An excimer laser PRK technique

by Noel A. Alpins, MD
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Excimer laser photorefractive keratectomy (PRK) has been performed on several hundred thousand eyes throughout the world, mostly in countries outside the United States. The accuracy and effectiveness of PRK is under continual review and refinement, but its ability to change the refractive state of the eye is unquestioned.

There are many demanding aspects in the performance of the procedure. The process commences with the preoperative decision as to the visual and refractive goals, which is made ensuring that the probability of achieving these goals accords with the patient's expectation of success. The choice of ablation pattern, zone distribution and surgical method, followed by an analysis of outcome trends, are elements of surgical performance. Consideration is required for undercorrection retreatments and their timing, and the management of topographical aberrations and the associated symptoms that may arise.

The technique that I describe here is employed by the members of the Excimer Laser and Research Group at Melbourne University, with some individual personal variations acceptable to our self-regulated protocol. The critical examination of results, followed by their publication in the peer-reviewed literature, can only expand our knowledge of procedures in their developmental years, which will ultimately lead to continuous incremental improvement in techniques.

Excimer procedure

A lid speculum is inserted in place to maintain comfort and an adequately exposed cornea, and an additional drop of amethocaine is instilled on the cornea. With the patient fixating on the flashing red fixation light of the VisX Excimer Laser, the center of the pupil and the red light reflection are then aligned with the grid reticule visible through the surgeon's microscope.

After a clear focus of the eye is obtained under low-medium magnification, a 7-mm OZ marker is used to impress a circle for delineation of epithelial removal. Epithelium is separated from the cornea using a dulled number 57 Beaver blade. Commencing peripherally, an annular area of epithelium 1-mm wide is removed. The paracentral epithelium is removed next and the central epithelium last.

A sweeping action is used with the semi-sharp blade. If the epithelium is loosely attached, it may peel off like a capsulorhexis. When firmly attached, much attention is required for a complete removal of residual epithelial cells. The removed epithelium is preserved on a moist sponge for replacement on the cornea after treatment.

After confirming an adequate removal of epithelium, a moistened cellulose sponge is used to ensure an even hydration and smoothness of the cornea, eliminating any pressure marks created during epithelial removal. This process also helps identify any epithelial cell nests that may be remaining, so that complete removal can be effected.

The required magnification (14/12) is set with clear focus on an evenly dry Bowman's membrane of the cornea. The patient actively fixates on the flashing red light, and the pupil is centered under the reticule that is visible to the surgeon through one eyepiece of the binocular microscope. Treatment is commenced at the time of optimal corneal hydration, when Bowman's membrane is dry but retains a sheen. Delays may cause a peau d'orange appearance, indicating excess dehydration that results in an uneven surface. Wiping the cornea again with a moistened sponge restores the desired condition.

The patient has had adequate explanation of the stages of the procedure prior to treatment, so that the noise of the suction apparatus and the ablation pulses do not cause alarm. I prefer the technique of forceps-assisted fixation (Bores), as the patient's view of the fixation light becomes progressively obscured as treatment progresses, rendering self-fixation difficult and unreliable. This is more apparent with higher myopic corrections. The patient is requested to maintain fixation on the red light and report any deviation from central fixation should it occur. Treatment is frequently stopped to allow the movement of air to dry the accumulated moisture by evaporation. Central island formation can be present due to the masking of the beam by moisture released from the central corneal stroma during ablation.

The qualitative topographical appearance of treated cornea has improved since "slowing down" the treatment. The fractionation of the treatment creates less rise in tissue temperature, which is likely to contribute to reduced corneal scarring and haze formation. The "dry" treatment technique gives a ground-glass appearance to the ablated cornea, reducing the cornea's transparency and the patient's ability to fixate, so that assistance by the surgeon is necessary.

Water is never added to the cornea between zonal treatments. Any tears that have collected in the fornices are dried with a sponge, to prevent uneven hydration and stromal swelling and potential irregular ablation.

With spherical correction alone, the beam expands with progressive opening of the diaphragm. When astigmatism is corrected in association with spherical myopia, correction is optimally performed with an elliptical treatment pattern. An elliptical-shaped ablation is created by the opening of parallel blades, limiting the beam aperture on two sides, and the concurrent closing of a round diaphragm aperture.

In the presence of a constant pulse rate (five per second), the slower the parallel blades open, the greater the astigmatic correction. The maximum correction of myopic astigmatism cannot exceed the spherical myopia utilizing an elliptical pattern alone; at this point the ellipse has a dimension of 4.5 mm by 6.0 mm. Any excess of astigmatism over spherical myopia is treated sequentially, using the 6.0-mm planocylindrical mode.

At the completion of the ablation sequence, the patient's retained epithelium is replaced on the central and paracentral area to expedite regeneration of the corneal epithelium.

A non-steroidal anti-inflammatory agent, indomethacin eye drop suspension (10 mg/mL), is applied topically to the treated cornea at the end of the procedure to assist healing and reduce postop pain. One drop of homatropine 2% is placed in the medial conjunctival sac for mydriasis and reduction of ciliary spasm.

Chloramphenicol eye ointment (10 mg per gram) is placed in the conjunctival sac prior to applying a firm eye patch for lid closure.

For pain relief, Panadeine forte tablets (Paracetamol 500 mg, codeine phosphate 30 mg) I-II is administered four hourly and Rohypnol (flunitrazepam 2 mg) at night for sedation.

Postop

The chloramphenicol ointment continues until two days after reepithelialization, FML drops (fluorometholone 0.1%) are commenced four times a day on day four, after epithelial integrity has been reestablished, and continues for one month. It is progressively reduced over the subsequent three months.

Management of second eye

A soft hydrogel disposable contact lens is worn to maintain binocularity if spectacles are not tolerated in the higher amounts of myopia. Treatment is performed on the second eye one month after the first, or when the first eye has achieved stable satisfactory vision, whichever occurs later.

Retreatment

This is required for undercorrection in about 10% of cases. It is not performed until six months have elapsed from the initial treatment, and a stable refraction is present on consecutive visits. Retreatment is performed by correcting of the residual myopic refraction and the optimal astigmatic correction according to refraction and topography, as if this were a primary treatment. The epithelium is removed prior to ablation.

Treatment for a residual symptomatic island is infrequently required; its presence requires confirmation by a difference map (i.e., postop minus preop dioptric change). The amount of ablation required is determined by the diameter and the diopter elevation of the island as viewed on the most recent corneal topography map. Treatment for the island is performed prior to that required for any residual refractive error and is applied to the stroma at the location determined by the map. ■

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Follow-up plan

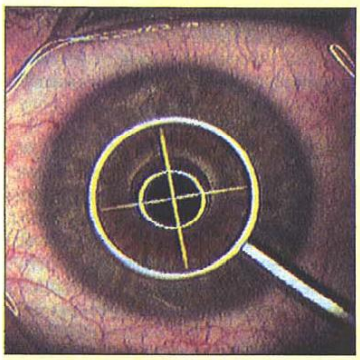
Day 1 Day 5

1 month 3 months 6 months 12 months

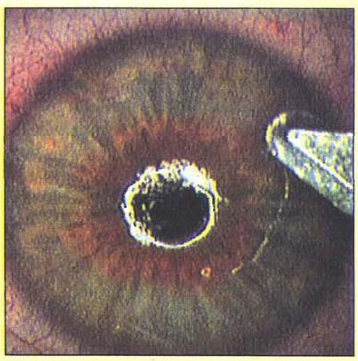
Outcome parameters tracked:

Unaided visual acuity, best corrected visual acuity with manifest refraction, keratometry, topography, ocular tension and corneal clarity.

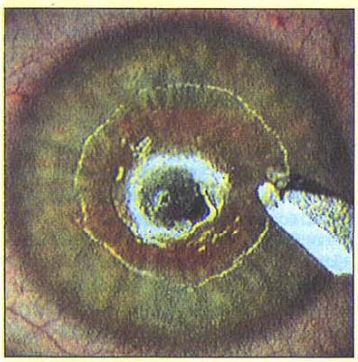
A Surgical Plan



***A 7-mm OZ** marker impression.*

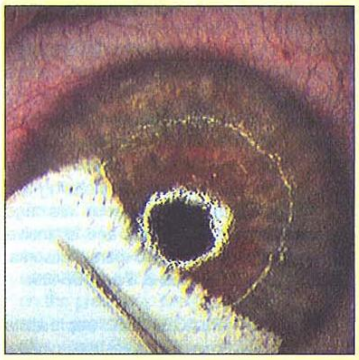


***Commencement** of epithelium removal.*

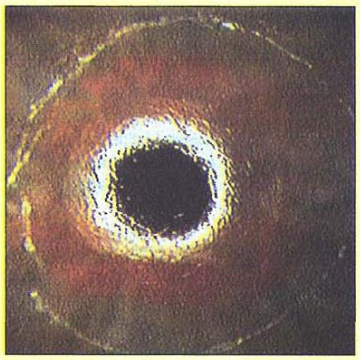


***Epithelium** is partially removed.*

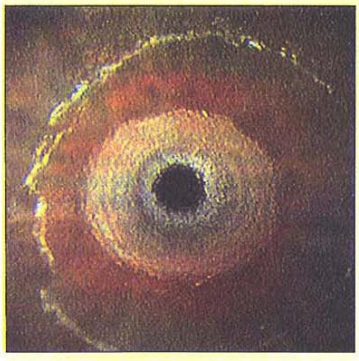
***6-mm** confirmation.*



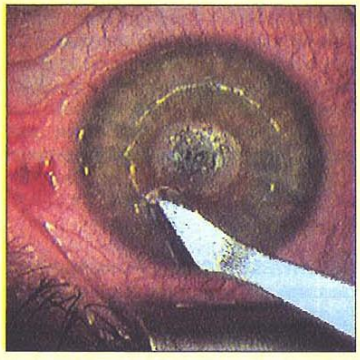
***Final preparation** for ablation.*



***Astigmatism** treatment (ellipse).*



***Spherical** treatment.*



***Epithelial** replacement.*

Preop preparation

1 hour prior	phenergan (promethazine) 25 mg tablet
15 min. prior	indoptol (indomethacin) 1 drop
15, 10, 5 min. prior	*1 drop each of:*
	amethocaine 1%
	xylocaine (lignocaine) 4%

Correction of sphere: zonal distribution

Spherical equivalent at corneal plane:

0.00 DS-5.00 DS	One Zone	6 mm	100% sphere
-5.01 DS-10.00 DS	Two Zones		
	First treatment	5 mm	50% sphere
	Second treatment	6 mm	50% sphere
-10.01 DS-15.00 DS	Three Zones		
	First treatment	4.5 mm	33.3% sphere
	Second treatment	5 mm	33.3% sphere
	Third treatment	6 mm	33.3% sphere

Correction of astigmatism: zonal distribution

Targeted astigmatism change:

6-mm zone (ellipse) 100%

If cylinder exceeds the sphere in 6-mm zone:

5-mm zone ellipse	50% astigmatism correction
6-mm zone ellipse	50% astigmatism correction

The equal split ensures two ellipses with parallel concentric margins.

If spherical myopia exceeded by astigmatism:

6-mm zone sphere-cylinder Astigmatism in excess of elliptical capacity.

Determination of target induced astigmatism (TIA)

(Assort Treatment Page)	(Assort Treatment Page)
Treatment by refraction	*Optimal treatment*

The targeted change in astigmatism (TIA) for each patient is determined by the optimal balance of the individual's differing topographic and refractive (corneal plane) astigmatism. The treatment emphasis apportioned to each is dependent on the orientation of the targeted corneal astigmatism that would result from treatment by refraction alone. The goal of incorporating topography into the surgical plan is to achieve less corneal astigmatism.

Example:

Residual Corneal Astigmatism	Treatment Emphasis			
Axis 180°	Topography	100%	Refraction	0%
Axis 90°	Topography	0%	Refraction	100%
Axis 45° 135°	Topography	50%	Refraction	50%

Adjustment of astigmatism magnitude:

Coefficient 1.2 X TIA to allow for system undercorrection.

Note: this is a figure calculated by vector analysis of prior outcomes and may vary between machines.