A COMPARISON OF SURGICAL INDUCED ASTIGMATISM FOLLOWING PHACOEMULSIFICATION WITH CLEAR CORNEAL VERSUS SCLERAL INCISION

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ABSTRACT: The present study included 50 Cases, Group-1- 25 Cases, underwent Temporal Sclera incision phacoemulsification, Group-2: 25 Cases underwent temporal clear corneal incision phacoemulsification. Out of this majority of the cases with scleral incision Group showed an surgically induced astigmatism of 0.5 D(56%), in clear corneal group 40% showed 0.5 D and 32% showed 0.75 D of Surgically induced astigmatism. The mean surgically induced astigmatism in scleral incision Group was 0.55±0.28 and in clear corneal group 0.69±0.25. In both the cases there is decrease in pre-operative against the rule astigmatism to Post–Operative against the rule astigmatism and an increase in with the rule astigmatism from Pre-Operative to Post–Operative period, but this is seen more with clear corneal incision group compared to scleral incision group.

KEYWORDS: Comparative Study of Astigmatism in 50 cases Following Phacoemulsification.

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INTRODUCTION: Cataract surgery incisions have been known for more than a century to influence astigmatism. Only in the past decade, however, have cataract surgeons mounted serious investigations in minimizing astigmatism induced by cataract surgery. Significant astigmatism may be visually disabling causing diminution in visual acuity, glare, monocular diplopia, asthenopia and distortion.[1] Surgical techniques are being continually modified and improved upon to decrease post-operative astigmatism. Per–operative factors such as location and type of cataract incision, size, configuration, suture material, technique of wound closure etc. influence the post-operative astigmatism is the location of cataract surgery.

It is known that flattening of the cornea occurs ultimately at a direction right angles to the direction of cataract incision. Also it has been that farther the cataract incision from the visual axis, less likely is the effect on the corneal curvature at visual axis Scleral incision is father from visual axis and flattening that is likely to affect the corneal curvature at visual axis, thus causing less post-operative astigmatism. But healing is faster in cornea compared to sclera. So, early wound stabilization occurs in clear corneal incision when compared to scleral incision. In this view, we have endeavored to compare the astigmatism following scleral incision and clear corneal incision in phacoemulsification surgery with posterior chamber intra ocular lens implantation.

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SURGICAL TECHNIQUE:

1. **Conjunctival Flap:** A limbal based conjunctival flap of length 4 mm long is made from the limbus and the sclera is exposed. It is not necessary to dissect the conjunctiva completely through the limbus. Dissection the conjunctiva just enough to expose the sclera preserved the surface anatomy of the limbus. By placing the conjunctival flap 4mm from the limbus it will cover the sclera site when the flap is closed at the end of the surgery. This step is not done when it is a clear corneal incision. So that, post-operative redness is less or sometimes no redness at all.

2. **Incision:**

   Scleral Incision:

   a. **External sclera incision:** Smile, straight, frown shaped or chevron incision is made 1.5 to 2mm behind the limbus and 3-3.2 mm in length at 0.25 to 0.3mm depth (40-50% thickness of sclera). Here the surgeon's choice is straight incision.

      Sclerocorneal Tunneling: 2.8mm bevel up crescent knife is used for lamellar dissection. Forward dissection in sclera and cornea is continued till 2 mm within the clear cornea. Side pockets i.e., additional spaces in sclera and cornea are made.

Internal Incision: Anterior chamber is entered by 3mm angled keratome, dipping towards the centre.

Advantages: As this incision is away from visual axis it causes less surgical induced astigmatism.

Disadvantages:

- Difficult access to anterior chamber with limited movement of the surgical instruments.
- Difficult access to the lens nucleus, aspiration of lens cortex and IOL manipulation.

Clear Corneal Incision: Fine classified the incision types depending location, architecture and size & planar configuration.

3. Depending upon Location:

- Corneal Tunel Incision: Entry posterior to limbus, exit at the cornea sclera junction.
- Corneal Tunnel Incision: Entry just posterior to the limbus, exit in clear cornea.
- Clear Corneal Tunnel Incision: Entry and exit in the clear cornea.
  In this study, the surgeon's choice is clear corneal tunnel incision.

4. Depending upon Architecture:

- Single plane no groove.
- Shallow groove < 40 microns.
- Deep grove > 400 microns.

5. Depending upon Size & Planer Configuration:

- Single–plane incision 2.5 by 1.5mm, rectangular tunnel.
- Two-plane incision 2.5 by 1.5mm rectangular tunnel.
- Three-plane incision 2.5 by 1.5 mm rectangular tunnel plus perpendicular actuate component.

Advantages:

- Bloodless, self-retaining, sutreless, and time saving quick incision, best performed temporally (more distant from visual axis).
- Surgery of choice in patients on anticoagulants, blood dyscraisas, ocular pemphigoid, Stevens Johnson syndrome.
- Angle structures are preserved if trabeculectomy is required at a later date.
- Greatest advantage is phacoemulsification can be performed under topical anesthesia.

Disadvantage:

- It is difficult to obtain square incisional geometry through cornea since a long tunnel presents a problem during manipulations in the anterior chamber.
- Wounds are less secure than Sclerocorneal tunnel incision.
- Surgically induced astigmatism is more compared to scleral incision.

6. Side Port Incision: A paracentesis knife or 26 gauze needle is used to make a side port entry at the limbus to facilitate introduction of a second instrument and to form the anterior chamber during the surgery.

7. Continuous Curvilinear Capsulorhexis: Developed by Gimble & Neuhan.

Technique of CCC: The physics of CCC consists of two physical forces.

1. **Tearing By Shearing**: The vector acts in the direction – as tearing capsule. Hence it has a better control on the tear.
2. **Tearing by stretching**: Here the force is applied perpendicular to the direction of tear resulting in radial tears. While tearing the flap the force has to be a combination of centripetal and centrifugal components. Centrifugal force is to achieve adequate size of the opening while centripetal force is to prevent the outrunning of rhexis edge.

8. Hydrodis Section: 25 to 30 gauze cannula (with a 45° angulations about 10mm from the tip) is placed 1mm beyond the rhexis margin and the fluid is injected. It separates the nucleus from the cortex and the cortex from the capsule. Golden ring reflex is seen due to fluid wave.

9. Hydrodilineation/Hydrodelamination/Hydrodemarcation: This involves injection of fluid between the epinucleus and nucleus. Aim of this maneuver is to create the smallest possible nucleus with the thickest possible epinuclear plate.

10. Phacoemulsification

i. Divide and Conquer (four quadrant technique): It is easy to maneuver. The steps include.

1. Sculpting is performed with the probe to create a groove.
2. The nucleus is rotated and a second groove is made at right angle to the first.
3. The probe and second instrument are engaged in opposite walls of the grove and the nucleus is cracked by applying force in opposite directions.
4. Nucleus is rotated 90° and a crack made in the perpendicular groove in an similar manner.
5. Each of the four quadrants is emulsified and aspirated in turn.

ii. Nuclear phaco chop (the Choo Choo Chop and flip technique)

It requires more surgical skill.

It has advantage of using requiring much less expenditure of energy.

The steps include:

1. In horizontal chopping a blunt tipped chopper is placed horizontally underneath the capsule and then turned vertically as the equator is reached.
2. Vertical chopping is performed with a pointed tip chopper which does not need to pass beyond the capsulorhexis.
3. The nucleus is chopped into several pieces each of which is emulsified and aspirated.

11. **Cortex Aspiration and Implantation of Intra Ocular Lens:** Cortex is aspirated using Simcoe irrigation and aspiration cannula. Viscoelastic material is instilled into the capsular bag and into the anterior chamber and a foldable IOL is inserted in the capsular bag.

Biometry & IOL Power Calculation:

- Estimation of IOL Power.
- It requires estimation of axial length of eye ball and refracting power of the cornea.

Measurement of axial length: By A-Scan ultrasonography.

Refracting power of cornea: It is measured by keratometer.

- Formula for calculating IOL power.
- P = A-2.5 L -0.9K.
- A-predetermined constant for each IOL.
- L-Axial length of the eye ball.
- K-Average of keratometry readings.

12. **Completion:**
    - Viscoelastic is aspirated.
    - The side port incisions are sealed with a jet of saline.
    - Closing the conjunctival flap is necessary in scleral incision.
    - The conjunctival flap is closed with wet field cautery.
    - The operation is completed by a subconjunctival injection of gentamycin and dexamethasone.
    - A patch is applied routinely over the patient's eye.

MATERIALS AND METHODS:

The Present Study: "Prospective, randomized, comparative study of astigmatism induced by scleral & clear corneal temporal incisions in phacoemulsification surgery conducted in the Department of Ophthalmology, SVVRR Govt. Gen. Hospital, Tirupati.

Source of Data: All patients attending the out-patient department of Ophthalmology of SVRRGGH, Tirupati, diagnosed to have cataract and willing to volunteer for this study.

Sample Size: The study included 50 patients who were diagnosed to have cataract. Of them, 25 patients underwent temporal scleral incision Phacoemulsification and 25 patients underwent temporal clear corneal incision phacoemulsification based on the surgeon's choice.

Inclusion Criteria:

1. Patients diagnosed to have cataract, with nuclear sclerosis not more than grade 3 & expressed willingness to volunteer for this study.
2. Patients with clinically normal cornea.
3. Patients in the age group of 30-80 years.

Exclusion Criteria:

1. Patients having hard cataracts. (Nuclear sclerosis grade 3 or 4 (brown /block nuclear cataracts).
2. Patients with corneal degenerations / dystrophies.
3. Patients with connective tissue disorders.
4. Patients unable to co-operate for pre and post–operative keratometry.
5. Traumatic and pediatric cataracts.

Method of Collection of Data:

1. Patients selected for study were subjected to detailed history taking and clinical examination.
2. Pre-operative keratometry readings were recorded.
3. Post – operative keratometry values in steeper and flatter meridians.
4. Amplitude of pre-operative and-operative astigmatism is calculated form difference in keratometry values in steeper and flatter meridians.
5. Amplitude of surgically induced astigmatism is calculated from pre-operative and post-operative amplitudes by subtraction method.

For simplification of analyses, all astigmatic changes (pre-operative and post-operative) were studied only in the vertical or horizontal axes (only at 90° or 180°). If readings were oblique, they were regarded as being with (at 90°) or against (at 180°) the rule, depending on their values (within 30°) proximity with the corresponding vertical or horizontal axes. All the surgeries were done by a single surgeon with same phaco machine and same type of instruments. Alle yes are implanted with same type of acrylic foldable lens. The incision size for both the scleral tunnel incision and clear corneal incision was the same 3 mm.

Type of Incision: The present study included 50 patients.
Group 1: 25 patients (50%) underwent temporal clear corneal incision Phacoemulsification.

Group 2: 25 patients (50%) underwent temporal clear corneal incision Phacoemulsification.

Type of incision	Number	%
Scleral	25	50
Clear Corneal	25	50

Table 1

	ATR	%	Neutral	%	WTR	%
Pre-Operative	19	76	1	4	5	20
1st Week	19	76	1	4	5	20
3rd Week	17	68	1	4	7	28
6th Week	17	68	2	8	6	24

Table 2: Scleral Incision–Astigmatism Pattern

ATR: Against the Rule Astigmatism.
WTR: with the Rule Astigmatism.

	ATR	%	Neutral	%	WTR	%
Pre-Operative	16	64	1	4	8	32
1st Week	12	48	2	8	11	44
3rd Week	1	40	2	8	13	52
6th Week	9	36	2	8	14	56

Table 3: Clear Corneal Incision–Astigmatism Patern

ATR: Against the Rule Astigmatism.
WTR: with the Rule Astigmatism.

As seen above, in scleral incision group, there is a reduction in pre-operative ATR astigmatism from 76% of cases to 64% cases. Where as in clear corneal incision group, the same is from 64% to 36%.

Pre-operative WTR astigmatism is increased from 20% to 24% in scleral incision group, from 32% to 56% I clear corneal incision group.

In scleral incision the mean decay of astigmatism from pre-operative to 6 weeks post-operative period is from 1.55±0.46 to 0.66±0.37 in case of ATR astigmatism and 0.80±0.27 to 1.08 ±.64 in case of WTR astigmatism.

In clear corneal incision the mean decay of astigmatism from pre-operative to 6 weeks post-operative period is from 1.00±0.52 to 0.78±0.26 in case of ATR astigmatism and 0.59±0.23 to 0.78±.57 in case of WTR astigmatism.

In both sclera and clear corneal incisions which are given temporally the surgical induced astigmatism is WTR astigmatism. The SIA is more is clear corneal incision compared to sclera incision. The mean SIA in scleral incision is 0.55±0.28 and in clear corneal incision is 0.69±0.29.

DISCUSSION: Astigmatism following cataract surgery is the end result of the combination of various factors like incision location, size, suture technique etc. as described in the first part of this dissertation. In this study an attempt has been made to analyze only one variable i.e., "the incision type".[2,3] The other variables have been kept constant and an attempt has been made to explain and compare how the astigmatism changes, following clear corneal and scleral incision in phacoemulsification surgery.

It was found that the patients in the first group (scleral incision) have a lower gross astigmatism when compared to the second group (clear corneal incision). Final Surgery induced astigmatism in scleral incision was 0.55±0.28 and in clear corneal incision was 0.69±0.29. The difference in astigmatism by clear corneal and scleral incisions was less significant and it was less in scleral incision.[4]

This study is similar to study conducted by MR Joshi and S Shakya (2009) in which the astigmatism was 1.02 and 0.55±0.31 D in the corneal incision group and the scleral incision group, respectively (P <.01).[5]

And also with the study of Huang FC, Tseng SH in which the SIA in clear corneal incision was 0.93 D and in scleral incision 0.72D.[4]

This is in contradict to the study conducted by the Bahskar Reddy, Amit Raj, Virendar pratap Singh in which phacoemulsification with clear corneal incision showed 1.08±0.36 D and scleral pocket 1.23±0.71 D astigmatism.[6]

The present study showed that the mean astigmatism in scleral incision phacoemulsification was 0.74±0.40 in the 1st post-operative week, 0.69±0.37 in third post-operative week, 0.66±0.37 after 6 weeks. The mean astigmatisms in clear corneal group are 1.11±0.74 in first – operative week, 0.92±0.52 in 3rd post-operative week and 0.78±0.57 after 6 weeks.

In this study, at any particular time scleral incision group has less astigmatism compared to clearly corneal group. But the difference in amount of astigmatism is clinically less.[7] Hence it may be stated that temporal scleral incision induces lesser astigmatism as compared to temporal clear corneal incision, but the difference amount of astigmatism is less.

Would stabilization occur early in case of clear corneal incision group compared to scleral incision group.

Surgically induced astigmatism in scleral incision group is 0.55±0.28 D and in clear corneal incision group is 0.69±0.29D. So, there is little difference between these two.

This is similar to the study conducted by Arq. Bras. Oftalmol in which the surgical induced astigmatism by clear corneal incision was 0.61±0.25 D in temporal incision.[8]

The gross astigmatic decay showed that there is decrease in ATR from pre-operative to post-operative period and there is increase in WTR from pre-operative to post-operative period. The astigmatic decay figures are more with clear corneal incision group compared to scleral incision group.

As the scleral incision is more away from the visual axis compared to clear corneal incision, scleral incision causes less surgically induced astigmatism.

Although present study clearly shows the added advantage of scleral incision over clear corneal incision in temporal location for a phacoemulsification in reducing the surgical induced astigmatism, it has to be concluded that the series, preferably a controlled random study would be required to make the study statistically comparable.

CONCLUSION:

1. Temporal clear corneal incision shows a more post-operative with the rule astigmatism drift as compared to temporal scleral incision. So, if the pre-operative with the rule astigmatism is more, it is better to go for scleral incision rather than a clear corneal incision, if the surgeon's choice is temporal incision.

2. Surgically induced astigmatism is less with scleral incision when compared to clear corneal incision (Difference in Surgically Induced Astigmatism is 0.14D).
3. The greatest advantage of clear corneal incision is we can do the surgery under topical anesthesia. The angle structures are not disturbed. So, if trabeculectomy is required, it can be conducted temporally. From the patient's point of view, clear corneal incision is better as immediate post-operative redness, discomfort is less with clear corneal incision.
4. Decay of astigmatism from third to sixth week in both scleral and clear corneal incision was negligible implying early wound stabilization. Therefore, early spectacle correction by third week is possible in both groups.
5. Scleral incision is more advantageous in:
   a. Astigmatically neutral patients.
   b. Patients with "with the rule astigmatism".
   c. Patients with against the rule astigmatism < 0.50 D.
6. Clear corneal incision is more advantageous in:
   - Patients with against the rule astigmatism > 0.50D.
   - If the surgery is planned to do under topical anesthesia.
   - To preserve angle structures (planned for trabeculectomy at a later date).

To have less post-operative redness of the eye, esthetically well.

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	ATR			WTR		
	Number	**%**	**Mean±SD**	**Number**	**%**	**Mean±SD**
Pre-Op	19	76	1.15±0.46	5	20	0.80±0.27
1 Week	19	76	0.74±0.40	5	2	1.00±0.35
3 Weeks	17	68	0.69±0.37	7	28	0.80±0.59
6 Weeks	16	64	0.66±0.37	6	24	1.08±0.64

Table 4: Decay Of Mean Astigmatism In Scleral Incision

ATR: Against the Rule Astigmatism.
WTR: with the Rule Astigmatism.

	ATR			WTR		
	Number	**%**	**Mean±SD**	**Number**	**%**	**Mean±SD**
Pre –Op	16	64	1.00±0.52	8	32	0.59±0.23
1 Week	12	48	0.79±0.40	11	44	1.11±0.74
3 Weeks	10	40	0.80±0.28	13	52	0.92±0.52
6 Weeks	9	36	0.78±0.26	14	14	0.78±0.57

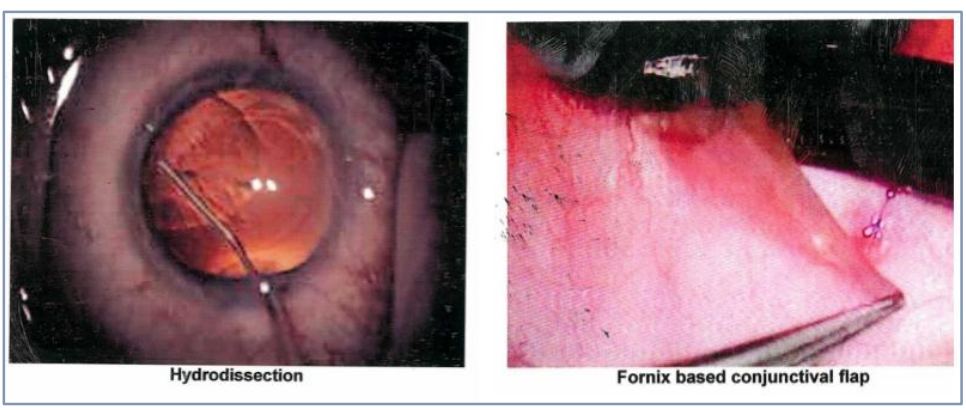
Table 5: Decay of Mean Astigmatism in Clear Corneal Incision

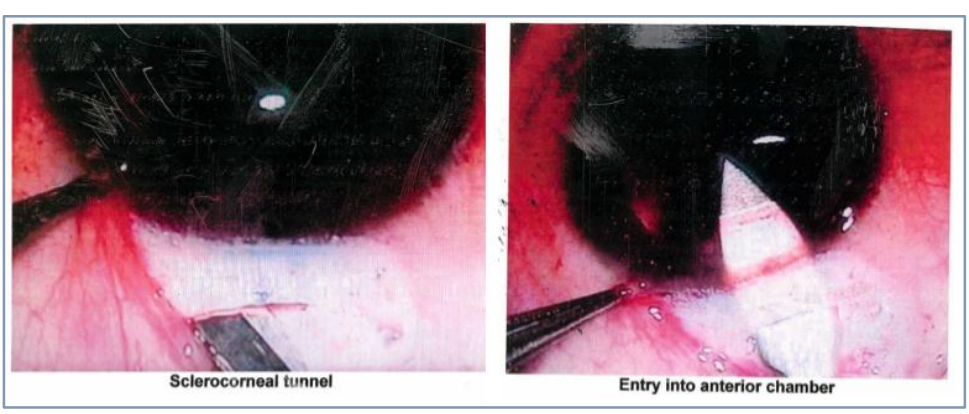
ATR: Against the Rule Astigmatism.
WTR: with the Rule Astigmatism.

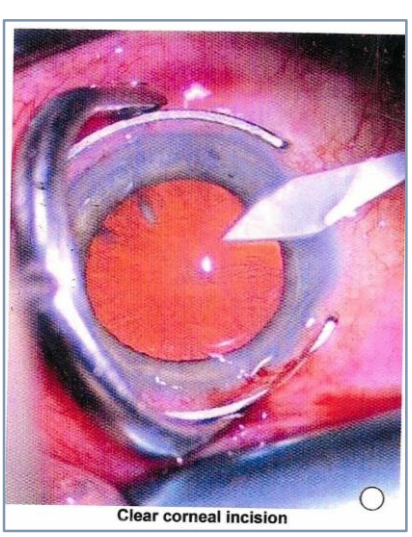
	Scleral Incision		Clear Corneal Incision	
Astigmatism in Diopters	**No. of Patients**	**%**	**No. of Patients**	**%**
0	2	8	0	0
0.25	4	16	2	8
0.50	14	56	10	4
0.75	2	8	8	32
1.00	2	8	3	12
1.25	1	4	1	4
1.50	0	0	1	4

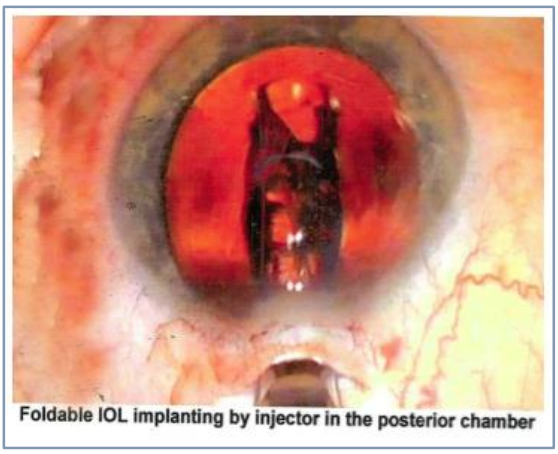
Table 6: Surgically Induced Astigmatism

ATR: Against the Rule Astigmatism.
WTR: with the Rule Astigmatism.

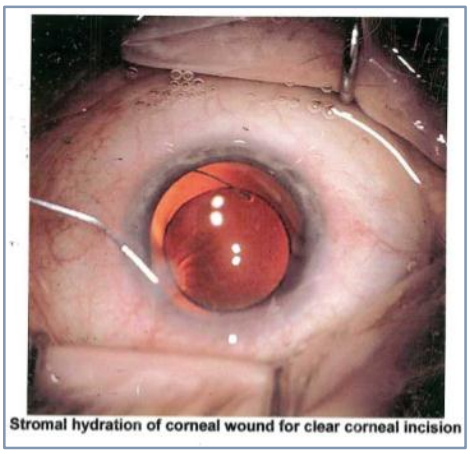




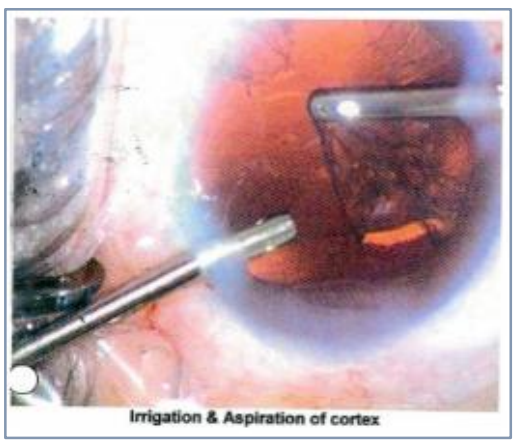




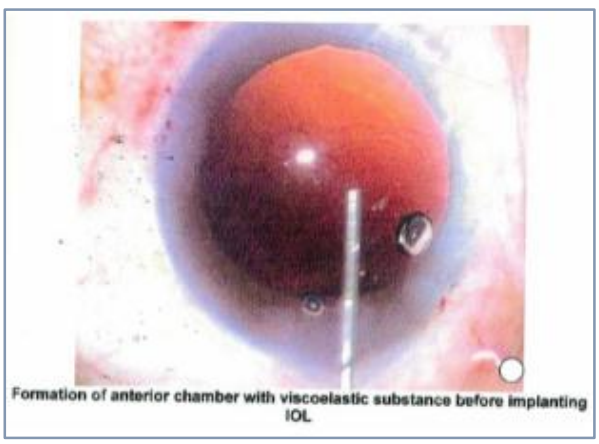
Foldable IOL implanting by injector in the posterior chamber



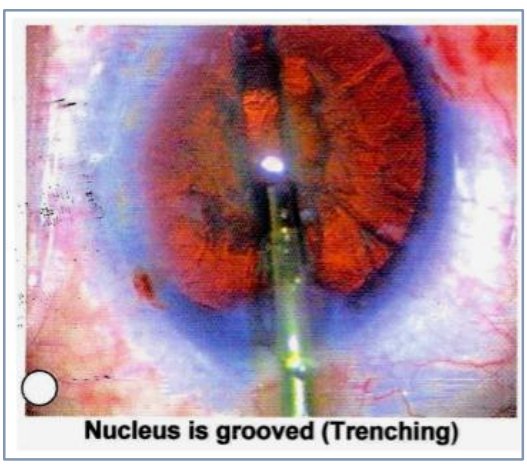
Stromal hydration of corneal wound for clear corneal incision



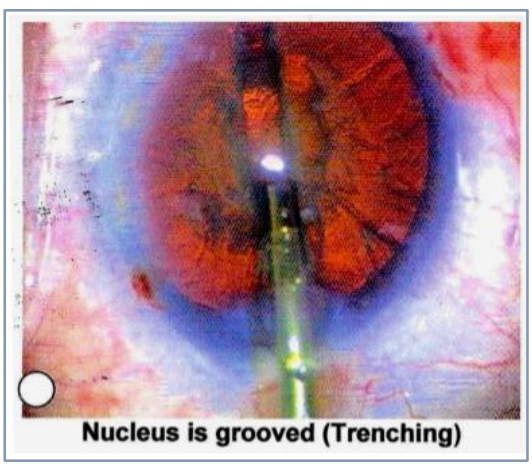
Irrigation & Aspiration of cortex



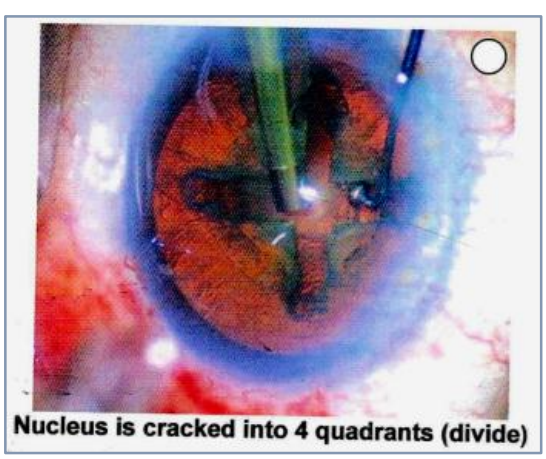
Formation of anterior chamber with viscoelastic substance before implanting IOL



Nucleus is grooved (Trenching)



Nucleus is grooved (Trenching)



Nucleus is cracked into 4 quadrants (divide)

Each quadrant is emulsified and aspirated (conquered)