One of the most devastating complications of LASIK is Post LASIK corneal Ectasia. This entity was described first by Seiler et al.\(^1\) as progressive stromal thinning, corneal steepening, decreased uncorrected distance visual acuity (UDVA), and corrected distance visual acuity (CDVA). Since then several guidelines have been laid for the refractive surgeons to prevent the occurrence of Post LASIK ectasia. Randleman et al.\(^2\) developed a scale, Ectasia Risk Score System (ERSS), which includes preoperative parameters, to predict the chances of post-LASIK ectasia. This scale includes risk factors such as low stromal bed thickness, low preoperative corneal thickness, abnormal preoperative corneal topography, young age and high refractive correction. However, despite the most advanced preoperative evaluation techniques, there have been reports of cases developing Post LASIK ectasia, even in the absence of any preoperative risk factors leaving the refractive surgeons faced with the challenge of management of post LASIK ectasia.

Other bothersome sequela of LASIK is regression of refractive correction. It is known to be higher with the use of certain types of excimer machines, ablation patterns, optical and transition zone diameters and patient age. Despite of improvements in the Excimer beam profile and alterations in treatment zone dimensions, regression still manages to annoy the refractive surgeons.

Management of Post LASIK Ectasia traditionally involved Spectacle correction, Rigid Contact Lenses, Intra Corneal Ring segments and ultimately Keratoplasty, Penetrating/ Anterior Lamellar, in the most advanced cases. In 1998, the introduction of Corneal Collagen Crosslinking (CXL) revolutionised the management of corneal ectatic disorders including progressive Post LASIK ectasia. It has been proven that CXL induces corneal biomechanical changes causing corneal stiffening thereby arresting/ slowing the progression of corneal ectasia.

In 2009 Kanellopoulos and colleagues introduced the concept of concurrent corneal collagen cross linking in a conventional LASIK procedure which later came to be known as LASIK Xtra. It seems to be addressing both the above mentioned complications of LASIK. Concurrent cross linking enhances the biomechanical strength of corneas undergoing Excimer ablation, thereby reducing the possibility of post LASIK ectasia and also promotes the long term stability of the refractive correction.

**Candidates for LASIK Xtra**

The procedure is indicated in an individual undergoing refractive correction using Excimer ablation, having higher risk for development of Post LASIK Ectasia or marked regression.

These include:
- High Myopes
- Hyperopic LASIK
- High Astigmatic refractive errors
- Those with borderline corneal thickness
- Those with topographic asymmetry or irregularities
- Younger patient age
- Those with family history of Keratoconus
- Those with Atopic Dermatitis
- Those with Chronic ocular allergy

**LASIK Xtra- Procedure**

As in a convention LASIK procedure, after lifting the corneal flap and performing the refractive correction, the LASIK flap is folded over itself in order to prevent Riboflavin absorption by the flap (Figure 1). Then a single instillation of Avedro’s Riboflavin formulation, Vibex Xtra™ is done.
over the exposed stromal bed and carefully spread over the stromal bed with the help of irrigating canula. This soaking is continued for 60 seconds and then the flap is repositioned into place. Residual Riboflavin is irrigated and next, very high fluence cross linking is carried out over the flap. Whereas the standard CXL procedure uses classic Dresden’s protocol, that is 3MW/cm² UV fluence at the average wavelength of 370nm, Avedro LASIK Xtra, KXL System (Figure 2) involves the use of higher fluence UV irradiation i.e. 30 MW/cm², for 80 seconds (total energy 2.4 J/cm²). Prior to introduction of Avedro LASIK Xtra, KXL System, concurrent cross linking was done with a UV fluence of 10 MW/cm². Vibex Xtra™ is 0.1% Riboflavin diluted in saline instead of Dextran. A significant incidence of Diffuse Lamellar Keratitis (DLK) was observed in initial cases of concurrent cross linking using standard 0.1% Riboflavin stabilised with 10% Dextran. Studied proved that Dextran which was left under the LASIK flap led to DLK, hence the Riboflavin used for LASIK Xtra, was diluted with saline instead of Dextran.

The rationale of treatment using a LASIK flap (as opposed to irradiating the riboflavin-soaked stroma) is to reduce stromal exposure time and the risk of flap dehydration.

LASIK flap is prevented from exposure to Riboflavin as this would lead to partial absorption of the UV radiation and hence suboptimal UV irradiation induced cross linking in the residual stromal bed, which is the most important zone contributing to corneal biomechanical stability. Also the flap would have only 60-70 micron thickness of the stromal tissue (depending on the planned flap thickness) and cross linking in such thin layer of stromal tissue may lead to flap shrinkage which might compromise the refractive outcome.

Hyperopic LASIK has an intrinsic biomechanical response, which results in progressive flattening of the central cornea beginning approximately 4-6 months after the procedure and can be noted even 5 years after hyperopic LASIK procedure. Therefore, hyperopic LASIK Xtra, by reinforcing the biomechanical behaviour of the cornea, counteracts the intrinsic progressive flattening of the hyperopic LASIK corneas and therefore offers higher stability and the ability to treat higher degrees of hyperopia with LASIK Xtra.

Discussion

Kanellopoulos and colleagues studied LASIK Xtra in Hyperopic corrections and concluded that Hyperopic LASIK Xtra, by reinforcing the biomechanical behaviour of the cornea, counteracts the intrinsic progressive flattening of the hyperopic LASIK corneas and therefore offers higher stability and the provides for treatment of higher degrees of hyperopia.

Kanellopoulos studied Forty-three consecutive LASIK cases treated with femtosecond laser flap and the WaveLight excimer and subsequently cross linked with UV-A irradiation. The eyes were evaluated perioperatively for uncorrected visual acuity, best corrected spectacle visual acuity, refraction, keratometry, topography, total and flap pachymetry, corneal optical coherence tomography, and endothelial cell count. Mean follow-up duration was 3.5 (range 1.0-4.5) years. He concluded that prophylactic collagen cross-linking for high-risk LASIK cases was a safe and effective adjunctive treatment for refractive regression and potential ectasia.
Kanellopoulos and colleagues conducted a study on 165 consecutive eye posted for Myopic LASIK correction. They compared 73 eyes undergoing standard LASIK with concurrent high fluence CXL with 82 eyes undergoing standard LASIK alone. Both the groups were followed up 1 year post operatively and manifest refractive spherical equivalent (MRSE), refractive astigmatism, visual acuity, corneal keratometry, and endothelial cell counts were evaluated. They concluded that application of prophylactic CXL concurrently with myopic LASIK surgery appeared to be a safe procedure which contributes to improved refractive and keratometric stability compared to standard LASIK. This was evidenced by slightly regressing keratometric stability plots in the standard LASIK group as compared to stable plots in the LASIK CXL group.

Mazzotta et al. performed in vivo confocal microscopy in a case of sequential accelerated CXL and followed up the patients unto 6 months post procedure. The study revealed that Epithelial basal cells showed an immediate slight damage related to a direct cytotoxic effect of UV-A irradiation; however, the epithelium appeared normal in the first month after treatment. During the follow-up, corneal edema disappeared gradually and keratocyte repopulation was complete at the 6th month. No changes in the density of the extracellular matrix, were recorded at the 6th month. Endothelial cell counts did not show any significant deterioration during the 6 month follow-up. The study proved the safety of this procedure.

Kanellopoulos et al. studied the possible topographic epithelial profile thickness changes (remodelling) after high myopic femtosecond laser in situ keratomileusis (LASIK) with concurrent prophylactic high fluence cross-linking in comparison to standard Femtosecond LASIK. They studied 3 dimensional epithelial thickness distribution 6 months post operatively using clinical spectral domain Anterior Segment Optical Coherence Tomography in matched high myopic correction subgroups. It was concluded that application of prophylactic CXL concurrently with high myopic LASIK operation results in a statistically significant reduced epithelial increase in comparison with stand-alone LASIK and this difference may correlate with higher regression rates and/or may depict increased biomechanical instability in stand-alone LASIK.

Tomita et al from Shinagawa LASIK centre, Tokyo in their study compared eyes which underwent LASIK XtraTM to those undergoing LASIK only. They found changes in the corneal stroma cells similar to the changes in conventional CXL using confocal microscope examination. No significant differences were found in UDVA, CDVA, MRSE, ECD, dynamic bidirectional applanation readings (eg, CH, CRF, KMI), or 37 additional studied parameters, between the 2 groups. Increased hyper reflectivity and a demarcation line similar to that seen after CXL were observed in the LASIK-CXL eyes. The demarcation line (mean depth 200.04 μm ± 27.01 [SD]; range 178 to 278 μm) was present in 95.8% eyes. They concluded that combined LASIK-CXL was safe, causing insignificant corneal biomechanical and morphologic changes similar to those with CXL treatment only.

Celik and group conducted a study in which patients underwent LASIK with concurrent accelerated CXL in 1 eye and LASIK only in the fellow eye to treat myopia or myopic astigmatism. The follow-up was 12 months. The attempted correction (spherical equivalent) ranged from -5.00 to -8.50 diopters (D) in the LASIK-CXL group and from -3.00 to -7.25 D in the LASIK-only group. Main outcome measures were manifest refraction, uncorrected (UDVA) and corrected (CDVA) distance visual acuities, and the endothelial cell count. They found that at the 12-month follow-up, the LASIK-CXL group had a UDVA and manifest refraction equal to or better than those in the LASIK-only group. No eye lost 1 or more lines of CDVA at the final visit. The endothelial cell loss in the LASIK-CXL eye was not greater than in the fellow eye. No side effects were associated with either procedure. They concluded that Laser in situ keratomileusis with accelerated CXL appears to be a promising modality for future applications to prevent corneal ectasia after LASIK treatment. The results in this pilot series suggested that evaluation of a larger study cohort is warranted.

In conclusion it can be stated that LASIK with prophylactic concurrent collagen cross linking is a safe procedure which enhances the post ablation biomechanical stability of cornea thereby providing a longer refractive and keratometric stability both in myopic and hyperopic eyes. It does not have any deteriorating effect on cornealstromal keratocytes or the endothelial cells. However issues such as the effect of concurrent cross linking on the visual acuity, induced aberrations, effect on contrast sensitivity require to be studied in detail. Further studies with a larger cohort and a longer followup period are recommended.

References


Refractive Surgery: LASIK Xtra: What is the Extra Benefit?

If you want to sell your used Ophthalmic Equipments at Good Price
OR
If you are Interested to Purchase Second hand Ophthalmic Equipments at Reasonable Prices in Good Condition
Please Contact: Manoj Pandey

Venus Surgitech
B-503, Plot No. 23, Sector-6, Dwarka, NEW DELHI-75
Ph.: 011-43557387, 9350257387
Email: pandeymanoj67@yahoo.co.in