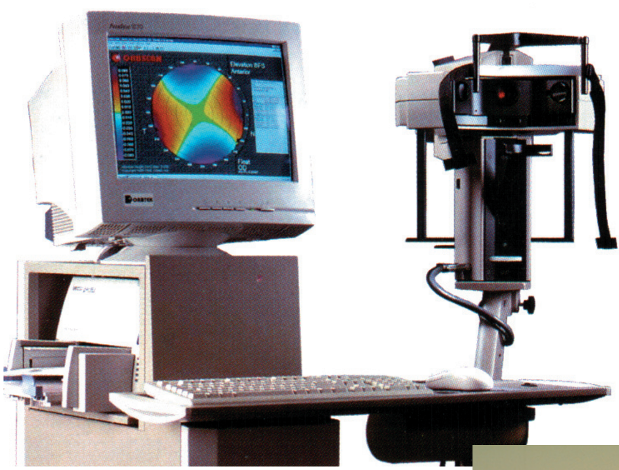


FIGURE 1a. Original Orbscan unit. Courtesy of Bausch and Lomb

FIGURE 1b. The later Orbscan unit with Placido disc

TODAY, EYE CARE CLINICIANS know what a corneal topographer is and what it can be used for.

Nevertheless, it is not always clear that all will know how to interpret the results given by the instruments and how to optimise the use of their applications. This may partly explain why, despite the fact that these devices have been around for many years and have dropped considerably in price, they have not become commonplace in primary eye care practices yet.

Different methods have been applied by different clinical topographers to determine anterior corneal topography; a good description of each method can be found in the literature.[1] Certainly, the most popular is Placido-based corneal topography, as used by most corneal topographers, such as Nidek's latest device the Magellan Mapper.

This device uses a Placido cone, enabling the instrument to be placed closer to the patient's eye, thus giving larger corneal coverage than some disc systems, although disc-based systems (for example, the Oculus Keratograph) may have fewer focusing errors.

Over the last decade, and certainly motivated by the advent of refractive surgery, topography systems have improved considerably. Many of the initial algorithm inaccuracies have been dealt with.

The Orbscan IIz system, from Bausch & Lomb, is a popular and extremely useful clinical tool that allows the determination of a number of ocular parameters of the anterior segment, namely anterior and posterior corneal surface topographies (in a number of different displays), corneal thickness and anterior chamber depth.

Additionally, knowing these parameters allows the system to offer a series of applications such as iridocorneal angle estimation, determination of a correction factor to apply to pneumo-tonometry readings based on corneal shape characteristics and also simulation of contact lens fitting and fluorescein patterns.

The system uses a slit scanning technique. Forty sections of the cornea are recorded in two scans, each of which takes approximately 0.7 seconds, that is a slit scan is performed from left to right and then from right to left obtaining 20 frames of corneal sections at different location during each of those scans.

The data obtained from the section is used to reconstruct the surfaces. Slit scanning techniques would avoid the approximation errors that arise from Placido-based systems since each surface is measured directly.

Nevertheless, the technique has disadvantages as well. First, the fact of being a scanning technique means that if the measure is not instantaneous, and if it takes more than 30 milliseconds, the ocular micromovements must be taken into account. The Orbscan IIz solves this problem by using a tracking system. Figure 1a shows the original Orbscan unit; note that it does not have a Placido disc, which was introduced on the later version (Figure 1b).

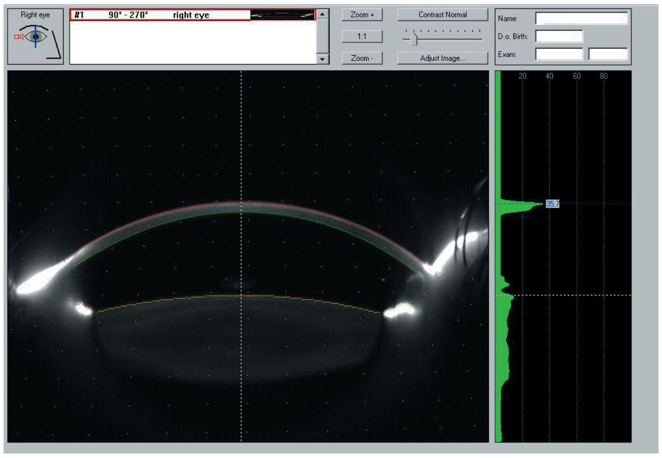


FIGURE 2. Image from the Pentcam

Another recent device, the Oculus Pentacam from Oculus, in Giessen, Germany, has also moved away from the idea of Placido technology and uses a rotating Scheimpflug camera.

This allows structures behind the cornea to be imaged too. It provides data from the anterior and posterior corneal shape (represented as either elevation or curvature data), plus corneal pachymetry data, anterior chamber volume, anterior chamber depth and anterior chamber angle. There is also a useful image of the anterior lens surface and, in patients with a sufficiently large pupil, the posterior lens surface can also be imaged (although shape of power data in not given for the lens). Figure 2 shows an image from the

Pentcam. All this information collected by topography systems comes from thousands of points, and needs to be converted into some form that allows a quick interpretation of the information. To take full advantage of the corneal topography measures, one must be able to differentiate rapidly and effectively the different conditions that may appear.

There are a number of ways to represent topography data: numeric, with powers displayed over the surface point where it was collected; wire-mesh representation, allowing 3D modelling; and colour-coded contour maps, allowing an easier interpretation.

The maps are considered the standard for representation of topography. A corneal topography map is a 2D display representing the variations in curvature as we move from the centre towards the periphery. In these maps, differences in curvature are represented by a colour legend in which each colour covers a variable range of dioptres. These changes in colour will form the pattern, which tells the practitioner the topographic variations of the corneal surface.

The clinical utility of these maps depends on the interpretation skills of the practitioner, as well as the colour-coded maps' capability to be interpreted.[2] This involves two aspects:

The colour association, with the cold colours (blues) representing the low powers, large radius, flattest surfaces or depressions from a reference point (the latter would apply if considering an elevation map), and the warm colours (reds) representing the high powers, short radius, steepest surfaces or elevations from a reference point (the latter would apply if considering an elevation map).

Pattern recognition to allow differentiation of different topographic entities from the regular corneal contours, this involves using a series of different scales in the topography systems.

All the topography systems offer the possibility of changing and customising the colour-scale in order to reveal aspects of interest of the corneal topography, or to hide the normal variation and make the identification of different abnormal entities easier.

The relative scale (or normalised scale) is set for that individual cornea, the middle colour on the scale (usually green) is allocated to the middle radius of curvature of that cornea and all other radii are plotted at small intervals (usually 0.25-0.50 dioptres) – this scale would allow subtle irregularities to be shown better. The absolute (or standardised scale) is pre-set by the machine and uses the same scale for all pictures taken on that device, namely, the steepest and flattest curvatures are pre-set and the intervals between the colours are usually 1 dioptre – this scale would allow different corneas to be compared (such as right eye versus left eye), or an eye to be checked over time on the same scale.

Nearly all corneal topography devices incorporate contact lens fitting software.

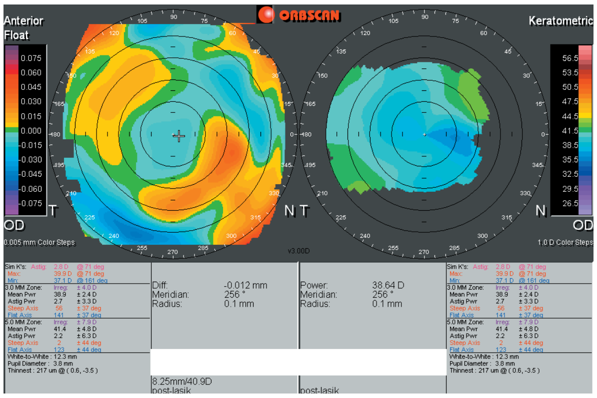


FIGURE 3. The irregular corneal topography of a patient after unsuccessful laser in-situ keratomileusis (Lasik)

FIGURE 4. The default lens that the programme created was ordered to a mean spherical equivalent power of -1.00 dioptres

FIGURE 5. The new power ordered was -3.00 dioptres

This software will range from pre-loaded designs of current lens manufacturers' stock lenses to those topography units that allow the clinician to create their own contact lens design.

The new Nidek Magellan Mapper, for example, allows a corneal lens to be created with up to seven customised peripheral curves. The Orbscan IIz allows creation of a clinician's own contact lens designs or selection of pre-loaded manufacturers' designs.

Figure 3 shows the irregular corneal topography of a patient after unsuccessful laser *in-situ* keratomileusis (Lasik).

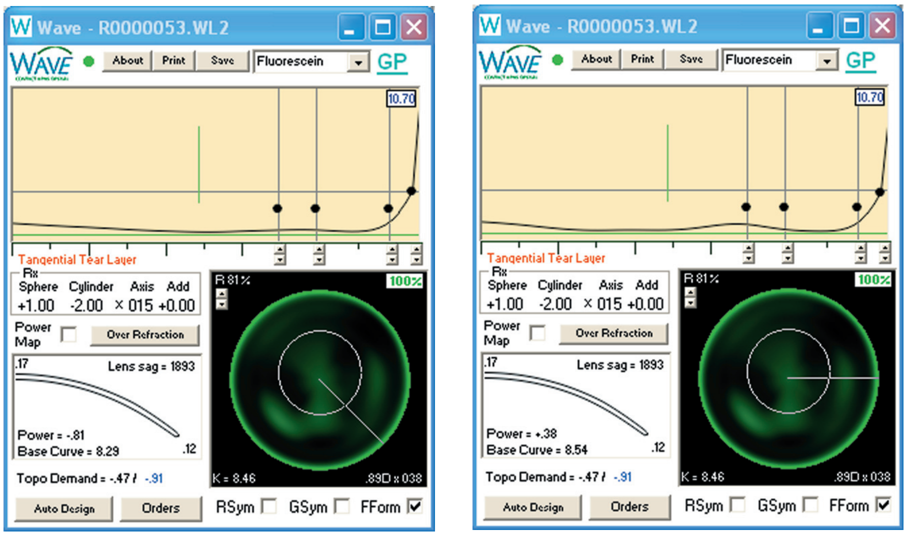
The patient, a 32-year-old male former soft lens wearer, had successful Lasik on his left eye but had epithelial in-growth under his corneal flap on his right eye. He then underwent flap 'lift and clean' but unfortunately had a flap melt resulting in a very irregular corneal profile to this eye.

His best corrected visual acuity with trial lenses in the affected eye was 6/12+ (refractive error was +1.00/-2.00x015).

It was decided to fit a rigid gas-permeable contact lens to this eye. Regular fitting sets were tried and with an over refraction the best corrected visual acuity improved to 6/5 but lens stability was very poor.

It was decided to fit a contact lens specifically to his corneal shape using the Orbscan IIz contact lens fitting software, Fitscan. The default lens that the programme created (Figure 4) was ordered to a mean spherical equivalent power of -1.00 dioptres. This lens was found to be underpowered and too mobile, so the lens fit was steepened and peripheral curves altered slightly to improve tear flow around the new tighter lens, and the power was re-ordered incorporating the positive tear lens (Figure 5).

The new power ordered was -3.00 dioptres. This lens was found to be comfortable by the patient and provided excellent Snellen acuity (6/5). The patient used this lens successfully for many months but nearly a year after he initially presented he returned complaining of increased lens awareness and worsening vision. His corneal profile was found to have altered further. This time a contact lens was refitted using the Keratron Scout corneal topographer. This device links directly to the Wave contact lenses that are specifically custom-made to the corneal shape by Northern Lenses.



FIGURES 6a and 6b. Fluorescein pattern of Wave lenses with variable refractive power plus a variable base curve

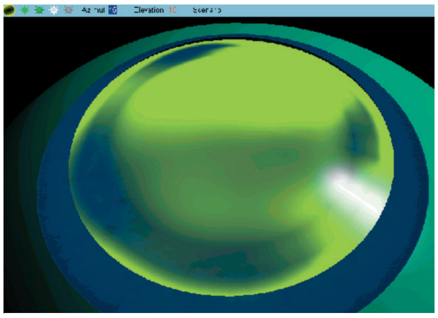


FIGURE 7. 3D fluorescein simulation by Magellan Mapper

These lenses have variable refractive power plus a variable base curve. Figures 6a and 6b show the fluorescein pattern of this lens design.

In the top section of each figure note the very small post-lens tear film, the result of this can be seen in the simulated fluorescein pattern which shows very little fluorescein pooling. Also, note the white radius marker on the fluoresecin pattern (bottom right in each picture) in the two figures is located at different places in the two pictures, the corresponding power and base curve reading (bottom left in each picture) is different in each picture – thus highlighting the unusual design of the Wave contact lenses.

In Figure 6a the power is -0.81 dioptres and base curve is 8.29 mm and in Figure 6b the power is +0.38 dioptres and the base curve is 8.54 mm. So far the patient has been happy with this lens.

Many practices will own corneal topography devices but may not have utilised them for more than screening of corneal abnormalities, although the uses of these devices stretch much further than that. Some devices have additional capabilities (such as poster shape and pachymetry measures with Orbscan IIz and Pentacam) or ocular wavefront maps (such as Nidek OPD unit) or corneal wavefront maps (Keratron Scout, Oculus Keratograph and others) and of course the contact lens fitting software. Figure 7 shows a 3D fluorescein simulation from the Magellan Mapper.

REFERENCES

1 Dave T. Current developments in measurements of corneal topography; *Contact Lens and Anterior Eye*, 1998;21(Supplement):S13-S30.

2 Naroo SA, Cervino A. Corneal topography and its role in refractive surgery; In Naroo SA, (editor), *Refractive Surgery: A guide to assessment and management*. London: Butterworth-Heinemann; 2004, pp 9-16.

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