ASTIGMATISM

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UTILISING TOPOGRAPHERS

Software tracks astigmatism changes to improve nomograms

by Howard Larkin

Corneal topography makes possible precise measurements of astigmatism induced by corneal surface irregularities before and after any type of cataract or refractive surgery. Combined with measures of total astigmatism from aberrometry or manifest refraction, it can also reveal how much astigmatism originates elsewhere in the eye.

"This quantitative value of how the eye looks is really very valuable," says Noel Alpins FRACS, FRCOphth, FACS, Melbourne, Australia. "But just looking at the changes in topographic corneal astigmatism values alone does not use the topographer to its full potential."

While raw data on corneal and non-corneal astigmatism gives insight into the eye's condition, it can't tell you how much astigmatism your surgical approach induced. For example, if the patient starts with 3.50 dioptres cylinder at 22 degrees before surgery and ends up with 0.50 dioptres at 160 degrees, did you overcorrect or undercorrect? You know your correction is off axis – but how much and in what direction? And what does it mean for the patient's vision?

Objectively answering these questions is essential for planning re-treatments and adjusting astigmatism correction nomograms, Dr Alpins says. Vector analysis of topographic data can provide the answers.

Long used by scientists to model complex interactions in multiple dimensions, Dr Alpins pioneered applying vector analysis to astigmatism correction in the early 1990s. His innovation was distilling the complex mathematics of vector analysis into a few actionable values that surgeons can use to measure outcomes and plan surgery.

Dr Alpins has also developed several software packages incorporating what has become known as the Alpins method of astigmatism vector analysis. The latest is iAssort, a program that can be installed on many topographers and aberrometers, including the Pentacam (Oculus) and Scout (Optikon).

Unlike raw topographic astigmatism values such as Sim K, vector values correlate well with surgical processes, and can be analysed quantitatively to adjust surgical technique, Dr Alpins says. iAssort automatically quantifies the degree of over- or under-correction as well as the magnitude and angle of off-axis corrections based on preoperative and postoperative topography. It also quantifies with an index how much the patient's astigmatism improved compared with the correction target.

Figure 1

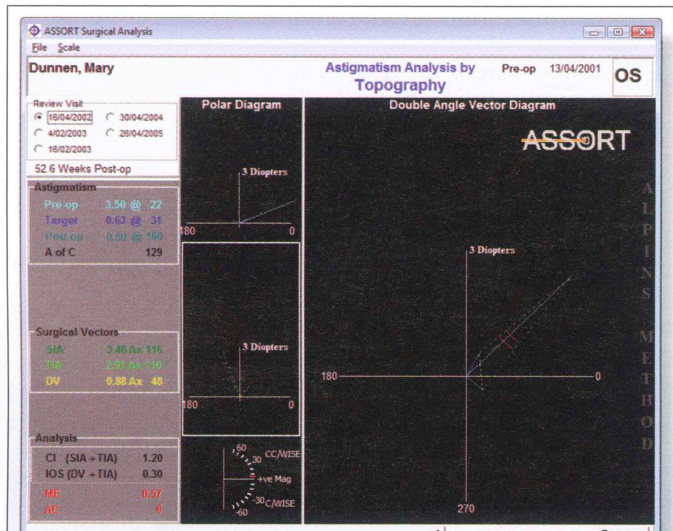
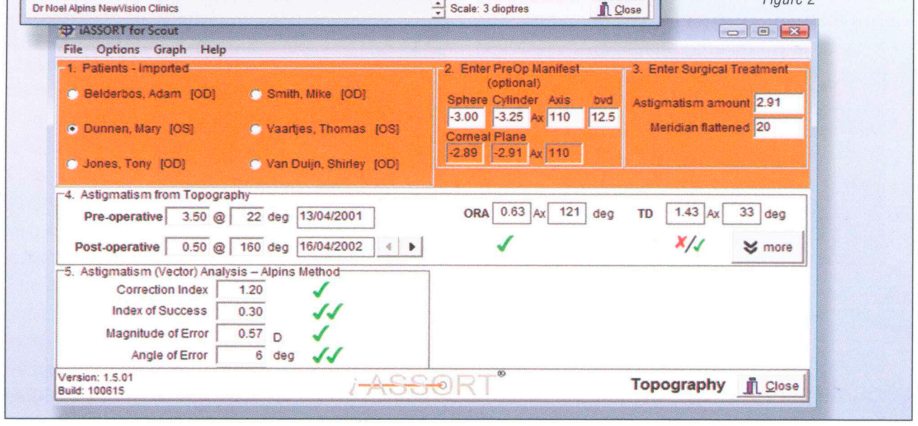


Figure 2



Courtesy of Noel Alpins FRACS, FRCOphth, FACS

Figure 1: The iAssort program displays double angle vector diagrams to better understand astigmatism analysis.
Figure 2: The iAssort program enables analyses using topography parameters and displays visual symbols to indicate the success of the sugery

Before surgery iAssort imports topographic data in the form of sim-K values and zonal parameters from topographers or second-order astigmatism values from aberrometers. The surgeon can also manually enter astigmatism parameters measured by manifest refraction or they can be imported directly from aberrometry in combined devices. From these the program calculates ocular residual astigmatism or ORA, a vectorial measure of astigmatism due to non-corneal surface causes (Figure 2). The ORA informs the surgeon of how much total astigmatism potentially can be corrected by reshaping the cornea, as well as the power and axis of surgical correction required to achieve the maximum potential correction.

This information can be used before surgery to help manage patient expectations, Dr Alpins says. For the 25 per cent to 30 per cent of patients with ORA values of 1.0 dioptre or more it may not be possible to achieve the degree of astigmatism correction they might expect, he notes. "Before surgery you can take that parameter into account and counsel the patient accordingly."

Pre-op measures also are used to determine a target for corneal astigmatism that minimises total astigmatism after surgery in cases where a zero astigmatism target cannot be achieved. "If everything goes according to plan, this difference between the spectacle astigmatism and the corneal astigmatism will be left on the cornea," Dr Alpins says. The target is also essential to quantitatively analyse outcomes, he adds. "If you don't calculate where the target ahead lies, you don't know how much you missed it by. Remember that zero cornea and/or refractive astigmatism is not always achievable."

After surgery iAssort compares post-surgery topographic data with pre-op values and the target astigmatism treatment. This yields a value for surgically induced astigmatism and a difference vector, which is how much the induced astigmatism differs from the target. Ratios of these values indicate the effectiveness (over or undercorrection and on or off-axis) of the astigmatic surgical intervention, whether incisional or ablative.

For example, in the case above the program generates a correction index value of 1.20, indicating a 20 per cent overcorrection, and a magnitude of error of 0.57 dioptres at 6 degrees (in a clockwise direction). The index of success is 0.30, indicating that the treatment corrected 70 per cent of the patient's astigmatism deficit relative to the treatment. These results suggest that the patient may benefit from an enhancement, and help guide the location and magnitude of the re-treatment based on the patient's response, Dr Alpins says. "Should you try to fully correct the residual error or peg the treatment back a bit? Given that you overcorrected a bit the first time, you may want to pull it back."

While the iAssort software allows analysis of one patient at a time due to the limitations of the topography systems, data from multiple patients can be analysed with Dr Alpins' Assort software. Assort also gathers information on incisions and ablations, as well other factors that might affect astigmatism outcomes. This enables identification of under- or over-correction trends for patient groups that can be used to adjust surgical nomograms.

Using corneal topography data to assess the success of surgery helps eliminate one significant source of error in measuring astigmatism outcomes – the manifest refraction which is a subjective test.

"Of course you want to measure the manifest refraction after surgery. But it is a subjective measure and the person doing the measuring knows the target is zero, so there is a risk of underestimating it. Topographic data it is like a truth drug. You know what the real surgical outcome is because you are measuring it totally objectively with a device that has no bias," Dr Alpins says.