As the number of patients undergoing LASIK surgery increases, we encounter greater number of patients with atypical corneas that may not strictly confirm to the ‘ideal’ and yet may not also strictly confirm to the list of contraindications. Also, patients with decentered ablation profile, post-LASIK ectasia, greater angle kappa, partially cut flaps and post keratoplasty astigmatism may present for visual rehabilitation. With evolving concepts and technology, it is possible to customize treatment for these highly demanding niche cases. We have tried to answer the following questions in a lucid manner:

- What is topography guided LASIK?
- How is it different from other customizations like Wavefront-guided LASIK/PRK?
- What are the specific indications?

Angle kappa and its importance in refractive surgery

Conventional photoablation is centered over the entrance pupil. However, the visual axis of the eye (line connecting the fixation point with the fovea) and the pupillary axis (line that perpendicularly passes through the entrance pupil and the center of curvature of the cornea) are essentially different. The angle between them is called angle kappa. In most patients, the value lies between $5.55 \pm 0.13^\circ$ and $5.62 \pm 0.10^\circ$ in right and left eyes respectively when measured by the Orbscan II corneal topographer (Bausch and Lomb, USA). In 97% of non-hyperopic eyes undergoing refractive surgery, a positive angle kappa of 0.5 mm or less was observed. However, the average angle kappa is greater in patients with hyperopia. In these patients, centering the ablation profile on the geometric center of cornea or on the pupillary center would result in eccentric ablation. The ideal physiologic centration point is the corneal intercept of the visual axis. The point that is closest to this physiologic centration point and can be measured by currently available devices is coaxially sighted corneal light reflex (CSCLR). It is imperative to have the technology to center the ablation profile on the CSCLR (Figure 1).

What is topography-guided LASIK?

The two principle elements of topography guided photoablation are:

(a) Assessment of topography
(b) Centering the ablation on the corneal vertex.

In topography guided photoablation, corneal topography (point to point variation in curvature and refractive power) is used for photoablation in conjunction with the refractive error of the eye. Secondly, all measurements are centered on the corneal vertex and not on the pupillary center or geographical corneal center.

Different methods are used to evaluate the corneal topography, each with its own advantages and disadvantages. Either a placido-disc reflection of the anterior corneal surface or a Schiernflug-based imaging system can be used to obtain the topography maps. The placido-disc based device captures up to 22,000 points on the anterior corneal surface, including corneas with scar or opacity (Figure 2). The data from this image acquisition is transferred directly to the excimer laser device for further integration and planning. The Schiernflug based device captures up to 25,000 true elevation points, including the posterior corneal surface. The disadvantage of placido-based devices is their inability to capture the central corneal data, whereas Schiernflug based devices are unable to capture images in relatively opaque corneas or scarred corneas. For images captured using placido
disc, 5 point pachymetry needs to be manually entered, unlike the Schiemflug based device which automatically captures the values. These devices also digitally determine the limbus and pupillometry measurements using infrared camera. This helps in correctly identifying the pupil center intraoperatively and then shifting the ablation profile towards the corneal vertex. All this pre-operative information is transferred to the excimer laser software. The software integrates refractive error and topography to generate an ablation profile (Figure 3). The profile can be mix of myopic and hyperopic ablation zones. It gives the surgeon the option to choose the optical zone as well as the transitional zone in 0.1mm steps.

Complete refractive error or a part of it can be corrected based on pachymetry or surgeon preference. This strategy is useful in cases of irregular corneas where smoothing of anterior corneal surface is a priority, rather than correction of refractive error.

In short, topo-guided treatments offer a basket of choices:

- Smoothening of anterior corneal surface with or without correction of refractive error
- Centering the ablation profile on the corneal vertex
- Correction of asphericity and choosing the desired optical zone in smaller steps than conventional LASIK.

However, the amount of corneal tissue ablated in most cases of topography guided treatments is more than the conventional wavefront optimized treatments.

**How is it different from other customizations like Wavefront-guided LASIK/PRK?**

The term ‘customized LASIK/PRK’ is a confusing terminology. It includes a plethora of options for catering to the specific demands of patients who may or may not be suitable for conventional wavefront-optimized LASIK/PRK. Wavefront guided, topography-guided and asphericity-guided treatments fall under the broad title of Customized LASIK.

Wavefront guided treatments center all their measurements on the entrance pupil. The size and the location of pupil limit the area that can be measured. The wavefront is also affected by accommodation and opacity in cornea or the...
The aberrometer often fails to capture accurate data in highly aberrated eyes. The ablation strategy employed by the Wavefront guided and topography-guided technologies differs significantly. Consider a heap of soil with a pit beside it. The aim of the treatment would be to get both to the same level. The wavefront guided treatment would work by abrating the heap of soil to the level of the pit. However, the topography guided treatment would ablate the heap but raise the bottom of the pit to get both to the same level. So you have an area that undergoes myopic ablation (heap of soil) and a mid-peripheral area that undergoes ablation to induced steepening in the center similar to hyperopic ablation (raising the bottom of the pit). The wavefront takes into account the aberrations of the entire eye, including the lens. The lens may induce significant aberrations which are corrected at the corneal level during ablation. A lot of surgeons disagree to this policy as the aberration status of the eye would change again when the patient would undergo a lens-based surgery at a later date.

The image acquisition in highly irregular corneas may be difficult for the current generation of topography devices. Also, multiple images may be needed (more than the average 8) to get images of sufficient quality (more than 70% data accurately captured along with the limbus). The quality of image is affected by the tear film as well. So image acquisition in a large number of indicated patients may be difficult. Two stage procedures may have to be done when one desires correction of the refractive error along with regularizing the corneal surface. The first step would smoothen the anterior corneal surface and at the same time may induce refractive errors. The second stage surgery would correct the residual refractive error.

What are the specific indications?

A Treatment of Regular Cornea

B Treatment of Irregular Cornea

- Post-LASIK Complications- Decentered ablation profile, small optic zone, button-holes or vertical gas breakthrough with irregular flaps, post-LASIK ectasia
- Post-RK cases
- Post-keratoplasty refractive error correction
- Regularization of cornea in keratoconus (Combined with Collagen cross linking)

As the experience with topography guided laser increases, customization is increasingly being used in routine photoablative procedures especially hyperopic ablation where the expected angle kappa is large. In cases with previously operated LASIK or RK, symptoms like star-burst, haloes or glare may be alleviated by using topo-guided LASIK. Holland et al, in their study of post-LASIK ectasia treated 12 eyes with topography guided laser and an UDVA of 20/40 or better was achieved in 71 % eyes compared with 12% in the pre-operative period, with ≥ 2 lines gain in vision in 53 % eyes. Chen et al documented an improvement in the irregularity index of cornea following topography guided ablation. Spadea reported an improvement in the spherical equivalent and a decrease in refractive astigmatism following post-keratoplasty Topo-guided treatment with...
CXL. However, complications in cases with highly aberrated corneas undergoing photoablative treatment are not yet well documented, due to small sample size of most studies as well as short term follow-up. A word of caution is mandated in the indiscriminate use of topography guided LASIK / PRK.

The role of epithelial remodeling to compensate for the irregularities in stroma is still being researched. Epithelial remodeling contributes a great deal to the eventual refractive outcome. Trans-epithelial phototherapeutic keratectomy aims at neutralizing this epithelial remodeling and then reshaping the underlying stroma³.

Planning software and treating platforms
A range of planning software and topography-guided ablation platforms are commercially available. Topography-guided customized ablation treatment (T-CAT) planning software with ALLEGRETTO WAVE Eye-Q Excimer laser platform (Alcon Laboratories Inc, Ft Worth, Texas, USA) has recently received the U.S. FDA approval, and has been approved in Europe since 2003. Other platforms currently available are the CRS-Master planning software (Carl Zeiss Meditec, Jena, Germany), Nidek Advanced Vision Excimer (NAVEX; Nidek, Gamagori, Japan), and the Corneal Interactive Programmed Topographic Ablation (CIPTAmax; iVis Technology, Taranto, Italy).

References