Over the years cataract surgery has evolved from traditional intracapsular cataract extraction to modern day micro-incision phacoemulsification. Along with it we have witnessed a change in the range of IOLs available, where one may feel lost with the options available. The aim of modern day cataract surgery is to provide independence from spectacles. Postoperative emmetropia can be achieved for myopic and hypermetropic errors by appropriate spherical lenses however corneal astigmatism will need special attention.

Options available for correcting astigmatism include:
- Spectacle correction
- Contact lens
- Arcuate keratotomies
- Limbal relaxing incisions (LRI)
- Opposite clear corneal incisions
- Toric IOLs
- Lasik

Limbal relaxing incisions or Toric IOL

Though LRI is a simple procedure not involving any additional cost, there remains the risk of overcorrection/undercorrection and regression, thus making them unpredictable. Like any other corneal procedure there are side effects like dry eye and neurotrophic effect with LRI. LRIs need to be done with diamond knife or guarded steel knife.

Toric IOLs don’t involve any other procedure different from routine cataract surgery however marginally increase the cost incurred. Therefore more and more surgeons prefer toric IOLs as the solution to astigmatism (Figure 1).

Successful outcome with toric IOLs depends on:
- Good patient selection
- Preoperative workup
- IOL calculation
- Good surgery with centered IOL

Patient selection for Toric IOL

An ideal patient would be a patient with regular corneal astigmatism between 1 to 3D with realistic expectations. Toric IOLs have been successfully implanted in cases with post keratoplasty astigmatism1,2 after complete suture removal. It is found to have an advantage of better IOL power predictability as compared to the 1 staged “triple procedure”. Good results have been seen in patients of stable keratoconus/corneal ectasia with cataract3.

Toric IOLs are also under study as a treatment option for refractory anisometropic amblyopia4 with promising results. There are case reports where toric IOLs have been used in patients after DALK5 (Figure 2) and DSAEK6,7.

Relative exclusion criteria would include irregular astigmatism, post refractive surgery, corneal dystrophies (awaiting keratoplasty), corneal oedema, problems encountered during surgery (including pupil damage, posterior capsule integrity, vitreous loss, poor IOL centration and discovery of zonular instability) etc.

Preoperative Workup
1) Refraction
2) Keratometry:
   i) Both manual or automated may be used
ii) One must take multiple readings.

iii) Frequent calibration of manual keratometer must be done

iv) Any discrepancy in K demands corneal topography

3) Surgically induced astigmatism

It is an important criterion to consider before ordering an IOL. The total astigmatism should incorporate the SIA. SIA is a surgeon specific criterion one can determine after about routine 20-25 cases with same wound construction. Factors which may change the SIA such as length of incision, distance from center must be considered in each case. SIA may be calculated with the help of online calculators. (e.g.: www.doctor-hill.com)

4) Biometry:

1. axial length measurement should ideally be done with IOL master or lenstar however immersion scan may also be used

2. Only corneal astigmatism should be used for IOL calculation.

3. Various companies providing toric IOLs have their online IOL calculators which calculate power according to surgeons comfort and also suggest the steepest axis for incision making thereby giving least residual astigmatism.

5) Marking technique

It is important to mark alignment axis accurately to get the best out of toric IOL implantation. Marking should be done in upright position in order to prevent cyclotorsion which occurs in supine position. This cyclotorsion is estimated to be about 2 to 4 degrees on an average but can be up to 15 degrees. Firstly the horizontal axis is marked preoperatively at the slit lamp with the coaxial thin slit turned to 0-180 degrees. Marking is done with either sterile ink or a needle or a bubble marker (Nuijts/Lane Toric Reference Marker (ASICO). The alignment axis is then marked intraoperatively using the preoperative horizontal axis with the help of toric axis marker (Figure 3).

Newer techniques have become available for intraoperative toric IOL alignment:

- Iris finger printing technique
- Intraoperative wavefront aberrometry (ORange, WaveTec Vision Systems)
- Real time eye-tracking (iris and blood vessel characteristics) - SG3000 (Sensomotoric Instruments, Tellow, Germany).

6) Surgery

A good standard phacoemulsification procedure is necessary for optimum results. It is imperative to have a well centered adequate size capsulorrhexis allowing 360 degree overlap of IOL haptic. One should aim for 20 to 30 degrees short of final axis while the IOL is unfolding. Final dialling should be done after viscoelastic removal.
One must take care to hydrate stroma properly and not over inflate the bag, as this has been associated with more postoperative rotational instability.

**Toric IOL**

The first toric IOL was presented by Shimizu et al. in 1994. It was a non-foldable three-piece toric IOL made from polymethyl methacrylate (PMMA). Over the years toric IOLs have changed tremendously in design and material.

Staar Surgical Intraocular Lens was the first toric IOL available in the United States, got FDA approval in 1998.

The FDA also approved the AcrySof IQ Toric IOL (Alcon) in September 2005. This lens also is available in aspheric versions. Different models can filter potentially damaging UV or blue light.

Toric multifocal IOL models are also available: the diffractive-refractive Restor IQ toric (Alcon), the diffractive AcrySof IQ Toric (Carl Zeiss Meditec), the refractive M-flex T (Rayner) and the Lentis Mplus toric (Oculentis). Multifocal toric IOLs have seen to provide greater spectacle independence.

In May 2013, the FDA approved the Trulign Toric IOL (Bausch + Lomb), the first accommodating IOL that also corrects astigmatism. The lens, corrects corneal astigmatism between 0.83 D and 2.50 D and offers patients clear distance, intermediate and near vision without glasses after cataract surgery.

The commonly used toric IOLs are enlisted in (Table 1).

**Disadvantages of Toric IOLs**

- Improper alignment or rotation of the IOL after surgery may result in more residual astigmatism than predicted
- For every 1 degree the toric IOL axis is off from the true postoperative axis of astigmatism, there will be a 3.3% loss of toric correction
- Need for binocular toric IOL implantation for best results.
- Astigmatism more than 4D at corneal plane still remains difficult to correct with Toric IOLs.

**Tips for making toric experience a successful one**

- Multiple, repeatable keratometric values from different sources.
- If there are discrepancies between the readings, some surgeons tend to rely on manual or automated keratometry for the magnitude of the astigmatism, and topography for the axis.
- Make sure patient has not been using contact lenses for at least 2 weeks.
- Marking reference and final axis in the sitting position on slit lamp.
- Well centered capsulorhexis of an adequate size (5 to 5.5 mm).
- Prior practice of few steps like removing viscoelastic from under the IOL without moving it.
- Practice rotating spherical IOLs to a precise axis.
- When initially implanting the lens, leave it about 20 degrees short of the final orientation to compensate for rotation during viscoelastic removal.
Remove all of the viscoelastic from behind the lens, this enables the lens to fall on to the capsular bag, making it less likely to rotate.

Avoid overinflating the bag at the end; it increases the chances of IOL rotation.

**Outcome**

- Ahmed et al. examined spectacle use in bilaterally implanted patients and found that 69% of patients never used spectacles for distance vision. (Ahmed, Rocha et al. 2010).
- Misalignment of more than 10 degrees is currently considered the indication for realignment.
- The overall cumulative incidence of surgical repositioning of STAAR toric IOls in the literature is 6.6%. (Ruhswurm, Scholz et al. 2000) as compared to that of acrylic IOls: 0.3% for Acrysof toric IOls, 2.1% for Rayner toric IOls (Alio, Agdeppa et al. 2010).

**References**


**Table 1**

<table>
<thead>
<tr>
<th>IOL Company Model</th>
<th>Material</th>
<th>Toric surface</th>
<th>Available spherical powers (dioptres)</th>
<th>Cylinder power (IOL plane) (dioptres)</th>
<th>Cylinder power at corneal plane (dioptres)</th>
<th>A constant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acrysof Alcon SN60T3 to SN60T9</td>
<td>Hydrophobic acrylic</td>
<td>Posterior</td>
<td>+6.0 to +30.0</td>
<td>1.5 to 6.0</td>
<td>0.75 to 4.0</td>
<td>119.0</td>
</tr>
<tr>
<td>Technis AMO ZCT100 to ZCT400</td>
<td>Hydrophobic acrylic</td>
<td>Anterior</td>
<td>+5.0 to +34.0</td>
<td>1.0 to 4.0</td>
<td>0.69 to 2.74</td>
<td>118.8</td>
</tr>
<tr>
<td>Supra Phob Toric Appasamy SP TORIC T3 to T4</td>
<td>Hydrophobic acrylic</td>
<td>Anterior</td>
<td>+10.0 to +30.0</td>
<td>1.5 to 6.0</td>
<td>1.03 to 4.11</td>
<td>118.0</td>
</tr>
<tr>
<td>STAAR Surgical AA4203TF AA4203TL</td>
<td>Silicone</td>
<td>Anterior</td>
<td>+9.5 to +23.5 (TL) +24.0 to +28.5 (TF)</td>
<td>+2.0 and +3.5</td>
<td>1.2 and 2.2</td>
<td>118.5</td>
</tr>
<tr>
<td>T-flex Rayner 573T 623T</td>
<td>Hydrophilic acrylic</td>
<td>Anterior</td>
<td>-10.0 to +35.0</td>
<td>1.0 to 11.0</td>
<td></td>
<td>118.9</td>
</tr>
</tbody>
</table>

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