Implantable Collamer Lens (ICL) implantation offers an exciting option of correction of refractive errors not amenable to laser refractive surgery. ICL is now seeing wider acceptance and in recent times more and more refractive surgeons have been incorporating this into their practice. This FOCUS on ICL is about the discussion of Dr. M. Vanathi with ICL experts Dr. Mahipal Sachdev, Prof. Sudarshan Khokhar, Dr. Somsheila Murthy, Dr. Bhaskar Srinivasan, Dr. Mathew Kurian, & Dr. D. Ramamurthy and it brings to you the interactive deliberations on ICL related issues and practice pearls from the panel of experts with wide experience on ICL implantation and its related issues.

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M. Vanathi: What is the range of refractive errors for which you prefer to do ICL implantation?

Mahipal Sachdev: I perform ICL for refractive errors ranging from -3 to -25 D with an astigmatism up to 6 D and in hypermetropes up to +10 D. If I have to perform it for patients with higher errors, I plan them for Biopics and combine it with an additional procedure like Lasik.

Sudarshan Khokhar: In our experience, range is not an issue; we have done ICL in refractive errors ranging from 2 to 24D of myopia and up to 8D of hypermetropia. Although when we started ICLs 5 years back we were taking eyes with more than 6 diopters of myopia, but now for any refractive error we offer ICL.

Somsheila Murthy: In my experience, -8D Sph is the lowest myopia for which I have implanted an ICL and -26 D Sph is the highest.

Bhaskar Srinivasan: -6.00 D or more those who are not a candidate for LASIK. And give an option for all patients > 8 / 9 D myopia who have the option of both ICL and LASIK.

Mathew Kurian: In our centre, we offer ICLs to patients beyond the treatable range of LASIK ie beyond 8D primarily due to the cost considerations. Lower refractive powers are being treated when patients make an informed choice and when they are poor candidates for corneal refractive correction.

D. Ramamurthy: Beyond -10 D, +4D & 4D of astigmatism.

ICL implantation is an effective treatment modality for higher refractive errors and can be used to current a wide range of refractive errors in combination with other refractive procedures/bioptics.
M. Vanathi: What are the routine preoperative investigations you undertake for your potential ICL candidates?

Mahipal Sachdev: We do a dry and cycloplegic refraction, a pentacam to measure the corneal parameters and anterior chamber depth, white-to-white measurement using pentacam and callipers (both Vernier and digital), scotopic pupil size and a dilated retinal examination to rule out any peripheral lesion.

Sudarshan Khokhar: We perform UCVA and BCVA using duochrome test, IOP measurement, anterior chamber depth (from endothelium), gonioscopy, cycloplegic and manifest refraction, central corneal depth and dilated retinal examination.

Somsheila Murthy: In the clinic: cycloplegic and manifest refraction, complete ocular examination including applanation, binocular indirect examination with scleral depression and gonioscopy to look for pigmentation in angles. Investigations: Corneal topography using ORBSCAN (to look at pattern of topography, measure pachymetry, keratometry and also white-to-white measurements), aberrometry if possible (this is unreliable or unrecordable for myopes more than -10D) and specular microscopy and A-scan. In my earlier cases I did use UBM for white-to-white measurements, but have stopped now.

Mathew Kurian: To reduce the margin of error, we order what might seem like a battery of investigations. Patients undergo manifest refraction by an experienced optometrist, slit lamp anterior segment examination and dilated fundus examination with scleral depression. In addition macular OCT is performed to ascertain the health of the posterior segment. Manual keratometry, A scan biometry (preferably optical or immersion) specular microscopy and corneal topography which includes Pentacam, Orbscan, OPD 3 and iTrace. These tests also give us an insight into the corneal, total and internal aberrations.

ASOCT is performed to assess the angle and also the angle to angle diameter. Post-operatively it is used to measure the vault. We have also performed UBM in all eyes over the past 7 years to directly measure the horizontal sulcus to sulcus (STS) diameter.

D. Ramamurthy: Apart from complete routine examination in which a good fundus examination of the macula & retinal periphery are vital, the following are the additional investigations: Corneal topography, white to white measurement, AC depth measurement, Specular microscopy.

Preoperative evaluation for ICL implantation should consist of a comprehensive ophthalmic evaluation including cycloplegic refraction, corneal curvature, intraocular pressure, anterior chamber depth (central and peripheral), white-to-white measurement, gonioscopy and iris configuration, pupil size, dilated fundus evaluation and specular count of corneal endothelium.

M. Vanathi: Who in your opinion are candidates highly unsuitable for ICL?

Mahipal Sachdev: Patients with shallow anterior chambers ie an AC depth < 2.8 mm are unsuitable for ICL though now the safe limit has been brought down to 2.6 mm by the manufacturers. Hypermetropic astigmatism cannot be treated by ICLs alone. Apart from this any other ocular pathology such as glaucoma, pigmentary dispersion, uveitis, pseudoexfoliation, unstable myopia, retinal disorders, early lenticular changes etc are unsuitable for ICL. Patients with unrealistic expectations are not good candidates either.

Sudarshan Khokhar: Besides all the contraindications for routine refractive procedures, an anterior chamber depth < 2.8 mm, occludable angles or a history of IOP rise are contraindications for ICL.

Somsheila Murthy: Apart for those with clearly specified contraindications: i.e. AC depth less than 2.8 mm, poor endothelial cell counts etc, acceptance of ICL is usually better than post-LASIK group of patients, perhaps the neural adaptation is better or these are very high myopes to start with. Patients with unrealistic expectations and those demanding “100% guarantee” are unsuitable candidates.

Bhaskar Srinivasan:

i. Low anterior chamber depth(< 2.80 mm)

ii. Low specular counts

iii. Large scotopic pupils

iv. Early lens changes

v. Irregular corneal topography

Mathew Kurian: Patients who are outside the inclusion criteria recommended by the company should obviously not undergo the procedure. In addition patients with high corneal and/or internal aberrations are also poor candidates as they will be unhappy with the post-operative quality of vision.

D. Ramamurthy:

- AC depth less than 2.8 mm
- Significant abnormalities in retinal periphery
- Significant myopic degeneration impairing vision
- Endothelial cell count less than 2,500
- Any lenticular changes which could progress
- Age below 18 or beyond 45
- Unstable refractive error
- Irregular Cornea

ICL implantation is not suitable of candidates with shallow anterior chamber of depth < 2.8mm, glaucoma, eyes with occludable angles, progressive myopia, eyes with pathologies such as uveitis, pigment dispersion, pseudoexfoliation and lens opacities.
M. Vanathi: In your opinion, how does ICL compare to LASIK?

Mahipal Sachdev: For patients with high myopia and thin corneas, ICL is the treatment of choice since the cornea remains untouched. Also higher order aberrations which come into play with large amounts of laser ablation do not occur with ICLs. In such patients the quality of vision after ICL is much better. Another area where ICL scores over Lasik is in treatment of patients with keratoconus, where after cross linking, ICLs can be used to treat the high refractive error and improve the UCVA. In patients with moderate myopia, the benefits and risks of both the procedures need to be carefully weighed since ICL is an intra-ocular procedure and comes with its own set of issues such as sizing, glaucoma, rotation etc.

Sudarshan Khokhar: ICL is more predictable for higher refractive errors as well as cylindrical errors, does not induce higher order aberrations, or change in contrast sensitivity, and causes less refractive surprises. It can as well be implanted in those patients who are unsuitable for LASIK like those with thin corneas or ocular surface disorders. And it is a reversible procedure. In case a patient is suitable for both LASIK as well as ICL, we counsel the patient about the risks and costs involved with each and subsequently decide.

Somsheila Murthy: I think ICL compares very well, with patients being very satisfied and adapt easily. The glare is noted in both groups. However, in my experience, only those patients where LASIK or PRK is not possible undergo ICL. Therefore a direct comparison is difficult.

Bhaskar Srinivasan: Is as good if not better in certain situations especially in higher error where the quality of vision with lasik is slightly inferior to ICL.

Mathew Kurian: ICL has been welcomed by LASIK rejects. It is a reversible procedure and finds favour with patients who are uncomfortable with the idea of burning off natural tissue during corneal refractive surgery. Amongst patients and ophthalmologists we train, we find the WOW factor is more when dealing with ICLs. If and when the V4C gets approval for commercial use in India then the ICL becomes an even more attractive option as it eliminates the need for peripheral iridectomy/iridectomies.

D. Ramamurthy: They complement each other & in extremes of power we use them together as Biopics. In high powers the quality of vision & stability of correction is better with ICL. But it is an intraoperative procedure with all the attendant risks & needs to be done one eye at a time & more expensive.

ICL implantation is indicated for correction of high myopia and thin cornea which is not suitable for laser refractive correction. Use of ICL implantation for moderate myopia is to be approached with caution.

M. Vanathi: What do you feel are significant factors to be kept in mind while planning an ICL surgery?

Mahipal Sachdev: Pre-operatively, the most important factor after planning with the aid of accurate refraction including spherical and cylindrical axis calculation is ICL sizing. Accurate measurement of white to white diameter is crucial and needs to be re-checked. Even then it may not correspond to sulcus to sulcus measurement and may create errors in calculation. Intra-operatively it is important to mark the axis of ICL placement and rotate the ICL accordingly. Axis can be marked pre-operatively on the slit lamp or using the axis marker. It is best to mark the 90 and 180 degree axis and then the axis of placement in reference to these on which the ICL will be placed. Alternatively, the gravity marker, Mendoza ring or the slit lamp protractor can be used for accurate axis marking.

Sudarshan Khokhar: All the preoperative investigations should be thoroughly looked at and only the appropriate patients should be selected, accurate sizing of the ICL and preoperative patient counseling are important.

Laser iridotomy should be done at least a week in advance if YAG is used or on the table where you use vitrectomy probe, scissors etc. Since it an intraocular procedure it is better to post the patient on two separate days for each eye.

Somsheila Murthy: Patients’ occupation (glare can be a side-effect), ability to return for follow-up (as annual monitoring to look for cataract and measure endothelial cells counts in important), assessment of all parameters preoperatively. Patients with very heavily pigmented irides and also high myopes with nystagmus would be difficult patients for YAG laser peripheral iridectomy and surgical PIs would be needed.

Bhaskar Srinivasan:

i. Stable refraction
ii. Motivated patient
iii. Sufficient anterior chamber depth
iv. Correct white to white estimate
v. PI planned prior to surgery or during ICL
vi. Retinal lesion if any to be barraged prophylactically

Mathew Kurian: Refractive stability is critical for effectiveness of the procedure and sizing is the most important criteria for safety.

D. Ramamurthy: Besides those mentioned earlier, there is only about 3 mm space between the anterior capsule & the endothelium unlike in cataract surgery where it is nearly 8mm & we are dealing with young patients in their prime of their productive lives & we are only offering an alternative to glasses.

Accurate white to white estimation for ICL sizing, anterior chamber depth, peripheral iridotomy, axis marking for toric ICLs are very important factors. It is to be remembered that this is a refractive alternative to spectacle correction.

M. Vanathi: How do you go about deciding the sizing of the ICL in your patients?

Mahipal Sachdev: Sizing of the ICL is based on white to white calculation which is an indirect method to calculate the sulcus to sulcus dimensions. Measuring the diameter in both the horizontal and vertical meridian with calipers (both Vernier and digital) and pentacam or orbscan is the first step. If the measurements are consistent, we add + 0.5 for myopic and - 0.5 for hypermetropic patients. ICLs are available in 4 sizes for myopic patients in increments of 0.5mm ie 12.0, 12.5, 13.0 and 13.5mm with optic sizes varying from 4.9 to 5.8 mm. For patients with AC depth < 3.5 mm, add 1.1 mm to the white to white measurement and for AC depth > 3.5 mm add 1.6 mm to the white to white
measurement. The UBM is recommended for accurate sulcus to sulcus measurements as none of the instruments mentioned above directly measure sulcus to sulcus diameter but base it on the white to white measurements. However the UBM is also operator dependent and not easily available.

**Sudarshan Khokhar:** Sizing is judged on the basis of white to white measurement using electronic calipers. Use of 35MHz UBM has also been proven accurate for this purpose. This measurement is then introduced into the Visian ICL software which calculates the correct sizing for each patient.

**Somsheila Murthy:** White-to-white measurement using the OrbScan is what we follow, although as part of studies, I have compared UBM, ASOCT and calipers measurements for white-to-white. In case of very high myopia, I use more than one technique.

**Bhaskar Srinivasan:**

1. Manual white to white measurement with caliper
2. Check angle to angle with ASOCT
3. Check anterior chamber depth and take a decision

**Mathew Kurian:** We do WTW on multiple instruments to minimize the potential for measurement error. In addition over the last 7 years that I have been doing ICLs I also measure STS on the UBM and use the STS to validate the ICL size recommended by the company online calculator. In a few cases of gross mismatch between the sizes suggested based on the WTW and the STS, I use the horizontal STS diameter to adjust the size. In such cases among the patients that I have operated on I usually find that I have to undersize the ICL and hence been able to avoid what I believe would have been cases of high vault.

**D. Ramamurthy:** Check the white to white with the calipers which is specifically meant for this & compare with orbscan or topolyzer measurements. Essentially go by the orbscan values, but the calipers is used to ensure the orbscan values are not inaccurate because of some pigment at the limbus. IOL master or Lenstar can also be used but they generally give a slightly higher (about 0.5 mm) reading. Compare in both eyes & they should nearly be the same.

The consences for ICL sizing is that it is dependent on the measured white to white diameter and the anterior chamber depth.

**M. Vanathi:** Do you have any recommendations for varying the ICL sizing depending on the white to white diameter, spherical equivalent and anterior chamber depth parameters?

**Mahipal Sachdev:** We normally calculate size our ICL based on the calculations discussed. However if the measurement is falling in between the available ICL steps we look at the AC depth. For patients with AC depth > normal, take the next highest value and for AC depth < normal take the closest lower value. This chart helps us to decide which ICL to be followed when in doubt.

White to White (mm) / ACD (mm) /Recommended ICL Length

- <10.5/ All / Not Recommended
- 10.5 - 10.6 / <=3.5 / Not Recommended
- 10.5 - 10.6 / >3.5 / 12.1
- 10.7 - 11.0 / All / 12.1
- 11.1 / <=3.5 / 12.1
- 11.1 / >3.5 / 12.6
- 11.2-11.4 / All / 12.6
- 11.5-11.6 / <=3.5 / 12.6
- 11.5-11.6 / >3.5 / 13.2
- 11.7-12.1 / All / 13.2
- 12.2 / <=3.5 / 13.2
- 12.2 / >3.5 / 13.7
- 12.3-12.9 / All / 13.7
- >13 / All / Not Recommended

**Sudarshan Khokhar:** ICL is available in 4 sizes: 11.5, 12, 12.5 and 13 mm. The correct sizing depends on parameters like white to white measurement and anterior chamber depth. Deeper anterior chambers usually require bigger sized ICLs.

**Somsheila Murthy:** I usually follow the manufacturer’s guidelines. In very high myopes, I may oversize by 1 mm, after crosschecking the white-to-white measurement with calipers.

**Bhaskar Srinivasan:** Would assess on a case to case basis, but if say the white to white is borderline say 11.5mm, and the size would be 12 mm for the ICL but if the ACD is deep say 3.5 mm, I would go for a 12.5mm

**Mathew Kurian:** ICLs are available in increments of 0.5mm. The online calculator considers the AC depth to refine sizing. If the AC depth is <3mm it chooses the smaller sized ICL, whereas AC depth of >3mm would warrant the next larger size.

The spherical equivalent does not have any role to play in the sizing of the ICL. However there is a growing body of published literature on the use of direct STS measurement using the UBM for ICL sizing. (Choi KH, Chung SE, Chung TY, Chung ES. Ultrasound biomicroscopy for determining Visian implantable contact lens length in phakic IOL implantation. J Refract Surg. 2007; 23(4):362-367.)

**D. Ramamurthy:** It is very important to have a consistency in reading the white to white & ACD measurements. Any major deviation should be evaluated and confirmed with multiple devices/readings. White to white being the most critical factor, it is suggested to take a subjective call (preferably with a digital caliper under the operating microscope). This has proved to be the most reliable of all the known ways of measurement.

Having said this, it is also important to keep the anterior chamber depth factor in mind while sizing the lens especially in borderline cases (white to white thresholds where the sizes change). Typically anything up to 11.1 mm with a normal anterior chamber depth (less than 3.5mm) the lens size is 11.5. However, one should remember that the lens size will change in this case if the white to white is 11.2 mm. Anterior chamber depth up to 3.2mm are considered to be optimal but anything deeper should draw the surgeon’s attention and could look at stepping
up to the next size (in this case 12.0). The same holds true for white to white of 11.6 - 11.7 mm. The size of the lens changes between these 2 points and one has to take a call looking at how deep or shallow the anterior chamber is. As far as Rx power is concerned, we always look at the spherical component (even in torics). Lower powers (until 13.5D lens power), the inherent vault of the lens is low, therefore one might want to size up a little (one step) if the anterior chamber is reasonably deep. Higher powers have high central vaults (inherent) and therefore one shouldn’t be worried unless it is a young patient who will have the implant for a number of years. The trend now is to go high on vaulting. It is safe for long-term stability. There are 2 extremes sizes (11.5 & 13.0). It is suggested to have a feel of the sulcus size in these cases and then take a call. The most commonly used sizes are 12.0 & 12.5.

Please note the above understanding is only for myopic lenses, not hyperopic.

**ICL sizing need to decided upon based on a case to case analysis of the parameters evaluated.**

M. Vanathi: What are the difficulties you commonly encounter during the ICL surgery?

Mahipal Sachdev: All surgical steps are crucial and need to be done well. Beginners may want to perform this surgery under block though I prefer topical anesthesia. Good patient co-operation is essential. Creating a valved temporal incision is important to have good wound security. Loading the ICL in the correct orientation and injecting slowly watching it unfold in the right way is essential. It is important to inject in the iris plane parallel to the lens unlike an IOL where we point towards the posterior pole. Make sure the injector tip is in the AC and not in the wound as that may make the ICL open upside down. Donot handle the optic with your instruments. Tuck the foot plate gently behind the iris with a manipulator. I make surgical PI’s after constricting the pupil. Make a short vertical corneal tunnel through which the iris tissue can be picked up and cut with a Vannas scissors. Alternatives are using a vitrectomy cutter or performing YAG PI’s prior to surgery. The newer ICL version has pre-placed holes for aqueous circulation and does not require a surgical PI. Washing the viscoelastic from behind the ICL after implantation is important to prevent post-op IOP spikes.

Sudarshan Khokhar: We haven’t faced any issue with the technical procedure so far, but the beginners should be wary during the ICL loading, as well as insertion. The long forceps used for pulling the ICL into the cartridge should be kept in working condition otherwise the ICL will slip during loading. The incisions have to be beveled and two planer to avoid iris prolapsed. If the pupil is not well dilated there might be a difficulty in tucking the haptics in the sulcus. Over or under filling of the anterior chamber may cause problems and should be avoided. Over filled AC with OVD going under iris will cause iris prolapse and under filled AC will have a risk to the endothelium. To avoid problems of retained viscoelastic, gentle irrigation aspiration (bottle height of 70 cms, low flow and aspiration) should be done at the end of the procedure using coaxial / bimanual system. To avoid shallow chamber at the end of surgery proper hydration of incisions (main as well as side ports) should be done. This becomes more important in cases of Toric ICL as the shallowing of the anterior chamber can cause rotation of ICL.

Somsheila Murthy: While loading the ICL is not difficult, it is important to store it carefully on the sterile table and we do not have a standby lens!! ICL implantation is a very simple surgery and does not pose a challenge for the experienced cataract surgeon. Complete viscoelastic removal should be done to prevent post-operative IOP spikes. Constricting the pupil in case a PI on table is planned may also pose a challenge. Initially follow the recommended technique for surgery for the first ten cases at least before going ahead with individual variations.

Bhaskar Srinivasan: Would be to keep the surgical peripheral iridectomy as small (to prevent glare) and as adequate as possible, if your combining the PI during the ICL insertion else it’s a fairly simple procedure.

Mathew Kurian: The learning curve may not be very steep for an experienced phaco surgeon.

However, utmost care must be taken while making the incisions, as accidentally puncturing the capsule may spell ‘Lawsuit’ to an unlucky practitioner. Tucking the ICL haptics under the iris should be gentle and under good dilatation as early lens opacities are surgeon related intra-operative anterior lens trauma.

Due to the thicker and more heavily pigmented irides some surgeons prefer an intra-operative surgical iridectomy with either a cutter or forceps. Surgeons not used to using anterior vitrectomy probes may obtain a partial thickness or inadequate opening initially.

D. Ramamurthy: With experience most steps become fairly routine. Specific areas to be looked into are:

- Correct loading
- Ensuring that the ICL opens in the AC without getting inverted.
- Adequate PI preferably superiorly under the lids
- Constantly taking care not to traumatise the endothelium or anterior capsule.
- Complete evacuation of the viscoelastic.

**It is important to realize that every step in the ICL surgery from loading to the actual procedure itself is to be performed with extreme care.**

M. Vanathi: What do you look for during examination on day 1 in postoperative patients?

Mahipal Sachdev: We look at the vision, AC depth and reaction, ICL vault, patency of PI and IOP. If the vision improvement is not as expected, dilate the patient to look for IOL rotation or mal-positioning. Treat any IOP spike or increased reaction by modifying the medications schedule post op.

Sudarshan Khokhar: On day 1 We look for UCVA, BCVA, vaulting, anterior chamber reaction IOP (NCT) and anterior chamber depth. In V4.03 NaCl ICL model, which we are currently using, the correct vaulting can be adjudged only after 24-36 hours as the ICL swells up inside the eye whereas in newer models (V4 B & C) which come in BSS solution the vaulting should stabilize within 1-2 hours of surgery.

Somsheila Murthy: Visual acuity should be 20/30 or better, AC depth, any obvious knob of iris suggesting that the haptic is folded, pupil centration, IOP and should have
only minimal inflammation (2+). The ICL may not be at its complete vaulted position so a little forward rotation is acceptable.

**Bhaskar Srinivasan:** Vaulting of ICL, Applanation tension, Visual acuity

**Mathew Kurian:** Apart from looking for obvious signs of infection and normal IOP, a patent PI and appropriate vault are essential. Day 1 normal vaults may predispose to high vaults by 1 or 6 weeks due to the hydration of the ICLs that are packaged in saline. This is not a problem in ICLs packaged in BSS.

**D. Ramamurthy:**
- UCVA, BCVA & residual refractive error if any.
- Clarity of cornea
- Adequate wound closure
- AC depth & any flare or cells
- Patency of PI
- ICL vault
- Clarity of the natural lens
- IOP measured with a sterile tonometer

Postoperative day one evaluation should include visual acuity, anterior chamber depth, ASOCT for ICL vault details, intraocular pressure, apart from all other routine postoperative evaluation parameters.

**M. Vanathi:** What are the common postoperative problems you have faced in ICL patients?

**Mahipal Sachdev:** IOP spikes can be seen in the first few weeks after surgery and need to be managed with medications. ICL re-dialling may need to be performed if the ICL rotates. Mild to moderate AC reaction needs topical steroids usually. Patients implanted with smaller optic zone ie 4.9 to 5.2 mm have an increased incidence of haloes and glare compared to patients implanted with larger optic zone diameters of 5.5 to 5.8 mm. Most patients do well and are happy with their results.

**Sudarshan Khokhar:** IOP may rise postoperatively due to excessive filling of AC or due to inadequate laser iridotomy for which laser augments should be done as soon as possible. We had 2 eyes which needed enhancement of PI in immediate post-operative period and steroid response may also cause excessive pressure rise.

Excessive AC reaction can also occur which usually is due to retained viscoelastic. Frequent topical steroids under antibiotics cover will resolve this problem. Since the viscoelastic can never be fully aspirated out specially the one sandwiched between ICL and anterior capsule the choice of good quality of OVD is mandatory.

Since the pupil are dilated for first few days the near vision might be blurry due to the paralysis of the accommodation, this gets OK after the cycloplegics are stopped

**Somsheila Murthy:** Raised IOP, and excessive vault in my earlier cases.

**Mathew Kurian:** Symptomatically, ghost images and dysphotopsias are the infrequent but most common problem. Due to the additional and more elaborate preoperative work up that we do our rate of ICL exchange for vault related problems has been very low (2 per 1000).

**Bhaskar Srinivasan:** Glaucoma, Glare, Low vaulting

**D. Ramamurthy:** Rarely: Mild inflammation & Transient raised IOP

The most common postoperative problems with ICL will include postoperative glaucoma, ICL vault problems.

**M. Vanathi:** Please elaborate on how you go about managing vaulting problems in your patients?

**Mahipal Sachdev:** Vaulting depends on the sizing of the ICL, smaller ICLs have a lower vault while larger ICLs will have a higher vault. The trick is to size the ICL well which in turn depends on the white to white measurement. For patients who do not fall into the available sizes or we are not getting consistent measurements, UBM may be used to get sulcus to sulcus dimensions. In the post-op phase we monitor the ICL vault in terms of corneal thickness with the ideal being within ½ to 2 times the corneal thickness. Rarely ICLs may need to be replaced in case inadequate vaulting occurs leading to chances of cataract or glaucoma with low or high vault respectively.

**Sudarshan Khokhar:** Low vault is known to cause cataract, for which ICL needs to be explanted. In cases of high vaulting, leading to change in Effective lens position and thus refractive error, ICL exchange may be required. We had to replace ICL in one eye due to excessive vault which had hyperopic shift although his IOP was normal.

**Somshelia Murthy:** Serial studies with ASOCT will let us know whether the vault decreases or not. I always perform OCT on 5-7 day visit, 1 month, 3 months, 6 months and then annual visits. In case the vault is not optimal, then I would call the patient for more visits in between. Usually, I plan at the second eye after 5 to 7 days, and in cases where the vault is not good, I wait for upto a month. If the vault is very low, I would consider exchanging the ICL of the first eye with a larger ICL (so far I have not had to do this).

**Bhaskar Srinivasan:** If the vaulting is low, 150 microns or so, in the centre, then there is a higher possibility of lens changes, so prefer to replace it. I have had that situation only in 1 patient so far. I try to decide on the ICL sizing based on white to white measurement, and angle to angle, and sulcus to sulcus measurement and adjust the sizing based on all the above 3 parameters and the anterior chamber depth.

**Mathew Kurian:** An underestimation in the selection of the ICL diameter is frequently associated with poor vault (less than 250 µm), thereby increasing the risk of cataract formation, whereas an oversized ICL may result in excessive vault (greater than 750 -1000µm), and thereby increasing the risk of angle-closure, pupillary block glaucoma, or pigment dispersion glaucoma.

An ICL exchange will have to be done with the ICL being replaced with a more appropriate one. If an undersized vault has caused a visually significant lens opacity a single stage ICL explant with cataract surgery and IOL implantation can be performed.

**D. Ramamurthy:** Prevention is the best cure. Correct sizing is most important.
Do nothing unless vaulting is excessive & causes crowding of the angles of AC & raised IOP or because of poor vault there is anterior sub capsular opacification. Though vaulting has been less than optimal in few of my cases, never had to exchange a lens because of that.

Managing ICL vault problems can be tedious and one needs to do a meticulous preoperative planning in order to alleviate this problem.

M. Vanathi: When do you consider use of toric ICLs?

Mahipal Sachdev: For patients with co-existing astigmatism > 1 D I use toric ICL.

Sudarshan Khokhar: In cases of low refractive errors (<6D), toric ICL may be implanted for > 1D astigmatism, using the spherical equivalent in cases having < 1D. For >6D spherical powers and astigmatism more than 1.5D toric ICL are mandatory to get the desired results.

Somsheila Murthy: When cylindrical power is more than 1.5 D in high myopes, and 1D or more in lower (moderate) myopes (I do not operate on low myopes).

Bhaskar Srinivasan: When the astigmatism is more than 2 D

Mathew Kurian: I would consider toric ICLs in all patients with at least 1 dioptre of astigmatism

D. Ramamurthy: Whenever corneal astigmatism is above 1D & patient desires complete correction & is willing to pay the difference.

Toric ICLs can be considered for astigmatism > 1 Diopters, with special attention to the procedure and axis marking.

M. Vanathi: What are your comments on the postoperative rotation of toric ICLs?

Mahipal Sachdev: Rotation occurs due to wrongly sized ICLs or if patients rub their eyes forcefully or after trauma. A correctly sized ICL which has been properly placed according to the axis will rarely rotate. All patients are advised not to rub their eyes post-op. If the ICL has rotated, it is best to re-dial as soon as it is detected.

Sudarshan Khokhar: In our series of 25 patients (50 eyes) over the past 3 years none had significant rotational instability of toric ICL.

Somsheila Murthy: I have data showing stability of the toric ICL so I think there is not much rotation. However the patient should be instructed not to rub his/her eye vigorously as this could cause movement of the ICL.

Bhaskar Srinivasan: It’s been fairly stable

Mathew Kurian: Spontaneous ICL rotation is very unlikely with the improved haptic design that is available on the current versions of the ICL. One bizarre case I can quote was of a patient who underwent facial massage 2 years after ICL implantation and had rotation by nearly 90 degrees in both eyes. He underwent uneventful repositioning in both eyes and is now doing well. But this is strictly the exception to the rule.

D. Ramamurthy: Is quite stable once the sizing is proper. If the refractive outcome is not emmetropia, then if the spherical equivalent of the residual error is around Zero (for example: -1.00 with + 2.00D) then it is due to inappropriate position of ICL & can be corrected by rotating the ICL. The exact degree of rotation can be found by slit lamp examination or more accurately by sending a refractive surprise form to Starr, who will revert with the details of rotation or by using instruments like the I trace.

The consensus seems to be that Toric ICLs are fairly stable and rotation is not an issue provided the ICL sizing has been got right.

M. Vanathi: Does ICL implantation affect biometry in eventual cataract surgery?

Mahipal Sachdev: There is no significant difference in axial length measurements before and after ICL placement because of the material used and the thin optic thickness in myopic ICLs. Some difference may be seen in eyes with hyperopic lenses as these are thicker in the centre. IOL calculations with optical biometry such as IOL master are fairly accurate and do not produce any significant errors.

Sudarshan Khokhar: ICL has no or almost negligible effect on biometry. Please refer to:


Somsheila Murthy: No.

Bhaskar Srinivasan: Have had to do 4 eyes which had ICL (done elsewhere) induced cataract; not much change in biometry.

- Theoretically one can use this formula CAL = AXL+ X X T
- Correct Axial Length = Corrected axial length
- AXL = axial length measured with USG 1555 m/s
- X = correction factor 0.11 for collamer, 0.42 for PMMA and 0.23 for acrylic, - 0.59 for silicone
- T = central thickness of lens – obtained from manufacturer

Since thickness of lens in centre is more in hyperopia, it might be more apt to use the formula there.

Mathew Kurian: No. The A scan can be done under phakic mode. The maximum difference between pre- and postoperative PIOL axial length measurements were less than 0.1 mm on optical biometry. (Sanders DR, Bernitsky DA, Harton PJ Jr, Rivera RR. The Visian myopic implantable collamer lens does not significantly affect axial length measurement with the IOL Master. J Refract Surg. 2008; 24(9):957-959.)

D. Ramamurthy: Not significantly. Since the thickness of the ICL is just about 50 microns in the center, it does not have any impact on the ultrasound passage or the axial length measurement. Anyway the K readings do not change.

However specific formulae have been mentioned for IOL power calculation post ICL. I don’t use them but stick to a routine biometry. No surprises in the few cases we have done so far.

ICLs do not seem to have much effect on biometry for an eventual cataract surgery.
M. Vanathi: What are your observations on endothelial cell count attritions rates following ICL surgery?

Mahipal Sachdev: In my nearly 10 years of experience, I have not seen a cornea decompensate after ICL surgery. Most patients are young and have healthy endothelium counts. We do perform specular - pre and post-operatively to monitor the endothelial counts but no significant loss has been noticed by us so far. The reported incidence of endothelial loss is about 2.2 % per year.

Sudarshan Khokhar: We have found an endothelial cell loss of 3.6% over 3 years after ICL implantation which is only a little higher than the age related ECC attrition.

Somsheila Murthy: I perform endothelial cell counts in all patients starting with the one-month visit.

Two cases (where in one case I had to go back and perform a pupilloplasty for a larger peripheral iridectomy, and in another care where there was subluxation of the ICL haptic in AC following trauma and I performed a repositioning, had endothelial cell loss of approximately 300 cells. In all other cases of routine ICLs, I have not noted any significant change in the cell counts, at the end of one year. (I started ICLs in 2010).

Bhaskar Srinivasan: We have assessed patient till 1 year post op without any significant deterioration in cell counts /morphology.

Mathew Kurian: My personal experience is similar to the reported 4.7% cell loss at 6 months that remained unchanged throughout 10-years follow-up. (Pesando PM, Ghiringhello MP, Di Meglio G, Fanton G. Posterior chamber phakic intraocular lens (ICL) for hyperopia: ten year follow-up. J Cataract Refract Surg. 2007;33(9):1579-1584.)

D. Ramamurthy: We essentially moved away from Iris clip lenses because of progressive endothelial cell loss. But serial specular microscopy has shown us that with ICLs there is no progressive cell loss beyond what could be considered as normal age related attrition. Whatever cell loss occurs is due to the initial surgery.

Reported endothelial cell loss rates after ICL surgery are minimal and do not pose any threat to the cornea in healthy eyes.

M. Vanathi: What message would you like to give for those who intend to start doing ICL surgery?

Mahipal Sachdev: I would encourage all refractive surgeons to use ICLs as they are very useful devices to treat patients with moderate to high myopia with thin cornea. The surgery has a short learning curve and very gratifying results. Meticulous pre and postoperative evaluation and attention to each surgical step will help you achieve near perfect results.

Sudarshan Khokhar: Meticulous patient selection is mandatory before ICL implantation. There is no shortcut for patient counselling, relieving patient anxiety and proper preoperative evaluation. Beginners should follow the dictum ‘No complication is too small for refractive procedures’. Initially the procedure can be undertaken in peribulbar anesthesia and later can be done under topical anesthesia as surgeon becomes more familiar.

Somsheila Murthy: Ensure that you have all the measurement tools in place before starting ICLs, as the surgery itself is not challenging. However, in order to provide the best quality of care to our patients, we must evaluate the outcomes at regular intervals. Since the incidence of cataract goes up with time, it is more important to look at long-term follow-up.

Bhaskar Srinivasan: It is a fairly safe surgery in a motivated patient who understands the small risk of cataract and glare in the post operative period.

Mathew Kurian: It is imperative to invest in the right preoperative diagnostic instruments. Understanding the patient’s expectations and proper counselling are essential for a peaceful and happy patient postoperatively.

Also, a few hours in the wet lab will definitely not hurt a starting surgeon!

D. Ramamurthy: Go ahead & do it. It is easier than what you think.

ICL surgery is an excellent option for eyes not suitable for laser refractive correction and can be adopted into practice following a extreme cautious approach.

M. Vanathi: Any interesting ICL case scenarios in your practice which you would like to share with the readers...

Mahipal Sachdev:
Bhaskar Srinivasan:

(i) *ICL and keratoconus*: Have done a couple of cases of high myopia and keratoconus which were stabilized with cross linkage. The indication being good spectacle visual acuity and reasonably regular topography.

If the topography is significantly irregular regularize with topography guided cross linkage/intacs and then later decide on ICL.

(ii) *Bioptics*: Indicated in very high myopic patients where ICL might not correct the error by itself can consider surface ablation post icl for residual error or to pre cut a lasik flap proceed with ICL and then lift the flap for laser ablation. But mostly these patients are so happy by just the ICL they don’t mind wearing thin glasses.

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