CONTENTS

PART-I

PART-II

PART-III

INTRODUCTION

Cataract is a pathologic condition in which the lens fibres become opacified which causes symptoms like blurring, colored halos, defective vision. The most common cause is senile cataract[1]. For this reason, cataracts are a leading cause of blindness worldwide.

Prior to 1700s, cataract were thought to be caused by opaque liquid material flowing through the lens, hence the etymology from the Latin word “cataracta" which means waterfall[2].

As cataract cause visual impairment, surgical treatment is currently the only method for treatment. Fortunately, with advances in technology, removal of cataractous lens is replaced with an intraocular lens.

Diabetes mellitus is one of the most prevalent and morbid disease worldwide. As diabetic patients have an increased risk of developing cataract, particularly cortical and posterior sub capsular opacities, they present for surgery at an early age. The risk of developing cataract increases with duration of diabetes, severity and age. Accumulation of advanced glycation end products in the lens is one of the mechanisms of cataract development in diabetics. Cataract surgery in diabetics carries a higher risk of both intraoperative and postoperative complication compared to non-diabetics.

ANATOMY

Retinal nerve fiber layer (**RNFL**) or **nerve fiber layer**, **stratum opticum**, is formed by the expansion of the fibers of the optic nerve; it is thickest near the optic disc, gradually diminishing toward the ora serrata.

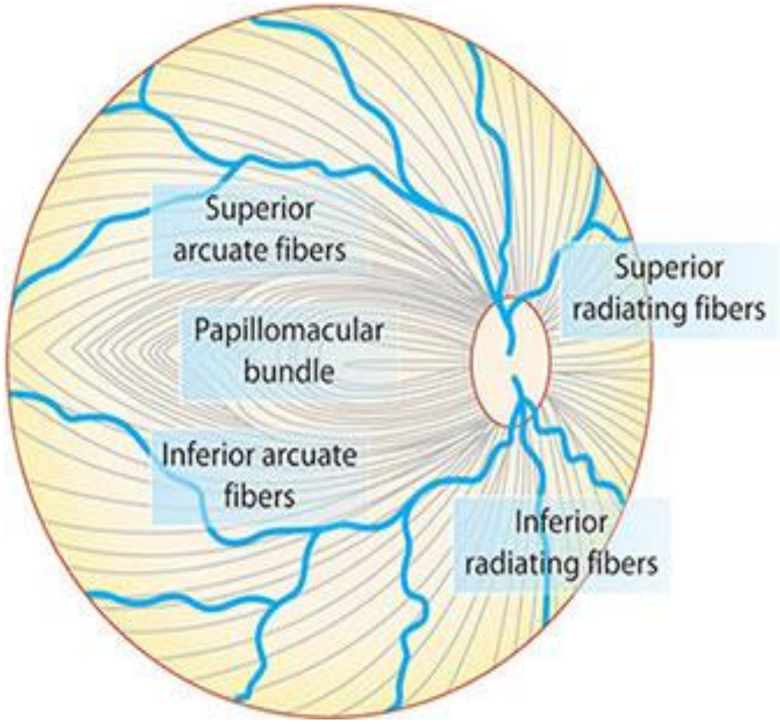
As the nerve fibers pass through the lamina cribrosa sclerae they lose their medullary sheaths and are continued onward through the choroid and retina as simple axis-cylinders.

When they reach the internal surface of the retina they radiate from their point of entrance over this surface grouped in bundles, and in many places arranged in plexuses.

Most of the fibers are centripetal, and are the direct continuations of the axis-cylinder processes of the cells of the ganglionic layer, but a few of them are centrifugal and ramify in the inner plexiform and inner nuclear layers, where they end in enlarged extremities.

Patients with retinitis pigmentosa have abnormal thinning of the RNFL which correlates with the severity of the disease.[3] However the thickness of the RNFL also decreases with age and not visual acuity.[4] The sparing of this layer is important in the treatment of the disease as it is the basis for connecting retinal prostheses to the optic nerve, or implanting stem cells that could regenerate the lost photoreceptors.

RNFL is a sensitive structure which may vary based on ethnicity.[5] Some process can excites its natural apoptosis. Harmful situation can make some damage on RNFL such as high intraocular pressure, high fluctuation on phase of intraocular pressure, inflammation, vascular disease and any kind of hypoxia. Gede Pardianto (2009) reported 6 cases of RNFL thickness change after the procedures of phacoemulsification. Sudden intraocular fluctuation in any kind of intraocular surgeries maybe harmful to RNFL in accordance with mechanical stress on sudden compression and also ischemic effect of micro emboli as the result of the sudden decompression that may generate micro bubble that can clog micro vessels.[6]


Superior
arcuate fibers
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REVIEW OF LITERATURE

1. Roy et al in 1975[7] described the technique of cataract extraction in India in the Sushruta period (800 B.C.) was couching is no longer tenable. A study of the original text suggests that the method was more closely allied to the extracapsular extraction of recent times.
2. Obuchowska et al[8] published an article which described On April 8, 1747, Jacques Daviel called to operate on M. Garion , a master wigmaker, whose cataracts appeared very favorable for surgery. Nevertheless, Daviel was unable to depress lens and he decided on a deliberate extraction. After widely opening the right cornea, he passed a small spatula through the pupil and extracted from the posterior chamber the lens. Thus was initiated the first significant advance in cataract surgery since the invention of couching in ancient India.
3. Moore et al [9]in 2009,reviewed the invention of intraocular lens by sir Harold Ridley and the struggles faced by him after invention.
4. Evaluation of peripapillary retinal nerve fiber thickness and macular changes before and after phacoemulsification ,Abdo et al, in 2020 showed phacoemulsification leads to significant increase in the central retinal nerve layer thickness and in nine macular area thickness after 1 week and 1 month postoperatively.this results supports the concept that

ultrasonification in phacoemulsification leads to inflammatory macular edema,and the removal of opacified media improves the transmittance and reflectivity of the RNFL boundary, so the RNFL thickness increases after phacoemulsification.

5. Evaluation of Peripapillary retinal nerve fibre layer thickness before and after phacoemulsification. A retina is affected by Abdo et al[10] 2020 in prospective study concluded that retina is affected by phacoemulsification as the ultrasonic energy produce mechanical effect which cause inflammatory reaction which release prostaglandins and phospholipids and other inflammatory mediators, which diffuse through the vitreous and disrupt the blood retinal barrier to cause macular edema which cause visual impairment and also cause significant increase in RNFL thickness in 1st week and 1st month after the surgery.
6. Comparison of retinal nerve fiber layer thickness between normal population and patients with diabetes mellitus using optical coherence tomography mehboob et al[11], 2019 concluded that RNFL thickness is reduced in patients with diabetes mellitus, as compared to age matched controls. The thinning of RNFL thickness is indirect evidence of neurodegeneration due to DM, which may precede the development of diabetic retinopathy, and is irrespective of age, glycemic control or duration of diabetes.

7. Ajmad et al[12] in 2020,study showed that the thickness of the retinal fibre layer is increased on OCT after cataract is removed by surgery. This showed cataract affects the measurement of retinal nerve fibre layer thickness as measured on OCT. cataract surgery enhances the ability of OCT to measure the change in retinal layer which showed increase in thickness.

HISTORY OF CATARACT SURGERY TECHNIQUES

- 800AD- couching done in India
- 1015-needle aspiration done in Iraq
- 1100- needle aspiration done in Syria
- 1500- couching done in Europe
- 1745-ECCE through inferior incision done in France by Daviel
- 1753-ICCE by thumb expression done in England by Sharp
- 1860-ECCE through superior incision in Germany by Von Graefe
- 1880-ICCE by muscle hook, zonulolysis and lens tumble in India by Smith
- 1900-ICCE by capsule forceps in Germany by Verhoeff
- 1940-ICCE by capsule suction erysiphake in Europe by Barraquer

- 1949-ECCE with posterior chamber IOL and operating microscope in England by Ridley
- 1951-Anterior chamber IOL in Italy by Strampelli, in Germany by Daneheim.
- 1957-ICCE by enzyme zonulolysis in Spain by Barraquer
- 1961- ICCE by capsule cryoadhesion in Poland by Krawicz, in south Africa by Amoils
- 1967-ECCE by phacoemulsification in USA by kelman.
- 1975-Iris-pupil supported IOLs in netherland by Binkhorst
- 1984-Foldable IOLs in USA by Mazzocco, South Africa by Epstein
- 1991-Cataract refractive surgery in USA
- 1993-Topical anaesthesia in USA by Fischman
- 1997-accommodating IOL prototypes in Europe by Cummings, Kamman

EVOLUTION OF CATARACT SURGERY:

COUCHING:

One of the earliest surgical technique for cataracts, dates back to 5th century BC. The word couching, derived from the French word "coucher" meaning "to put to bed". In this, a sharp needle is used to pierce near the limbus until one can manually dislodge the cataract into vitreous cavity and out of visual axis. Because of the lack of aseptic technique and rough nature of the procedure, resulted in poor outcomes.

EXTRACAPSULAR CATARACT EXTRACTION (ECCE):

Texts as early as 600 BC documents the use of a primitive ECCE in which the lens is removed and the lens capsule is left in place-by an Indian surgeon named Sushruta[7].

For centuries despite primitive ECCE, couching was the main procedure for cataract. until1747, Jacques Daviel French surgeon performed an ECCE, credited as the father of modern cataract surgery. In this corneal incision of >10 mm made with corneal knife and blunt needle is used to puncture the lens capsule and lens extracted using spatula and curette. Significant complications such as posterior capsular opacification, retained cataract and infections were prevalent[8].

INTRACAPSULAR CATARACT EXTRACTION (ICCE):

In 1753, a London surgeon, Samuel sharp is the earliest documented to perform ICCE. This procedure involve the removal of opacified lens and the capsule in one piece. There are many variations to this method but all of them require lysing the zonular fibres supporting the lens capsule, followed by subsequent removal of the lens-bag complex through a large libel incision. This often causes vitreous prolapse and subsequent retinal detachment.

INTRAOCULAR LENSES:

In 1949, Harold Ridley was credited to perform the first IOL operation at St Thomas Hospital in London. First IOL was made of polymethylmethacrylate (PMMA)[(9)].

In 1978,Kai-yi Zhou implanted the first foldable IOL made of silicone[(13)].

MODERN CATARACT SURGERY:

In 1993, Use of topical anaesthesia by Fischman, and the introduction of phacoemulsification in 1967 by Dr. Charles Kelman allowed for the modern extraction of cataracts to be safer and effective(14). Phacoemulsification uses ultrasound to break up the cataract and then subsequently aspirated from the eye. This development allowed surgeons to decrease the incision from 10mm to typically less than 3mm, which has the advantage of shorter recovery times, more stable surgery, and lower complication rate. In modern surgery, small incisions ranging from 1-3mm are made, the anterior lens capsule is opened in a usually curvilinear fashion and then lens is hydro dissected to loosen adherence to the capsule. Micro-instruments are used to help divide the lens into fragments and phacoemulsification is to break up and aspirate the cataract. An IOL, often foldable, is then inserted into the remaining lens capsule.

Femtosecond Laser-Assisted Cataract Surgery (FLACS) was approved by the U.S. Federal Drug Administration in 2010. The femtosecond laser has imaging software to image the cornea, capsule lens and anterior chamber. After registry, the laser can perform corneal incisions and capsulotomy, and lens softening or fragmentation. This technology can be used for corneal astigmatism correction or in cases where advanced-technology lenses, such as astigmatism correcting (toric) or multifocal or trifocal lenses are inserted.

PHACOEMULSIFICATION

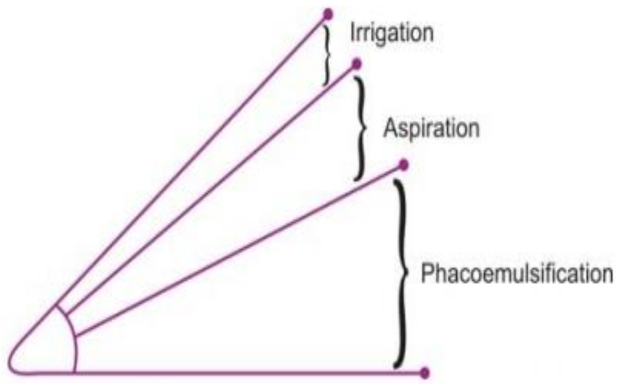
Phacoemulsification was first introduced by Charles Kelman in 1967, which revolutionized the management of cataract and visual rehabilitation. The word phacoemulsification is derived from the Greek word for the lens, “PHAKOS”

MACHINE FUNDAMENTALS:

The phacoemulsification machine is a complex device that controls the inflow and outflow of fluid from the anterior chamber and provide ultrasonic energy to the phacoemulsification tip and the machine´s parameters intraoperatively controlled by surgeon through foot pedal.

In standard phacoemulsification foot pedal, the vertical distance travelled is divided into three zones:

- First step –activates irrigation mode-all or none step
- Second step-activates irrigation system
- Third step-activates phacoemulsification



First step-all or none step-whatever the amount of depression, there will be similar amount of irrigation which is directly proportional to the bottle height.

Second and third step-linear or fixed. Linear control refers to the response of the foot pedal in a manner proportional to the amount of foot pedal depression.

PHACODYNAMICS:

The interaction of ultrasonic power and fluidics constitutes phaco dynamics.

FLUIDICS:

The balance of fluid inflow and outflow during Phacoemulsification cataract surgery -FLUIDICS. One of the goals of the surgery should be to maintain a stable anterior chamber. This can be done by making sure the fluid entering the eye is equal to the amount that exits. This will keep the anterior chamber pressurized.

INFLOW:

The inflow fluid from the irrigation bottle is a balanced salt solution which travels from the irrigation bottle through plastic tubing, into the phaco needle and finally into the anterior chamber of the eye. The fluid inflow is based on gravity and the infusion pressure is directly related to the bottle height. To create a pressure gradient the bottle is placed at a height above the patient. When the pinch valve is open , the fluid in the bottle and tubing creates pressure in the anterior chamber(15). Some newer generation phacoemulsification machine utilize forced infusion pumps that maintain a pre-set intraocular pressure during surgery which may provide improved anterior chamber stability.

OUTFLOW

Outflow is the fluid that leaves the anterior chamber. Most of which leaves through the phaco machine pump and some fluid through wound. This can be increased by increasing the aspiration flow rate.

FLUID BALANCE

The bottle height or intraocular pressure is set so that the infusion pressure is adequate to balance the outflow. This balance maintains a stable anterior chamber by keeping the pressure in the anterior chamber fairly constant during surgery.

FLUID IMBALANCE

If the balance of inflow and outflow is altered, the anterior chamber can be under or over-pressurized. Under-pressurization can lead to shallowing or collapse on the anterior chamber. This causes forward movement of the iris, lens and posterior capsule, which may lead to inadvertent rupture of the posterior capsule, due to its movement towards the phaco needle. One indicator of anterior chamber pressure imbalance is the bouncing movement of the iris and lens.

Over-pressurization (bottle height or intraocular pressure set too high) can cause misdirection of aqueous fluid or deepening of the anterior chamber with zonular stress.

Both safety and efficiency of phacoemulsification cataract surgery are directly related to fluidics. Proper settings and use of the machine will improve the safety and efficiency of the surgery.

ASPIRATION FLOW RATE

Aspiration flow rate is the volume of fluid flowing through the tubing at any given time which is expressed in cubic centimetres per minute (cc/min)[15]. With a peristaltic pump, flow is determined by the speed of the pump. Increasing flow rate improves the attraction of particulate material to the phaco tip.

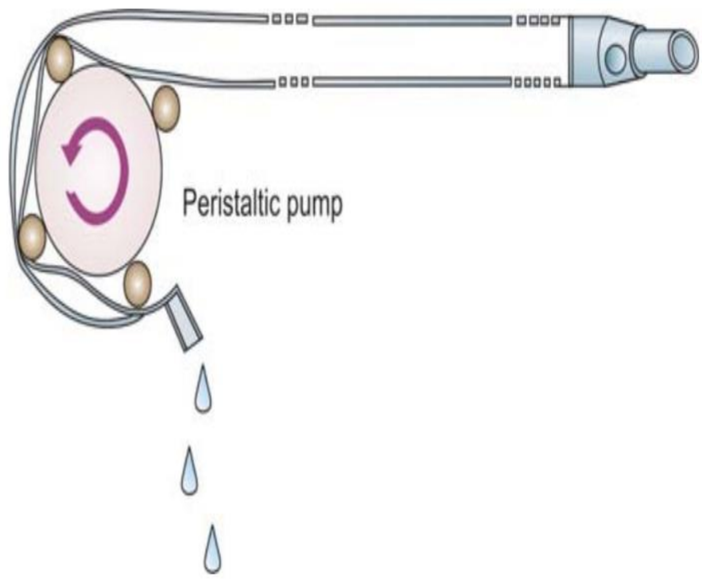
PUMP

The part of the phaco machine which moves fluid through the aspiration tubing. The pump settings control the aspiration flow rate.

The two main types of pumps:

- flow pumps (peristaltic)
- Vacuum pumps (venturi).
- Hybrid systems that incorporate both types.

The prototype example of the flow pump is the peristaltic pump. This pump consists of series of rotating rollers that compress the aspiration tubing, moving fluid within the tubing and creating vacuum. The speed of rotation of the pump head maintain the flow rate. One main advantage of this class of pumps is the ability to allow independent control of both aspiration rate and aspiration level.



The example of the vacuum pump is the Venturi pump. In the Venturi pump, compressed gas is passed through Venturi, which creates a vacuum. The venturi is attached to a rigid reservoir that is attached to the aspiration tubing. The velocity of the compressed gas passage through the Venturi creates greater or lesser vacuum which is then transferred through the reservoir to the aspiration line. This results in varying amounts of vacuum.

Other examples of pump type are the rotary vane and diaphragmatic pumps. Vacuum pumps allow direct control of only vacuum level. Flow control is dependent on the vacuum level setting. There is no independent setting of aspiration flow. Modifications of the basic pump types have prompted the creation of a new pump category, the hybrid pump. These pumps are interesting can act like either a vacuum or flow pump, independent of their original design, depending on their programming. They are the most recent supplement to pump types. They are controlled by digital inputs, producing extraordinary flexibility and responsiveness. The primary example of the hybrid pump is the Allergan Sovereign peristaltic pump or the B&L Concentrix pump.

Recognizing that surgeon preference over pump types may play a role in surgeon machine purchase, some new machines offer both types of pumps. The AMO Signature with Fusion Technology and the B&L Stellaris offer this option. The challenge to the surgeon is to balance the effect of phaco power intensity, which tends to push nuclear fragments away from the phaco tip, with the effect of flow, which attracts fragments toward the phaco tip, and vacuum, which holds the fragments on the phaco tip. Generally, low flow slows down intraocular events, and high flow or vacuum speeds them up. Low or zero vacuum is helpful during sculpting of a hard or a large nucleus. In this circumstance, the large, hard endonucleus may cause the surgeon to phacoemulsify near the iris, or anterior capsule, with a high-power intensity. With normal aspiration the phaco tip may aspirate the iris. The high power will cause severe damage to the iris. Therefore, zero or very low vacuum will prevent inadvertent aspiration of the iris or capsule, preventing significant damage.

VACUUM

The difference in fluid pressure among two points. Negative pressure measured in millimetres of Mercury (mm Hg)[15]. Vacuum determines how well, once occluded on the phaco tip, nuclear material will be held to the tip (holding power).

COMPLIANCE

Compliance describes the change in volume of tubing when subjected to negative pressure. Highly compliant tubing has a tendency to collapse, when subjected to negative pressure, while rigid, low compliance tubing does not have such a tendency to collapse.

SURGE

Surge occurs, when outflow exceeds inflow, which occurs post-occlusion. As the occlusion breaks, there is an outflow of fluid and the tubing springs back to its original volume which increases suction. Thus excess fluid is suddenly taken up by the aspiration system, which may cause temporary shallowing of the anterior chamber. This is called post-occlusion surge and this can cause posterior capsule rent. Low compliance tubing, decreased flow and vacuum, micro-pulse phaco, venting and variable rise time all can decrease surge.

ASPIRATION BYPASS SYSTEM (ABS):

There is a small opening in the phacoemulsification probe with an ABS tip, which function only when there is an occlusion of the phaco tip. Following occlusion of the tip, as vacuum rises, fluid from within the sleeve goes through the small opening into the aspiration tubing reducing the surge and the minimal fluid in the tubing also provide thermal protection.

RISE TIME

The amount of time required to reach a given vacuum preset, assuming complete tip occlusion.

ULTRASOUND POWER

FIXED MACHINE SETTING

Parameters like vacuum, aspiration, and ultrasound can be selected as fixed or variable. If a parameter is fixed, the preset value for that parameter is activated

When the foot pedal enters the appropriate position. The parameter remains constant during the excursion of the foot pedal in that position.

SURGEON CONTROLLED OR VARIABLE MACHINE SETTING

Variable settings increase linearly through continued excursion of the foot pedal in a given position.

PHACO NEEDLE

The ultrasound generating mechanism of the hand piece causes the tip attached to it to vibrate rapidly. .Tip excursion or stroke length is defined as the distance the tip displaces in the longitudinal direction at maximum power. Stroke length normally ranges from 1.5-3.75 milli-inches. All phaco machines permit the user to alter phaco power and this is usually indicated as a percentage. Whenever the phaco power is set at 100 percent, the stroke length is the maximum permissible for that machine. When the power is decreased by a given percentage, the stroke length also decreases.

POWER GENERATION

Power generation at the phaco tip is dependent on the frequency of the needle movement and stroke length.

FREQUENCY

The speed of the needle movement. Most phaco- needle move at a frequency of between 35,000 to 45,000 cycles per second (Hz). This range is the most efficient for nuclear emulsification: lower frequencies are less efficient and higher frequencies create excess heat.

STROKE LENGTH

The length of the needle movement. This length is generally 2-6 mils (thousandths of an inch). Longer stroke lengths generate excess heat. The longer the stroke length, the greater the physical impact on the nucleus, and the greater the generation of cavitation forces. Stroke length is determined by foot pedal excursion in position 3 during linear control of phaco.

PHACO NEEDLES

The shape and size of the needle will impact the fluidics and the power of the ultrasound delivered to the cataract. Selection of the appropriate needle depends on lens removal technique. The bevel at the end of standard tips can range from 0-60 degrees. End configurations can be round or ellipsoid, bent or flared.

MECHANICAL ENERGY OF THE PHACO TIP

Two types of energy:

[16] THE JACKHAMMER EFFECT - physical striking of the needle against the nucleus.

THE CAVITATION EFFECT is created energy that is released when micro-bubbles implode. The phaco needle, moving at ultrasonic speeds, creates intense zones of high and low pressure. Low pressure, created with the backward movement of the tip, pulls dissolved gases out of the solution, creating micro bubbles. Forward tip movement creates an equal zone of high pressure, which causes compression of the micro bubbles until they implode. This implosion create a temperature of 13000° F and a shock wave of 75,000 pounds per square inch (PSI). 75% of the micro bubbles implode, to create a powerful shock wave radiating from the phaco tip in the direction of the bevel with annular spread. 25% of the bubbles are too large to implode. These micro bubbles are swept up in the shock wave and radiate with it [17]

OCCLUDABILITY

Occludability is the tendency of the tip to get occluded, giving rise to a build-up of vacuum. Smaller tip angles have higher occludability. Sharpness of the tip is directly proportional to the tip angle. Tip selection is dependent on the lens removal technique and the hardness of the lens. Larger angles (45-60 degrees) are desirable for sculpting, smaller angles (0-15 degrees) are preferred for quadrant removal or chopping. Combination tips are available that maximize features of both types. Epsilon tips are oval tips which are used like a sharpened spoon to remove the lens. Bent tips have good cavitation but are harder to visualize[18].

BALANCING PHACO POWER AND ASPIRATION FLOW RATE

For effective emulsification of the nucleus, balance between the attraction and repulsion forces at the phaco tip is essential. The aspiration flow pulls material towards the phaco tip and the ultrasound movement of the tip pushes material away. Vacuum holds nuclear fragments on the phaco tip.

ULTRASOUND POWER SETTINGS TO LIMIT ENERGY DAMAGE

Minimizing energy damage to the endothelium iris and wound can be accomplished by the choosing the most efficient nuclear disassembly technique and choosing machine settings that efficiently utilize power.

For Sculpting:

Linear control instead of fixed control allows more control over the amount of energy being applied.

Pulse instead of continuous phaco reduces the energy applied.

For Chopping:

It is necessary to first make a purchase of the nucleus by applying ultrasound power, embedding the phaco needle into the nucleus, and then building vacuum in position 2, prior to chopping the lens into fragments. Utilizing burst mode phaco power, with a burst width from 40-80ms, followed by fixed vacuum is the most efficient for this method of nuclear disassembly.

Four Quadrant removal:

Pulse phaco is the most efficient method for removal of disassembled nuclear material. This provides "on" time with phaco power applied to the nucleus for emulsification, followed by "off" time to allow aspiration of emulsate and to hold the nucleus to the tip. Power can be efficiently titrated using linear control.

TECHNIQUE:

INCISION

Important Prerequisites.

- It should not permit excessive leakage of fluid so that fluidics can be used effectively.
- Minimum astigmatism.
- Self- sealing.

The choice of a particular incision must be made by the surgeon considering several factors, which also account surgeon comfort. Superior incisions are typically made at the limbus or sclera, and generally under regional block.

ADVANTAGES:

- Easier to make for a person already used to making incisions for SICS.
- Easier to abandon and convert to large section surgery should the need arise.
- Lesser incidence of postoperative endophthalmitis
- Lesser postoperative foreign body sensation.

DISADVANTAGES:

- Upper conjunctiva is disturbed, which may be undesirable if a later filtering surgery is required.
- Difficult to perform under topical anaesthesia.
- Difficult access to the cataract, especially in deep set eyes.
- Greater induced astigmatism than temporal incision.

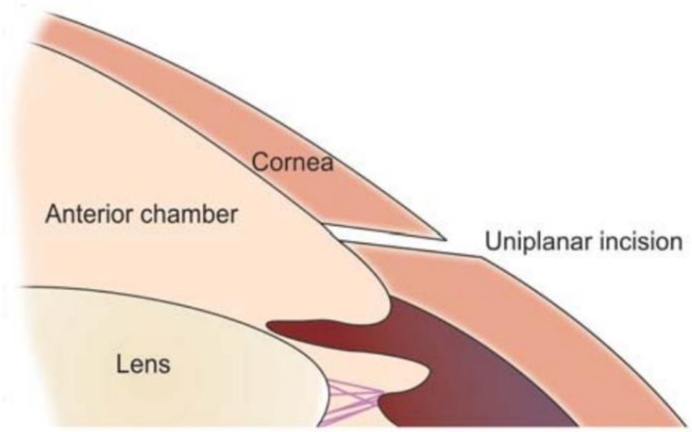
These points are reversed when one considers the clear corneal temporal incision.

The incision, irrespective of location, has to be bevelled. The inner lip extends into the anterior chamber, forming a valve which is closed by intraocular pressure once the probe is out of the incision. This gives a self-sealing incision that starts working as soon as the surgery is over. The ideal configuration described for a tunnelled incision is a square form, where the tunnel is as wide as it is long. In practice, however, a tunnel that is about 2.8 mm wide can be about 1.5 mm into the cornea and still be extremely stable[(15)]. For proper action of valve, the inner lip of the incision must be at a uniform distance from the limbus. Ragged or wavy inner lip causes the wound to leak.

ENTRY INCISION:

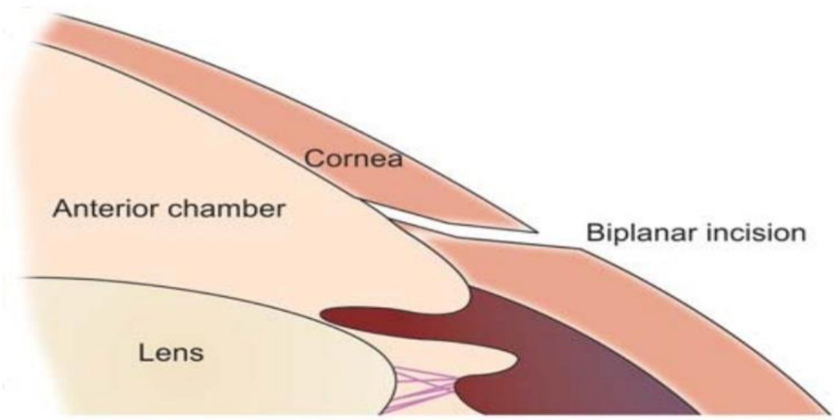
UNIPLANAR INCISION:

The surgeon makes a direct straight entry into the anterior chamber at an angle, the outer point of entry is near the limbus while the endothelial cut at about 1.5 to 2 mm inside the limbus.



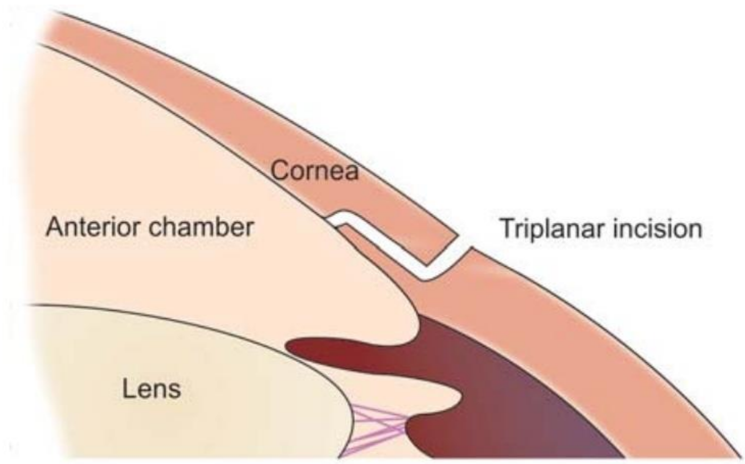
BIPLANAR INCISION:

The surgeon makes a vertical groove at the limbus, which is the outer limit of the incision. The blade is then directed forwards and downwards into the cornea till entry into the anterior chamber is achieved. This provide a better valvular action but induces more astigmatism.



TRIPLANAR INCISION:

A triplanar incision is made in the same way as above, but first the blade travels parallel to the corneal surface and then dips down at the point where entry into the anterior chamber is desired, which enhances the valve action.

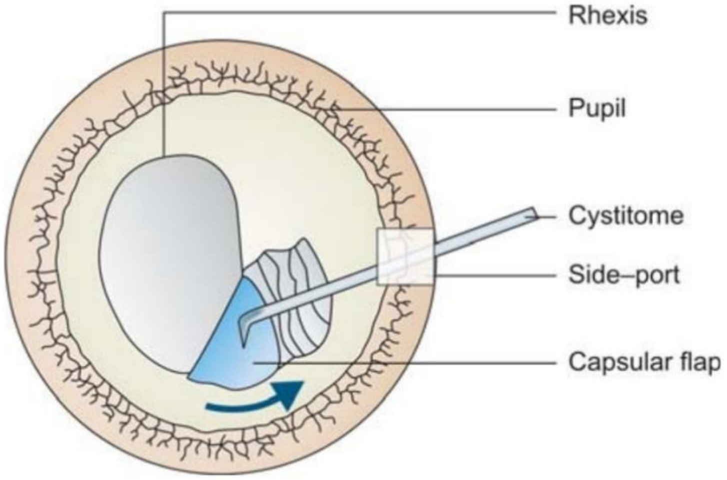


SIDE PORT INCISION:

The side ports may be one or two in number, are placed about 80 degrees away from the main incision[15], and are used to introduce instruments like the chopper or the rhexis needle into the anterior chamber. They are made in the manner of paracentesis incisions, bevelled and pointing to the centre of the eye. The incision should be entirely corneal in location to permit good sealing.

CAPSULORRHEXIS:

A capsulorrhexis is a circular opening in the capsule. The anterior CCC (continuous curvilinear capsulorrhexis) has several advantages over other openings such as the can-opener or the envelope.



ADVANTAGES:

- The margin of the opening is a continuous, it forms a strong edge that resists backward extension.
- It allows insertion of IOL entirely in the capsular bag, by which enhances the stability and centration of the IOL.

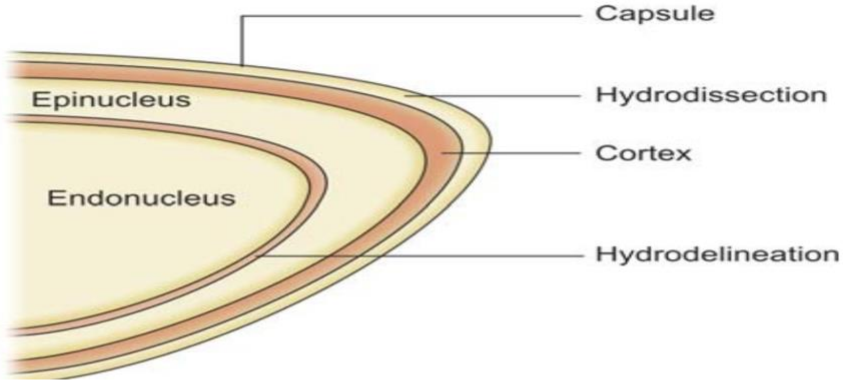
- CCC with an adequate overlap over the optic edge promotes the formation of a shrink wrap over the IOL, accentuating the effects of the posterior square edge in retarding posterior capsular opacification.
- In-the-bag phaco thus performed is least traumatic for the corneal endothelium.
- The absence of capsular tags permits a thorough cortical clean-up.

Capsulorrhexis can be created using either a bent 26-G needle or an Utrata forceps. First initiate a tear in the central part of the anterior capsule, and then lift the capsular flap, which can be turned around the central axis in a smooth, circular configuration. This creates a central circular opening in the anterior capsule which provides access to the underlying cataract. A good CCC is about 5 to 5.5 mm in diameter(15).

HYDROPROCEDURES:

The use of balanced salt solution as a physical, cleaving force- hydro procedures.

- Hydro dissection
- Hydro delineation



HYDRODISSECTION:

Hydro dissection is the passage of fluid wave between the capsule and the sub capsular cortical fibres, which creates a plane that separates these two structures and permits easy removal of lens matter. In case of posterior polar cataract, hydro dissection should not be done as there is increased risk of posterior capsular rent.

HYDRODELINEATION:

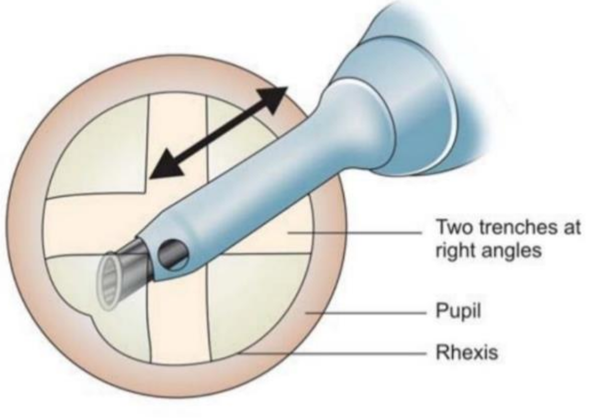
Hydro delineation is the passage of fluid similar to hydro dissection, but here it separate the endonucleus from epinucleus. The fluid may get trapped inside the capsular bag during this procedure and when further fluid is injected, raised intracapsular pressure may force the content of capsular bag through the posterior capsule. To prevent this, gentle rocking motion of the nucleus to be done to release the trapped fluid.

NUCLEUS MANAGEMENT TECHNIQUES:

Breaking the nucleus into manageable fragments and removing them through the tiny lumen of the phaco probe.

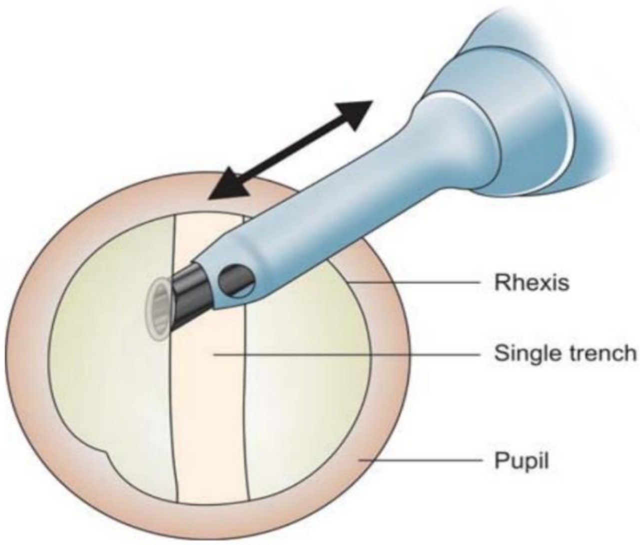
FOUR QUADRANT, OR THE DIVIDE AND CONQUER:

- In the divide and conquer technique, two deep grooves or trenches are made in the nucleus, extending to about 80-90% of depth(15) . This is called trenching or sculpting. These are at right angles to each other.
- The nucleus is then divided into four segments along these grooves, and each segment is then emulsified independently.
- This is efficient technique for hard cataracts and for the beginning surgeon.
- It often requires increased phaco energy dissipated in the eye during sculpting.



STOP AND CHOP:

- Single deep trench is made and the nucleus bisected along it.
- The two hemi-nuclei are chopped into smaller fragments and emulsified.
- Lesser phaco energy is used and more emphasis is placed on using fluidics to remove the cataract.



DIRECT CHOP:

• In this technique, no trench is made; the probe is buried in the centre of the nucleus and fragments are generated by chopping. Phaco energy required is the least when compared to other techniques.

EPINUCLEUS REMOVAL:

- Epinucleus is the soft shell that surrounds the harder endonucleus. It can be roughly divided into anterior, equatorial and posterior parts.
- A round tip repositor is used for the manipulation of the epinuclear plate.
- At the outset, the anterior part is grasped with the phaco probe (bevel up), pulled towards the centre and aspirated.
- Gradually most of the anterior and equatorial part will be peeled off. When only a small anterior edge remains, the plate needs to be flipped.
- Care should be taken that not all such edges are removed without flipping.
- Use of the second instrument to manipulate the epinuclear plate is very important.
- As a rule, phaco energy is not required during epinuclear plate removal, but short bursts may be needed to clear the lumen of the phaco probe from time to time.

CORTEX REMOVAL:

- Coaxial irrigation aspiration
- Bimanual irrigation aspiration

Done in linear foot pedal control.

No phacoemulsification needed at this stage

BIMANUAL IRRIGATION ASPIRATION:

It consist of two hand pieces. The irrigating hand piece consist of two openings 180° apart for fluid entry into anterior chamber[15].It is connected to the infusion line of the phacoemulsification machine which is inserted into the anterior chamber with foot pedal in position 1.Aspiration hand piece has one opening which have to be face upwards to aspirate the cortex and connected to the aspiration line and there is no need for any infusion sleeve as the infusion and aspiration cannula inserted through the side ports and there is no heat production.

CO-AXIAL IRRIGATION ASPIRATION:

It consists of an aspiration tip surrounded by the silicone sleeve which is inserted through the main incision. The aspiration has one opening facing upwards to aspirate the cortex and is connected to the aspiration line. The infusion line is also connected to the coaxial IA probe. The fluid passes through it and comes out from within the sleeve openings. The major skill lies in aspirating the sub incisional cortex. Tangential motion of the IA tip makes it easier.

- As the IA tip is smaller than the phacoemulsification tip, higher flow setting can be used safely.
- Aspiration tip is positioned just below the capsulorrhexis margin and in the middle of the cortical fibres.

- Tangential movement of the instrument prevents the accidental capture of the capsular rim.
- Once the cortex has been firmly grasped, pulled to the centre, peeling it from the equator and the posterior capsule.
- The free cortex is then aspirated by increasing the vacuum through foot pedal. This process is repeated around the entire circumference.
- When using bimanual IA, the irrigation should be advanced into the anterior chamber. Inadvertent removal of the irrigation tip can cause sudden collapse of the anterior chamber, which can cause posterior capsule rupture.
- Residual cortical fibres sticking on the posterior capsule, a low vacuum mode called the capsular polish mode can be employed.
- Bimanual IA offers better control and access as compared with the co-axial method.

IMPLANTATION OF FOLDABLE IOL:

As a rule, insertion of foldable IOLs is done through the incision without enlarging it. The anterior chamber must be adequately filled with viscoelastic prior to insertion of the IOL.

There are two main types of delivery systems:

- The injector based
- The forceps based.

❖ Injector based systems ensure delivery of the IOL straight to the bag without the risk of picking up contaminants along the way. The lens may come preloaded, or with an injector assembly, which involves placing the IOL in the cartridge in a correct orientation, and then loading the cartridge into the main injector.

❖ In forceps based method, we use special forceps to fold and implant the IOL. The IOL is held by the ‘folder’- folds it along the optic as its arms are brought together. The folded IOL is then transferred to a slimmer forceps called the ‘holder- used for placing the IOL in the bag. This system generally requires a larger incision size.

IOLs made of silicone are very slippery when wet and cannot be held by the forceps. A silicone IOL should not be rinsed prior to implantation if a forceps implantation is planned.

COMPLICATIONS OF CATARACT SURGERY IN DIABETICS[19]

PRE AND INTRAOPERATIVE COMPLICATIONS:

- Greater endothelial cell loss
- High prevalence of conjunctival colonization and supposedly blepharitis.
- Difficulties to dilate the pupil.

POSTOPERATIVE COMPLICATIONS:

- Increased risk of pseudophakic cystoid macular oedema
- Increased risk of postoperative endophthalmitis.
- Increased risk of postoperative posterior capsular opacification.
- Risk of diabetic retinopathy exacerbation or developing diabetic macular oedema.

VISUAL OUTCOME OF CATARACT SURGERY IN DIABETIC PATIENTS:

Patient with mild to moderate retinopathy, and without previous macular oedema, had the same visual outcome after cataract surgery at 6 month as non-diabetic patient. Diabetic patient with macular changes, and thus have worse visual acuity 6 weeks after surgery. Diabetic patients had a slight decrease in retinal sensitivity, which corresponds to macular thickness.

Cataract surgery in a diabetic patient is associated with several difficulties. Diabetic patients present lower endothelial density and endothelium is more susceptible to trauma associated with surgery. A small pupil is common in diabetic patients making surgery very challenging. Diabetic patient have increased risk of developing postoperative pseudophakic cystoid macular oedema, posterior capsule opacification or endophthalmitis. In patients with severe non-proliferative, proliferative diabetic retinopathy, diabetic macular oedema or iris neovascularisation adjunctive therapy such as intravitreal anti-VEGF injection will inhibit exacerbation related to cataract surgery.

PHACOEMULSIFICATION IN DIABETIC PATIENTS(15):

PREOPERATIVE CONSIDERATIONS:

Good control of diabetes is essential prior to planned surgery. Consultation with the diabetologist regarding any modification to the anti-diabetic therapy should be done well in advance. Measurement of glycosylated haemoglobin gives an estimate of the glycemic control over the past three months, and is a better indicator than blood sugar levels in isolation.

CAPSULORRHEXIS:

Larger rhexis (5.5–6.0 mm) is planned, to allow easy visualization of the posterior segment postoperatively.

PHACOEMULSIFICATION:

Phacoemulsification is done using low parameters preferably under low illumination and filter to avoid phototoxic damage to the unhealthy macula. Any of the standard techniques can be used to remove the cataract. Chopping technique can be preferred over nuclear fractis technique to minimize energy transmitted to corneal endothelium.

CORTICAL ASPIRATION:

Thorough cortical wash should be performed after phacoemulsification. Careful polishing of posterior capsule and under surface of the anterior capsular rim also helps to prevent posterior capsular opacity.

IOL IMPLANTATION:

A foldable acrylic or PMMA Intraocular Lens (IOL) with at least a 6.0 mm optics or larger is preferable for diabetic eyes. Silicon IOLs are not a good choice if the patient is likely to undergo an air fluid exchange (due to condensation) or require a vitreous substitute such as silicon oil (due to irreversible silicon oil adhesion to the silicon IOL). In general, foldable IOLs are preferred, as they offer larger optic diameter, suitable for later fundus evaluation, in conjunction with smaller incision that heals quickly and is less liable to cause endophthalmitis.

ALTERNATE PROCEDURES

• In high risk PDR with vitreous haemorrhage and cataracts, a pars plana lensectomy, vitrectomy, endolaser, and an IOL implant should be considered.

• In neovascular glaucoma with high IOP and cataract, pan retinal photocoagulation and cryo-ablation is recommended prior to cataract surgery. Also, glaucoma shunt procedure at the time of the cataract surgery should be considered. Recently, anti-vascular endothelial growth factor (anti-VEGF) drugs like bevacizumab have been used intracamerally in neovascular glaucoma before pan retinal photocoagulation and filtering surgery with success.

• If pupil dilation yields inadequate visualization, converting to an extraction technique should be considered. Conversion, may be considered particularly in cases of dense nuclear sclerosis and pseudo exfoliation in which there is an increased risk of capsular disruption.

All factors considered, phacoemulsification with a foldable acrylic IOL remains the procedure of choice as it provides a small wound, a large IOL and spares the superior conjunctiva for filtering procedures later, if required

Phacoemulsification as the ultrasonic energy produce a mechanical effects that cause an inflammatory reaction which release phospholipids and prostaglandins and other inflammatory mediators which affects the retina to cause macular oedema which is the most common cause of visual impairment after phacoemulsification. The increase of RNFL thickness can also be increased after uncomplicated cataract surgery. The high resolution SD-OCT permits the measurement of the retinal nerve layer thickness[10].

OPTICAL COHERENCE TOMOGRAPHY

It is a non-invasive, noncontact optical technique that allows imaging with high resolution and measurement of the retinal nerve fibre layer. OCT has been used mainly in detection of glaucoma and macular diseases. It has become the standard tool for imaging in macular disease, diabetic retinopathy, glaucoma diagnosis, because thinning of the nerve marks the onset and progression of the disease. OCT system have a resolution power of 20-50μm.

PRINCIPLE:

MICHELSON INTERFEROMETRY or low-coherence interferometry is used in OCT.

A ray of light is divided into a sample beam and a reference beam. The sample beam falls on the retina and backscattered and interferes with the reference beam to form interference patterns which are used to construct axial A-scans. Multiple A-scans are constructed to give two dimensional cross images.

TYPES OF OCT:

TIME DOMAIN OCT:

It takes 400 A scans per second and uses 820 nm wavelengths light.

SPECTRAL DOMAIN OCT:

- It uses an array of detectors to acquire all A scans and is faster than time domain OCT.
- Reference mirror –stationary.
- Interference spectrum data is detected by a spectrometer and Fourier transformed to generate axial measurements.
- Spectral domain OCT has a much faster scan speed (at least 20,000 A-scans per second) than time-domain OCT (up to 400 A-scans per second for the stratus OCT, Carl Zeiss Meditec

SPECTRALIS OCT:

It combines spectral domain OCT and confocal scanning laser ophthalmoscopy.

It facilitates co-localization of the fundus scan with cross sectional OCT images and opened up previously unknown diagnostic possibilities.

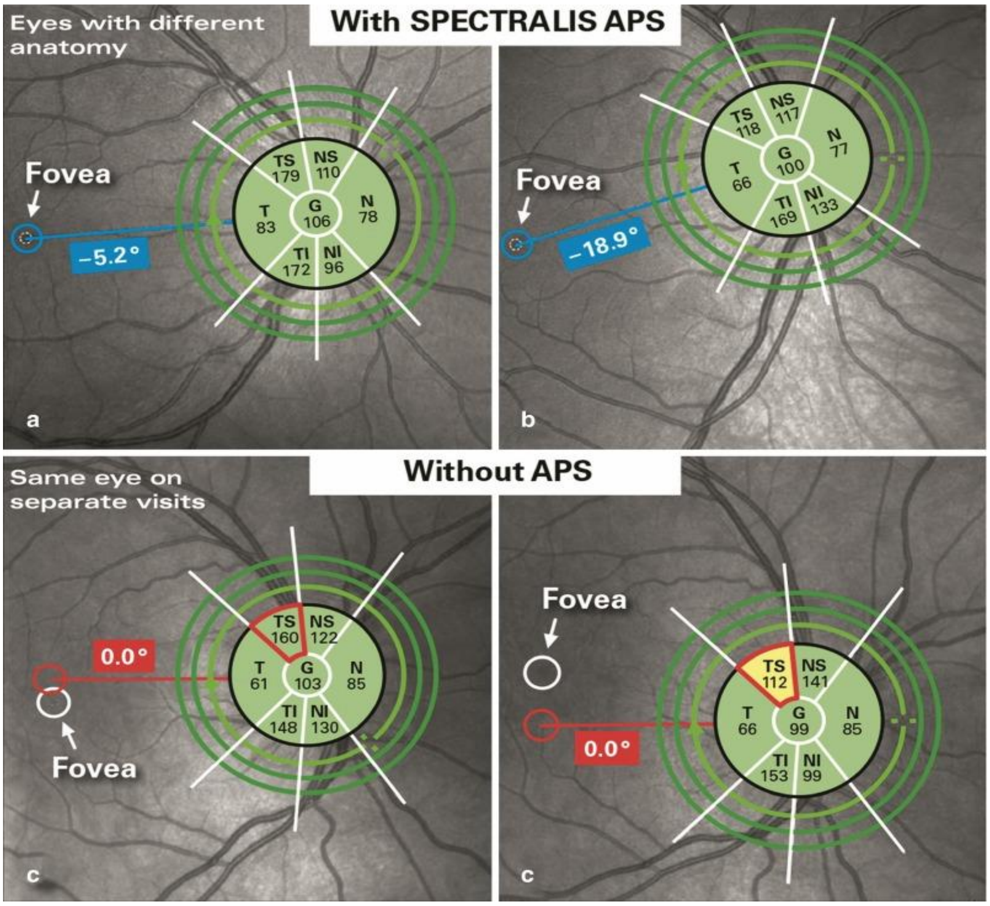
SWEPT-SOURCE OCT:

It uses a broadband super luminescent diode light source of 1050 nm.

In spectralis OCT, thickness maps of retinal nerve fibre layer (RNFL) are derived from a combination of circle and radial OCT scans on the optic disc. Sectorial and global RNFL thickness measurements require a reliable point-to-point comparison to assess progression and to accurately compare with reference data. It is necessary to remove the influence of head tilt and eye rotation for each individual scan. Moreover, it has to be taken into account that the anatomy can significantly vary among individuals. The Anatomic Positioning System (APS) creates an anatomic map of each patient's eye using two anatomic landmarks: the centre of the fovea and the centre of Bruch's membrane opening. All scans are aligned along this fovea-to-disc axis, and the sectors are defined relative to this axis As a result, sectorial analysis is less affected by anatomical diversity. This improves the classification based on the reference database and increases diagnostic precision.

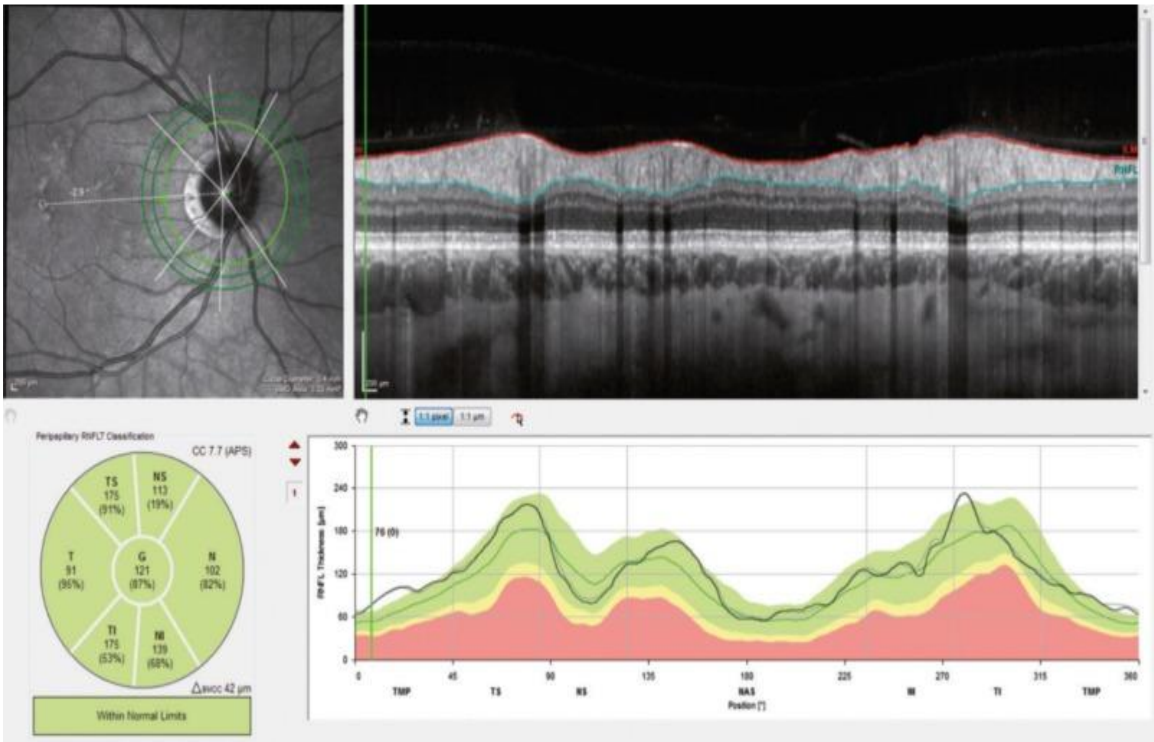
APS can reduce the influence of head tilt and eye rotation on RNFL analysis. Without APS, differences in patient alignment may impede the sectorial analysis of RNFL thickness and thereby impact the assessment of progression. In circle scans, the segmentation of RNFL is displayed.

THE SPECTRALIS HRA+OCT COMBINES CONFOCAL (CSLO) IMAGING WITH OCT



The Anatomic Positioning System (APS) ensures that the circle scans of the ONH scan pattern are aligned along the fovea-to-disc axis for each patient individually (upper row). Without APS, the influence of head tilt and eye rotation can alter the sectorial analysis of RNFL thickness and assessment of progression (c, lower row). The white lines through the ONH indicate the six sectors according to the Garway-Heath regions for classification of RNFL thickness

The RNFL of healthy eyes is visualized on OCT images as a highly reflective layer that becomes increasingly thick as it approaches the optic disc. The thickness of the peri papillary nerve fibre layer can be determined from three peri papillary circular scans —which are defined by the scan protocol ONH-RC. The RNFL of each circle is automatically segmented and the thickness values are compared with a reference database. The results are analysed within predefined sectors (called Garway-Heath sectors) as well as globally.



Nerve fibre layer thickness analysis: Three peri papillary circular sans are placed at the optic nerve head with a fixed starting point relative to the macula position (top left inset) and in each circle scan the RNFL and ILM are segmented (top right inset). Standardized measurements include thickness in predefined segments (bottom left) and comparison of the thickness with a normative database (bottom right inset). The black line indicates the measurement of the individual patient in comparison with the average thickness for this age and population (green line) and in comparison with margins of normative data base (green—normal, yellow—borderline and red—out of normal range)

OPTIC DISC CUBE SCAN:

This is used to image the optic disc and the RNFL over the 6×6mm2 peri papillary region using 200×200 pixels and the RNFL thickness map is composed of 50×50 super pixels. RNFL measurements below the lower 95% normal distribution range will be highlighted in the RNFL thickness deviation map and colour -based on the probability of normality.

ANALYSIS OF CIRCUMPAPPILARY RNFL THICKNESS:

The software automatically identifies the centre of the optic disc by finding a dark spot near the centre of the scan that has a shape and size consistent with a range of optic discs. A calculation circle 3.46mm in diameter is then positioned around the optic disc. By minimizing the variability relating to scan circle misalignment in this way, circum papillary RNFL thickness measured.

ANALYSIS OF RETINAL NERVE FIBRE LAYER PROGRESSION:

Event analysis is performed on the RNFL thickness and change maps and the RNFL thickness profiles. The two earliest measurements are taken as baseline. Progression will be indicated as ‘possible loss’ when the changes between the follow-up and the two baseline measurements exceed the test–retest variability, and ‘likely loss’ when the same region of changes is confirmed by an additional scan. At least 20 adjacent super-pixels for the RNFL thickness and change maps and 14 adjacent A-scans (or 20 degrees) for the RNFL thickness profiles are required to show significant changes in order to report ‘possible loss’ or ‘likely loss .Linear regression analyses between average, inferior and superior RNFL thicknesses and age are performed when at least four serial measurements are available wavelength. It has a longer wavelength and a better penetration and therefore identifies structures deep to the retinal pigment epithelium.

PART-II

METHODOLOGY

TITLE OF THE STUDY:

"A CLINICAL STUDY ON RETINAL NERVE FIBRE LAYER THICKNESS FOLLOWING PHACOEMULSIFICATION CATARACT SURGERY IN DIABETIC POPULATION"

AIMS AND OBJECTIVES:

- To analyse the alterations in retinal nerve fibre layer as measured on OCT following phacoemulsification cataract surgery in diabetic patient.
- To assess the impact of duration of diabetes and oral hypoglycemic drugs on retinal nerve fibre layer.

STUDY DESIGN:

- Prospective study.

STUDY POPULATION:

- 86 eyes

STUDY PERIOD:

- January 2021-June 2021

MATERIALS AND METHODS:

- Cataract patients with diabetes attending RIOGOH OPD between January 2021 - June 2021 will be selected randomly, abiding with inclusion and exclusion criteria
- After getting consent from the patient, detailed history and presenting illness will be taken.
- All patients under this study will be subjected to measurement of visual acuity (best corrected visual acuity), intraocular pressure (Goldmann applanation tonometry) and spectral domain OCT-RNFL
- Anterior segment examination and grading of cataract using slit lamp, Fundus examination using slit lamp bio microscopy with 90D and indirect ophthalmoscopy with 20D will be done.
- After preoperative evaluation, patient will be planned for phacoemulsification cataract surgery.
- All patients under study will be reviewed at an interval of 1 week and 1 month postoperatively and subjected to measurement of visual acuity(best corrected visual acuity),intraocular pressure, spectral domain OCT-RNFL

INCLUSION CRITERIA:

- Age 40years - 60years
- Patient with Type 2 diabetes mellitus
- Immature cataract

EXCLUSION CRITERIA:

- Optic nerve head pathology
- Diabetic retinopathy
- Uveitis, glaucoma
- Family history of glaucoma
- History of previous ocular surgeries
- Media opacity hindering OCT measurement(corneal opacity, vitreous haemorrhage, dense nuclear sclerosis, mature cataract)
- Postoperative complication
- Patient not willing for follow up.

STUDY PARAMETERS:

- Visual acuity assessment
- Intraocular pressure (Goldmann applanation tonometry)
- SD-OCT RNFL
- Fasting and postprandial blood sugar
- Slit lamp bio microscopy of anterior segment
- Fundus evaluation with indirect ophthalmoscopy
- Slit lamp examination with 90D lens

ANALYSIS OF DATA

Statistical analysis was performed in R-programming, SPSS 20.0 version and MS-Excel. Frequency and percentage were used to indicate categorical variables and mean & standard deviation were used to indicate continuous variables. Repeated measures ANOVA test was used to compare the inter variations of intraocular pressure and RNFL thickness of patients before and after the surgery. Pearson correlation analysis is used to find the linear relationship between duration of diabetes mellitus and RNFL thickness. Unpaired t test was used to find the association between visual acuity and RNFL thickness. Statistical significance was considered 5 percent level ($P<0.05$).

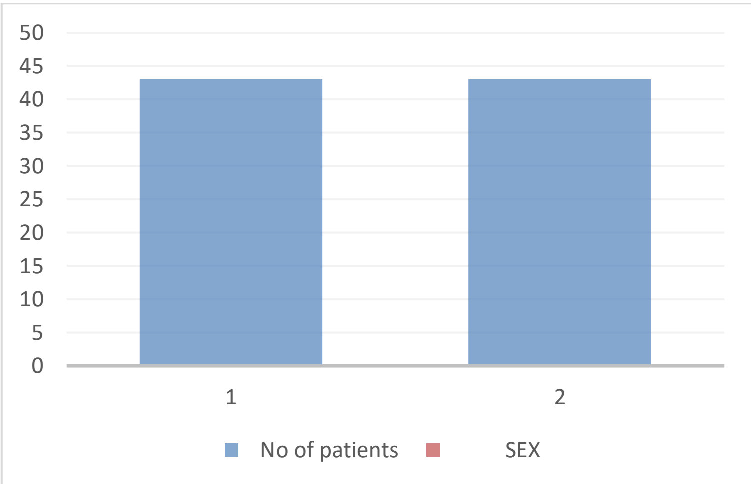
4.2 Demographic information of patients

AGE DISTRIBUTION AND DURATION OF DIABETES

Age (Mean±SD)	49.67±5.74
Duration of DM (Mean±SD)	8.45±1.10

SEX DISTRIBUTION OF THE PATIENTS

No of patients	SEX	Percentage (%)
43	Male	50.0
43	Female	50.0
86	Total	100.0



LATERALITY

Left Eye	54	62.8%
Right Eye	32	37.2%
Total	86	100.0%

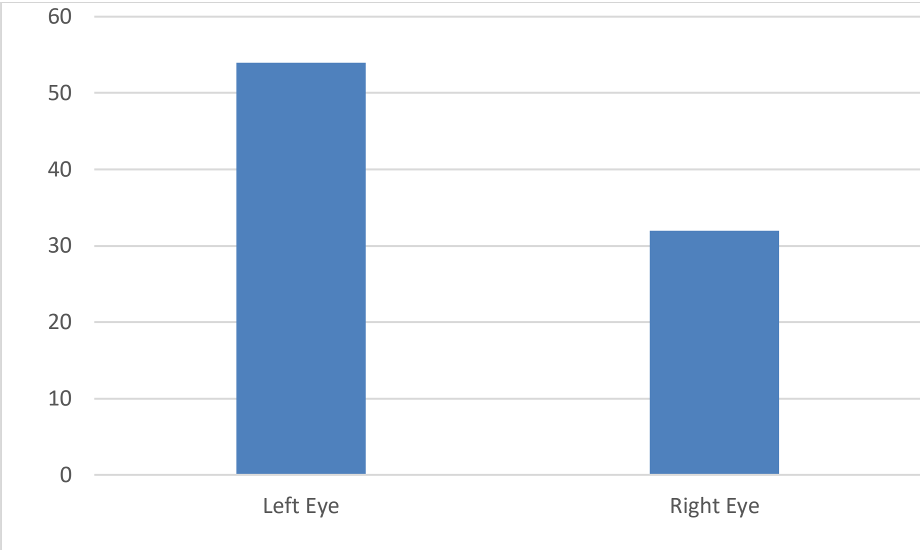


Table 4.2 shows the demographic information of patients. In the study, equal number of patients participated from both genders. The mean age of the patients was 50 years old and the mean duration of diabetes mellitus was 8.45(±1.10) years. Phacoemulsification was done in the left eye of 54 (62.8%) patients and in the right eye of 32 (37.2%) patients.

BEST CORRECTED VISUAL ACUITY (BCVA)

Preoperative	NO .of patients	Percentage (%)
6/18	21	24.4
6/24	21	24.4
6/36	25	29.1
6/60	19	22.1

Post-Operative (1 Week)	NO .of patients	Percentage (%)
6/6	42	48.8
6/9	44	51.2

Post-Operative (1 Month)	NO .of patients	Percentage (%)
6/6	59	68.6
6/9	27	31.4

Twenty-five (29.1%) patients had 6/36 BCVA followed by, respectively 21 patients (24.4) patients had 6/18 and 6/24 BCVA and 19 patients had 6/60 BCVA in preoperative. Forty-four (51.2%) patients had 6/9 BCVA and forty-two (48.8%) patients had 6/6 BCVA one week after surgery. Fifty-nine (68.6%) patients had 6/6 BCVA and twenty-seven (31.4%) patients had 6/9 BCVA one month after the surgery.

4.4 Descriptive Statistics for Intraocular Pressure (IOP) and RNFL thickness

INTRAOCULAR PRESSURE

INTRAOCULAR PRESSURE(mm Hg)	Min.	Max.	Mean	Std. Dev.
Preoperative	16	20	18.28	1.411
Post-Operative 1 week	16	18	17.00	1.006
Post-Operative 1 month	16	18	16.85	.901

SUPERIOR RNFL THICKNESS (μm)

	Min.	Max.	Mean	Std. Dev.
Preoperative	120	124	122.09	1.468
Post-Operative 1 week	126	134	129.53	2.279
Post-Operative 1 month	126	142	135.73	4.957

INFERIOR RNFL THICKNESS (μm)

	Min.	Max.	Mean	Std. Dev.
Preoperative (μm)	110	114	112.31	1.340
Post-Operative 1 week (μm)	116	124	120.48	2.529
Post-Operative 1 month (μm)	117	132	127.21	4.457

NASAL RNFL THICKNESS (μm)

	Min.	Max.	Mean	Std. Dev.
Preoperative	70	74	72.09	1.428
Post-Operative 1 week	76	83	79.79	2.087
Post-Operative 1 month	76	91	86.06	3.273

TEMPORAL RNFL THICKNESS (μm)

	Min.	Max.	Mean	Std. Dev.
Preoperative	50	56	52.70	1.885
Post-Operative 1 week	56	65	60.09	2.428
Post-Operative 1 month	56	73	65.97	4.874

TOTAL RNFL THICKNESS (µm)

	Min.	Max.	Mean	Std. Dev.
Preoperative	80	86	82.76	2.040
Post-Operative 1 week (µm)	87	95	90.69	2.595
Post-Operative 1 month (µm)	88	102	96.93	3.260

Descriptive statistics of Intraocular Pressure (IOP) and RNFL. The mean IOP was reduced after the surgery: The mean Preoperative IOP was 18.28 (±1.41) mm Hg and the post-operative IOP was 16.83 (±0.90) mm Hg. The mean thickness of superior, inferior, nasal, temporal and total RNFL were increased after the surgery: The mean post-operative superior, inferior, nasal, temporal and total RNFL were 135.73 (±4.96) µm, 127.21 (±4.46) µm, 86.06 (±3.27) µm, 65.97 (±4.87) µm and 96.93 (±3.26) µm respectively whereas the mean preoperative superior, inferior, nasal, temporal and total RNFL were 122.09 (±1.47) µm, 112.31 (±1.34) µm, 72.09 (±1.43) µm, 52.70 (±1.88) µm and 82.76 (±2.04) µm respectively.

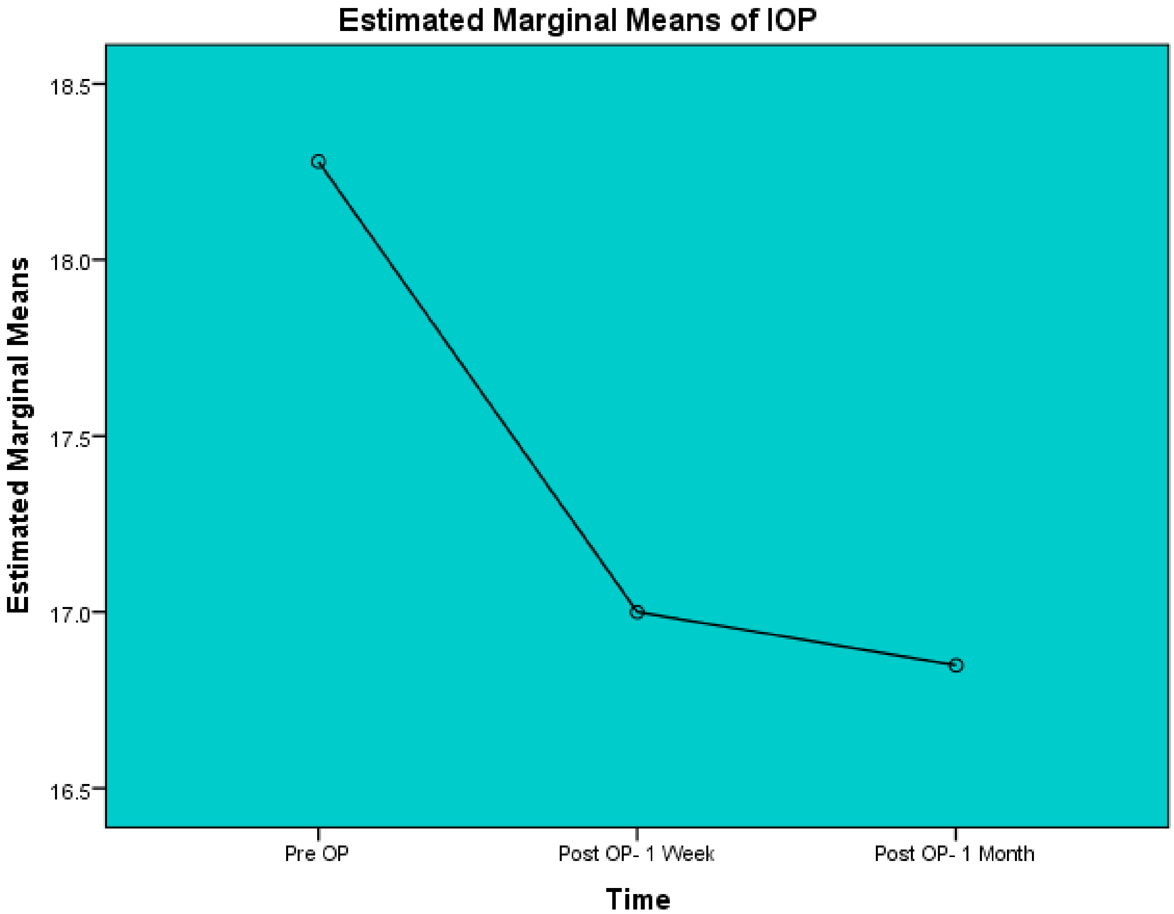
4.5 Comparing Intraocular Pressure (IOP) and RNFL Thickness during preoperative and post-operative period.

4.5.1 Comparing the mean scores of Intraocular Pressure (IOP) during preoperative and post-operative period

Label	Intraocular Pressure (IOP)	Mean±SD (mm Hg)	Sphericity	P-value	Pairwise Comparison
1	Preoperative	18.28±1.41	0.669	0.001	1 Vs.2; P=0.001
2	Post-Operative 1 Week	17.00±1.01			1 Vs. 3: P=0.001
3	Post-Operative 1 Month	16.85±0.90			2 Vs. 3: P=1.000

Table 4.5.1 shows repeated measures ANOVA outcome of intraocular pressure (IOP) comparison.

Figure 1: Profile plot for IOP

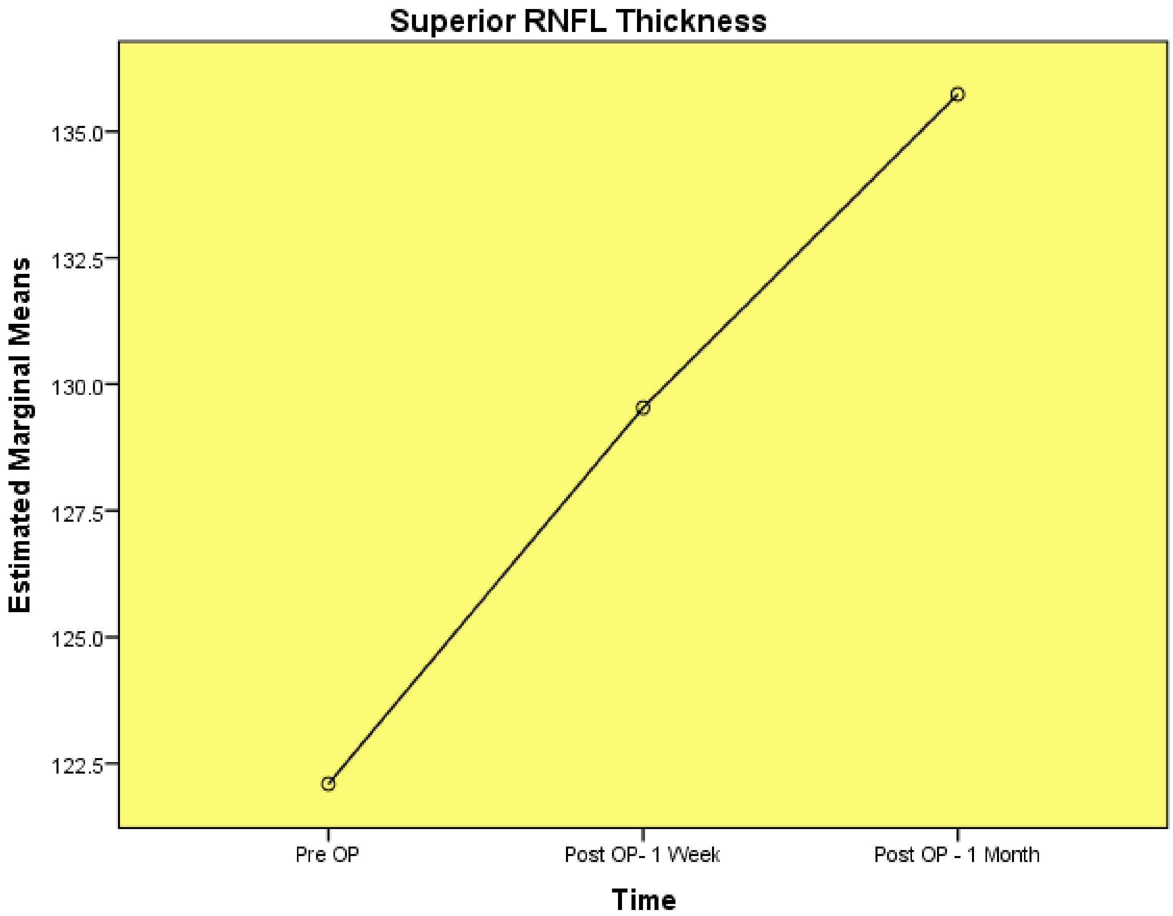


4.5.2 Comparing the mean scores of Superior RNFL Thickness during preoperative and post-operative period

Label	Superior RNFL Thickness	Mean±SD (μm)	Sphericity	GG P-value	Pairwise Comparison
1	Preoperative	122.09±1.47	0.001	0.001	1 Vs.2; P=0.001
2	Post-Operative 1 Week	129.53±2.28			1 Vs. 3: P=0.001
3	Post-Operative 1 Month	135.73±4.957			2 Vs. 3: P=0.001

Table 4.5.2 shows repeated measures ANOVA outcome of superior RNFL thickness comparison.

Figure 2: Profile plot for Superior RNFL Thickness

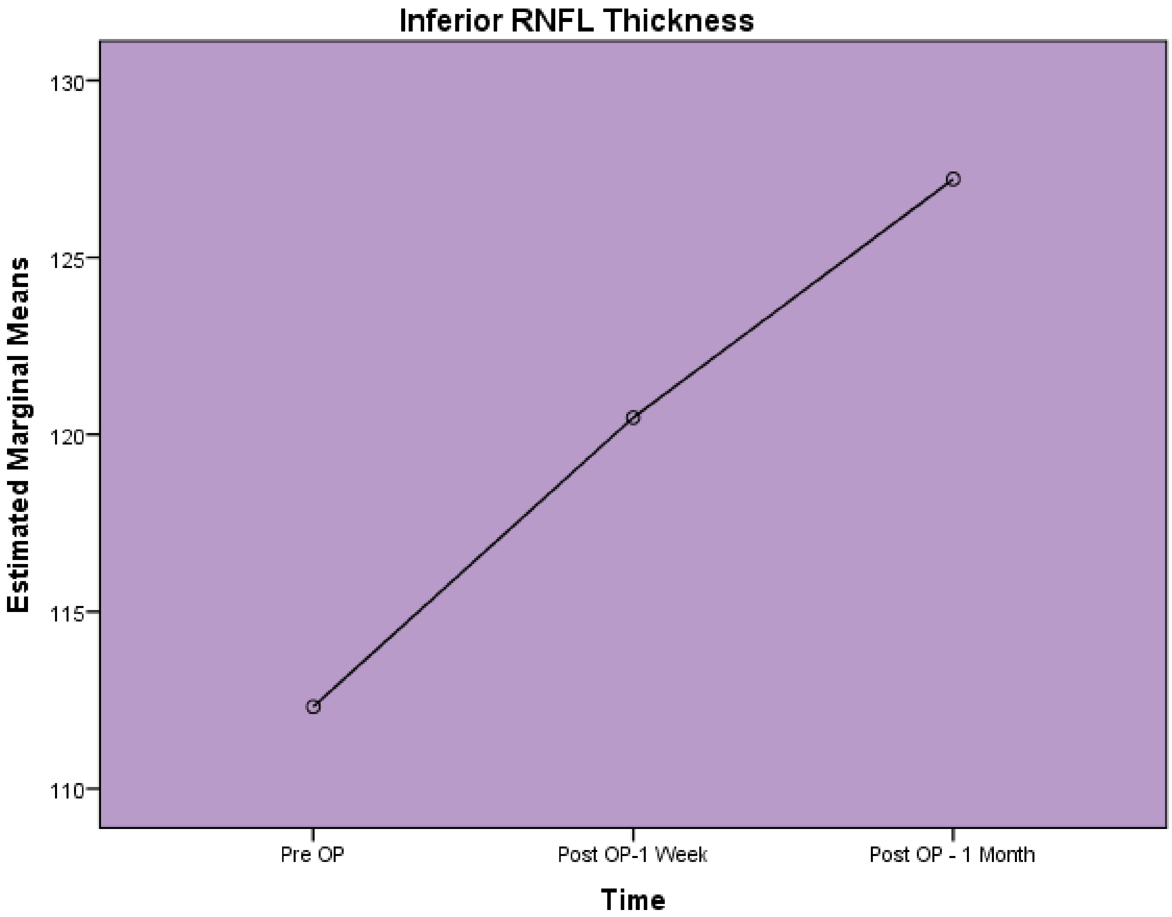


4.5.3 Comparing the mean scores of Inferior RNFL Thickness during preoperative and post-operative period.

Label	Inferior RNFL Thickness	Mean±SD (µm)	Sphericity	GG P-value	Pairwise Comparison
1	Preoperative	112.31±1.34	0.001	0.001	1 Vs.2; P=0.001
2	Post-Operative 1 Week	120.48±2.53			1 Vs. 3: P=0.001
3	Post-Operative 1 Month	127.21±4.46			2 Vs. 3: P=0.001

Table 4.5.3 shows repeated measures ANOVA outcome of inferior RNFL thickness comparison.

Figure 3: Profile plot for Inferior RNFL Thickness

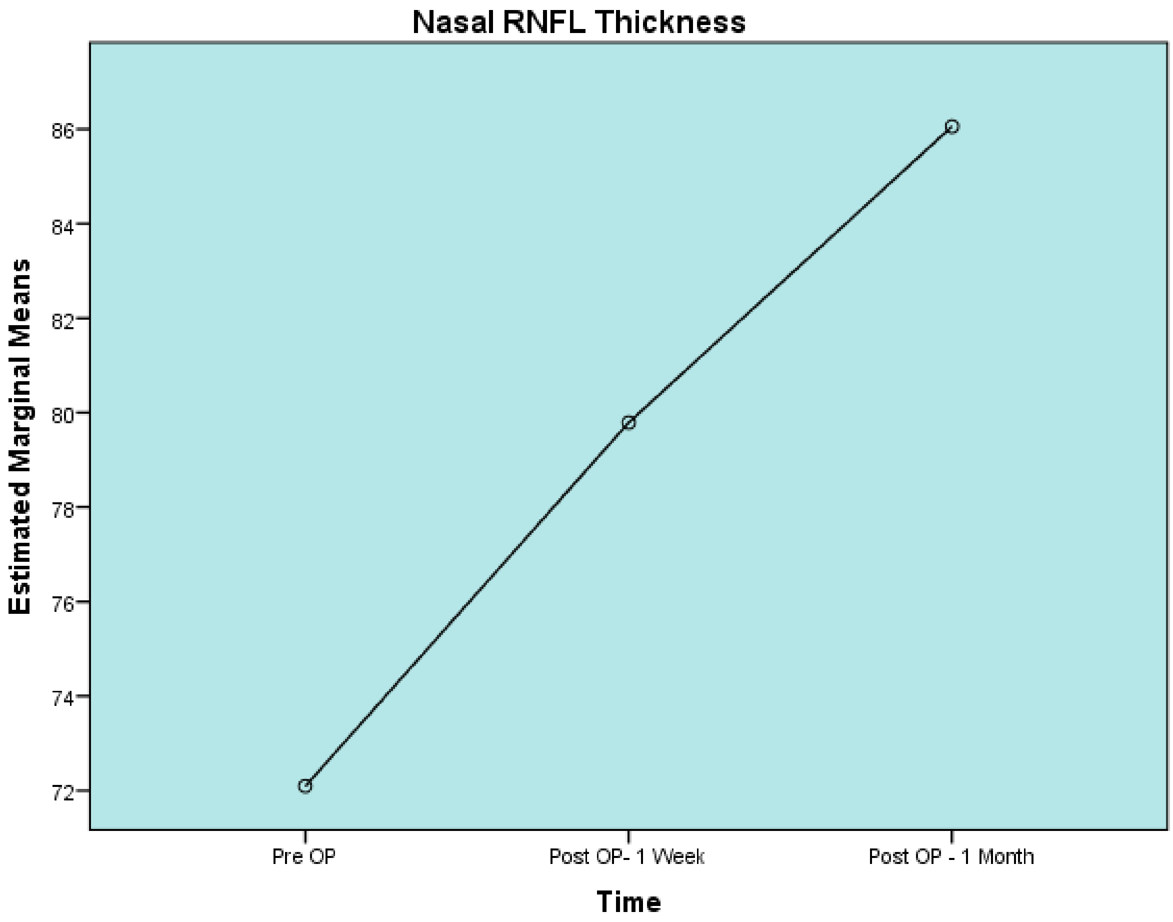


4.5.4 Comparing the mean scores of Nasal RNFL Thickness during preoperative and post-operative period

Label	Nasal RNFL Thickness	Mean±SD (µm)	Sphericity	GG P-value	Pairwise Comparison
1	Preoperative	72.09±1.43	0.001	0.001	1 Vs.2; P=0.001
2	Post-Operative 1 Week	79.79±2.09			1 Vs. 3: P=0.001
3	Post-Operative 1 Month	86.06±3.27			2 Vs. 3: P=0.001

Table 4.5.4 shows repeated measures ANOVA outcome of Nasal RNFL thickness comparison.

Figure 4: Profile plot for Nasal RNFL Thickness

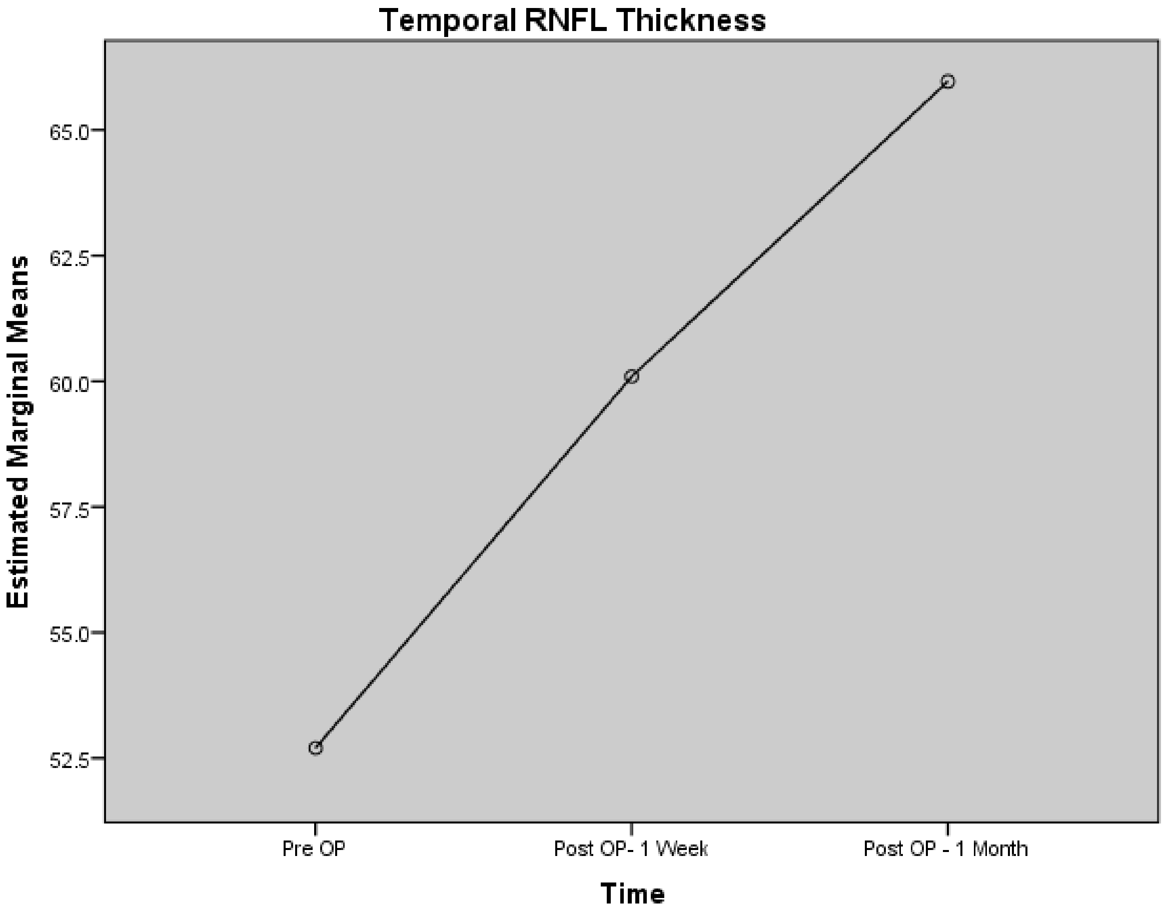


4.5.5 Comparing the mean scores of Temporal RNFL Thickness during preoperative and post-operative period.

Label	Temporal RNFL Thickness	Mean±SD (µm)	Sphericity	GG P-value	Pairwise Comparison
1	Preoperative	52.70±1.88	0.001	0.001	1 Vs.2; P=0.001
2	Post-Operative 1 Week	60.09±2.43			1 Vs. 3: P=0.001
3	Post-Operative 1 Month	65.97±4.87			2 Vs. 3: P=0.001

Table 4.5.5 shows repeated measures ANOVA outcome of temporal RNFL thickness comparison.

Figure 5: Profile plot for Temporal RNFL Thickness

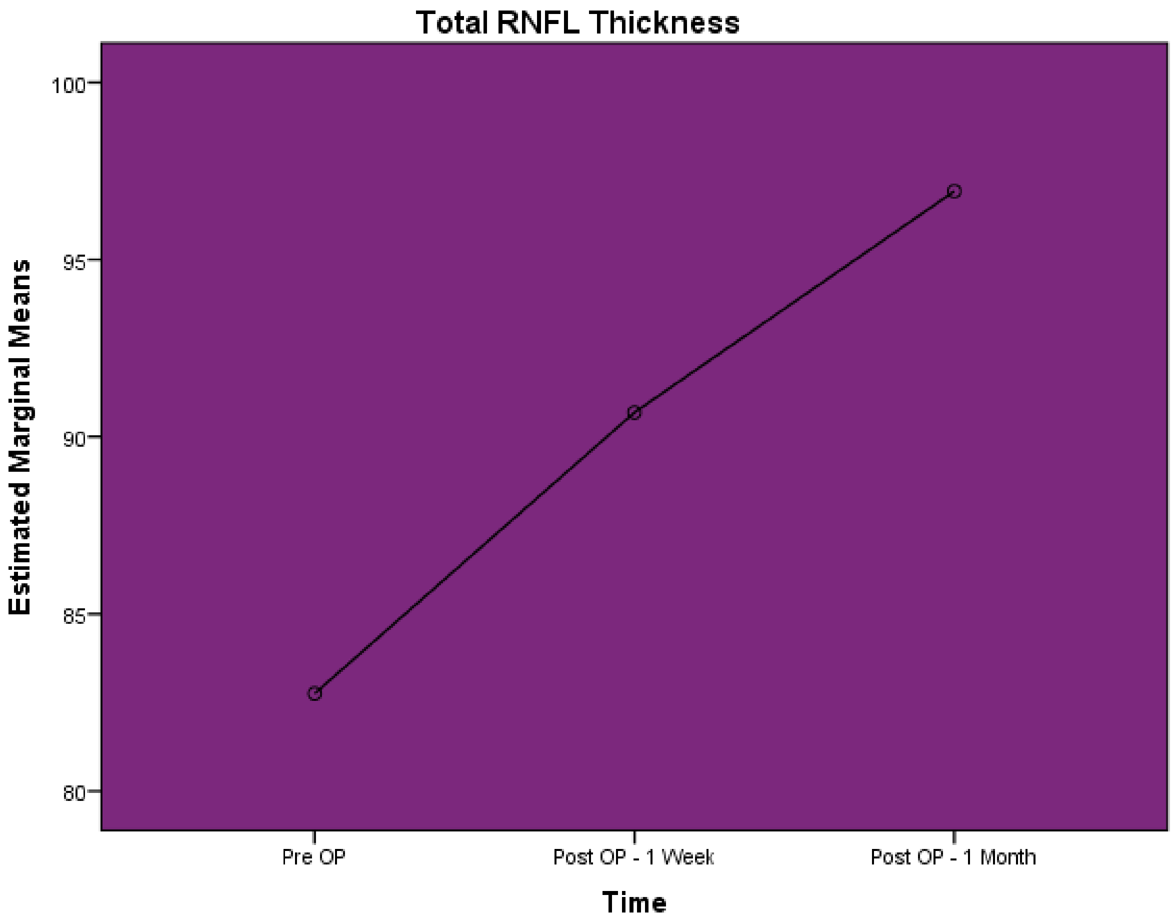


4.5.6 Comparing the mean scores of Total RNFL Thickness during preoperative and post-operative period

Label	Total RNFL Thickness	Mean±SD (μm)	Sphericity	GG P-value	Pairwise Comparison
1	Preoperative	82.76±2.04	0.001	0.001	1 Vs.2; P=0.001
2	Post-Operative 1 Week	90.69±2.59			1 Vs. 3: P=0.001
3	Post-Operative 1 Month	96.93±3.26			2 Vs. 3: P=0.001

Table 4.5.6 shows repeated measures ANOVA outcome of total RNFL thickness comparison.

Figure 6: Profile plot for Total RNFL Thickness



4.6 Correlation between Diabetes Mellitus and RNFL Thickness

Superior RNFL Thickness	r-value	-.104
	P-value	.339
Inferior RNFL Thickness	r-value	-.121
	P-value	.265
Nasal RNFL Thickness	r-value	.107
	P-value	.325
Temporal RNFL Thickness	r-value	-.041
	P-value	.709
Total RNFL Thickness	r-value	-.055
	P-value	.616

Pearson correlation between duration of diabetes mellitus and RNFL thickness is displayed in the Table 4.6.

4.7 Association between Visual acuity and RNFL thickness in post-operative period.

4.7.1 Comparing mean scores of RNFL thickness and visual acuity at one-week post-operative period.

RNFL Post-Operative (One Week)	**Mean±SD**		P-value
Superior RNFL Thickness	129.55±2.44	129.52±2.14	0.960
Inferior RNFL Thickness	120.57±2.49	120.39±2.59	0.737
Nasal RNFL Thickness	79.90±2.14	79.68±2.05	0.623
Temporal RNFL Thickness	60.33±2.39	59.86±2.47	0.373
Total RNFL Thickness	90.98±2.45	90.41±2.72	0.314

Table 4.7.1 shows the unpaired t test outcome for comparing the RNFL thickness scores and visual acuity one-week after the surgery.

4.7.2 Comparing mean scores of RNFL thickness and visual acuity at one-month post-operative period

RNFL Post-Operative (One Month)	Mean±SD		P-Value
Superior RNFL Thickness	135.56±4.73	136.11±5.50	0.635
Inferior RNFL Thickness	127.00±4.54	127.67±4.32	0.523
Nasal RNFL Thickness	85.92±3.46	86.37±2.87	0.553
Temporal RNFL Thickness	66.10±4.69	65.67±5.33	0.703
Total RNFL Thickness	97.29±3.21	96.15±3.30	0.133

Table 4.7.2 shows the unpaired t test outcome for comparing the RNFL thickness and visual acuity one-month after the surgery.

RESULTS AND OBSERVATIONS

- Repeated measures ANOVA outcome of superior RNFL thickness comparison (Table 4.5.2). The statistical significance value ($P<0.01$) clearly reveals that there was a significant variation in the patients superior RNFL thickness before and after the surgery. The mean scores reveal that post-operative superior RNFL thickness were gradually increased compared with preoperative superior RNFL thickness. The Bonferroni pairwise comparison indicates that preoperative superior RNFL thickness was significantly differed with that of one week after the surgery ($P<0.01$) and with that of one month after the surgery ($P<0.01$). Similarly, there was a significant variation in the superior RNFL thickness one week after the surgery and one month after the surgery ($P<0.01$).
- Repeated measures ANOVA outcome of inferior RNFL thickness comparison (Table 4.5.3). The statistical significance value ($P<0.01$) clearly reveals that there was a significant variation in the patients' inferior RNFL thickness before and after the surgery. The mean scores reveal that post-operative inferior RNFL thickness were gradually increased compared with preoperative inferior

RNFL thickness. The Bonferroni pairwise comparison indicates that preoperative inferior RNFL thickness was significantly differed with that of one week after the surgery (P<0.01) and with that of one month after the surgery (P<0.01). Similarly, there was a significant variation in the inferior RNFL thickness one week after the surgery and one month after the surgery (P<0.01).

- ❖ Repeated measures ANOVA outcome of Nasal RNFL thickness comparison (Table 4.5.4). The statistical significance value (P<0.01) clearly reveals that there was a significant variation in the patients' Nasal RNFL thickness before and after the surgery. The mean scores reveal that post-operative Nasal RNFL thickness were gradually increased compared with preoperative Nasal RNFL thickness. The Bonferroni pairwise comparison indicates that preoperative Nasal RNFL thickness was significantly differed with that of one week after the surgery (P<0.01) and with that of one month after the surgery (P<0.01). Similarly, there was a significant variation in the Nasal RNFL thickness one week after the surgery and one month after the surgery (P<0.01).
- ❖ Repeated measures ANOVA outcome of temporal RNFL thickness comparison (Table 4.5.5). The statistical significance value (P<0.01) clearly reveals that there was a significant variation in the

patients' temporal RNFL thickness before and after the surgery. The mean scores reveal that post-operative temporal RNFL thickness were gradually increased compared with preoperative temporal RNFL thickness. The Bonferroni pairwise comparison indicates that preoperative temporal RNFL thickness was significantly differed with that of one week after the surgery ($P<0.01$) and with that of one month after the surgery ($P<0.01$). Similarly, there was a significant variation in the temporal RNFL thickness one week after the surgery and one month after the surgery ($P<0.01$).

- Repeated measures ANOVA outcome of total RNFL thickness comparison (Table 4.5.6). The statistical significance value ($P<0.01$) clearly reveals that there was a significant variation in the patients total RNFL thickness before and after the surgery. The mean scores reveal that post-operative total RNFL thickness were gradually increased compared with preoperative total RNFL thickness. The Bonferroni pairwise comparison indicates that preoperative total RNFL thickness was significantly differed with that of one week after the surgery ($P<0.01$) and with that of one month after the surgery ($P<0.01$). Similarly, there was a significant variation in the total RNFL thickness one week after the surgery and one month after the surgery ($P<0.01$).

- ❖ Pearson correlation between duration of diabetes mellitus and RNFL thickness is displayed in the Table 4.6. The statistical significance values ($P>0.05$) reveal that there was no significant relationship between duration of diabetes mellitus and RNFL thickness.
- ❖ The unpaired t test outcome for comparing the RNFL thickness and visual acuity one-week after the surgery (Table 4.7.1). The superior, inferior, nasal, temporal and total RNFL thickness were not differed among the patients who had 6/6 visual acuity and patients who had 6/9 visual acuity ($P>0.05$) one-week after the surgery. Therefore, there is no association between RNFL thickness and visual acuity.
- ❖ The unpaired t test outcome for comparing the RNFL thickness and visual acuity one-month after the surgery (Table 4.7.2). The superior, inferior, nasal, temporal and total RNFL thickness were not differed among the patients who had 6/6 visual acuity and patients who had 6/9 visual acuity ($P>0.05$) one-month after the surgery. Therefore, there is no association between RNFL thickness and visual acuity one month after the surgery.

DISCUSSION

The analysis of 86 eyes of 86 patients done during the study period of 6 months and the observation from this prospective study are as follows

- ❖ The statistical significance ($p<0.01$) in our study clearly revealed that there was a significant variation in superior, inferior, nasal, temporal and total retinal nerve fibre layer thickness before and after the uncomplicated cataract surgery. The mean scores showed that postoperative retinal nerve fibre layer thickness increased compared to the preoperative retinal nerve fibre layer thickness, which was observed at 1 week and 1 month postoperatively.
- ❖ The increase in RNFL thickness after uncomplicated phacoemulsification surgery correlates well with Abdo et al[(10)] 2020 in prospective study concluded that retina is affected by phacoemulsification as the ultrasonic energy produce mechanical effect which cause inflammatory reaction which release prostaglandins and phospholipids and other inflammatory mediators, which diffuse through the vitreous and disrupt the blood retinal barrier to cause macular edema which cause visual impairment and also cause significant increase in RNFL thickness in 1st week and 1st month after the surgery.

- ❖ Forty-four (51.2%) patients had 6/9 BCVA and forty-two (48.8%) patients had 6/6 BCVA one week after surgery. Fifty-nine (68.6%) patients had 6/6 BCVA and twenty-seven (31.4%) patients had 6/9 BCVA one month after the surgery. The superior, inferior, nasal, temporal, total retinal nerve fibre layer thickness showed no significant association with visual acuity.
- ❖ Pearson correlation between duration of diabetes mellitus and RNFL showed ($P>0.05$) that there was no significant relationship between duration of diabetes mellitus and RNFL thickness.

CONCLUSION:

- An increase in retinal nerve fibre layer thickness was noted in all patients after uncomplicated phacoemulsification surgery in diabetic population.
- This increase in retinal nerve fibre layer thickness had no correlation with duration of diabetes.
- This increase in retinal nerve fibre layer thickness had no effect on visual acuity and intraocular pressure.
- Though retinal nerve fibre layer thinning was found to be a predictor for diabetic retinopathy in diabetic population. We didn´t find any retinal nerve fibre layer thinning in diabetic patients in our study.
- The increase in retinal nerve fibre layer thickness noted following phacoemulsification surgery did not have any adverse outcome on visual acuity and intraocular pressure in diabetic population irrespective of the duration of disease. But the effect of long term outcome on visual acuity needs further follow up.

PART-III

PROFORMA

NAME										
HOSPITAL OP NO										
AGE (in years)		SEX								
ADDRESS										
PHONE NO										

CHIEF COMPLAINTS	

DURATION OF DIABETES	
TREATMENT HISTORY FOR DIABETES	
FASTING BLOOD SUGAR	
POST PRANDIAL BLOOD SUGAR	

OCULAR PARAMETERS

RIGHT EYE		LEFT EYE

	BCVA	
	IOP	
	OCT RNFL THICKNESS SUPERIOR INFERIOR NASAL TEMPORAL	

ANTERIOR SEGMENT:

	LIDS	
	CONJUNCTIVA	
	CORNEA	
	ANTERIOR CHAMBER	
	IRIS	
	PUPIL	

	LENS	

FUNDUS:

RIGHT EYE		LEFT EYE
	MEDIA	
	DISC	
	VESSELS	
	MACULA	
	POSTERIOR POLE	
	PERIPHERY	

POST OPERATIVE FOLLOW UP:

	AT 1 WEEK		AT 1 MONTH	
	RE	LE	RE	LE
BCVA				
IOP				

OCT RNFL THICKNESS:

QUADRANTS	AT IWEEK		AT 1 MONTH	
	RE	LE	RE	LE
TOTAL				
SUPERIOR				
INFERIOR				
NASAL				
TEMPORAL				

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KEY TO MASTER CHART

BCVA- Best corrected visual acuity

IOP- Intraocular pressure

NAD-Nothing abnormal detected

RNFL-Retinal nerve fibre layer

POSTOP-Postoperative period

PREOP-Preoperative period

S.NO	NAME	AGE	SEX	DURATION OF DIABETES	EYE	FUNDUS	BCVA (PREOP)	BCVA POST OP(1 WEEK)	BCVA POSTOP(1MONTH)	IOP (PREOP)	IOP POSTOP(1 WEEK)	IOP POSTOP (1MONTH)	SUPERIOR RNFL THICKNESS(PREOP)	SUPERIOR RNFL THICKNESS (1WEEK)	SUPERIOR RNFL THICKNESS (1 MONTH)	INFERIOR RNFL THICKNESS (PRE OP)	INFERIOR RNFL THICKNESS (1 WK)	INFERIOR RNFL THICKNESS(1 MONTH)	NASAL RNFL THICKNESS (PRE OP)	NASAL RNFL THICKNESS (1 WK)	NASAL RNFL THICKNESS (1 MONTH)	TEMPORAL RNFL THICKNESS (PRE OP)	TEMPORAL RNFL THICKNESS(1 WK)	TEMPORAL RNFL THICKNESS(1 MONTH)	TOTAL RNFL THICKNESS(PRE OP)	TOTAL RNFL THUICKNESS(1 WK)	TOTAL RNFL THICKNESS(1 MONTH)
1	Sandhiya	46	Female	7	RE	NAD	6-18	6-9	6-6	16	16	18	123	130	137	112	119	126	73	81	88	55	61	68	82	88	94
2	Raghul	43	Male	9	RE	NAD	6/36	6-9	6-6	20	18	17	121	126	126	110	117	117	71	79	85	53	59	66	80	90	96
3	Vijay	50	Male	10	LE	NAD	6-24	6-6	6-6	19	18	16	123	132	141	114	124	130	70	77	84	51	58	67	85	93	99
4	Yogasree	51	Female	7	LE	NAD	6/60	6-9	6-6	18	16	18	120	128	135	112	118	127	72	79	79	53	60	60	83	91	99
5	Santhosh	55	Male	8	LE	NAD	6/36	6-9	6-9	17	18	16	124	134	142	114	122	129	74	83	90	54	62	69	86	95	100
6	Dharshini	56	Female	10	RE	NAD	6/36	6-9	6-6	20	16	16	122	129	136	111	119	126	71	80	89	50	57	65	81	87	95
7	Raju	57	Male	8	LE	NAD	6/60	6-6	6-6	19	16	18	121	127	127	113	123	132	70	77	85	52	60	69	84	92	99
8	Rajeswari	45	Female	7	RE	NAD	6-24	6-6	6-6	18	18	17	120	128	135	112	121	130	72	81	87	56	65	73	86	94	102
9	Rajesh	48	Male	10	LE	NAD	6/36	6-6	6-6	16	18	16	123	131	139	114	123	131	74	82	88	51	58	58	80	88	88
10	Anbu	50	Male	10	LE	NAD	6/36	6-6	6-6	20	16	18	124	130	138	110	116	125	73	79	86	55	63	70	83	91	96
11	Elakkiya	56	Female	9	RE	NAD	6/36	6-6	6-6	18	18	16	123	130	137	112	119	119	72	81	81	54	61	68	82	90	97
12	Roshini	47	Female	7	LE	NAD	6-18	6-9	6-9	17	16	16	121	126	126	113	122	129	71	79	88	52	59	67	81	89	98
13	Muthu	42	Male	9	RE	NAD	6/36	6-6	6-6	20	16	18	123	132	141	113	123	132	70	76	84	50	56	56	80	87	95
14	Ruban	56	Male	8	LE	NAD	6-24	6-6	6-6	18	18	17	120	128	135	112	121	130	73	80	87	53	60	58	84	93	101
15	Yuvasree	53	Female	10	RE	NAD	6-24	6-6	6-6	16	18	16	124	134	142	114	123	131	74	83	91	51	59	67	85	94	94
16	Vaishnavi	54	Female	9	LE	NAD	6-18	6-9	6-9	20	16	18	122	129	136	110	116	125	74	82	88	54	62	69	82	88	96
17	Vishalini	51	Female	8	RE	NAD	6/36	6-9	6-9	19	18	16	121	127	127	112	119	119	73	79	86	50	57	65	82	88	94
18	Srikrishna	47	Male	7	LE	NAD	6/60	6-6	6-6	18	16	16	120	128	135	113	122	129	72	81	81	52	60	69	80	90	96
19	Ranjani	43	Female	9	LE	NAD	6-18	6-6	6-6	17	16	18	123	131	139	113	123	132	71	79	88	56	65	73	85	93	99
20	Viknesh	57	Male	8	RE	NAD	6/60	6-9	6-9	20	18	17	124	130	138	112	121	130	70	76	84	51	58	58	83	91	99
21	Tharani	53	Female	10	LE	NAD	6/36	6-9	6-9	19	18	16	123	132	141	114	123	131	73	80	87	55	63	70	86	95	100
22	Venkatesl	52	Male	9	LE	NAD	6-18	6-6	6-6	18	16	18	120	128	135	110	116	125	74	83	91	54	61	68	81	87	95
23	Sneha	54	Female	9	RE	NAD	6/60	6-6	6-6	16	18	16	124	134	142	112	119	119	72	78	87	52	59	67	84	92	99
24	Ajay	56	Male	7	LE	NAD	6/36	6-6	6-6	20	16	16	122	129	136	113	122	129	73	81	88	55	61	68	86	94	102
25	Sujithra	58	Female	9	LE	NAD	6-24	6-6	6-6	18	16	18	121	127	127	114	124	130	71	79	85	53	59	66	80	88	88
26	Sanjay	59	Male	8	RE	NAD	6-18	6-6	6-6	17	18	17	120	128	135	112	118	127	70	77	84	51	58	67	83	91	96
27	Priya	51	Female	10	LE	NAD	6-24	6-9	6-9	20	18	16	123	131	139	114	122	129	72	79	79	53	60	60	82	90	97
28	Vasanth	41	Male	8	RE	NAD	6/60	6-9	6-6	18	16	18	124	130	138	111	119	126	74	83	90	54	62	69	81	89	98
29	Sudha	43	Female	7	LE	NAD	6-18	6-9	6-9	16	18	16	123	130	137	113	123	132	71	80	89	50	57	65	80	87	95
30	Arvind	46	Male	9	RE	NAD	6/60	6-6	6-6	20	16	16	121	126	126	112	121	130	70	77	85	52	60	69	84	93	101
31	Sundari	49	Female	8	LE	NAD	6/36	6-9	6-9	19	16	18	123	132	141	114	123	131	72	81	87	56	65	73	85	94	94
32	Angeline	60	Female	10	RE	NAD	6-24	6-9	6-6	18	18	17	120	128	135	110	116	125	74	82	88	51	58	58	82	88	96
33	Suresh	45	Male	7	LE	NAD	6-24	6-6	6-6	17	18	16	124	134	142	112	119	119	73	79	86	55	63	70	83	91	96
34	Poovizhi	41	Female	8	LE	NAD	6-18	6-9	6-9	20	16	18	122	129	136	113	122	129	72	81	81	54	61	68	82	90	97
35	Prakash	47	Male	9	RE	NAD	6-24	6-9	6-6	19	18	16	121	127	127	113	123	132	71	79	88	52	59	67	81	89	98
36	Rani	51	Female	10	LE	NAD	6/60	6-9	6-9	18	16	16	120	128	135	112	121	130	70	76	84	50	56	56	80	87	95
37	Kumar	52	Male	8	LE	NAD	6/36	6-9	6-6	16	16	18	123	131	139	114	123	131	73	80	87	53	60	58	84	93	101
38	Mahesh	56	Male	9	LE	NAD	6-18	6-9	6-9	20	18	17	124	130	138	110	116	125	74	83	91	51	59	67	85	94	94
39	Bhavani	43	Female	7	RE	NAD	6-24	6-9	6-6	18	18	16	122	129	136	112	119	119	74	82	88	54	62	69	82	88	96
40	Guru	44	Male	7	LE	NAD	6/36	6-9	6-9	17	16	18	121	127	127	113	122	129	73	79	86	50	57	65	86	95	100
41	Selvi	47	Female	10	LE	NAD	6-24	6-9	6-6	20	18	16	120	128	135	110	117	117	72	81	81	52	60	69	82	88	96
42	Raja	53	Male	8	LE	NAD	6-18	6-9	6-9	18	16	16	123	131	139	114	124	130	71	79	88	56	65	73	80	87	95
43	Revathi	56	Female	9	RE	NAD	6-24	6-9	6-6	16	16	18	124	130	138	112	118	127	70	76	84	51	58	58	84	93	101
44	Pradeep	57	Male	10	LE	NAD	6/36	6-6	6-9	20	18	17	123	130	137	114	122	129	73	80	87	55	63	70	80	90	96
45	Ganesh	43	Male	9	LE	NAD	6-24	6-6	6-6	19	18	16	121	126	126	111	119	126	74	83	91	54	61	68	84	93	101
46	Balaji	44	Male	8	RE	NAD	6-18	6-9	6-6	18	16	18	123	132	141	113	123	132	70	76	76	52	59	67	82	88	94
47	Gayathri	45	Female	7	LE	NAD	6-24	6-6	6-6	17	18	16	120	128	135	112	121	130	73	81	88	53	59	66	80	90	96
48	Gyanesh	51	Male	10	LE	NAD	6/36	6-6	6-6	20	16	16	124	134	142	114	123	131	71	79	85	51	58	67	85	93	99
49	Lakshmi	54	Female	8	RE	NAD	6/60	6-9	6-6	19	16	18	122	129	136	110	116	125	70	77	84	53	60	60	83	91	99
50	Sathish	55	Male	9	LE	NAD	6-18	6-9	6-6	18	18	17	121	127	127	112	119	119	72	79	79	54	62	69	86	95	100
51	Merlin	57	Female	10	LE	NAD	6/60	6-6	6-6	16	18	16	120	128	135	113	122	129	74	83	90	50	57	65	81	87	95
52	Sharath	58	Male	7	RE	NAD	6/36	6-6	6-6	20	16	18	123	131	139	113	123	132	71	80	89	52	60	69	84	92	99
53	Shravan	41	Male	8	LE	NAD	6-24	6-9	6-9	18	18	16	124	130	138	112	121	130	70	77	85	56	65	73	86	94	102
54	Lucy	44	Female	9	LE	NAD	6-18	6-6	6-6	17	16	16	123	130	137	114	123	131	72	81	87	51	58	58	80	88	88
55	Arjun	45	Male	10	RE	NAD	6/60	6-6	6-6	20	16	18	121	126	126	110	116	125	74	82	88	55	63	70	83	91	96
56	Arun	47	Male	7	LE	NAD	6-24	6-9	6-9	18	18	17	123	132	141	112	119	119	73	79	86	54	61	68	82	90	97
57	Akash	48	Male	8	LE	NAD	6-18	6-6	6-6	16	18	16	120	128	135	113	122	129	72	81	81	52	59	67	81	89	98
58	poorani	59	Female	7	RE	NAD	6/36	6-9	6-9	20	16	18	124	134	142	112	119	126	71	79	88	50	56	56	80	87	95
59	Praveen	46	Male	9	LE	NAD	6-18	6-6	6-6	19	18	16	122	129	136	110	117	117	70	76	84	53	60	58	84	93	101
60	Vincy	43	Female	7	LE	NAD	6-24	6-9	6-9	18	16	16	121	127	127	114	124	130	73	80	87	51	59	67	85	94	94
61	Thayalan	44	Male	8	RE	NAD	6/60	6-6	6-6	17	16	18	120	128	135	112	118	127	74	83	91	54	62	69	82	88	96
62	Shivani	54	Female	7	LE	NAD	6-18	6-9	6-9	20	18	17	123	131	139	114	122	129	74	82	88	50	57	65	82	88	94
63	Samson	60	Male	8	LE	NAD	6/36	6-6	6-6	19	18	16	124	130	138	111	119	126	73	79	86	52	60	69	80	90	96
64	Mohana	43	Female	9	LE	NAD	6/60	6-6	6-6	18	16	18	123	130	137	113	123	132	72	81	81	56	65	73	85	93	99
65	Manoj	57	Male	10	LE	NAD	6/36	6-9	6-9	16	18	16	121	126	126	112	121	130	71	79	88	51	58	58	83	91	99
66	Monisha	52	Female	8	RE	NAD	6-24	6-6	6-6	20	16	16	123	132	141	114	123	131	70	76	84	55	63	70	86	95	100
67	Rajguru	56	Male	9	LE	NAD	6/36	6-6	6-6	18	16	18	120	128	135	110	116	125	73	80	87	54	61	68	81	87	95
68	Sindhu	47	Female	10	LE	NAD	6-18	6-6	6-6	17	18	17	124	134	142	112	119	119	74	83	91	52	59	67	84	92	99
69	Rathnam	48	Male	7	LE	NAD	6/60	6-6	6-6	20	18	16	122	129	136	113	122	129	71	79	85	51	58	67	86	94	102
70	Hema	42	Female	8	RE	NAD	6-18	6-9	6-9	18	16	18	121	127	127	113	123	132	70	77	84	53	60	60	80	88	88
71	Atharva	43	Male	9	LE	NAD	6/60	6-6	6-6	16	18	16	120	128	135	112	121	130	72	79	79	54	62	69	83	91	96
72	Nithyasre	44	Female	9	LE	NAD	6/36	6-9	6-9	20	16	16	123	131	139	114	123	131	74	83	90	50	57	65	82	90	97
73	Renuka	54	Female	8	RE	NAD	6-18	6-9	6-6	19	16	18	124	130	138	110	116	125	71	80	89	52	60	69	81	89	98
74	Deepak	42	Male	7	LE	NAD	6-18	6-6	6-6	18	18	17	120	128	135	112	119	119	70	77	85	56	65	73	80	87	95
75	Reena	60	Female	9	LE	NAD	6/60	6-6	6-6	17	18	16	124	134	142	113	122	129	72	81	87	51	58	58	84	93	101
76	Surya	49	Male	10	RE	NAD	6-18	6-9	6-9	20	16	18	122	129	136	110	117	117	74	82	88	55	63	70	85	94	94
77	Arya	42	Male	7	RE	NAD	6/60	6-9	6-6	19	18	16	121	127	127	114	124	130	73	79	86	54	61	68	82	88	96
78	Deepika	53	Female	8	LE	NAD	6-24	6-6	6-6	18	16	16	120	128	135	112	118	127	72	81	81	52	59	67	80	90	96
79	Deepan	59	Male	9	LE	NAD	6/36	6-6	6-6	16	16	18	123	131	139	114	122	129	71	79	88	50	56	56	85	93	99
80	Vinitha	43	Female	8	RE	NAD	6/60	6-9	6-9	20	18	17	124	130	138	111	119	126	70	76	84	53	60	58	83	91	99
81	Vinoth	47	Male	7	LE	NAD	6-24	6-9	6-6	18	18	16	123	130	137	113	123	132	73	80	87	51	59	67	86	95	100
82	Shakin	48	Female	10	RE	NAD	6/36	6-6	6-6	17	16	18	121	126	126	112	121	130	74	83	91	54	62	69	81	87	95
83	Narmatha	46	Female	9	RE	NAD	6/60	6-9	6-9	20	18	16	123	132	141	114	123	131	74	82	88	50	57	65	84	92	99
84	Girija	45	Female	7	LE	NAD	6/36	6-6	6-6	18	16	16	120	128	135	110	116	125	73	79	86	52	60	69	86	94	102
85	Sharithra	42	Female	10	LE	NAD	6/36	6-9	6-9	16	16	18	124	134	142	112	119	119	72	81	81	56	65	73	80	88	88
86	Sahithya	51	Female	7	RE	NAD	6-24	6-9	6-6	20	18	17	122	129	136	113	122	129	71	79	88	51	58	58	83	91	96