

Keratorefractive Surgeries

Laser assisted in-situ keratomileusis (LASIK) surgery is the most commonly performed keratorefractive surgery; altering shape of the cornea. Other common keratorefractive procedures to correct low to moderate myopia include variations of photorefractive keratectomy (PRK) and SMILE. Here we try to highlight general practice patterns for elective keratorefractive laser surgery based on expert opinion and consensus. The questions have been prepared by **Dr. Tarun Arora** (TA) Senior Resident Cornea, Cataract & Refractive Surgery Services, from R.P. Centre for Ophthalmic Sciences, All India Institute for Medical Sciences, Ansari Nagar, New Delhi

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TA: What range of refractive errors do you usually treat with LASIK and what is your age limit for treatment?

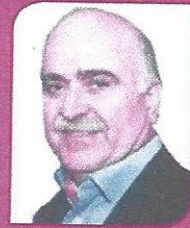
IP: I treat -8D for myopia. and upto +4 D for hyperopia. Age limit up to 45 years old for both.

GK: I usually treat 3 to -8D for myopia. Age limit up to 40 years old and +2 to +4D for hyperopia. Age limit up to 55 years old.

MPS: I treat myopia ranging from 0.5 to 10.0 D, hypermetropia till 6 D (not making the post-op cornea steeper than 48 D) and astigmatism till 6D with LASIK. Minimum age is 18 years but there is no upper limit.

JST: The refractive error to be treated is never an absolute number, but a dynamic decision involving the refractive error, central corneal thickness, pupillary diameter and the elevation maps. Our primary aim is to leave a residual bed of at least 300 μ , to reduce the risk of having subsequent ectasia. Hyperopia of upto +6 D (SE), astigmatism of -4 D and myopia of -10 D (SE) is the upper-limit that we have treated so far. I would like to reiterate the fact that every case has to be individualized.

The lower age limit for LASIK is 18 years and the upper age limit is flexible. The oldest patient that we have treated is 43 years old. Here, extensive patient counselling and imminent presbyopia have to be well explained. In these patients, we target emmetropia, rather than under-correction or mono-vision. We do not perform paediatric LASIK procedures.



Ioannis Pallikaris



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Mahipal S. Sachdev



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D. Ramamurthy

DRM: The range of refractive error that I treat by LASIK is upto - 10D myopia, +4 D hyperopia and 4D astigmatism. Minimum pachymetry for LASIK procedure should be 500 microns and for Surface ablation 450 to 500 microns.

The patient should be above 18 years of age with stable refraction for at least for a year.

TA: What is your preferred treatment profile for LASIK and do you prefer any particular profile for selective cases?

(Topo guided/ Wavefront-guided/ or Wavefront optimized)

IP: Conventional Wavefront optimized treatments. I use topoguided selectively in eyes with topographic abnormalities such as keratoconus (in combination with topo PRK), post ablation eccentric zones or central islands.

GK: Wavefront optimized is my preferred profile. I use topo-guided treatments in combination with corneal collagen cross linking for ectatic corneal diseases such as keratoconus.

MPS: I do wave-front guided ablation for most of my patients as I find that gives optimum correction and better quality of vision. We do a wavescan pre-op to measure the higher order aberrations and accordingly incorporate their correction in our laser treatment profile.

JST: In our routine cases we perform a Wavefront optimized treatment, and have achieved satisfactory results. In patients with larger pupil size (> 6 mm) and with previous night vision problems, a wave-front guided treatment is preferred. For re-treatments, we prefer Custom-Q (corrected for asphericity) treatments. We have the Alcon® Wavelight Refractive suite at R P Centre, (AIIMS) with and integrated Topolyzer for topography guided LASIK as well as the Analyzer for wavefront guided treatments.

DRM: In normal eyes, wave front optimized profile is my treatment of choice. When patients have abnormal cornea, I choose the topo guided treatment. Where HOA > 0.4 microns & patient is symptomatic I offer wave front guided treatment.

TA: What is the routine flap thickness? What advantages and disadvantages do you observe with it?

IP: 100µm, it gives more residual bed thickness.

GK: From 90-100µm, it is appropriate thickness, so that the residual bed thickness is optimized and flap stability is not compromised.

MPS: I routinely do femto-laser LASIK where the flap thickness is 100 microns which allows me greater tissue saving while the flap cut with the femto-laser gives good stability and faster healing. In the last 1 year I have been doing ReLEx SMILE procedures which is essentially a flap-less LASIK. Since no flap is created, incidence of flap related complications like flap folds or displacement is nil.

DRM: If corneal thickness is not a concern, I routinely make 120 microns flap. Thicker flaps is a waste of tissue & thinner flaps are more prone for striae, displacement etc.

JST: In routine cases we prefer having 120 and 110 µm flaps. The side cut angle for our flap is 70°, with a superior hinge. These flaps are easy to reposit, rarely curl or fold upon themselves and have minimal post-operative striae. When the expected residual bed thickness is slightly less than 300 µm, we prefer 100 and 90 µm flaps. With the 200 Hz femto-second LASIK, these flaps are easy to make. However, one has to be gentle during dissection, especially over areas of anomalous adhesions. Thin flaps have a tendency to recoil over themselves, and have to be repositied with precaution. It is necessary to check that there are no folds in these flaps intraoperatively with a slit-beam before removing the speculum.

If corneal thickness is a concern, I make 90 micron flap with a femto laser.

TA: Which corneal topography system do you prefer to use in your preoperative workup? What advantages do you gain from it?

IP: I am using i-Tracey and Galliley.

GK: For placid topography I am using i-Tracey For tomography I am using Galliley.

MPS: I use the Pentacam (Oculus) for corneal topography which uses a Scheimpflug camera for imaging the anterior segment. It uses corneal elevation data as the basis of measurements and is a very sensitive, accurate and reliable tool for pre and post-refractive surgery evaluation of the cornea. Apart from pachymetry and keratometry it provides anterior and posterior corneal elevation maps which help to identify patients at risk for ectasia or with forme-fruste keratoconus and helps to reliably exclude them. Its Belin-Ambrosio enhanced ectasia displays further help to identify at-risk patients. I also find it a versatile instrument for measuring the true-net corneal power, anterior chamber depth and volume, IOP correction and lens status.

JST: We use the Orbscan IIz and Pentacam routinely in all our patients. The preliminary screening, pupillometry and WTW measurements are obtained using Orbscan, a combined placido-disc and slit-scanning device. The Pentacam, a Scheimpflug imaging based device provides valuable information about the posterior elevation, which is absolutely necessary to rule out sub-clinical ectasia. The refractive maps as well as the Belin Ambrosio Enhanced Ectasia display are seen, to rule out forme-fruste keratoconus.

DRM: I use Pentacam for the pre - operative work up and I see the following advantages with it: Reliable information about anterior & posterior floats, no extrapolation of data centrally, fairly reliable curvature & thickness maps, useful for topo guided treatment on the Wavelight platform, Belin Ambrosio display (BAD) for

selecting borderline keratoconus, fairly reliable data in post refractive surgery cases.

TA: What is your routine post-operative regime post LASIK and post PRK?

IP: Combination of dexamethasone and chloramphenicol for one week.

GK: Combination of dexamethasone and chloramphenicol for two weeks in LASIK and for four weeks tapering in PRK.

MPS: I use an antibiotic for 1 week, low intensity steroids for 3 weeks, lubricants for 2-3 months post-LASIK. For PRK I use an oral and topical NSAID in addition for immediate post-op pain till the bandage contact lens is removed and epithelium grows back.

JST: A fourth generation fluoroquinolone like preservative-free moxifloxacin hydrochloride 0.5 %, gives a good cover against the gram positive and gram negative bacteria. Moxifloxacin is instilled immediately after the surgery and then on TDS basis for a month. We prefer to use prednisolone 1% as phosphate salt, as it is available in a solution rather than a suspension. It reduces the antibiotic drug depositions on eyelashes, reducing patient inconvenience. We start with a 6 times a day dose, reducing it to four times a week after 1 week looking at the clinical response, and then taper it over a month's time. As dry eye and foreign body sensation are common after LASIK, we prefer preservative free lubricant topical eye-drops 6 times a day. The frequency is reduced after 1 month to 4 times a day. Cyclosporine is not administered on routine basis.

DRM: In Post LASIK patients, I prescribe topical loteprednol & 4th generation fluoroquinolones qid for 1 week and non preserved tear substitutes qid for 2-3 months.

In Post PRK, BCL is placed for 3 days or till reepithelialisation is complete. I prescribe 4th generation fluoroquinolones qid for 1 week, Loteprednol qid for 4 weeks & slow taper over next 1 month and non preserved tear substitutes for 3 - 6 months.

TA: In what cases do you prefer surface ablation? Which is your preferred technique and what problems do you find to be associated with it?

IP: Diopter corrections < 3D myopia, eyes with thin corneas (<500u) and normal topography. In my practice I perform almost 50% surface ablations.

GK: Thin corneas < than 500µ, we use epithelial rotatory brush for epithelial removal during surface ablation.

MPS: For patients with a normal topography but corneal thickness between 460 to 490 microns I perform surface ablation. I use the hockey stick to debride the epithelium, perform the excimer laser correction followed by Mitomycin 0.02% application for 20-60 seconds depending on the amount of refractive error. After copious irrigation I then apply a bandage contact lens. I find this

technique very reliable in my hands with minimum post-op haze and stable refractive correction.

JST: Professional history and patient requirement are of great importance in considering surface ablation. Sportsman, patients targeting armed forces and patients in adventure sports are good candidates, as flap displacements are a real risk in these patients. It is important to choose a patient with low to moderate myopia as myopic regression and haze are a definite problem with surface ablation. We often do alcohol assisted PRK (20 % concentration) with mitomycin C 0.02 % application for 12 seconds. Recently we have shifted to T-PRK that is removal of epithelium with the laser itself in PTK mode and than ablation with desired treatment profile. This gives an advantage of speedy healing and less pain. Some amount of haze can still be expected. A bandage contact lens is a must. Pain and watering are more than in LASIK and epithelial healing takes 2-5 days in these patients.

DRM: Indications for surface ablation include corneal thickness between 450 - 500 microns, refractive error less than -6D / +3D, small powers but involved in contact sports or military personnel, family history of keratoconus in normal individuals, normal corneas with few doubts about topographic evidence of keratoconus.

My preferred technique is TRANS epithelial PRK.

The problems experienced with a surface ablation procedure are pain, irritation watering for 2-3 days, need to wear CL for 2-3 days, absence of immediate WOW factor, more time for refractive outcome to stabilize, haze & regression.

TA: Do you find any difference in doing hyperopic LASIK? Is there any difference in outcomes and patient satisfaction in these cases?

IP: Visual recovery is delayed, however patient satisfaction is actually more.

GK: I dont perform hyperopic LASIK more than four dioptres, as the visual recovery is considerably slower.

MPS: In hyperopic patients, I tend to treat closer to the dilated refraction. Intra-op I create a larger flap (usually 9.2mm) with pocket off. Post-op the recovery takes a little longer in these patients but after 3-4 weeks, most of the hyperopic patients are fairly satisfied and happy with the improvement.

JST: Patient selection is important, as the keratometry is steepened in these eyes after LASIK. Pre-operative keratometry should be assessed, and a K reading of more than 44 should be avoided. We choose the manifest refraction in hypermetropes as well. The patient should be counselled that some amount of refractive error may return as the amplitude of accommodation reduces with age. The ablation zone is larger, and hence the flap is also bigger. Sometimes, it may reach the para-limbal area, causing bleeding from the limbal arcade. Also, problems with

night time driving are more pronounced in these patients.

DRM: There is no difference in procedure although I find greater chances of residual error, regression and decentered treatment in these cases.

TA: What is your protocol for treating residual refractive errors post LASIK?

IP: By lifting the flap, I have lifted flaps more than 15 years after primary LASIK.

GK: Six months postoperative interval, I am treating residual refractive errors by lifting the flap.

MPS: I wait 3 months before performing any re-do surgeries to allow the refractive error to completely stabilize. Once I have a stable topography and refraction I obtain 3 fortnightly readings which are repeatable and plan a re-do. I always try and re-lift the flap and I find that one can lift the flap even many years after the primary surgery has been performed. If the flap cannot be lifted, I perform a PRK.

JST: We wait for a period of 3-6 months for the refractive error to stabilize after the primary procedure. In patients presenting late, it is important to distinguish ectasia from myopic regression and keratometry should be thoroughly assessed. Corneas undergoing refractive surgery are oblate with positive spherical aberrations. Normal cornea has -0.3 to -0.4 asphericity. So we prefer to use Custom Q, or asphericity corrected treatments in these patients. A word of caution is to assess the RBT thoroughly as Custom Q treatments ablate more than the routine wave-front optimized treatment and the ablation depth has to be adjusted for the same. In post-operative period, it is important to carefully look at epithelial ingrowth.

DRM: I wait for at least 3 months & ensure that the residual power & topography is stable. Then relift the flap & treat on the bed.

TA: What all preoperative evaluation is necessary to prevent the risk of postoperative ectasia?

IP: Topography and tomography both.

GK: Both topographic and tomographic evaluation with corneal pachymetry.

MPS: A good pre-op work up is essential. Make sure the refractive error is stable, there is no family history of keratoconus, age is over 18 years and the patient is not pregnant. Then we perform a pentacam and scan the anterior and posterior corneal elevation maps, the pachymetry and keratometry. Finally we look at the BAD display. I don't plan excimer ablation more than 100 microns and leave a residual corneal bed closer to 300 microns.

JST: Steep keratometry (> 47 D), high and asymmetrical astigmatism, frequent change in refractive error, skewed axes on topography maps, thin cornea, and asymmetric topography - all should raise a suspicion of predisposition to ectasia. A thorough screening with

Belin Ambrosio enhanced ectasia display on Pentacam is necessary in all these patients. Ablation ratio, ablation depth, corneal depth and the total vertical fibres (flap and excimer ablation) are increasingly being considered as risk factors for post-operative ectasia, and we like to take these factors into consideration as well. In patients where expected RBT is < 300 μ , consider going for a thinner flap. Surface ablation is another consideration in such cases.

DRM: The presence of the following are considered Red flags : family history of keratoconus, scissoring reflex on refraction, high non orthogonal cylinders, unstable refractive error & BCVA < 20/20, thin corneas, abnormal topography.

TA: How frequently do you see progressive corneal ectasia post LASIK? How do you manage these patients?

IP: 1 out of 15,000 cases.

I manage these patients with CXL.

GK: 1 out of > 5000 cases. They are managed with CXL with or without combination with topoguided PRK.

MPS: The incidence of ectasia is reported to be ranging from 0.04 to 0.6%. I see not infrequently referred patients from various parts of the country who have primary LASIK surgery performed elsewhere and develop ectasia. After a complete evaluation I perform corneal cross linking with /without intra-corneal ring segments, usually as a simultaneous procedure to provide maximum benefit. Post-operatively contact lenses maybe prescribed to optimize the vision.

JST: Fortunately the post LASIK ectasia incidence is very less but being a tertiary referral centre we do see quite a number of cases.

Whenever a patient with a drop in CDVA comes to us, myopic regression and ectasia are two important considerations, and need to be distinguished from each other. Apart from documenting vision and refractive error, keratometry and elevation maps are very important. Myopic refractive error with increased astigmatism, worse spectacle-corrected visual acuity, increased corneal toricity with topographic abnormality, and progressive corneal thinning are hallmark of post- LASIK ectasia that needs to be assessed over a time period.

Checking progression and visual rehabilitation are the cornerstones of management. Cases with more than 400 μ central corneal thickness are good candidates for CXL. We have facilities for both accelerated and the routine CXL. Currently we are doing an epithelium off CXL with 0.1% riboflavin in 20 % Dextran with 3 mW/cm² for 30 minutes. It is important to note that while debriding the epithelium, the sweeping movement should be initiated from the hinge area, going in the opposite direction. In doubtful cases, epithelium on CXL is a good option.

DRM: Very rarely these days with careful preop evaluation. Management would be CXL, Glasses, CL.

TA: Do you use ReLEx and SMILE technique in your practice? If yes, in what cases and what advantages do these procedures have over LASIK?

IP: No.

GK: No.

MPS: I have been using ReLEx and SMILE for the last 1 year and have performed over 1000 procedures. I recommend them for all patients with a myopic refractive error up to 10 D. Since no flap is created, I find the cornea very stable and flap-related complications such as flap folds do not occur. Incidence of DLK is also minimal. Since corneal tissue is removed from a small clock hour incision, the corneal nerves are not transected and incidence of dry eye is negligible.

DRM: No, I don't.

JST: We do not have ReLEx SMILE facility at our centre.

TA: Have you combined LASIK with accelerated CTR (LASIK XTRA) in your practice? If, yes, for which cases?

IP: No.

GK: No.

MPS: I offer LASIK XTRA to patients who I feel are at risk for ectasia such as patients with a refractive error between 8-10 D or those who are otherwise fit for refractive surgery but have a family history of ectasia or keratoconus.

JST: No, we haven't yet tried LASIK XTRA in our patients.

DRM: Yes. The indications are: Young age, Thinner corneas, Mildly doubtful topography, Higher powers especially hyperopia & astigmatism.

TA: What is your experience with presbyopic correction? What difficulties do these patients face postoperatively?

IP: I use variety of methods (Monovision using LASIK or CLE, multifocal/ accommodative IOL - crystalens AO, W-IOL and corneal inlays)

GK: We use variety of methods, however my preferred is Monovision using LASIK.

MPS: NIL.

JST: Currently we do not employ any keratorefractive procedure for presbyopia correction.

DRM: None. I Don't do Laser vision correction for presbyopia.

TA: What are the common complaints that patient face post LASIK in your practice and how do you manage those?

IP: I guess most common complaint is dry eye. My

patients get cyclosporine eye drops and lubricants for atleast 3 months.

GK: Most common complaint is dry eye, We use cyclosporine eye drops and lubricants for first 3 months.

MPS: Most common complaint is dry eye and such patients benefit from extra lubrication for 3-6 months post-op. Patients with higher corrections sometimes complain of glare and haloes in the evening when their pupil dilates. I usually prescribe a pupil stabilizing (alpha agonist) eye drop in the form of brimonidine 2 hours before they step out or drive at night. Some patients are steroid responders and may develop high IOP even after a few days of steroid use leading to haze and a drop in vision. These patients need to be differentiated from DLK as the treatment is exactly opposite, namely withdrawing steroids in the former and adding steroids in the latter.

JST: Dryness and night time blurring, haloes and glare are the most common complaints. Pre-operative and post-operative counselling is a must in all the cases for commonly anticipated problems. In symptomatic patients with dry eye, but without any evident punctate staining we increase the frequency of lubricants and advocate a gel formulation for night time use. In severe cases, 0.05 % cyclosporine is our drug of choice.

DRM: Dry eye: treat with non preserved lubricants, Residual ref error : if patient is bothered by it & enough tissue available I'll do enhancement procedure. Patients with abnormal topography, I perform a topo guided treatment and in DLK, interface wash.

TA: How frequently do you see infections in post LASIK cases? What are the commonly isolated organisms in these cases and in what time period do they present?

IP: I have personally not encountered post LASIK infection.

GK: None of my patients have suffered from post LASIK infections as yet.

1 case with atypical mycobacterium infection after LASIK was referred to me.

MPS: Post LASIK keratitis has a very rare occurrence as the UV light of the excimer laser has a sterilizing effect. Diagnosis can be missed especially when atypical microorganisms such as acanthomeba or fungi are the cause. With use of femto-LASIK the incidence has further dropped as no micro-keratome comes in contact with the eye. The organism usually comes from the ocular flora of the patient, though instruments, sponges and the surgeon may be the source. Gram positive bacteria and atypical mycobacteria are commonly isolated and the reported incidence by ASCRS is around 0.035%.

JST: R.P. Centre being a tertiary referral centre we do see all types of post operative cases including infections. We have seen early as well as late onset of infectious

keratitis in post LASIK patients. In 2005 and 2006, we have published fungal infection with *Alternaria* and early infection with *Pseudomonas aeruginosa* respectively. We have recently seen an interface fungal infection with *Fusarium*, 9 years after the initial LASIK. On an average we get 3-4 referred cases of post-LASIK infection per year. Early infections are more common than late infection, bacterial keratitis predominating over fungal and atypical mycobacterial infection.

DRM: I have seen a single unilateral case of infection in my practice of LASIK over 17 years.

TA: How frequently do you see flap related complications and interface related problems in your practice? How do you manage those?

IP: Flap and interface related complications are very rare now a days with femtosecond lasers and also due to new generation microkeratomes. Probably the most common still is mild DLK (diffuse lamellar keratitis), which we manage with increasing steroid dosage.

GK: Very rarely after the introduction of femtosecond laser. If at all, very few cases of DLK, which were managed with steroids.

MPS: Flap related complications and DLK have become minimal with the use of flapless LASIK (ReLEx SMILE). When referred from other areas, I normally manage them by re-lifting the flap, irrigating the interface, straightening out the folds with or without epithelium debridement depending on whether they are fixed or not. Distilled water to loosen the adhesions is used and ironing out the folds with a warm spatula maybe needed in resistant cases. A BCL is applied at the end of the procedure. DLK is managed by frequent topical and oral steroids in mild to moderate cases but severe cases need a flap-re-lift and wash to remove the inflammatory cells.

JST: Microstriae and DLK are the most common flap related complications. For, microstriae grade 1- 3, we prefer to start topical corticosteroids on two hourly basis, monitoring the glare, contrast, aberrations and vision. In these patients functional visual acuity than Snellen's visual acuity is always a concern. Resolution of symptoms is quite common with increase in corticosteroids. For macrostriae and grade 4 microstriae not amenable to steroid therapy, PTK is a good option. Sometimes, refloating, stretching and repositing the flap are considered. Refractory cases may call for suturing the flap edge.

DRM: I rarely see flap complications even less with femtoflaps. The following is the management for various flap related complications: Striae - if in visual axis hydrate & smoothen the flap, flap displacement - replace the flap in position, interfaces debris & DLK - interface wash, epithelial ingrowth - lift the flap & debridement if progressive, free flaps - if adequate bed proceed with laser & replace flap, flap tears or inadequate flaps - postpone

laser, replace flap, wait for 3 months & treat by PRK or with flaps thicker than on the first occasion.

TA: Do you find any difference in the outcomes of microkeratome assisted and Femtolaser assisted LASIK?

IP: There is probably no difference in refractive outcomes, but FS LASIK gives more safety and flap stability in my opinion.

GK: Yes, especially in term of safety.

MPS: Femto-laser is definitely a safer and more advanced way to perform LASIK. The iLASIK femto-laser creates planar flaps which are more consistent with a smoother tissue separation. The flaps are cut at an acute angle which makes them less prone to displacement with fewer incidence of microstriae and greater flap stability such that they can withstand high gravitational forces. With the introduction of flap-less LASIK with ReLEx SMILE, flap complications have become a thing of the past. The greater stability, superior refractive correction and minimum incidence of DLK makes femto-LASIK the procedure of choice for all my refractive patients.

JST: Yes, definitely. The rates of intra-operative flap related complications like free cap and buttonholes have definitely gone down. In past 1000 eyes that we have operated, we haven't noted a single free cap. So, Femto-laser assisted LASIK is useful in patients with keratometry < 40 D and steeper than 47 D.

On the flipside, we had a few cases with vertical gas breakthrough with Femto-Laser assisted LASIK. Loss of suction during flap creation has been seen in a couple of cases. These have been managed by taking 20 μ thicker flaps, larger by 0.5 mm in size. Opaque bubble layer is another finding not seen in microkeratome assisted LASIK. Rarely, it may involve the centre cornea and interfere with pupil tracking.

Though literature reports increase in DLK incidence with Femtosecond assisted LASIK, we haven't seen a significant rise in its incidence at our centre.

DRM: Femto laser assisted LASIK is better.

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