Refractive Surgery
Free Papers
# REFRACTIVE SURGERY

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Is Posterior Float A Significant Factor in Ectasia Screening?

Dr. Hassan H. AL Arrayed, Dr. Revathy Subramany, Dr. Vinod K. Thomas, Dr. Sigi George

The detection of early keratoconus or “forme fruste keratoconus” (FFKC) is a challenging issue in the field of refractive surgery. The term FFKC or “subclinical keratoconus” was introduced to indicate a very early, preclinical stage of the disease in eyes that do not show the classical keratometric, retinoscopic, or biomicroscopic signs, but show subtle topographic features similar to clinical keratoconus on videokeratoscopy. Screening for corneal abnormalities related to subclinical keratoconus is important to avoid corneal ectasia following LASIK.

Advances in diagnostic technology and methods have been described over the past years for the screening of refractive surgery candidates and they have led to improved results. Many clinicians diagnose keratoconus based on inferior corneal steepening on the curvature map of Placido–disk based videokeratography, but, large refractive surprises continue to be reported. Posterior elevation is considered as an important clinical correlation in predicting post operative ectasia in patients seeking refractive surgery because anterior elevation and thinning can occur in the later stage and people seek refractive surgery in earlier ages.

Posterior elevation is detected viewing elevation maps and comparing the data to a standard reference surface (shape). It is actually an elevation subtraction map. The purpose of this study was to analyze the significance of posterior elevation in screening laser refractive surgery candidates.

MATERIALS AND METHODS

This study includes 113 eyes of 65 refractive surgery screening patients with posterior elevation of >11. The preoperative workup of candidates included a detailed medical history, manifest and cycloplegic refraction, slit-lamp biomicroscopy, scotopic pupil measurement, and a dilated fundus examination. As part of our preoperative examination protocol, all soft contact lens wearers were out of their lenses for 3 or more days before examination. All hard contact lens wearers were out of their lenses for 3 weeks or more before examination.
All candidates underwent corneal topography measurement with the Tomey TMS-1 corneal topography unit and Pentacam rotating Scheimpflug camera, software version 1.15 (Oculus) by a single expert examiner, who was blind to the clinical condition of the patient. Clinically diagnosed keratoconus patients were excluded. We chose Belin/Ambrosio ectasia screening map as the reference. Analysis of the Belin/Ambrosio ectasia screening color maps in Oculus Pentacam was focused on six quantitative parameters: anterior elevation (AF), posterior elevation (PF), thinnest pachymetry (TP), Pachymetry progression (APPI), Displacement of thinnest point from the apex (D) and steep keratometry (K).

For posterior corneal elevation measurement, a 8mm best-fit sphere (BFS) was used as reference surface. The thinnest pachymetry was determined by taking the minimum elevation difference between the anterior and posterior corneal surfaces. The anterior elevation was determined by taking the maximum difference in anterior elevation between best-fit sphere and patient cornea. Pachymetry progression represents the thickness distribution throughout the cornea. The steepest K and thinnest point displacement obtained from the Pentacam report.

Anterior elevation (AF) >8.00mm, corneal thickness at the thinnest point (TP) <510u, thinnest point displacement (D)>0.9mm, and pachymetric progression (APPI)>1.2 and a steep keratometric curvature greater than 47 D were evaluated and correlated with posterior elevation values. Although Belin/Ambrosio ectasia map was our reference, we also referred to the Holladay map for possible extra information and comparison. In the Holladay maps we looked for the ‘hot spot’ in the tangential, relative pachymetry and posterior elevation maps. A hot spot in the same location on all three maps indicates a suspicious irregularity such as a cone or corneal thinning point. Thus, the information provided by these three maps added substance to the preoperative evaluation.

RESULTS

Our results showed TP of < 510u was seen in 21 %, D > 0.9mm in 40 %, APPI >1.2 in 8%, AF in 3.6% and K > 47D in 27.4% of the eyes. 40% of eyes showed the thinnest point shift infero temporarily.

To assess our results we devised a grading system in which, if only posterior elevation was present, it was designated as grade “0”. If any one of the indices TP, AF, D, APPI or
K was present, it was grade “1”, if 2 indices, “2”, if 3 indices “3”, and in the presence of 4 positive indices, grade “4”. 1% of eyes with PF had 4 abnormal indices while 7% had 3. Two indices were raised in 18%, 74% had one abnormal value or none. 44.4% of eyes with 3 or more raised indices were diagnosed as forme fruste keratoconus. These patients showed the coincidence of “hot spot” in Holladay map of Pentacam.

DISCUSSION

The posterior elevation value is considered important in screening patients undergoing laser refractive surgery. Although it has been suggested that an increase in posterior elevation may be the earliest sign of subclinical keratoconus. In our practice, we noticed significant posterior float values in many candidates screened for refractive surgery. Clinical history and other factors were found to be normal. Based on the classification of posterior float values as recommended by Belin all the cases would have been considered keratoconus suspects. The Pentacam however, helps us utilize other parameters which are also sensitive indicators of corneal architecture change namely, TP, APPI, D, K and AF. The significance of these parameters is evident in the fact that in 44.4% of patients who had grade 3 or more could be diagnosed as forme fruste keratoconus. A finding corroborated in the Holladay maps. In this study 74% eyes fell in grade 1 or grade 0. This indicates that although the presence of a posterior float is a significant factor in determining keractasia, on its own it is not a contraindication for laser refractive surgeries. The posterior elevation was less effective in discriminating subclinical keratoconus than it was in discriminating keratoconus. Based on the data collected from this study, we are following a screening algorithm for LASIK patients in which, if the posterior elevation is above 11.00mm, in the absence of other risk factors, we proceed with LASIK, if the presence of elevated posterior float with 2 or 3 risk factors, we proceed with surface ablation.

REFERENCES


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**Deep Anterior Lamellar Keratoplasty, Vs Penetrating Keratoplasty in Keratoconus**

**Dr. Anita Panda**, Dr. Anoop Kishore Gupta, Dr. Sasikala N K, Dr. Vanathi M.

Keratoconus (KC) is a non inflammatory, degenerative, self limiting ectatic disease of the cornea characterized by progressive thinning and steepening of the central cornea giving rise to a cone shape.¹ This cone prevents light from focusing on the macula. As the disease Progresses it gives rise to high irregular astigmatism which becomes responsible for gradual deterioration of vision.

The treatment option varies from spectacle to contact lens to corneal transplantation. PKP remains as the gold standard of treatment.² However, deep anterior lamellar keratoplasty (DALK) could be an alternative by which the progressive cone can be flattered and also the scar upto Descemet membrane if any can be removed and replaced by donor tissue.³

With this background we aimed at to compare the outcomes of DALK and PK in eyes with advance keratoconus.

**MATERIALS AND METHODS**

This retrospective study includes 60 eyes for progressive keratoconus (KC) (Kmax 55-62D) those were neither improving with spectacle nor tolerating contact lens (CL) and subjected to keratoplasty were included. The demographic
data, preoperative visual acuity, slit lamp biomicroscopy, keratometry and Orbscan II were noted preoperative. Pre-operative examinations included ocular surface evaluation, both A and B ultra (AL) sonography to find out axial length and posterior segment details and electrophysiological evaluations. Eyes with normal ocular surface and posterior segment were included. DALK was performed in 30 and (PK) in rest 30 eyes. Patients were matched between groups for keratoconus severity. In all, the size of the cone was measured by slit lamp beam to decide the diameter of recipient button to be removed.

**Surgical procedures**

Either general or peribulbar anesthesia was selected depending upon the age and cooperation of the patient. The size of the true trephine was decided as per the size of the cone. Care was taken to include entire cone irrespective of whether it was DALK/PK. All PKs were performed in conventional manner and all DALKs by manual dissection, either by big bubble or open technique.

The donor tissue with nonviable endothelium not fit for penetrating keratoplasty was selected. The corneoscleral tissue was kept over a Teflon block endothelium facing up and the endothelium was stained with trypan blue. It was followed by Descemet and endothelium peeling. The donor tissue 8-8.5mm diameter (same as that of recipient bed) was punched from posterior corneal side. For PK, the size of the recipient varied from 7.5mm-8mm. Obtained buttons were fixed to the recipient bed in both the groups with 16 interrupted 10-0 monofilament suture with buried knots. S/C injection of Gentamicin 20mg and Dexamethasone 4mg followed by betadine wash to the cul de sac and a patch completed the surgery.

Post operative regimen included topical prednisolone acetate 0.1% drops as 4 hours interval, 3% ciprofloxacin drops 4 times a day and tear substitute at 2 hours interval. The antibiotic drops was continued for 1-2 weeks. The steroid was tapered after 2 weeks and discontinued after 3 months in DALK and continued up to 6M in PK. Artificial tear drops, however, continued twice daily.

The patients were evaluated by slit lamp daily upto one week for 4 weeks, every 2 weeks for 4 more weeks, every month upto 6 months and every 3 months upto one year. Best corrected distant visual acuity (BCDVA), keratometry and orbscan II were performed at each visit.

**RESULTS**

The mean age of the patients was 25.6 ± 5.9 years and 27.3 ± 6.8 years in DALK and PK group respectively. (p=NS). The mean follow up time was 10.72 ± 4.46 months. The mean pre operative least corneal thickness was 326 ± 10.2mm and 276±11.4 mm in DALK and PK group respectively. All the eyes had preoperative
corrected spectacle distant visual acuity (CSDVA) < 20/200 which was improved significantly in both the groups. (Fig. 1) Astigmatism of <3.5D was achieved in 60% eyes of DALK 40% of PK at the end of one year (Fig 2). Though the dioptre of astigmatism varied in both the groups the values were non significant. Glasses and rigid gas permeable contact lenses were the preferetial means of achieving CDVA in both the groups.

Microperforation was encountered in one eye during dissection in DALK Group the size being 2mm. The dissection was stopped and the pressure patch was applied for 15 minutes. Dissection was initiated from a fresh site away from the perforation and the same was successfully completed. One of the PK eye showed Descemet detachment for which a full thickness suture was applied and followed by the air injection from the opposite side.

Table 1: ECD- Cells/mm²

<table>
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<tr>
<th>Post-op</th>
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<th>Cell Loss</th>
<th>PK-ECD</th>
<th>Cell Loss</th>
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<tr>
<td>Pre</td>
<td>2560 Cells/mm²</td>
<td>—</td>
<td>2500 cells/mm²</td>
<td>—</td>
<td>NS</td>
</tr>
<tr>
<td>3M</td>
<td>2440 Cells/mm²</td>
<td>3.1%</td>
<td>2080 cells/mm²</td>
<td>3.9%</td>
<td>DALK vs PK-NS</td>
</tr>
<tr>
<td>6M</td>
<td>2420 Cells/mm²</td>
<td>4%</td>
<td>1940 cells/mm²</td>
<td>10.0%</td>
<td>DALK vs PKs(p&lt;0.01)</td>
</tr>
<tr>
<td>12M</td>
<td>2416 Cells/mm²</td>
<td>4%</td>
<td>1900 cells/mm²</td>
<td>13.8%</td>
<td>DALK vs PKs(p&lt;0.01)</td>
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3M vs 6M vs 12M vs 18M (DALK NS); 3M vs 6M (PK NS), 3M vs 12M vs 18M (PK S)
Post operatively 2 eyes revealed graft infection which however, could be controlled medically in one and after interface wash in other in DALK group. In PK, one eye revealed localized oedema due to Descemet detachment, one post keratoplasty glaucoma, two endothelial rejections and one epithelial rejection (Table). All could be controlled medically.

Maximum number of eyes had graft clarity of 3+ or more which was comparable in both the groups. (Fig 3) Pre operative cell count was 2560 and 2500 in DALK and PK group respectively. The cell count at 3, 6 and 12 months was almost stable in DALK group and revealed continuous decrease in PK group (Table). In PK group, the cell loss at 6M and 12M was highly significant when compared to pre-op value (Table). However, the same was non significant at 3M when compared with that of 3M value.

**DISCUSSION**

Though PKP is the gold standard for advanced KC DALK is becoming popular in recent years as it has a number of advantages over PKP.\(^2\)

Bahar *et al.* reported it produces higher order of Aberration (HOA) than that of PK, but considering the numerous advantages the technique in such eye is justified.\(^3\) Further, as all keratoconic eyes posses good endothelium, PK in such eyes is not justified. Moreover, graft rejection following PK is a frequent problem accounting to 20% in KC cases. Nevertheless, PK requires excellent donor cornea with viable endothelium which is a limitation for developing countries. Despite all advantages of DALK, most of the corneal surgeons hesitate to perform it in keratoconic eyes considering it as a technically challenge procedure. However, with mind set and experience the technique will appear much simple than expected.\(^3,5\)

Karabatsas *et al.* in 1998 commented that astigmatism up to 3.5 D can be well tolerated by the patients. We in our study found 60% and 40% of eyes achieved astigmatism 3.5 D following DALK and PK respectively. We also observed early visual rehabilitation in DALK.

DALK may be associated with corneal perforation during lamellar dissection. It is so in an irregular thin cornea, which is always true in kertoconic eyes. However, in our series we have encountered the problem only in one eye which also could be completed successfully after patching the eye for 15 minutes there after initiating the incision at a fresh site away from the perforation site and including the perforated area at the end.

Interface opacity is one of the greatest limiting factor flowing DALK either due to incomplete removal of the opacity or related to irregular lamellas dissection. However, the same is avoided with smooth dissection techniques 6-8 which could have been achieved by modified techniques followed in the present study.
Considering the above facts, we are in concurrence with that of literature that PK is no longer is the only means of management in advanced KC.

REFERENCES

Complications during Lasik Flap Creation with Femto-Second Laser

**Dr. Ajay Khanna, Dr. Om Parkash Rohit**

This is retrospective, non-randomized clinical observation study of femto-flap complications observed for 1000 femto-flaps created during last 3½ years with 60 KHz Intralase femto-second laser.

Intralase 60 KHz Femtosecond Laser Flap Creation Procedure consists of -

- Applying suction ring to sclera
- Fitting and applying the transparent applanation cone to flatten the cornea
- Femtosecond laser procedure:
  - Femtosecond laser works by formation of multiple gas bubbles.

Steps of Intralase 60 KHz FS Laser procedure
  - Formation of pocket at the start near the hinge
  - Formation of plane of separation at desired level in corneal stroma
  - Side cut creation

Then we separate and lift the flap with blunt spatula.
Fault at any step can lead to complications.

**Suction Loss**

Suction apparatus consists of suction ring attached to syringe to create vacuum.

- If suction loss occurs at the start, you can reapply suction and proceed again.
- If it occurs during formation of plane of separation, then again reapply suction and restart laser procedure by keeping pocket off with same settings using same cone.
- If it occurs during side cut, then use “Side cut only” option by keeping flap diameter at least 0.5mm less than original setting.

In my study, suction loss occurred in 9 eyes (0.9%), out of which we could complete process in 8 eyes. In one eye, repeated suction loss occurred due to uncooperative patient in which we repeated the procedure successfully after 2 months by keeping flap thickness 40 microns more than previous thickness.

**Double Layered Flap** occurred in one eye (0.1%) when after reapplication of same cone, the plane of separation was different from the original plane and it created double layered flap in superior half and there was difficulty in lifting and repositioning of flap.

**Incomplete Flap** occurred in one eye (0.1%) where despite visible bubbles formation, the flap lifting was not possible with blunt spatula and I had to use sharp blade to create the flap successfully.

**Incomplete Side Cut** occurred in one eye (0.1%) despite good visible side cut where I had to complete the side cut in that area with the corneal scissors.

**Flap Tear** An unusual finding was noted in 3 eyes out of 36 eyes operated between 13th Feb 2011 to 12th March 2011. A thin opaque line was observed during bubbles formation on right side (i.e. on temporal side in right eye and nasal side in left eye) which caused

- Linear epithelial tear in one eye (0.1%)
- Raised stromal ridge in one eye (0.1%)
- Full thickness flap tear in one eye (0.1%)

with great difficulty in flap separation in that area.

Later on, it was found during servicing of laser machine that there was thin fibre on corresponding side in the optical pathway of laser which might have caused inappropriate application of laser.

**Vertical Gas Breakthrough** occurred in 2 eyes (0.2%) through full thickness of flap without any consequence.
Air Bubbles In Anterior Chamber occurred in 2 eyes (0.2%) due to passage of bubbles through canal of schlemm into A/C. In one eye, bubbles were enough to cause difficulty in recognition of pupil by eye tracker of Excimer Laser and I had to complete the procedure by switching off the eye tracker.

Opaque Bubble Layer Formation is a common condition with Intralase 60 KHz FS laser where gas bubbles migrate into deeper stroma creating opaque whitish layer in that area of corneal stroma. OBL occurred in 117 eyes (11.7%) but without any consequence in 112 eyes except in 5 eyes where central OBL caused difficulty in eye tracking by Excimer Laser.

Epithelial Defects can occur while entering the side cut if patient suddenly moves the eye.

I could somehow manage all these complications and ultimately did not have any deleterious effect on visual outcome.

In conclusion femtosecond Laser has its advantages and has its own set of complications but we can manage them in much controlled manner as compared to Microkeratome. Further improvement in technology can help in minimizing complications and give even safer, smoother and stronger flaps.

Optics of Unhappy LASIK Patients with 20/20 Vision!

Dr. Chintan Malhotra, Dr. Rohit Shetty, Dr. Shikha Dhawan, Dr. Bhujang Shetty K.

Eye care professionals are increasingly realizing that the 20/20 vision standard needs to be supplemented, as it refers to only one component of vision, specifically visual acuity (VA). Conventional LASIK while correcting the spherocylindrical refractive error is known to induce an increase in higher order aberrations (HOA's) post operatively. The OQAS Optical Quality Analysis System II (Visiometrics, SL, Terrassa, Spain), quantitatively evaluates visual performance. It creates two- and three-dimensional retinal images (or maps) that describe a patient’s total optical system. These images, displayed on a computer screen, include the effects of light scatter and all higher order aberrations (HOA). These are now seen as essential factors in assessing vision quality. In the present study we used the OQAS to study the quality of vision in post LASIK patients having 20/20 Snellens VA, yet complaining of symptoms like haloes, glare and ghosting of images, and attempted to correlate it with pattern of post operative higher order aberrations.
MATERIALS AND METHODS

In this pilot study conducted at a tertiary care ophthalmic hospital, 20 eyes (10 patients) who had undergone bilateral LASIK for simple myopia or myopic astigmatism, and complaining of visual symptoms like glare, haloes and ghosting of images persisting even at 6 months post operatively, were evaluated. All patients gave a written informed consent and the study was approved by the ethics committee of the institute. Patients were examined after surgery on the first day, first week, and then at 1, 3 and 6 months as part of the routine post–operative schedule.

Inclusion criteria

Patients having unaided Snellen’s visual acuity 20/20 or better (measured uniaxially for each patient, for both eyes on all visits), with objective spherocylindrical refractive of less than or equal to ± 0.25 diopters (D) as measured by the OQAS were included in the study. Centration of ablation zone was confirmed by a post operative topography.

Exclusion criteria

Patients with significant dry eyes (leading to a poor ocular surface), objective spherocylindrical error of >± 0.25 D, and decentred ablation were excluded.

Examination with the OQAS and aberrometry was done at 6 months post operatively. Pre and post operative aberrometry was compared in all patients.

RESULTS

20 eyes (10 patients) were examined. All the patients had been complaining of post operative disturbing visual symptoms glare, haloes and ghosting of images which did not improve over the study period (6 months). Mean age of the study group was 25.1 years (range 20-33 years). Male :female ratio was 2:3 (8 males, 12 females). Mean pre operative spherical equivalent was -4.5 D (range -2.5 to -7D).

Group 1 had 12 eyes had an objective scatter index (OSI) of <2 (mean 1.17, range 0.5-1.6) and an MTF cut off > 25 cycles per degree (cpd) (mean 34.47 cpd, range 28.75-37.88 cpd). Mean RMS of HOA was 0.241 (range 0.112-0.414). This subset of eyes had spherical aberrations as the most significant HOA (mean 0.536, range -0.023 to 1.074). Horizontal coma (mean 0.093, range -0.29 to 0.269) was significantly less than vertical coma (mean -0.408, range -0.726 to -0.094) in this group.

Group 2 comprised 4 eyes, all of which had an OSI<2 (mean 1.2, range 0.9-1.5) and MTF<25 cpd (mean 18.91 cpd, range 16.59-21.23 cpd). Mean RMS of the HOA in this group was 0.259 (range 0.18 to 0.330). Vertical coma (mean -0.515, range -0.285 to -0.744) was higher than the horizontal coma (mean-0.004, range -0.118 to 0.11).
Group 3 consisted of 4 eyes which had an OSI > than 2 (mean 6.25, range 5.7-6.8) and an MTF <25cpd (mean 8.66 cpd, range 7.25 to 10.06 cpd). Mean RMS of HOA, was 0.064 (range 0.061 to 0.068). This group had a higher level horizontal coma (mean 0.134, range 0.110-0.157).

**DISCUSSION**

Higher order aberrations induced after LASIK have been linked to visual symptoms of glare, halos, and double vision and also a worsening in contrast sensitivity.\(^1\)\(^2\) It has been demonstrated by Applegate *et al.* that specific combinations of Zernike modes can improve or worsen visual function.\(^3\) A trend towards this was also seen in our study. However we had a very small sample size and a larger study is required before extrapolating these results to the general population.

In conclusion suboptimal optical quality after LASIK using OQAS co-related with certain specific patterns of induced HOA in this pilot study. Eyes which had horizontal coma as the predominant HOA appeared to have the poorest optical quality, with high scatter and a low MTF. This was also seen subjectively on the images of the OQAS. A further understanding of the role of individual HOA on the quality of vision may help in our endeavour to provide aberration free LASIK.

**REFERENCES**


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**Optical Quality Analysis in Forme Fruste Keratoconus**

Dr. Himabindu Veluri, Dr. Rohit Shetty, Dr. Chintan Malhotra, Dr. Bhujang Shetty

Pre-operative screening before LASIK refractive surgery is important for achieving optimal outcomes and maximizing results. Not all patients undergoing refractive surgery will have the best outcomes as refractive surgery is a combination of several items including technology, biometry,
aberration, and surgical technique. Patients with keratoconus and forme fruste keratoconus (FFKC) or other forms of ectasia, such as pellucid marginal degeneration, often have poor outcomes and may have progressive ectasia after laser-assisted in situ keratomileusis (LASIK) and photorefractive keratectomy.\textsuperscript{1-3} Clinical diagnosis of moderate to advanced keratoconus is not difficult. However, the identification of subclinical forms of the disease or forme fruste keratoconus (FFKC) in patients with normal best spectacle-corrected visual acuity and minimum or no clinical signs is challenging and is key for screening candidates for refractive surgery.\textsuperscript{4} Corneal tomography has been proposed to help to identify FFKC at an earlier stage.\textsuperscript{5-7}

An important component of overall visual function is the eye’s optical quality. Several technological methods have allowed ophthalmologists to assess optical quality more objectively. The most promising of these technologies is the wavefront aberrometry based on Shack’s modification\textsuperscript{8} of the Hartmann technique.\textsuperscript{9,10} Liang et al.\textsuperscript{11} adapted this method for measuring conventional refractive errors as well as higher order aberrations of eyes. A Hartmann-Shack device uses a narrow laser beam that is sent along the ocular line of sight into the eye, where it reflects on the retina. This reflection serves as secondary source that illuminates the pupil area from behind. Contrary to the Hartmann-Shack method, the Tscherning principle uses forward projection that can be implemented in both an objective\textsuperscript{12} and a subjective\textsuperscript{13} way while using not one but a group of laser beams that enter the eye. These beams are generated using a wide laser beam passing through a screen with a large number of round holes. These rays form a retinal spot pattern resembling a Hartmann-Shack pattern, on the retina that is more or less distorted according to the optical errors of the eye. The deviations of all spots from their ideal regular positions are measured by means of a computer and from these values the optical aberrations are computed in the form of Zernike polynomials up to the 8th order. Wavefront aberrometry measures aberrations over the entire eye, taking into account not only spherocylindrical refractive error, but also spherical aberrations, trefoil, coma, secondary astigmatism, and several other higher order aberrations (HOA) described by Zernike polynomials. Such HOA are thought to contribute to over 20% of the total number of aberrations in a normal eye, and may contribute to a much greater percentage of aberrations in eyes with diseases such as keratoconus.

The OQAS (Optical Quality Analysis System) from Visiometrics (OQAS, Visiometrics SL, Spain)\textsuperscript{14} is a new development basing on the asymmetric scheme of the double pass technique layout. It incorporates improved features such as direct measurement of the combined effect of the optical aberrations and the loss of ocular transparency on the optical quality of the eye. It is therefore adapted for routine measurements in clinical practice. The OQAS
developed by Pablo Artal and Jaume Pujol, measures the Objective Scatter Index function (OSI) represented as two- and three-dimensional retinal images (or maps) of the optical system of the eye and analyzes the size and shape of a singular infra-red light spot that enters the eye and is reflected from the retina. As such, the light passes twice through the media of the eye. From the double-pass image, OQAS computes the Modulation Transfer Function (MTF), which represents the loss of contrast produced by the eye’s optics as a function of the spatial frequency. It allows surgeons to characterize quantitatively, the performance of the optical system of the eye. Another parameter, the Strehl ratio is computed as the ratio between the areas under the MTF curve of the measured eye and that of the aberration-free eye, and therefore it provides more global information on the optical quality.

MATERIALS AND METHODS
In this prospective, observational, comparative case series, consecutive patients with FFKC were enrolled from the cornea clinic of our institute between January and June 2011. Informed consent was obtained from all participating subjects and the institutional ethics committee approved the study. Patients with co-morbidities known to affect the optical quality of the eye, such as corneal scars or lens opacities were excluded from the study. Patients with a history of previous refractive surgery, or any intraocular surgery, evidence of active uveitis or history of trauma and were also excluded. A medical and ocular history was taken in detail. Each patient underwent autorefractometry (AR600 Nidek Co., Ltd.), assessment of uncorrected visual acuity (UCVA) and best corrected visual acuity (BCVA) with Snellen's chart and full cycloplegic refraction. Those patients suspected of FFKC, either due to positive family history or due to having clinically evident keratoconus in one eye, but with no biomicroscopic signs of keratoconus in the other eye, underwent corneal topographical tests using Orbscan II (Bausch and Lomb, Rochester, NY) and Pentacam (Oculus Inc., Lynnwood, WA, USA). FFKC in these patients was confirmed from these tests based on a combination of data from the topography, including abnormal keratometry, posterior elevation and/or pachymetry maps. All procedures and evaluations were performed by a single observer. Once identified as having FFKC, the optical quality, in terms of the Modulation Transfer Function (MTF) and intraocular scatter by means of the Objective Scatter Index (OSI) were measured using the Optical Quality Analysis System (OQAS). The refractive error was automatically corrected by the double-pass system, and astigmatism was corrected with an external lens. Tscherning aberrometry was performed using Allegro analyser, and with a pupil size of 6mm in all patients. This data was compared with normative data (serving as the control group) already obtained for a separate study from the same institute, during the same time period.
RESULTS
We examined 10 eyes of 9 patients with FFKC and compared them to 100 eyes of 168 normal persons. Of the FFKC group, 60% were male, and 40% female. Of the control group, 58.8% were female. The mean age of the FFKC group and the control group was 21.6 (range: 19 to 28) and 32.47 (range: 18 to 40) respectively. In the FFKC group, the mean steep keratometry value was 43.7 (range: 42.2 to 45.6) and mean pachymetry was 514 (range: 444 to 569). The mean values of MTF, SR and OSI were 32.7 (N: 41.21), 0.19 (N: 0.216) and 1.36 (N: 0.428) respectively, where N is the normative data. The mean root-mean-square (RMS) of spherical, defocus and coma-like aberrations were 0.08 (N: 0.04), 2.88 (N: 0.35) and 0.26 (N: 0.08) microns respectively.

DISCUSSION
In this study, the optical quality analysis showed an increased OSI in eyes with FFKC (1.36) as compared to normal subjects (0.428). Higher order aberrations, particularly coma were also higher with values of 0.26 in the FFKC group, compared to 0.08 in the control group. The importance of detecting forme fruste keratoconus cannot be over emphasized. It is not only important for evaluating and following patients considered to have asymmetric or unilateral keratoconus, it is also important for studying family members of patients with the disease. Furthermore, the pre-operative detection of forme fruste keratoconus is of paramount importance for screening candidates for refractive surgery. If missed, these cases could potentially result in disastrous consequences such as post-LASIK ectasia. Although topography has been the primary modality for identifying cases of forme fruste keratoconus, this study shows that an increase in the OSI parameter and coma like aberrations add support in favour of FFKC to the topographical findings. The optical quality analysis and aberrometry not only aid in the diagnosis of FFKC, but when topographical findings are inconclusive, may even provide an indication as to whether the patient may potentially be a case of FFKC or not. The main limitation of this study is its small sample size. To our knowledge, no similar studies have been performed. Further studies with a larger sample size are required in order to fully assess the utility of the optical quality analysis and aberrometry in diagnosing forme fruste keratoconus. In conclusion, optical quality analysis of forme fruste keratoconus can be an important indicator and a great tool for detection in addition to corneal topography.

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Gonioscopic and UBM Evaluation of The Morphological Changes following Posterior Chamber Phakic IOL Implantation

Dr. Mamatha B, Dr. Jyoti Shetty, Dr. Chetana Naik

Posterior chamber phakic intraocular lens (Implantable contact lens-PCPIOL) implantation is at present the accepted modality of surgical correction for high myopia and hyperopia. They have the advantage of having
greater distance from corneal endothelium, so that long term endothelial damage would be lower than the anterior chamber and iris fixated phakic IOL. However, the PCPIOL position in posterior chamber can cause new problems, especially development of cataract and pigment dispersion.

An ideal lens fit is critical for stability. If it is too small and does not fit in the sulcus, greater movement would be expected. If the PCPIOL is too large, it causes mechanical pressure in the sulcus and forward displacement of peripheral iris. Chafing of the iris by the PCPIOL leads to pigment dispersion and deposition in the trabecular meshwork which may eventually lead to glaucoma.

Ultrasound biomicroscopy (UBM) is a high resolution technique that provides a unique method for testing the exact PCPIOL location and its relationship with adjacent intraocular structure, including the lens, ciliary body, zonulae and iris.

This study was undertaken to systematically evaluate the gonioscopic features and ultrasound biomicroscopic analysis of the relation between PCPIOL and its surrounding structures.

MATERIALS AND METHODS

This prospective study conducted at Bangalore West Lions Super Speciality Eye Hospital, comprised 30 eyes of 20 patients who had implantation of ICL V4 model to correct severe myopia. All surgeries were performed by the same surgeon. Patient selection criteria were: Age >18 years, Spherical Equivalent ranging from -3 and -20D, <3D corneal astigmatism, Stable refraction for 1 year, Intraocular pressure ≤21 mmHg, Grade 3 or 4 anterior chamber angle on Shaffer’s classification with pigmentation of grade ≤2, Central anterior chamber depth from endothelium of ≥2.8mm, no treatable peripheral retinal changes.

The following patient data were fed into company software package to obtain the required ICL model and power.

- Best spectacles accepted sphere and cylinder at 12 mm vertex distance.
- Keratometry reading in dioptric value.
- Anterior chamber depth from endothelium, central corneal thickness and white–white diameter as recorded by Orbscan 11z.

The ICL diameter was supplied by the supplier according to the white to white distance.

A 360-degree gonioscopy with a Goldmann 2-mirror lens was performed pre-op and 3 months post-op. Angle was graded according to the Schaffer’s grading system. The angle pigmentation was graded from light to heavy in
a semi quantitative manner: 0-none; 1-trace; 2-mild; 3-moderate; 4-dense. The grade of pigmentation in all 4 quadrants was averaged to determine the mean pigmentation of trabacular meshwork.

UBM was performed pre-op and at 3 months post-op using the UBM 840 (50 MHz, OTI). The major axis of the PCPIOL, Endothelium–PCPIOL distance (central section), PCPIOL –lens (central) PCPIOL–lens peripheral distance, the location of the final tip of the PCPIOL haptics, Contact zones between the capsule of lens and the PCPIOL were studied.

The statistical analysis was performed by using SPSS version 14.0 for Windows (SPSS, Inc., Chicago, IL) Student’s “t” test and Spearman correlation coefficient.

RESULTS

The mean age in the study group was 22.9± 2.2 years. Female preponderance was seen in our study with ratio being 19:11. The preoperative spherical equivalent (BSCVA) at 12mm vertex distance ranged from -6.5D to -23.5D. The mean pre operative central corneal thickness was 524.3 ±49.2 µm. The white- white corneal diameter ranged from 11mm to 12.5mm. ICL power used ranged from 10Dto -23D.

The ICL diameter ranged from 11mm to 12.5mm, given by STAAR company. Preoperative best corrected visual acuity was 6/9 or better in 40% of the patients while postoperative best corrected visual acuity was 6/9 or better in 56% of the patients.

Postoperatively 70% patients gained one line of vision, 2 patients gained more than 2 lines.

Gonioscopic angle grading changes

Statistically significant (p=0.002) decrease in angle grade in most of the patients was noted following ICL
implantation, 50% of grade 4 angle reduced to grade 3, however angle remained open in all cases.

**Post-op angle pigmentation changes**

Statistically significant (p=0.00) increase in angle pigmentation grade was noted.

**UBM changes**

a) We found 66% of the study group had both the haptics in sulcus, 30% in ciliary body and only one case had on zonules

b) 60% of the patients had postoperative anterior chambers depth ranging from 2.2mm to 2.6 mm.

c) Post op gonioscopic angle.

The mean postoperative gonioscopic angle grading was 3.05 when both the haptics were in sulcus and 3.44 while on ciliary body. However, no statistically significant difference was noticed between positions.

d) Vaulting of ICL

The distance between ICL and crystalline lens ranged from 0.3 to 1.2mm. Ideal vaulting to prevent cataract was achieved in 56% of patients. The mean vaulting was 0.6mm when both the haptics were in sulcus and 0.4mm while on ciliary body.

The distance between ICL-crystalline lens in major axis ranged from 0.1mm to 0.6mm and in minor axis ranged from 0.3mm to 0.9mm. No contact noticed between ICL-crystalline lens in any axes in any patients.
DISCUSSION

Implanting a PCPIOL in highly myopic eyes achieves better optical results than other procedures. However, the procedure raises many questions about the potential long-term risks to the corneal endothelium, lens, anterior uvea, and other eye structures. Some risks can be minimized if the ICLs are implanted in the desired place.

Gonioscopy revealed statistically significant decrease in angle grading though angle remained open in all. Yeoun Sook Chun et al. also showed that, the irido corneal angle was narrowed to within less than 20 degrees in 16 eyes (19.8%). Postoperatively 56.7% had more than grade 3 angle pigmentation at 3 months. This increase in angle pigmentation was statistically significant. The mean distribution of postoperative ACD (from endothelium-ICL) was $2.27\pm0.15\text{mm}$ in our study which was consistent with study by Juliana et al. $(2082.8 \pm277.6 \mu\text{m})$. This could be achieved as we strictly adhered to the recommended pre-op anterior chamber depth of $2.8 \text{mm}$.

We found ideal vault in 56% of our cases and high vault in 6% patients. Ki Hwan Choi et al. found similar results. An important factor in predicting proper vaulting is an appropriately sized ICL and location of footplates. Recommended sulcus positioning of PCPIOL was achieved in 66% patients, while 30% in ciliary body and only one case had on zonules .We noticed that when the foot plates were placed in the sulcus, we could achieve an ideal vaulting of $0.6 \text{mm}$ where as vaulting reduced to $0.4 \text{mm}$ when the foot plates were positioned in the ciliary body.

In conclusion our study showed that the distance between crystalline lens and PCPIOL is generally large. However location of haptics in sulcus, reduction of irido corneal angle and depth of AC suggest it would be advisable to have ICL of different diameters available or perhaps implement small changes in the design. Strict adherence to recommended guidelines is very important as any deviation could cause long term significant complications.

REFERENCES

Thin Flap LASIK Versus PRK in Thin Corneas

Dr. Shrutika Kankaria, Dr. Prakash Kankaria, Dr. Vardhaman Kankaria

Laser in situ keratomileusis (LASIK) and laser surface ablation (LSA) are effective, predictable, stable, and safe techniques for the correction of myopia. LSA includes laser-assisted subepithelial keratectomy (LASEK) and photorefractive keratectomy (PRK), which differ from each other only in whether or not the epithelium is conserved. Traditionally, contraindications to these procedures include pregnancy, lactation, corneal edema, dry eye, thin cornea, steep cornea, prominent posterior corneal elevation, asymmetric astigmatism, and systemic immune disorders. Interest in central corneal thickness (CCT) has increased over the years because of a correlation with postoperative corneal ectasia, a devastating complication characterized by progressive topographic alterations and dramatic loss of visual acuity. Several case reports of post-LASIK ectasia and post-PRK corneal ectasia have also been published. Many surgeons consider preoperative CCT greater than 500 μm a cut-off value for laser refractive surgery, although some authors achieved good results with LASIK in corneas thinner than 500 μm. The purpose of this study was to evaluate and compare the long-term refractive and visual outcomes of LASIK and LSA in patients with CCT less than 500 μm.

To compare the efficacy, predictability, stability and safety of thin flap Laser in situ keratomileusis (LASIK) versus photorefractive keratectomy (PRK) with mitomycin C in eyes with thin corneas.

MATERIALS AND METHODS

A comparative retrospective analysis of 182 eyes (92 patients) was done. All patients had a stable refraction for at least 1 year before the procedure, no significant ocular pathology, and no family history of keratoconus or historical finding like corneal transplant suggesting this pathology. Informed consent was obtained, the clinical charts of each patient were reviewed, and the relevant fields of the case report form were completed. Preoperative and postoperative examinations included uncorrected distance visual acuity (UDVA), corrected distance visual acuity (CDVA), refraction, cycloplegic refraction, slit-lamp examination, intraocular pressure, indirect ophthalmoscopy, keratometry, pachymetry, and topography (Pentacam and EyeSys, EyeSys Inc., Houston, Texas, USA). All eyes were designated for distance vision. The patients were generally examined immediately after surgery, at 12 hours, at 1 week, at 1 month, at 3 months. Annual follow-up was recommended. Postoperative corneal topography was performed at 1, 3 months and annual follow-ups.

Functional and Refractive Results

We defined as predictability indicators the percentage of eyes that achieved...
a postoperative spherical equivalent of ±1.00 diopters (D) and ±0.50 D. The indicators of visual outcome were the efficacy index, defined as UDVApostoperative/ CDVApreoperative, and the safety index, defined as CDVApostoperative/CDVApreoperative.

**Statistical Analysis**

Homoscedasticity of quantitative variables was verified using the Kolmogorov-Smirnov test. For homoscedastic variables, independent group differences for continuous quantitative variables were tested using an unpaired Student’s t test; the Mann-Whitney test was used for nonhomoscedastic variables. Percentages were compared using Pearson’s Chi-square test. Statistical differences were considered significant when the P-value was <0.05. Statistical analysis was performed using SPSS 17.0 for Windows.

Mean pre-operative CCT was 486.20 μ (range, from 470 to 497 μ). 98 eyes underwent thin flap LASIK (flap thickness: 90 microns) and 84 eyes underwent PRK with adjuvant mitomycin C. Mean spherical equivalent in the LASIK group was -4.84D and mean SE in PRK group was -5.02D. Mean follow up was 25.12 months.

**RESULTS**

1 and 3-mth UCVA results showed a statistically significant difference: SBK, 88% 20/20 or better vs. 68% 20/20 or better for PRK. At 6 mths, UCVA was 94% 20/20 for PRK and 92% for SBK. There was no incidence of keratectasia and other sight threatening complications till 1 year follow up.

**DISCUSSION**

Preoperative CCT is a crucial parameter for successful outcomes in refractive patients. Several studies have correlated the preoperative CCT and flap thickness with the presence of post-LASIK corneal ectasia. There continues to be increasing concern regarding the relationship of corneal thickness and the induced corneal biomechanical alterations after refractive surgery. The average CCT has been found to range from 537 to 550 μ. Although evidence is lacking as to what is truly a safe preoperative CCT, under 500 microns has generally been accepted as a cut-off value for safe refractive surgery by a majority of surgeons. Despite this, there are several publications reporting good results in these corneas, while others reports post-refractive corneal ectasia in patients with preoperative corneal thickness in the “safe” zone greater than this limit. In addition to the possibility of induced post-refractive corneal ectasia, thin corneas pose a greater theoretical risk of other post-refractive problems. Lin and associates. correlated the depth of ablation to the preoperative corneal pachymetry and the presence of post-LASEK haze formation. He determined that patients with ablation depth (AD) to corneal thickness (CT) ratios (AD/
CT) greater than 0.18 demonstrate a greater level of visually significant haze. Furthermore, predictability of the refractive outcome may be worse in thinner corneas.

In our retrospective study, we demonstrated that laser refractive surgery (LASIK or PRK) can be safe even in corneas thinner than 500μ. In all the patients, the topography and Pentacam was normal, without evidence suggestive of forme fruste keratoconus. This study also demonstrated efficacy, predictability, stability and safety of both procedures. This study suggests that thin flap LASIK is equally safe as PRK in patients with thin corneas.

Outcome of Toric Phakic Intraocular Lens in Stable or Stabilized Keratoconus

Dr. Aditi Ghodke, Dr. Mathew Kurian, Dr. Rohit Shetty

Keratoconus is a progressive, non inflammatory, bilateral corneal dystrophy characterized by paracentral cone-like steepening of the cornea and corneal ectasia. The progressive thinning and subsequent anterior bulging of the cornea can lead to severe astigmatism and central scarring. A recent study found that implantation of a phakic intraocular lens (pIOL) alone or combined with other surgical procedures is a safe, effective, and predictable way to correct myopia associated with keratoconus. In this study, we evaluated eyes with keratoconus that had Visian Implantable Collamer Lens posterior chamber pIOL (Staar Surgical) implantation for the refractive correction of keratoconus.

MATERIALS AND METHODS

This prospective interventional study comprised consecutive eyes of patients with stable or stabilized keratoconus that had implantable collamer toric pIOL for correction of myopia and astigmatism. All patients provided informed consent after receiving an explanation of the characteristics of the study. For the purpose of our study, stable keratoconus was defined as stable refraction in eyes without any surgical intervention for two years and stabilized keratoconus was minimum 3 months of stable refraction following riboflavin/ultraviolet-A-induced collagen cross linking. Inclusion criteria for pIOL implantation were corrected distance visual acuity (CDVA) of 20/50 or better and clear central cornea. Exclusion criteria were age less than 20 years, anterior chamber depth (ACD) less than 2.8 mm, and endothelial cell density less than 2000 cell/mm2 and ocular co-morbidity and ocular inflammation. Before surgery, patients had a complete ophthalmologic examination comprising of slit lamp evaluation,
indirect ophthalmoscopy, tonometry, manifest and cycloplegic refraction, keratometry, corneal topography (Oculus Pentacam and Orbscan II) and specular microscopy. All patients had implantation of a model V4 Visian toric posterior chamber Intraocular Collamer Lens (Staar Surgical Co.) designed to correct myopic astigmatism. Power, correct toric pIOL size based on the horizontal white-to-white distance measured by the Orbscan and the axis placement for the toric pIOL were calculated using software provided by the manufacturer. All pIOL implantations were performed by the same surgeon (MK) through a 3.2 mm temporal clear corneal tunnel incision. Postoperative follow-up visits were on day 1, 1 week, and 6 weeks and at 6 months. At each visit uncorrected distance visual acuity (UDVA), CDVA, slitlamp, tonometry and dilated fundus examination were performed.

**RESULTS**

This study evaluated 30 eyes of 20 patients. The mean age of the 13 women (65%) and 7 men (35%) was 25.43 ± 3.95 years. Ten eyes had bilateral and 10 unilateral pIOL implantation. Four eyes had stable keratoconus, 7 eyes required intrastromal corneal ring segments (INTACS) for cone centration, 11 were stabilized with collagen cross linking and 4 more eyes required stabilization by cross linking with INTACS for cone centration. Four eyes were pseudophakic.

![Graphs showing visual acuity results](image)

The mean pre-operative UDVA in decimals was 0.08 ± 0.07. The mean CDVA was 0.80 ± 0.21. The mean spherical error was -4.43 ± 3.51 dioptre sphere (DS), the mean cylindrical error was -4.25 ± 1.68 dioptres cylinder (DC) and the mean refractive spherical equivalent (MRSE) was -6.56 ± 3.35 dioptres (D). The mean power of the ICLs used was -14.22 ± 4.85 DS, 6.30 ± 2.68 DC. Post-operatively, at 6 weeks and 6 months, the mean
UDVA had improved to 0.56 ± 0.25 and 0.63 ± 0.27 respectively (Fig A), while at the corresponding periods the mean CDVA was 0.75 ± 0.21 and 0.85 ± 0.21 respectively. CDVA was 20/40 or better in 26 (86.6 %) eyes at 6 weeks and in 28 eyes (93.3%) at 6 months. At 6 weeks 10 eyes (33.3%) and at 6 months 15 eyes (50%) were 20/25 or better. Five eyes (16.7%) lost 1 or more lines of CDVA, 13 eyes (43.3%) maintained and 12 eyes (40%) gained 1 or more lines of visual acuity (Fig B). At 6 weeks the residual refractive error was 0.14 ± 1.33 DS, -2.14 ± 1.92 DC and the MRSE had reduced to -1.02 ± 1.77 D. The refraction remained stable and at 6 months the values were 0.08 ± 0.96 DS, -1.32 ± 1.53 DC and -0.63 ± 1.28 D MRSE (Fig D and E).

**DISCUSSION**

In this prospective study of 30 eyes of 20 patients, we wanted to determine whether implantation of a toric posterior chamber pIOL is a safe, predictable, and effective in correcting myopia and astigmatism in eyes with keratoconus. The safety index, defined as mean postoperative CDVA divided by mean preoperative CDVA, was 1.06 at 6 months and indicated a 10% improvement in visual acuity and 50% of eyes having UDVA of 20/20 or better. The safety index matches that in published literature. The mean vault at 6 weeks post-operative was 0.69 ± 0.31 mm. None of the patients had a low vault, postoperative IOP rise or cataract in our study. The predictability of the procedure was limited, with 28 eyes (93.3%) within 1.00 D and only 2 (0.67%) within 0.50 D of the intended MRSE, 6 months after surgery (Fig C). Efficacy was defined as the number and percentage of eyes achieving UDVA 6/12 (20/40). In our study, 22 (73%) of the eyes achieved 6/12 UDVA. The efficacy index, defined as the mean postoperative UDVA/mean preoperative CDVA, was 0.72 at 6 months, indicating that at 6 months after implantation, patients could achieve only 72% of the preoperative CDVA without correction. Refractive outcomes in terms of the efficacy index (0.72) and predictability were comparable with that reported elsewhere. Stability was defined as the number and percentage of eyes with change in MRSE less than 1 D from the 6 weeks postoperative baseline to the 6 month postoperative visit. In our series 27 eyes (90%) had stable MRSE (Fig F). In conclusion we found that correction of spherical and cylindrical refractive
errors in keratoconic eyes by toric pIOL implantation gave significantly better outcomes, particularly in the astigmatic component of refraction.

REFERENCES

To Study the IOP Changes in Non-Glaucomatous High Myopes Implanted with ICL

Dr. Suhas. S. Haldipurkar, Dr. Preeti Maithil, Dr. Anirban Paik, Dr. Vijay Shetty, Dr. Maninder Singh

Several studies report good visual and refractive outcomes with the implantable contact lens (ICL) in high myopes. Some studies report cataract formation and trace pigmentation in the trabecular meshwork1,2,3. The long-term course of intraocular pressure (IOP) values after implantation of an ICL is not well known.4 Present study evaluated effect of ICL on IOP over a period of 6 months.

MATERIALS AND METHODS

A Retrospective analysis of data of 18 patients (29 eyes) with mean age of 23.34 years with mean Spherical Equivalent (SE, -17.97; +/- 5.29) was done. Visual acuity, Cycloplegic refraction, Slitlamp and Indirect Ophthalmoscopy, Intraocular pressure (IOP) by Non-Contact tonometry (NCT) and Applanation tonometry (AT), Axial length (AL), Anterior Chamber Depth (ACD), White to White (WTW) on IOL master, Corneal topography, Slit lamp OCT (in a few cases) was carried. ICL was implanted in those patients whose pre-operative IOP were within normal range (10-21 mm Hg), with no sign of pre-existing primary or secondary, open or closed angle glaucoma and a minimum ACD of 2.8 mm with clear lens. A standardized technique through a 3.2 mm clear corneal sutureless incision using paraocular anesthesia, with implantation of STAAR Collamer Implantable Contact Lenses (STAAR Surgical Inc., Nidau, Switzerland) was performed by a single surgeon. In bilateral implantation, second eye was operated within 1
week. IOPs were noted on post operative day 1(+1), day 7th (+/-3)and 1st, 3rd and 6 months. All patients were treated with Omepred e/d 6 times daily for a week followed by Prednisolone acetate e/d, starting with 5 times a day, tapered weekly by one dose. All diagnosed cases of post operative raised IOP were first treated on medical line by adding an antiglaucoma drug like Timolol maleate, 0.5% eyedrops or replacing Omepred or Prednisolone acetate 1% eyedrops with Lotepred e/d, along with Timolol eyedrops.

RESULTS

The mean preoperative and post operative IOPs were 15mm Hg (+/-3.1) and 18.3mmHg (+/-5.3) at 6 months; (T test p=0.005). Increased IOP (>21 mm hg) occurred in 07/29 eyes (24.13%). Four eyes (3 patients) were diagnosed as steroid responders. Surgical intervention was needed in 1 /29 eyes (3.4%) which showed angle closer glaucoma due to excessive vaulting; (Graph 2) refractory to medical line of treatment, so trabeculectomy was done. One eye exhibited post operative inflammatory glaucoma and 1 eye had raised IOP due to non patent YAG PI (which was relieved after repeating YAG PI post operative). After treatment, all eyes showed IOP in normal range except one patient, which was lost to follow up.

DISCUSSION

Cases with an elevated IOP after ICL implantation are detailed in previous reports. According to Jimenez-Alfaro and coauthors, the IOP could increase in the immediate postoperative period because of retention of viscoelastic material or the appearance of a pupillary obstruction by lens resulting from impervious iridotomies. Also they have found that the IOP could increase progressively during the follow-up period because of a narrowed angle originated by the lens or because of pigmentary dispersion that can result in pigmentary glaucoma. In their study the IOP had normal values after the first postoperative month.
In addition, Chung \textit{et al.}\textsuperscript{6} had analyzed several studies and reviewed the cases with elevated IOP and found that the elevated IOP was associated with acute pupillary obstruction, chronic pigment dispersion and other mechanisms, not specified. The elevated IOP in cases of pupillary obstruction was normalized by additional iridotomy and recommended careful monitoring of IOP during the early postoperative period, especially for 1 month. Like other authors, we attribute the increase in IOP during the first postoperative month to the effect of postoperative inflammation and steroid medication, which required anti-glaucoma treatment in some of the eyes. In all the patients, IOP normalized when the signs of inflammation disappeared and the steroid treatment was suppressed.

One eye showed mixed mechanism Glaucoma with angle closure component due to excessive vaulting and pigmentary glaucoma which was refractory to medical treatment, UBM (Ultrasound Biomicroscopy) showed right sided iris elevation with narrow to complete angle closure due to peripheral synechiae and normal ciliary processes. Finally, Trabeculectomy with MMC (Mitomycin C) was done. post-op IOP was 08 and UCVA 6/36. Shallow choroidals were seen which was treated with oral steroid and IOP finally normalized to 16mmHg. ACD was 3.22mm and 3.32 mm pre and post operative. In a similar study, Pupillary block glaucoma requiring surgical intervention occurred in 3 patients (7.9%) out of 22 patients. One patient (2.6%) developed cataract 1.5 years after ICL implantation; both ICLs were removed, and the refractive errors were corrected by lensectomy and implantation of low-power posterior chamber IOLs.\textsuperscript{1}

In another case (1 eye), Exchange of Toric by Spherical ICL, due to refractive surprise secondary to decentration and reduced vaulting, showed post-op inflammatory raised IOP which was well controlled medically.

Of 4 eyes 13.7\%) showing steroid induced raised IOP, One patient (2 eyes) had raised IOP with medical treatment, so Glaucoma evaluation was carried and Perimetry was done which showed depressed points. But the patient was lost to follow up.

A case of non patent YAG PI exhibited raised IOP postoperative 3rd day. Medical treatment and repeat YAG PI post-op on day 5th immediately deepened the anterior chamber and lowered the IOP to 12mm Hg after 2 hours. She did well with BCVA 6/6, N6. According to Chung\textsuperscript{6} inadequate preoperative iridotomies and a high ICL vault due to inaccurate sizing of the ICL could be considered as primary causes of the elevated IOP in these cases. Thus in our study, we have 4 eyes (13.7\%) with raised IOP as a result of Steroid response, while 1 eye had angle closure with pigmentary glaucoma due to ICL vaulting and AC shallowing, One eye had non patent YAG PI as a cause of transient
post operative rise in IOP; And lastly one patient had re-surgery for ICL exchange with resultant inflammatory Glaucoma (Graph 3).

In general, 20% of all patients when given steroid eye (Prednisolone Acetate 1%) drops dosed at four times a day or greater for a period of 7 days or greater are at risk for a clinically significant rise in their eye pressure. The mechanism by which steroids raise the eye pressure has been suggested that the steroids alter the body’s immune response and as a consequence can cause blockage or obstruction of the drainage channels (glycosaminoglycan accumulation in trabecular meshwork, which does not allow the aqueous fluid to leave the eye, leading to severely elevated eye pressure.

In all our patients with High IOP, none of them showed Optic disc changes during 6 months. The presence of an implant can have a long term effect on the redirection of aqueous flow.8 While primary open-angle glaucoma usually starts after the age of 40, pigment dispersion syndrome (PDS) or glaucoma typically affects younger individuals. The diagnosis of elevated IOP at a young age should prompt the examiner to search for a cause. Myopia is an important risk factor for the development of PDS and is present in approximately 80% of affected individuals. Patients with higher degrees of myopia and deeper anterior segments tend to develop glaucoma at an earlier age. This association is low for eyes with low myopia (odds ratio, 2.3) but is much higher in eyes with moderate-to-high myopia (odds ratio, 3.3).7 Therefore, phakic IOL patients need mandatory lifelong attention and follow up to diagnose and treat the raised IOPs.

In conclusion raised IOP in ICL implanted patients was mostly due to steroid response and post operative inflammation, and very rarely due to ICL perse. Thus ICL is a safe procedure but close monitoring in early post operative period is required to avoid any long term damage due to raised IOP.

REFERENCES


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**Posterior Chamber Phakic IOL Implantation: Results and Complications**

**Dr. Charu Khurana, Dr. Mahipal S. Sachdev**

Management of high refractive errors especially with thin cornea is a refractive challenge. Lasik for correcting high refractive errors has the drawbacks of lack of predictability, regression, corneal ectasia, and induction of high order aberrations. Phakic IOLs is a preferred modality for correction of high myopia and for patients with thin corneas. It was first developed in the late 1980’s in Russia by Dr. S. Fyodorov and the first implant was placed in Europe in 1993. Fyodorov introduced the concept of a soft phakic lens in the space between the iris and the anterior surface of the crystalline lens.

A posterior chamber phakic IOL (Visian ICL, STAAR Surgical) or Implantable contact lens (hereafter referred to as ICL) is indicated for placement in the posterior chamber of the phakic eye for correction of moderate to high myopia ranging –3.0 D to –20.0 D. Toric ICL (TICL) can correct up to –3 to –23 D of sphere and + 1.0 to + 6.0 D of cyl. The toric ICL has the same overall design as the spherical ICL with the addition of a toric optic. The toricity is manufactured in the plus cylinder axis, within 22 degrees. The STAAR® Visian ICL™ is made from a combination of copolymer and collagen called Collamer®. This Collamer® implantable contact lens reduces reflections and glare, and the collagen makes it extremely biocompatible. Made of 60% poly-HEMA, Water (36%), Benzophenone (3.8%) and Collagen (0.2%), it attracts the deposition of fibronectin on the lens surface, inhibits aqueous protein binding and makes the lens invisible to the immune system. ICL/TICL calculation and implantation
In the pre-operative planning, the critical parameter in sizing the ICL is the white-to-white (WW) measurement which can be measured with a Pentacam, OrbScan or using vernier calipers or digital calipers. In myopic eyes, to determine the overall length (in mm) of the ICL, add 0.5 mm to the horizontal WW measurement. If the ICL is too short for the sulcus, the lens vault may be insufficient to clear the crystalline lens, exposing it to the risk of an anterior capsular cataract. If it is too long, the lens will vault excessively, crowding the angle and possibly causing closed angle glaucoma. An ideal vault is 500 µm over the crystalline lens.

To evaluate the results and complications of biocompatible collagen copolymer posterior chamber phakic IOL (Visian ICL, STAAR Surgical) or implantable contact lenses (ICL) in 352 consecutive eyes over a 3 year follow up and study the long term safety and stability and complication rate.

MATERIALS AND METHODS

352 eyes of 211 patients were involved in this study. Patients with a stable refraction (<0.5D change in previous 12 months) between the age of 21 – 45 years were scheduled for ICL implantation when residual bed after LASIK was likely to be less than 250µ, anterior chamber depth was greater than 3.00 mm, initial corneal thickness was less than 480µ, mesopic pupil size was less than 6.0 mm and there was no other ocular pathology (cataract, glaucoma, lid pathology, etc).

The procedure followed was as described: Under topical anesthesia, after making a 0.6mm side port, a 3.2-mm clear corneal incision was made on the steep meridian. The lens was introduced with angled-suture forceps or
through the injector and positioned behind the iris on a horizontal axis with a cyclodialysis spatula. To control for potential cyclotorsion in a supine position, the zero horizontal axis was marked pre-operatively on the slit-lamp. The lens was implanted temporally and gently rotated to align the axis with the cylindrical axis of the patient. Complete removal of viscoelastic material is essential. Presence of residual viscoelastic material behind the implant may cause opacification of the crystalline lens. A miotic agent was injected and the aspiration completed. We performed a surgical iridectomy for all patients using either a vitrectomy cutter or a Vannas scissor. It was made sufficiently wide (at least 500 μm), positioned superiorly (from 11 to 1 o’clock) and well away from the haptics placement. The incision was closed by hydrating the corneal incision.

**RESULTS**

At Centre for Sight, New Delhi we have treated 352 eyes of 211 patients of which 23% were males (48) and 77% females (163). ICL was implanted in 56 eyes (15.9%) and TICL implanted in 296 eyes (84%). Degree of myopia ranged from -2.5 to -22.5 DS. The highest cylindrical power treated -5.5 D. 15 eyes received ICL after collagen cross linkage treatment for keratoconus while 9 eyes had hyperopia with astigmatism.

Till last follow up, 299 (85%) eyes had visual acuity within 0.5 D and 324 (93%) within 1.0 D of intended correction. 2 ICLs opened upside down in the initial stages. One of the ICLs was removed and re-inserted while the second was flipped inside the eye using visco-elastic. In one eye, vitrectomy cutter caused a large PI which enlarged to form a complete iridectomy. This was repaired using 10-0 prolene on a straight needle taking care not to damage the ICL lying just beneath the iris. One case of endophthalmitis occurred on 2nd post-op day. This was treated using intra-vitreal antibiotics. The patient regained 6/6 vision after 3 weeks of treatment. 3 toric ICLs needed redialing while one ICL had to be replaced due to wrong sizing. 2 cases of anterior subcapsular cataract were seen but have so far stayed stationary and have not required surgical intervention.

**DISCUSSION**

Various studies have reported that phakic TICL implantation is a good option for the correction of moderate to high myopia high myopic astigmatism in eyes with keratoconus correction of hyperopia post radial keratotomy and post penetrating keratoplasty. Kamiya K et al. studied long-term clinical outcomes of implantation of the Visian ICL for moderate to high myopia in 56 eyes of 34 patients with myopic refractive errors of -4.00 to -15.25 diopters (D). They concluded that
Implantation of ICLs is safe and effective and provides predictable and stable refractive results in the treatment of moderate to high myopia during a 4-year observation period. Alfonso et al.9,10 evaluated the efficacy, predictability and safety of myopic phakic posterior chamber Implantable Collamer Lens (ICL) to correct myopia associated with keratoconus. They showed that spherical equivalent refraction was within +/-1.00 D of the desired refraction in all cases and within +/-0.50 D in 84% of cases. They concluded that phakic intraocular lens implantation is a viable treatment for myopia and astigmatism after PKP in patients for whom glasses, contact lenses, or corneal refractive surgery is contraindicated.

Studies comparing ICL implantation with wavefront guided lasik by Igarashi A et al.11 have shown that ICL implantation induces significantly fewer ocular HOAs than wavefront guided lasik. Kamiya K et al.12 compared Collamer toric implantable contact lens implantation and wavefront-guided LASIK for high myopic astigmatism and found that all eyes in the ICL group and 71% of eyes in the LASIK group were within +/-1.00 D of the targeted SE correction at 6 months. They suggested that Toric ICL implantation was better than wavefront-guided LASIK in eyes with high myopic astigmatism in almost all measures of safety, efficacy, predictability, and stability. The overall complication rate with ICL is minimal and most patients have a good visual recovery. The incidence of glare, haloes and night driving problems is also minimal.

It is crucial to load the ICL in the injector in a straight and smooth manner to implant it correctly in the posterior chamber. Improper loading may lead to an upside down implantation. The visco-elastic material must also be removed carefully and meticulously to prevent a post operative IOP spike. The 2 cases of upside down implantation occurred earlier in our series. Both were managed uneventfully. In the first, the ICL was removed from the eye, re-loaded and implanted again. In the second case, visco-elastic material was placed underneath the ICL and the lens was flipped in the right orientation in the eye itself.

Sanders et al.13 studied incidence of anterior subcapsular opacities and cataracts 5 years after surgery in the Visian implantable collamer lens FDA trial. Approximately 6% to 7% of eyes developed anterior subcapsular opacities at 7 years following ICL implantation but only 1% to 2% progress to clinically significant cataract during the same period, especially very high myopes and older patients. Visual outcome following cataract extraction was good. Other reported complications of ICL are pigment dispersion and lens deposits, acute angle closure glaucoma, late subluxation of ICL, endophthalmitis and retinal detachment. One case of endophthalmitis occurred in our series which was treated with intra-vitreal antibiotics. Vitreous and aqueous tap was culture negative. The patient recovered completely after 3 weeks and regained
6/6 unaided visual acuity. We have only seen 2 eyes with anterior sub-capsular opacities so far which have not progressed. We have not encountered angle closure glaucoma in our patients but have seen 15 cases of steroid induced glaucoma between 2-4 weeks post-op which resolved with medical treatment. Till last follow up, 299 (85%) eyes had visual acuity within 0.5 D and 324 (93%) within 1.0 D of intended correction.

In conclusion in our experience, the phakic posterior chamber IOL (ICL) is a safe and effective modality for correction of high myopia and for patients with thin corneas with excellent and stable post operative results. Though complications may occur, early diagnosis and appropriate intervention helps to maintain good visual results.

REFERENCES

Intracorneal Lenses (Inlays) Using Femtosecond Laser for Treatment of Presbyopia. A Prospective Study

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Presbyopia is an age-related loss of crystalline lens accommodation that results in an inability to focus at near distances. In general, a person is considered presbyopic when the subjective amplitude of accommodation has decreased to less than 3.00 diopters (D). External devices (i.e., spectacles and contact lenses) and surgical methods have been used to treat or manage presbyopia. Spectacles and contact lenses can successfully correct presbyopia; however, some patients want freedom from spectacles and some are intolerant of contact lenses. Current surgical approaches involve lens-based procedures, most frequently intraocular lenses (IOLs) implanted after cataract extraction, and corneal-based procedures in phakic eyes. Corneal-based treatment is performed using 2 types of methods.

The first type changes the refractive status of the eye by altering the shape of the anterior corneal surface; such procedures include presbyopic laser in situ keratomileusis (LASIK), conductive keratoplasty, and intracorneal implants. The second type increases the depth of focus without changing the refractive status; one method is intracorneal inlay implantation.
Purpose: To investigate the visual outcomes and safety of an Intracorneal lens (Presbia, Presbitech, CA, USA) for the treatment of presbyopia using femtosecond laser (Intralase, AMO, Irvine, CA,160 KHz).

MATERIALS AND METHODS

Using the iFlap treatment-type software of the femtosecond laser (IntraLase 150, Abbott Medical Optics), a full lamellar cut was created at 280-µm depth. A keyhole-shaped mask was placed at the internal part of the glass of the applanation cone. A separator was used to separate the stroma, and an inserter was used to implant the inlay at the center of the line of sight. To determine the line of sight, the microscope and centration system of the excimer laser (Allegretto Wave 400 Hz, WaveLight Laser Technologie AG) were used. The Flexivue Microlens inlay (Presbia) was implanted. An intracorneal tunnel was created in the non-dominant eye of all patients using femtosecond laser. Mean age was 51.32 ± 3.1. All eyes had uncorrected distant visual acuity of 20/20 pre-operatively. Follow-up was 6 months in all patients.

Statistical Analysis

Statistical analysis was performed using the SPSS statistics software package for Windows (version 11.5, SPSS, Inc.). The Wilcoxon signed-rank test for paired data was used for comparison between preoperative and postoperative data. In all cases, differences were considered statistically significant when the P value was less than 0.05.

RESULTS

Mean uncorrected visual acuity for distance pre-operatively, one day, 1 week, 1 month, 3 months, and 6 months after surgery was 20/20, 20/40, 20/40, 20/32, 20/32,20/30 respectively, whereas for near was 20/50, 20/32, 20/30, 20/25, 20/25, 20/25 for all operated eyes. Confocal analysis showed healthy stroma surrounding inlay. No intra or post-operative complications were found.

DISCUSSION

The subjective evaluations also provide evidence of the visual improvements that follow the implantation of the inlay. Over the course of the study, patients reported substantial decreases in near visual problems and symptoms as well as little change in function at distance from pre-operatively.

There are always concerns regarding placement of a synthetic material in the cornea. The ideal synthetic material should be permeable enough to allow for adequate nutrient flow through the cornea as virtually all corneal nutrients come from the aqueous humor. The material should also maintain its desired optical properties after implantation. If an intracorneal implant interrupts the flow of glucose and other nutrients to the corneal tissue located anteriorly to it,
progressive melting of the anterior cornea and loss of transparency can result. In this study, a deep pocket was created to place the inlay, furthermore the inlay had a small hole in centre, for nutrients to flow and excellent biocompatibility of the material makes it a good choice. All patients demonstrated good improvement in uncorrected distance and near vision. This indicates the adaptation process required. The changes in best corrected distance acuity were transient, and there was no permanent reduction in visual acuity.

In conclusion Intracorneal lenses for presbyopia seem to be a safe and effective method in patients aged between 45 to 60 years old.
Anton Chekhov (1860-1904): He studied medicine, but was famous for his plays. His one eye was myopic and the other hyperopic. He lost his RE due to HZO.

Degas Edgar (1834-1907): A French painter, is best known for his ballerina paintings. In 1880s, when his eyesight began to fail from myopic degeneration, Degas started working with two new media (Sculpture and pastel) that did not require intense visual acuity. He was permanently blind when he was 63.

Benjamin Franklin (1706-90): First invented the bifocal lens.