Dissertation on

"ULTRASOUND BIOMICROSCOPIC ASSESSMENT OF ANGLES AFTER LASER PERIPHERAL IRIDOTOMY IN PRIMARY ANGLE CLOSURE & PRIMARY ANGLE CLOSURE GLAUCOMA PATIENTS"

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2017

CERTIFICATE

This is to certify that this dissertation entitled **"ULTRASOUND BIOMICROSCOPIC ASSESSMENT OF ANGLES AFTER LASER PERIPHERAL IRIDOTOMY IN PRIMARY ANGLE CLOSURE & PRIMARY ANGLE CLOSURE GLAUCOMA PATIENTS"** is a bonafide record of research work done by **Dr. NOORUL HIDAYA,** Post Graduate Resident in Department of Ophthalmology, Madurai Medical College, Madurai.

She has submitted this in partial fulfillment of the regulations laid down by The Tamil Nadu Dr. M.G.R. Medical University, for the award of Master of Surgery Degree Branch III (Ophthalmology), under our guidance and supervision during the academic years 2014-2017.

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I, Dr. NOORUL HIDAYA, hereby solemnly declare that, this dissertation titled **"ULTRASOUND BIOMICROSCOPIC ASSESSMENT OF ANGLES AFTER LASER PERIPHERAL IRIDOTOMY IN PRIMARY ANGLE CLOSURE & PRIMARY ANGLE CLOSURE GLAUCOMA PATIENTS"** was done by me.

I also declare that this bonafide work / a part of this work was not submitted by me / anyone else, for any award, for Degree / Diploma to any other University / Board either in India / abroad. This is submitted to The Tamilnadu Dr. M. G. R. Medical University, Chennai in partial fulfilment of the rules and regulations for the award of Master of Surgery degree Branch -III (Ophthalmology) to be held in April 2017.

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PART I

INTRODUCTION

Glaucoma is the second leading cause of blindness worldwide & is especially common & morbidity causing among women and Asians[1]. Glaucoma afflicts 12 million people in our country . In tamilnadu " The Aravind Comprehensive Eye Survey (ACES) reported a prevalence of 1.7% for POAG, and 0.5% PACG [2]"

History of Glaucoma

Glaucoma has been known since the time of Hippocrates when he used the term 'glaucosis' which referred to dimness of vision in his works. It is derived from the greek word 'glaukos' meaning 'cloudy'. Probably because of the corneal edema associated with it. Yet the term was still used interchangeably with cataract and other age related defective vision throughout the centuries.[3]

It was not until 1832 when Sir William Lawrence gave a complete description of the symptomatology of glaucoma.

William McKenzie MD (1791-1868) first differentiated the acute and chronic glaucomas and also suggested surgery to correct the hardness of the eye [4.] Later with the invention of the ophthalmoscope, Von Graeffe & Donders described the fundus changes associated with glaucoma.

The term glaucoma now includes a group of diseases that differ in their clinical presentation, pathophysiology and treatment. These group of

disorders have a common presentation as chronic progressive optic atrophy characterised by optic disc cupping with corresponding visual field defects and often associated with a raised intraocular pressure as a risk factor.

Primary open angle glaucoma is more common in general population . However angle closure glaucoma tends to be more aggressive & visually debilitating. Inspite of being treated with iridotomy ,medical & surgical management,it continues to produce excessive visual morbidity. Acute angle closure glaucoma which is vision threatening is a potentially preventable condition and hence early identification and treatment of susceptible patients is of utmost importance.

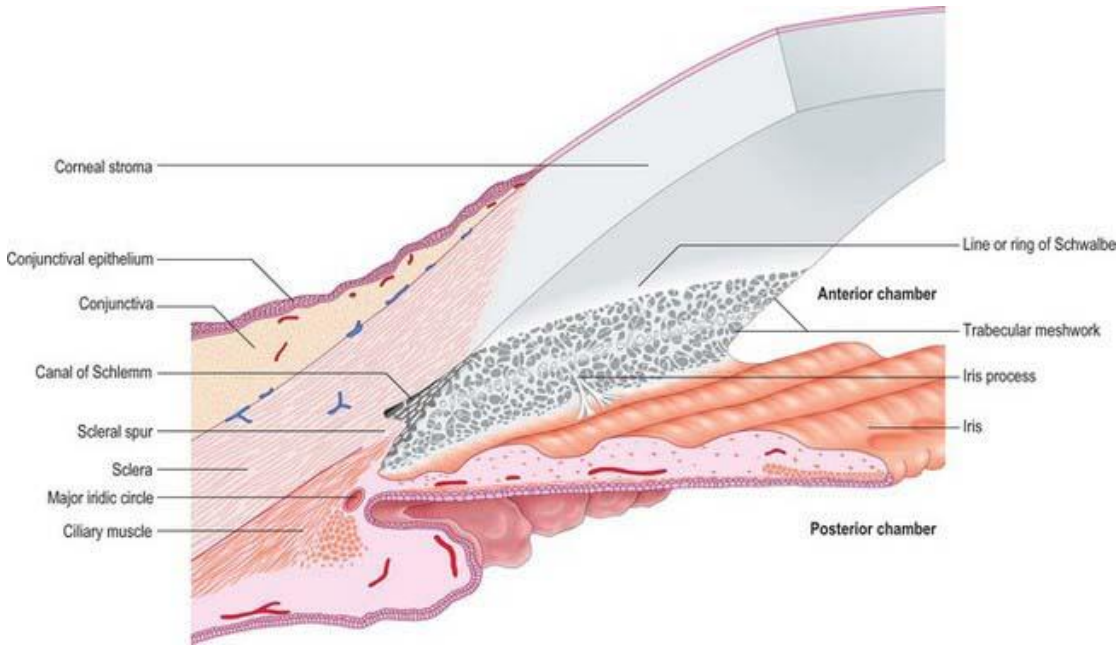
Anatomy of anterior chamber angle

" The pathology of most glaucomas depends on anatomy of anterior chamber angle. The anterior chamber is formed by root of iris,anterior part of ciliary body,sclera spur,the trabecular meshwork and schwalbes line which is the prominent line on descemets membrane of cornea in its periphery[5]."

" The limbus is the transition zone between the cornea and the sclera. On the inner surface of the limbus is an indentation; the scleral sulcus, which has a sharp posterior margin; the scleral spur; and a sloping anterior wall that extends to the peripheral cornea.

A sieve-like structure, the trabecular meshwork, bridges the scleral sulcus and converts it into a tube, called the Schlemm canal. Where the meshwork inserts into the peripheral cornea, a ridge is created, known as the Schwalbe line. The

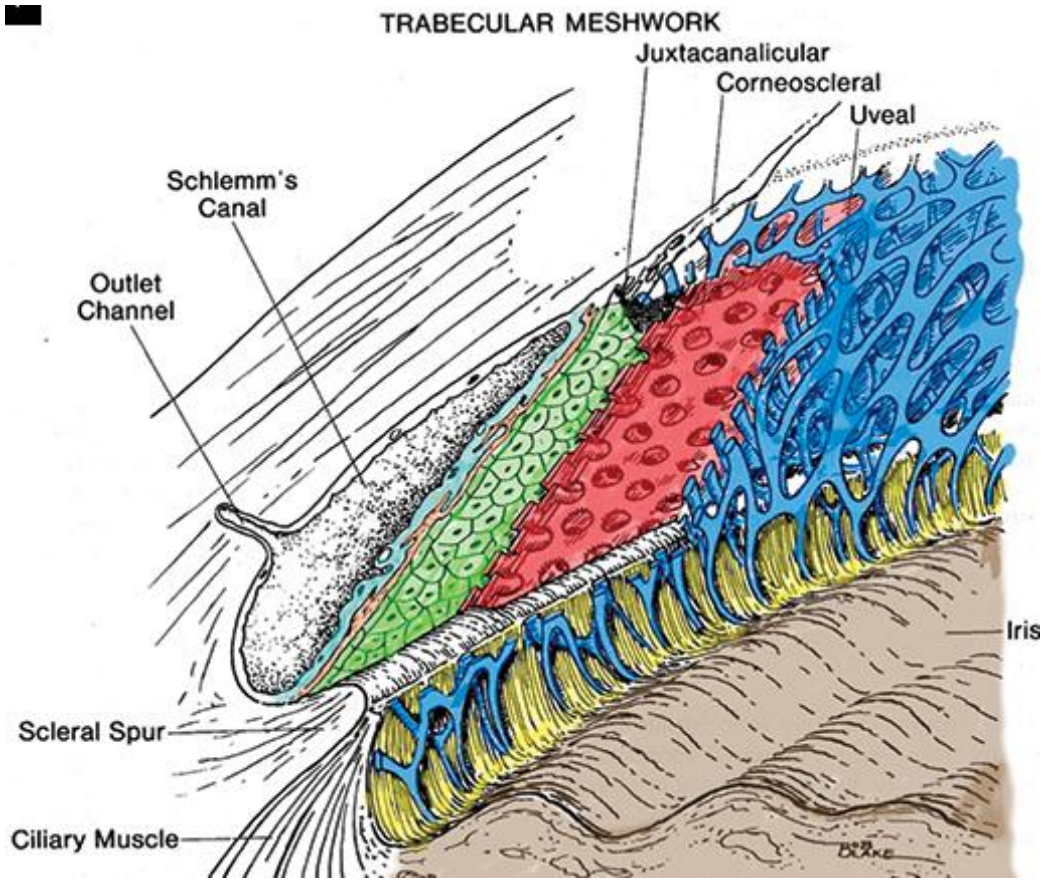
Schlemm canal is connected by intrascleral channels to the episcleral veins. The trabecular meshwork, Schlemm canal, and the intrascleral channels make up the main route of aqueous humor outflow.”



The aqueous outflow system

“Consists of the trabecular meshwork,Schlemms canal,collector channels,aqueous veins & the episcleral veins.

***1. Trabecular meshwork*-**sieve like structure having 3 layers namely the Uveal meshwork,Corneoscleral meshwork & Juxtacanalicular meshwork.



Uveal meshwork- lies innermost and has pores in diameter of 25-75µ.

Corneoscleral meshwork- large ,forms the middle portion and evtends from sclera spur to lateral wall of sclera sulcus. It has openings with size of 5-50µ.

Juxtacanalicular meshwork-it forms the outermost portion from the corneoscleral meshwork to the inner wall of schlemms canal externally.

This is the narrowest portion providing maximum resistance to aqueous flow.

2.Schlemms canal-

Circumferential blood channel that is lined by endothelium and it receives openings of collector channels in its outer wall.

3.Collector channels-

These are 25-35 in number. They leave the schlemms canal to reach the episcleral veins either directly or indirectly after forming an intrascleral plexus.

Drainage of aqueous occurs through two pathways mainly

a)Trabecular (conventional) outflow

It forms the main outflow pathway. There is free flow of aqueous from anterior chamber through trabecular meshwork till it reaches the inner wall of schlemms canal which provides resistance to flow.

Mechanism of outflow through inner wall of schlemms canal

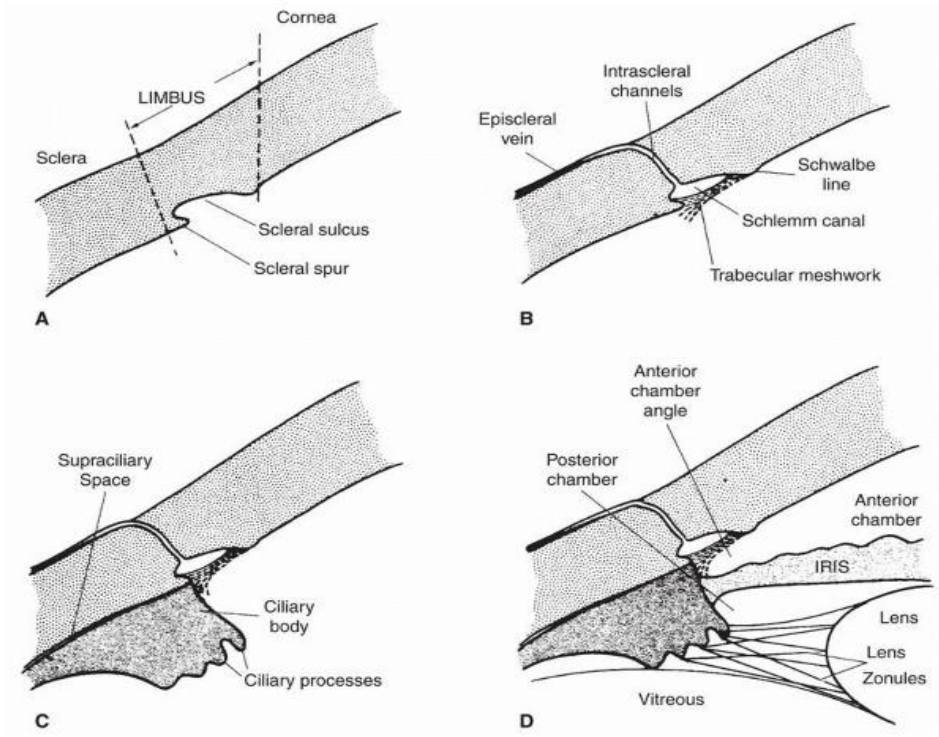
1.passive filter mechanism

2.active pump mechanisms

b) uveoscleral (unconventional outflow)

20-30% of aqueous drains through this route. From the anterior chamber aqueous enters the iris root,ciliary body face and uveal trabecular meshwork

and into suprachoroidal space and finally into veins of ciliary body ,choroid and sclera.”

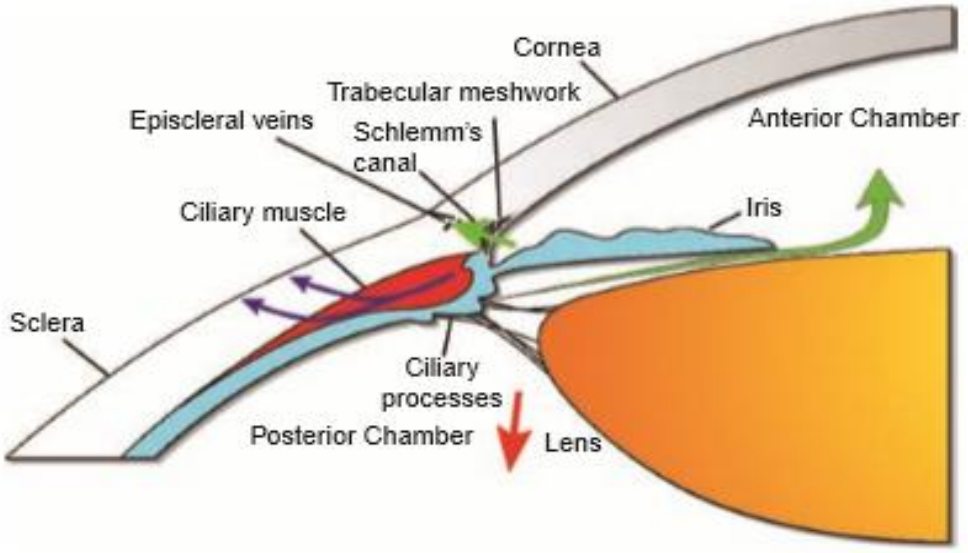


Anatomy of Aqueous humour formation

Aqueous humour circulation was first identified by Seidel in the year 1921 when he performed an experiment on a rabbits eye by connecting its anterior chamber to a reservoir containing blue dye. When the reservoir was lowered,clear fluid entered the reservoir and when it was elevated , the dye entered the anterior chamber and finally entered the episcleral veins. Thus Seidel concluded that aqueous humor must be continuously formed and drained.[6]

Aqueous humour is a clear watery liquid which fills the anterior segment of eye with a volume of 0.25ml in anterior chamber and 0.06ml in posterior chamber.

" Aqueous humour is produced by the ciliary body at a rate of 2-2.5 µl/min and is circulated from the posterior chamber into the anterior chamber through the pupil. Here it is subjected to thermal currents because of difference in temperatures between the cornea & iris. The iris is warmer because of its vascularity. So the aqueous rises near the iris and descends near the cornea. It then leaves the anterior chamber through the angle structures[8]."



Functions of aqueous humour

-Provides nutrition & oxygen to the cells of lens, cornea, iris

-Removes products of metabolism and toxic substances from these structures

-Provides optically clear medium for vision

- Maintains intraocular pressure

-Has free radical scavenging action due to high ascorbate levels.

- Facilitates cellular and humoral responses of eye to inflammation and infection

Factors responsible for maintenance of Intraocular pressure

1.Genetics-

There have studies linking glaucoma with groups of chromosomes like 10q22,5q22 & 14q22.

2. Environment

Physical factors like *exposure to cold* reduces IOP due to decreased episcleral venous pressure.

Reduction in gravity causes raise in IOP upward shift of body fluids.

Tobacco smoking- raised IOP due to vasoconstrictive properties

There are various *drugs* affecting the IOP including anaesthetics & illicit drugs.

Physiological factors affecting IOP

Sex-

In older age women have higher incidence of glaucoma.however there are few studies which show no difference in incidence among the sexes.

Age-

IOP tends to increase with age.

Ethnicity-

Blacks have a greater incidence of chronic open angle glaucoma and primary angle closure disease is found more often in Asians.

Refractive error-

Myopia is a consistent association with open angle glaucoma & hyperopic patients are associated with angle closure disease.

Diurnal & postural variation

The IOP varies throughout the day. The fluctuation has two peaks usually. The morning peak occurs at around 6 am & the next peak around 4-5pm. These

variations may be attributed to the levels of circulating adrenocortical hormones & catecholamines which also have diurnal variations.

Current studies show increase in IOP due to supine position during sleeping at night probably due to raised episcleral venous pressure.

Straining ,valsalva maneuver,electroshock therapy tend to raise IOP.

Movements of eyes & blinking

Blinking can raise IOP by almost 10mm of Hg. And hard eyelid squeezing can even elevate it to 90mm of Hg. The movement of eyes due to contraction of muscles of the eye can also alter the IOP.

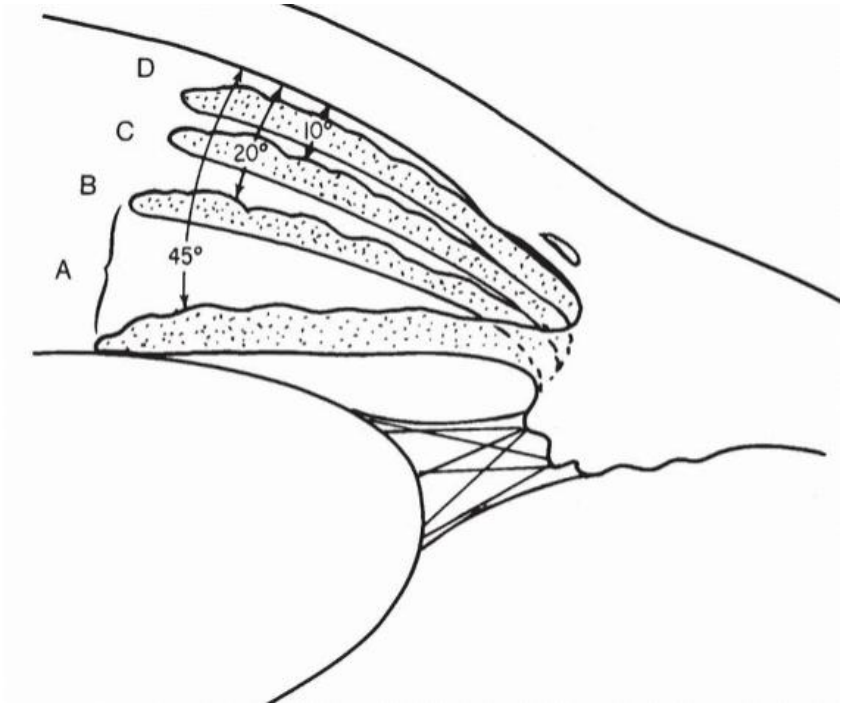
Co- morbid conditions

Systemic hypertension & diabetes are consistently associated with glaucoma. However the reason for the same remains elusive.

Gonioscopic Grading of anterior chamber angle width

There are various systems of grading of anterior chamner angle width. The most widely used is the **Shaffer's system.**

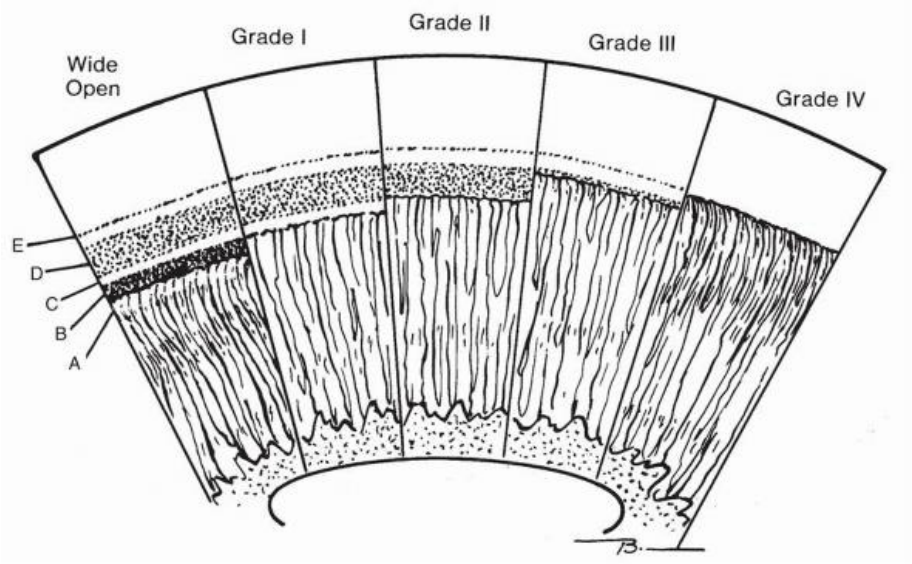
Numerical grade	Angle grade	Angle width	Clinical interpretation
4	Wide open angle Ciliary body seen	35-45	Closure impossible
3	Wide open angle Scleral spur identified	25-35	Closure impossible
2	Narrow angle – moderate Only the trabeculum identified	20	Closure possible
1	Narrow angle – extreme Only Schwalbe's line and top of the trabeculum identified	10	Eventual closure probable
0	Narrow angle – complete or partial closure Iridocorneal contact, apex or corneal wedge not identified	0	Closure present or imminent



Schie's classification

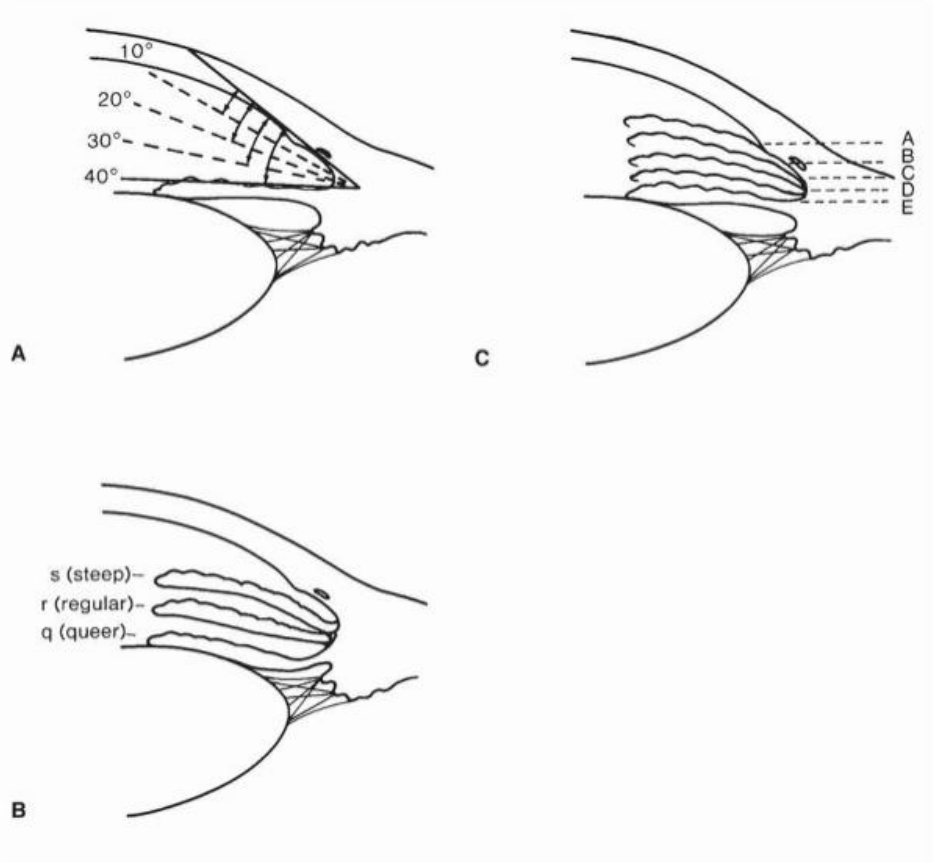
"Based on the extent of visible angle structures

A: Root of the iris. B: Ciliary body band. C: Scleral spur. D: Trabecular meshwork. E: Schwalbe line."



“The Spaeth gonioscopic classification of the anterior chamber angle, based on three variables

A: Angular width of the angle recess. B: Configuration of the peripheral iris. C: Apparent insertion of the iris”



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Primary angle closure disease

“Irido-trabecular contact is the final common pathway of angle closure disease, obstructing aqueous outflow; it can be conceptualized in two complimentary schemes:

1. According to Natural history

a. Primary angle closure suspect

b. Primary angle closure

c. Primary angle-closure glaucoma

2. Anterior segment mechanisms of closure

a. Iris–pupil obstruction (e.g., ‘pupillary block’)

b. Ciliary body anomalies (e.g., ‘plateau iris syndrome’)

c. Lens–pupil block (e.g., ‘phacomorphic block’ (swollen lens or microspherophakia))”

Epidemiology of angle closure:

Ethnicity –

PAC is more common amongst Asians.[9]

According to the Vellore Eye Study PACG has a prevalence of 4.32% .[10]

Age-

There is an increased incidence as age advances especially after 4o yrs

Sex –

Angle closure disease is commoner in females.

Genetics-

Evidence of genetic loci for angle closure comes from a study on nanophthalmos ,hyperopia & angle closure – it links the gene NNO-1 (NANOPHTHALMOS-1) on chromosome 11 to PACD. Also there are group of genes identified.[12]

Anatomical risk factors that predispose to angle closure

- Narrow anterior chamber angle
- Shallow anterior chamber depth
- Short axial length of globe
- Small corneal diameter
- Increased thickness of lens

Classification of angle closure glaucoma

"According to **ISGEO**(International Society of Geographical and Epidemiological Ophthalmology Classification) , Primary angle closure disease is classified as follows"

(1) Primary angle closure suspect - An eye in which appositional contact between the peripheral iris and posterior trabecular meshwork is considered possible ie anatomical narrow angles.

(*2) Primary angle closure (PAC)-* characterised by anatomically narrow angles with features suggestive of iridotrabecular contact such as peripheral anterior synechiae, raised IOP , iris whorling , lens changes such as "glaucomfleken" , or excessive trabecular pigmentation. However without optic nerve head changes.

(3) Primary angle closure glaucoma (PACG) - when PAC is associated with evidence of glaucomatous disc changes then it is called as primary angle closure glaucoma [13].

Screening for Angle closure :

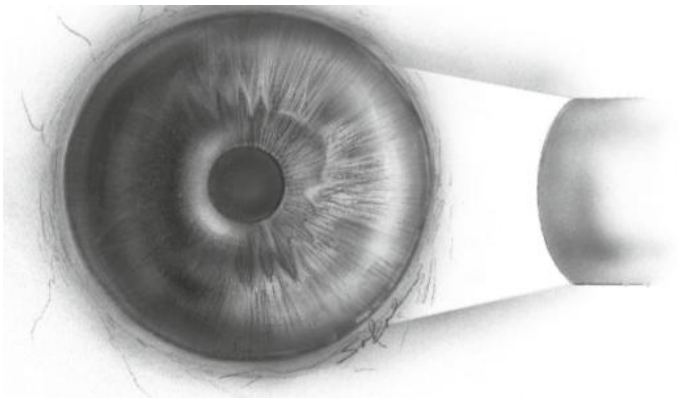
Screening is an important tool in primary angle closure disease since it is a more visually debilitating and aggressive condition than open angle glaucomas. screening is essential for early detection of susceptible patients so that timely management can be done to prevent irreversible visual loss.

Anterior chamber depth examination is done commonly by

-***Torchlight examination*** –

-to find the rough anterior chamber depth

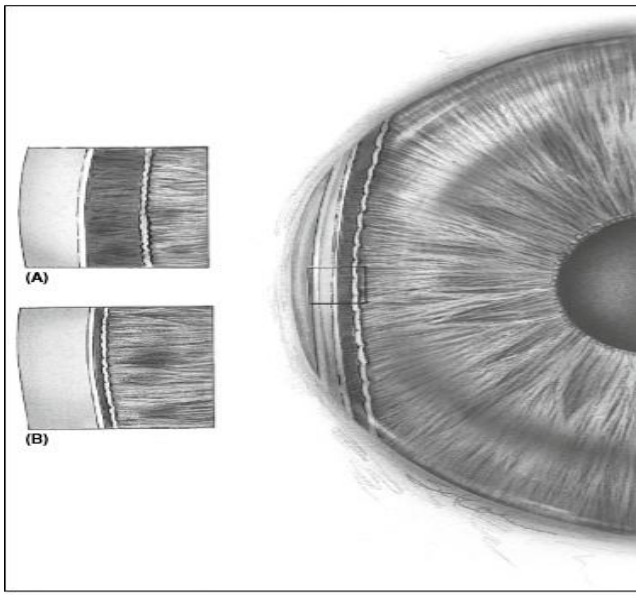
A torch should be shone near to illuminate the anterior chamber. If a shadow is seen on nasal side of iris then it denotes a shallow AC. This is due to the more anteriorly displaced iris & lens.



-Slit lamp examination

by *Van herricks* method of angle assessment

during slit lamp examination,a thin slit beam of light at about 45 degree angulation is focussed just 1mm inside the limbus and the anterior chamber depth is compared with the peripheral corneal thickness.



Usually when the depth is equal to or less than one fourth of the peripheral corneal thickness, gonioscopy is adviced for the patient in routine practice.

- gonioscopy-

Most important tool for assessing the angle.

It has to be done in all glaucoma patients and also the suspects.

It differentiates an open angle from a closed one..

Normally due to total corneal reflection the anterior chamber angle cannot be directly visualised . hence it requires special methods. During gonioscopy this interface is replaced by the lens cornea interface which removes this total internal reflection and allows the viewing of the angle structures by increasing the critical angle.

The structures visualised are the schwalbes line, trabecular meshwork,sclera spur & ciliary body band. The angle is then graded according to various grading systems .

The various lens available include

"Direct Gonioscopes: Koeppes' lens, Swan-Jacob, Hoskin Barkan"

"*Indirect Gonioscopes* : Goldmann lenses, Thorpe and Ritch lens Indentation : Zeiss, Posner, Susmann"

Gonioscopic grading of angle should be done in dark room so that the constriction of the pupil due to light does not falsely open up the angle by pulling the iris away from the angle structures. This also prevents differences in measurement by different persons at different times.

"In order to allow comparison of studies occludable angles have been defined as one in which the posterior, pigmented trabecular meshwork is not visible for more 270 degrees or more, without indentation or manipulation of the gonioscope.[14]"

Some studies such as Vellore Eye study considered angle closure when trabecular meshwork was not seen in 180 degree of angle.[15]

The other methods include

-Anterior Segment OCT

-Ultrasound Biomicroscopy

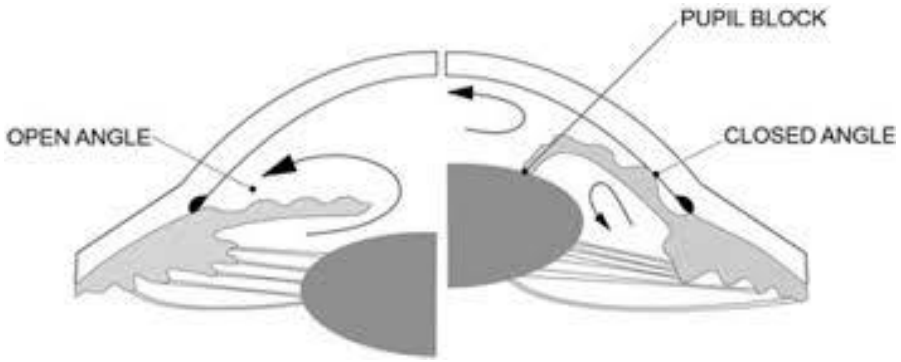
Mechanism of angle closure glaucoma:

Initially there is only an apposition between the iris and the angle structures which can be reversed. Later with continued long duration of angle closure there will be development of synechiae which will occlude the angle irreversibly .

Hence the mechanics by which angle closure occurred has to be identified so that proper planning of management can be done.

a**) Pupillary Block :**

Usually the block of aqueous flow occurs at the pupil. As the aqueous humour increases in volume in the posterior chamber, the pressure builds up.so there is a forward bulge of iris which touches the back of cornea. At this stage the angle is shallow as seen by gonioscopy.



"Pupillary block glaucoma is the most common form of angle closure glaucoma. The initiating event is thought to result from increased resistance to flow of aqueous humor between the pupillary portion of the iris and the anterior lens surface ,which is associated with mid-dilatation of the pupil. The functional block produces increased fluid pressure in the posterior chamber, causing a forward shift of the iris. Anterior movement of the peripheral iris can result in closure of the anterior chamber angle .[16]"

"Four forms of pupillary block glaucoma may be distinguished on the basis of symptoms and clinical findings

Namely acute angle-closure glaucoma, subacute angle-closure glaucoma, chronic angle-closure glaucoma, and combined-mechanism glaucoma.

Acute Angle-Closure Glaucoma

In acute angle-closure glaucoma, the symptoms are sudden and severe, with marked pain, blurred vision, and a red eye. The patient may also have nausea and vomiting.

Subacute Angle-Closure Glaucoma

Subacute angle-closure glaucoma is thought to have the same pupillary block mechanism as the acute form, but symptoms are mild or absent .The condition has also been called intermittent, prodromal, or subclinical. Patients with subacute angle-closure glaucoma may have repeated subacute or subclinical attacks before finally having an acute attack or developing peripheral anterior synechiae with chronic pressure elevation.

Chronic Angle-Closure Glaucoma

In chronic angle-closure glaucoma, portions of the anterior chamber angle are permanently closed by peripheral anterior synechiae, and the intraocular pressure (IOP) is chronically elevated . The synechial closure may result from a prolonged acute attack or repeated subacute attacks of angle-closure glaucoma. A variation of this condition has been called shortening of the angle or creeping angle-closure glaucoma. It is important to look carefully for evidence of exfoliation syndrome, because exfoliation can predispose to pupillary block in some patient populations .

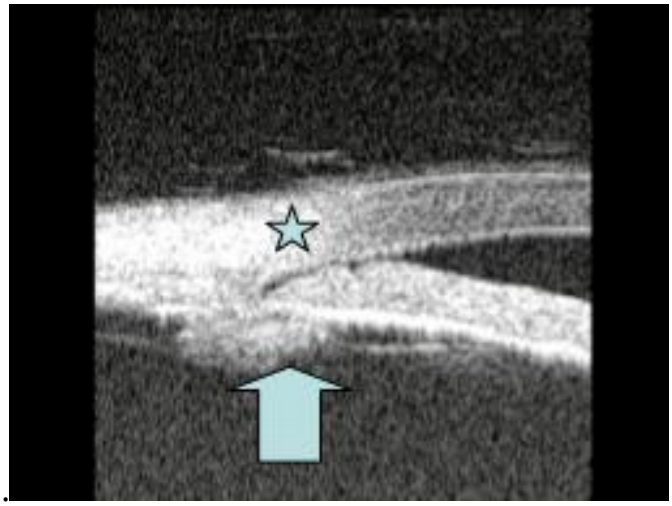
Combined-Mechanism Glaucoma

In some eyes, the glaucoma appears to have open-angle and angle-closure mechanisms. The diagnosis is usually made after an acute angle-closure

glaucoma attack in which the IOP remains elevated after a peripheral iridotomy, despite an open, normal-appearing angle.[17,,]

b) Plateaus iris mechanism:

this is an abnormality where the peripheral iris is inserted too anterior on the sclera spur. So when the pupil is dilated the iris shows folds and closes the angle . it is an anatomic abnormality of the angle. On examionation the iris is seen to insert more anteriorly on sclera spur .



Usually diagnosed when the angle remains closed even with a patent iridotomy. Hence in all cases of angle closure an iridotomy is done. Then if it is not effective then other measures like laser iridoplasty,miotic therapy etc can be tried.

c) Lens induced angle closure:

Lens induced angle closure can occur either because of too large a lens or due to more anteriorly positioned lens . anterior positioning can be due to lens subluxations or dislocations.

d) Creeping angle closure

In creeping angle closure the angle slowly zips up from the posterior to anterior trabecular meshwork and thus causes a shallow AC.

Here again chronic angle closure causes the formation of adhesions between the iris and angle structures which can either occur due to repeated attacks of subacute or acute attacks.

In creeping angle closure when more than one half of the angle gets closed by synechiae(due to the iris creeping)and hence when the angle becomes irreversibly occluded, the IOP starts to increase.

Asians are more likely to suffer from creeping angle closure

e) Cilio lenticular block:

when there is a misdirection of aqueous into the vitreous usually due to surgery when there may be a disruption of zonules , the aqueous that escapes into vitreous form pockets and cause a rapid rise in IOP with severe pain.

Due to the aqueous in the vitreous cavity the iris lens diaphragm may be moved more anterior thus closing the angle. Here the management involves use of cycloplegics .

f) Combined mechanism glaucoma:

When an open angle glaucoma co exists with anatomically narrow angles it is called a combined mechanism glaucoma. Here obviously an iridotomy alone always fails to control the IOP and additional management measures have to be done in order to control the IOP since here the trabecular meshwork does not function properly as in open angle glaucoma.

The treatment of combined mechanism glaucoma includes laser iridotomy and medical therapy aimed at the open angle component as well

In addition there are certain drugs and medications that can induce or precipitate an angle closure in those who are already susceptible. These drugs include CNS drugs such as antipsychotics, mood elevating drugs, anti allergic drugs, certain tranquilisers , anticholinergics & sympathetic agonists.

Clinical presentation of angle closure :

1) Acute Angle Closure:

When factors such as a narrow angle, short eyeball , large lens thickness, and increased iris lens contact are found there is an increased chance of pupillary block.

So when there is an occlusion to the flow of aqueous due to pupillary block the pressure builds up in the posterior chamber causing an angle closure and thus a raised IOP.

There are certain physiological conditiona that can occur in our day to day life that may precipitate an attack of angle closure due to mydriasis . during mydriasis there is an increased apposition of peripheral iris to uveal structures thus causing occlusion of angle. These conditions may occur in a dark movie theatre or during reading in inadequate illumination. Drugs that may cause mydriasis include the cycloplegics & dilating drugs. Conditions like acute stress, anxiety, trauma or excessive emotion may also be the cause of mydriasis and thus an acute attack in pre disposed people.

Acute angle closure glaucoma-Signs and Symptoms

- Severe Pain
- Nauseating sensation or frank vomiting
- Defective vision
- Narrow angle, with dome shaped iris
- CCC- Circumcorneal congestion
- Vertically mid dilated pupil which reacts very sluggishly to light
- Corneal edema
- Glaukomflecken
- Edema of ONH.

There should be evidence of a closed angle in the affected eye demonstrated by a gonioscopic examination in order to be diagnosed as case of angle closure.

Only if gonioscopy cannot be performed in the involved eye due to severe corneal edema , the other eye can be examined to demonstrate narrow angle.

2) Intermittent (sub-acute) Angle Closure:

When there is an intermittent or subacute angle closure , there are recurrent episodes of raised IOP that occur in bouts . the angle becomes narrow narrow at intervals due to pupillary block. But the aqueous manages to seep into the anterior chamber by breaking the pupillary block spontaneously. Then

the IOP returns to normal. So at the time of presentation the IOP may be normal. There is only an intermittent rise in these cases.

There may be repeated attacks which may lead on to achronic stage of glaucoma hence early iridotomy is needed in these patients even though IOP may be normal at presentation.

Here their Signs and symptoms are only mild and hence most patients do not seek medical counsel at early stage.

When the angle is examined by gonioscopy it will show signs of irido trabecular contact such as pigmentation of trabecular meshwork or even peripheral anterior synechiae.

3) Chronic Angle Closure :

When chronic angle closure develops , usually the patients are asymptomatic and often present only with defective vision.

Gonioscopic examination must be done which will identify a narrow angle usually with PAS .

Once PAS develops and covers significant portion of the angle the intra ocular pressure will start to rise.

Medical therapy may be tried and may initially even be successful. However the long term benefits fall short of expectations . since the synechiae continues to form and angle closure proceeds,the IOP will go on increasing.

Hence this condition will most likely need invasive procedure like surgery. Thus in these cases it is imperative to do gonioscopy and identify susceptible people and treat with laser peripheral iridotomy when it is still reversible.

Management of angle closure disease:

PACD presents with a raised IOP which is often symptomatic with/ without disc damage. Management resolves around immediate control of symptoms and raised intraocular pressure, modifying configuration of the angle and preventing further closure, detection and prevention of further damage to the optic disc and visual field, and very importantly treating the fellow eye.

PACS-

Treatment of a case of primary angle closure suspect will depend on relative risk of progression to primary angle closure and primary angle closure glaucoma. There are varying views on whether treatment of PACS is justifiable or not.

PAC-

It includes anti glaucoma medications and iridotomy. Laser peripheral iridotomy has to be performed whenever there is a pupillary block.

This will make another way for the passage of the aqueous humour from the posterior chamber into the anterior chamber.

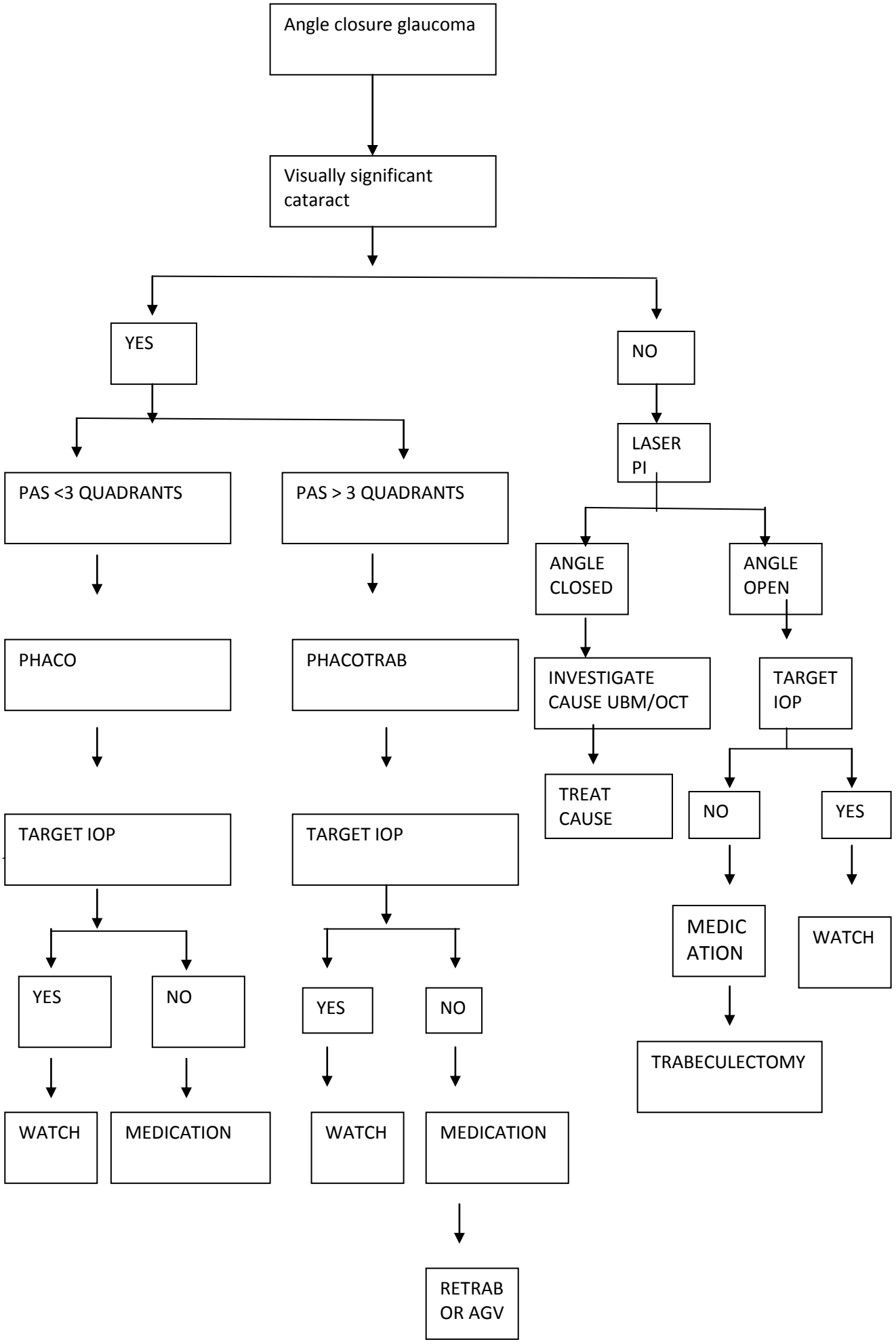
The only indication of doing a surgical iridectomy in recent times is only the lack of laser facilities. The obvious risks of intraocular surgery far outweighs the benefits gained especially when a conservative method of management is available.

PACG-

There are various modalities of treatment including medical therapy with antiglaucoma medications , laser peripheral iridotomy. However their efficacy in PACG appears to be limited.

Most PACG patients still require additional and definitive therapy such as surgery (which includes trabeculectomy ,glaucoma drainage devices etc).

Definitive treatment is however only by surgery because they do not usually respond to the other modalities.


Angle closure glaucoma
Visually significant cataract
YES
NO
PAS <3 QUADRANTS
PAS > 3 QUADRANTS
LASER PI
ANGLE CLOSED
ANGLE OPEN
PHACO
PHACOTRAB
INVESTIGATE CAUSE UBM/OCT
TARGET IOP
TREAT CAUSE
NO
YES
TARGET IOP
TARGET IOP
MEDIC ATION
WATCH
YES
NO
YES
NO
TRABECULECTOMY
WATCH
MEDICATION
WATCH
MEDICATION
RETRAB OR AGV

Laser peripheral iridotomy

Laser peripheral iridotomy has replaced incisional iridectomy for most part mainly due to its safety & non invasiveness.

Indicated for all types of angle closure glaucoma having a component pupillary block and also as prophylactic procedure for patients with potentially occludable angles.

LPI will help in treatment of appositional angle closure by negating pupillary block and thereby reducing the IOP.

The primary aim of performing a peripheral iridotomy is to relieve pupillary block by creating an hole in the peripheral iris and equalising the intraocular pressure in anterior & posterior chambers, widening the angle recess & flattening the iris.[20]

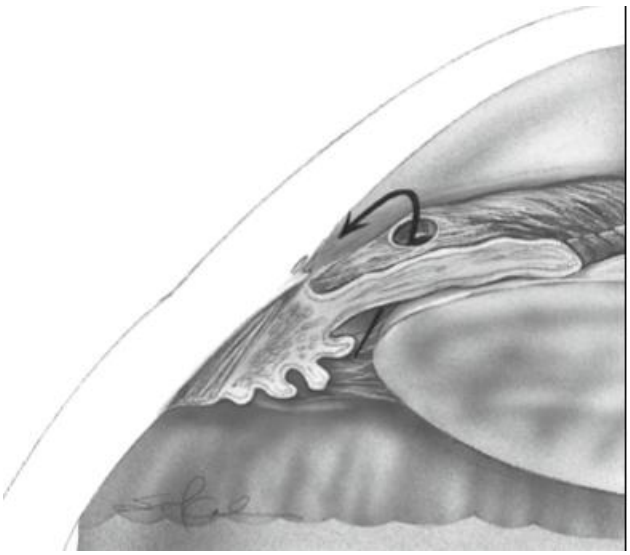
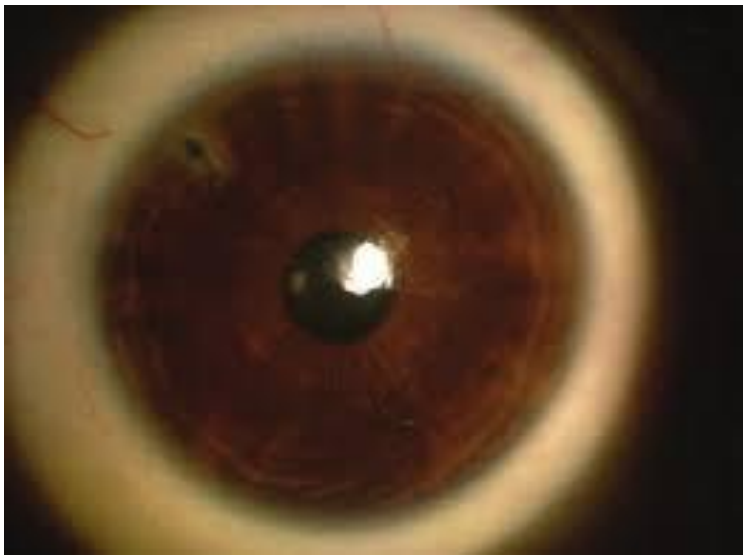


Image showing patent iridotomy allowing aqueous outflow.



“INDICATIONS

- Acute angle-closure glaucoma
- Chronic angle-closure glaucoma with peripheral anterior synechiae Intermittent angle-closure glaucoma with classic symptoms of angle closure
- Aphakic or pseudophakic pupillary block
- Anatomically narrow angles and signs of previous attacks
- Narrow-angle eye with acute angle-closure glaucoma in the fellow eye "

It is also indicated in asymptomatic patients and in Younger patients with Critically narrow angles, especially those who may not have access to medical care .[21]

Types of lasers for peripheral iridotomy

The lasers commonly employed for iridotomy are the photodisruptive Q-switched Nd:YAG laser, the photothermal argon lasers and the solid state lasers.

Nd:YAG laser iridotomy

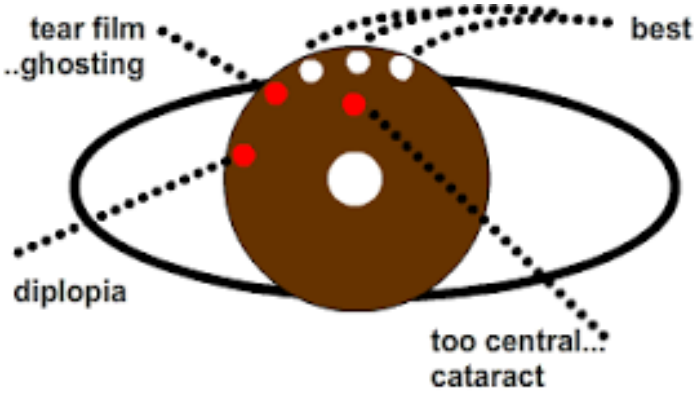
Photodisruptive Q-switched Nd:YAG laser is mostly preferred by many surgeons since it can penetrate and perforate the iris easily.

The laser settings depend on individual patient and machine parameters. After constriction of pupil with miotic to pull the iris away from the cornea as much as possible Abraham lens having + 66D planoconvex button is used to separate the eyelids, prevent corneal burns & also for focussing the beam.[22]

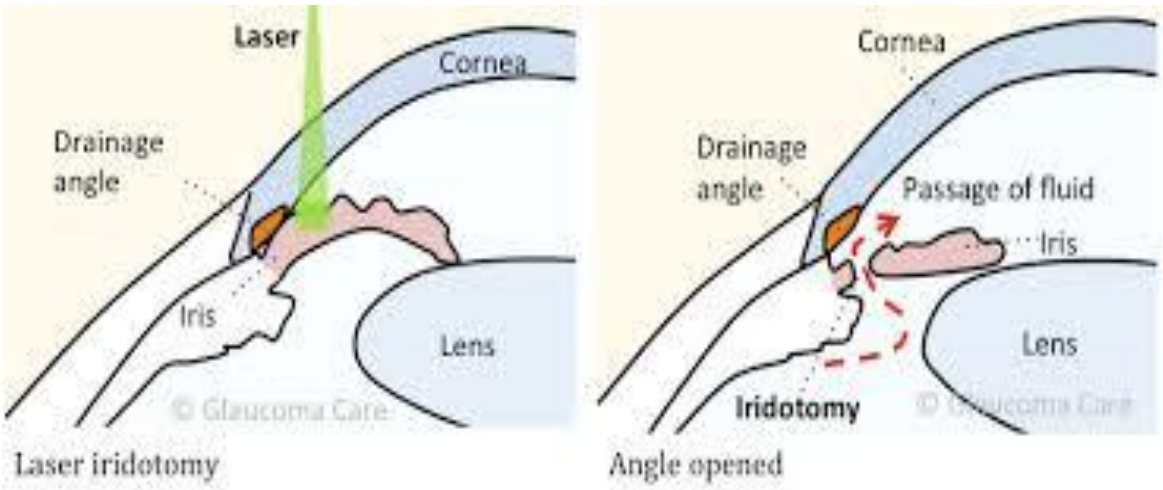
Usually the thinnest part of the iris is identified i.e the crypts and laser beam is directed . the out gushing of fluid with pigment dispersion indicates an opening in iris.

Peripheral location is chosen to prevent ghost images & visual problems.

Commonly done at 11-1 0'clock positions. 12 o'clock is avoided since in argon laser the air bubbles formed may block the PI & in NdYAG laser there may be a trickle of bleeding which may move down and obscure vision transiently[23].



Because the Nd:YAG laser (unlike photothermal argon or solid-state lasers) has no coagulative effect, bleeding occurs more frequently.



Laser peripheral iridotomy in PAC & PACG

Laser peripheral iridotomy procedure has almost a 100% success rate in angle closure due to pupillary block when not associated with other conditions.

The change in angle parameters is often best when only appositional iridotrabecular contact(PAC) exists. The changes in angle morphology & reduction in IOP is not so satisfactory in PACG where extensive Peripheral anterior synechiae may have formed and a laser iridotomy may not relieve the pupillary block

Gonioscopy vs UBM

Traditionally the patients anterior chamber angle is assessed before and after laser peripheral iridotomy using gonioscopy. However gonioscopic

examination is associated with inter-observer bias. It also does not estimate the angle accurately.

Ultrasound biomicroscopy (UBM) is a imaging modality that has near light microscopic precision for examination of anterior segment. It allows objective & reproducible method of evaluation of angle morphology. It gives two dimensional gray scale images with a depth of penetration of about 5mm and hence the structures from the conjunctiva, cornea , anterior chamber angle, iris, the ciliary body & anterior layers of lens zonules & pars plana can be visualised .

Hence the etiological factors causing glaucoma can be assessed. It also allows quantitative analyses of angle relationships using various parameters which can be saved for future comparison.

ULTRASOUND BIOMICROSCOPY

The first application of diagnostic ultrasound in the eye was reported by Mundt and Hughes in 1956.

Soon afterward, Oksala and Lehtinen of Finland described first clinical examinations with a handheld A-mode transducer.

At that time however the available transducers were typically unfocused and had frequencies of only around 4 MHz, which was not useful for many ophthalmic goals. Baum and Greenwood were the first to utilise B-mode scanning for ocular examinations in the year 1950.

Pavlin et al was the one who introduced a 50-MHz probe using a PVF transducer and a scanner . This device could provide good quality images of the anterior segment of eye. They named this device as the ULTRASOUND BIOMICROSCOPE.[23]

First commercial UBM

It is a high resolution ultrasound imaging that uses higher frequencies in the range of 50-100Hz for visualisation of anterior segment of the eye. Due to higher frequency it has good resolution but with lesser penetration than conventional B-Scan which has a frequency range of around 10Hz.

The penetration of UBM is around 4-5mm and the structures visualised include cornea, conjunctiva, sclera, anterior chamber, iris, ciliary body, lens upto its posterior capsule.

Allows dynamic capture of anterior segment responses to accommodation, or to dark or light stimulation as well.

Instrumentation

Consists of an ultrasound transducer,signal processor and an articulated arm to steady the scanning head & provide precise motion control. The system is connected to a computer for synchronisation & analysis.

Commercially probes with frequencies ranging from 30-50 Hz are available.

Technique

It uses the immersion technique using fluid . A silicone eyecup serves to hold the fluid which acts as a coupling medium. The procedure is done in lying down position after application of a local anaesthetic.

The eyecup is used to separate the eyelids and is filled with 1% methylcellulose or normal saline.the transducer is immersed in the solution & placed directly over the part to be scanned perpendicular to it. The arm is rotated and turned in the horizontal meridian to scan any part needed.

In this way the cornea & all the anterior segment structures can be visualised at near light microscopic resolution.

Various modifications of UBM including seated position UBM,prone position UBM, and indentation UBM are now available and used for specific indications.

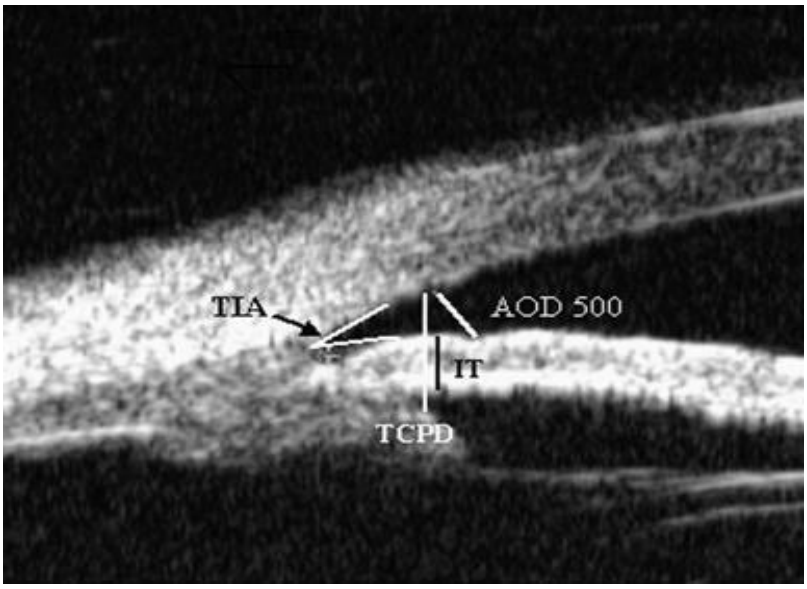
Since the images are produced with high resolution,it is possible to measure accurately the various parameters. For this certain landmarks are chosen from which the measurements are made.

In a normal eye, the cornea is seen with its multiple layers with a highly reflective epithelium, high reflective bowmans layer and a high reflective line consisting of endothelium & descemets membrane.[24]

The anterior chamber depth can be measured from the internal corneal surface to the anterior surface of lens or the iris.

The anterior chamber assessment is aided by identifying the sclera spur and the corneoscleral junction since they are consistently seen in most images. All other measurements are taken from these landmarks.

In angle closure , the anterior chamber depth,angle opening distance,iris thickness,iridolenticular contact and various other parameters can be assessed which will allow precise evaluation of the anterior chamber.


TIA
AOD 500
IT
TCPD

PART II

DETAILED STUDY PROPOSAL

TITLE

Ultrasound biomicroscopic assessment of anterior chamber angles after laser peripheral iridotomy in primary angle closure & primary angle closure glaucoma patients

AIMS & OBJECTIVES

To study the angle morphology before and after laser peripheral iridotomy in patients with primary angle closure & primary angle closure glaucoma

MATERIALS & METHODS

STUDY DESIGN

Prospective observational study

STUDY PERIOD: 6 months

STUDY CENTRE

Department of Ophthalmology,Government Rajaji Hospital,Madurai

SAMPLE SIZE

50 patients fulfilling the inclusion criteria

INCLUSION CRITERIA

1. Patients presenting with occludable angles (trabecular meshwork not seen in more than 180 degrees)with signs of trabecular iris contact such as PAS(peripheral anterior synechiae,raised IOP,lens glaucomflecken or excessive pigmentation on trabecular meshwork (PAC-primary angle closure)
2. Patients presenting with features of PAC with associated evidence of glaucoma.(PACG-primary angle closure glaucoma)
3. Age 40-70years

EXCLUSION CRITERIA

1. patients in which angle closure is associated with other ocular causes (lens induced, post vitreoretinal surgery etc)
2. Age <40 yrs or >70yrs

METHODOLOGY

Prospective observational study to study the changes in anterior chamber angle structures before and after laser peripheral iridotomy using Ultrasound biomicroscopic technique. To be done in patients presenting to the glaucoma clinic of the department of ophthalmology of Govt Rajaji Hospital ,Madurai for the period of 8 months. A total of 50 patients will be studied. Patients presenting with shallow angles will be studied & their complete history, assessment of anterior segment which includes slit lamp examination ,

gonioscopy by Goldman 3 mirror goniolens, IOP measurement by applanation tonometry, fundus examination using +90D lens and standard perimetry will be done. The patients are categorised as Primary angle closure or as Primary angle closure glaucoma depending on the clinical findings . Then Ultrasound biomicroscopic assessment is to be done prior to and after 2 weeks of laser peripheral iridotomy to measure central ACD(anterior chamber depth) AOD(angle opening distance),TIA(trabecular iris angle) & other angle parameters. Results to be analysed statistically.

PROCEDURE

1. The procedure is explained to the patient & informed consent is obtained

2. After initial history taking, slit lamp examination ,gonioscopy by Goldman's three mirror lens, fields by standard perimetry & fundus examination by +90D lens is done.

3. Ultrasound biomicroscopy is performed by OTI having 35/16 Hz transducer probe.

4. Patient is made to lie down after application of topical anaesthetic and a plastic eyecup of the appropriate size is inserted between the lids & filled with normal saline which acts as a coupling medium.

5. The transducer probe is placed in water bath with care not to touch the corneal surface.

To maximize the detection of the reflected signal, the transducer should be placed so that the scanning ultrasound beam strikes the surface in a perpendicular fashion.

6. “The following parameters are measured in the anterior chamber angle.

i) **The angle opening distance (AOD)**

“It is defined as the length of a line drawn from a point on the endothelial surface of cornea 500 μm anterior to the scleral spur to the iris perpendicular to the corneal endothelial surface.”

ii)**The trabecular–iris angle (TIA, θ 1)**

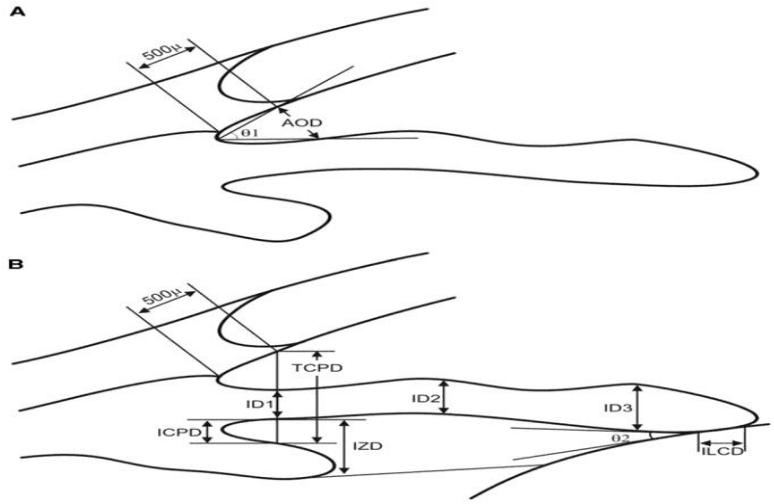
“It is defined as an angle at apex at the triangular iris recess and the arms passing through the point on the meshwork 500 μm from the scleral spur and the point on the iris perpendicularly opposite.”

iii)The trabecular ciliary distance (TCPD)

“It is defined as the distance between a point 500 μm from the scleral spur and the ciliary process on the line that is perpendicular through the iris.

Iris thickness(IT) is measured 2 mm from the iris root and at its thickest point near the margin” .

iv)The length of iris–lens contact (ILCD) and the angle at which the iris leaves the lens surface **(iris–lens angle; ILA,)** are also measured.”



7. Laser peripheral iridotomy is performed using Q switched Nd Yag laser (ZEISS VISULAS YAG III)

8. Informed consent is obtained & 2% pilocarpine eye drops applied (1 drop every 15 minutes beginning 2 hours before procedure) to cause maximal stretching of iris so that it is thin & is easily penetrable.

9. 1 drop of 1% apraclonidine or 0.15-0.2 % brimonidine tartrate eye drops is applied to prevent post laser spikes in intraocular pressure.

10. Topical anaesthesia 4% xylocaine eye drops is instilled

11.The patient is seated comfortably & head is positioned in the chin rest & secured

12. Slit lamp is adjusted for accurate focussing & steady fixation.

13. Site is identified between 11 & 1 o'clock position & in the peripheral iris the thinnest part, that is the crypts are identified

14. The Abraham contact lens which has a +66D peripheral button over a contact lens is used to stabilise the eye & maximise laser energy .

15. Illumination of laser room is adjusted- semidark/dark room

16. Laser settings are adjusted &usually 1-3 shots of 3-8mJ energy is sufficient. There will be sudden outflow of aqueous & pigment .

Patient is adviced steroid & antiglaucoma medications for 2 weeks.

17. The patients is then reviewed after 2 weeks & repeat UBM performed & all above parameters are measured

18. Statistical analysis is done

Statistical analysis

The data was analyzed with SPSS statistical software package (version 16.0 SPSS Inc. Chicago , USA) The change in the angle parameters were analyzed

using unpaired student t test,$P < 0.05$ will be considered as statistically significant

OBSERVATION & ANALYSIS

TABLE 1 PAC VS PACG

Among the 50 patients of study group, 24 were diagnosed as PAC & 26 were having primary angle closure glaucoma.

TYPE	NO	%
PAC	24	48%
PACG	26	52%

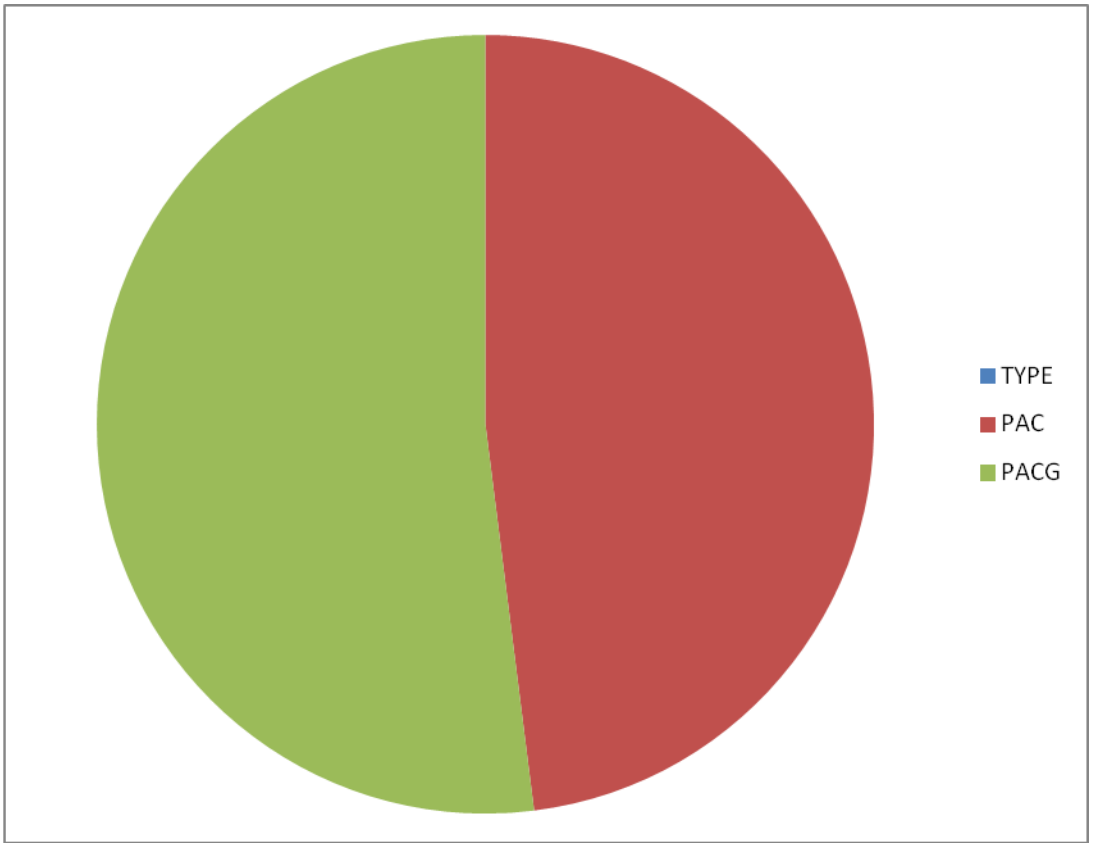


TABLE 2

AGE DISTRIBUTION

Of the studied population, among PAC patients, 6 were less than 50yrs, 16 were between 51-60 yrs & only 2 were above 60 yrs.

Among the PACG group, 1 patient was less than 50 yrs, 14 were between 51-60 yrs & 11 were more than 60 yrs.

Age	**PAC**	**PACG**
<50	6	1
51-60	16	14
>60	2	11
Total	24	26

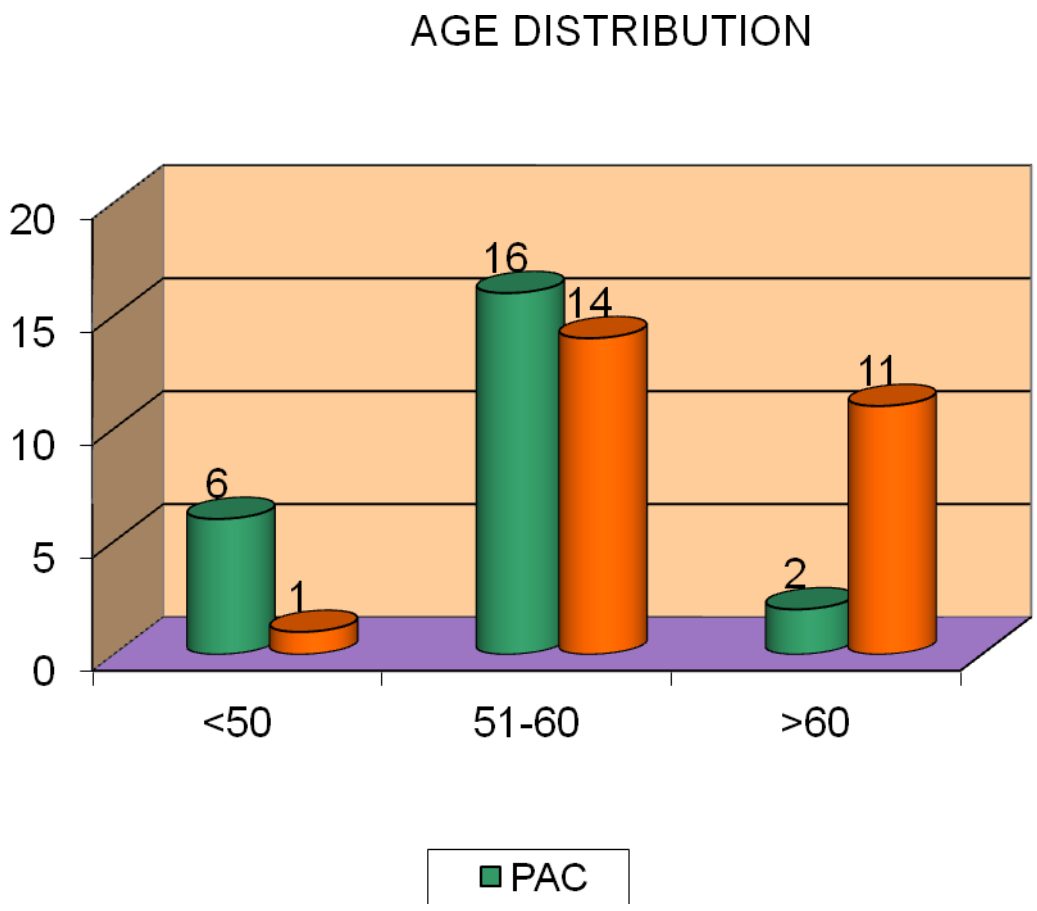
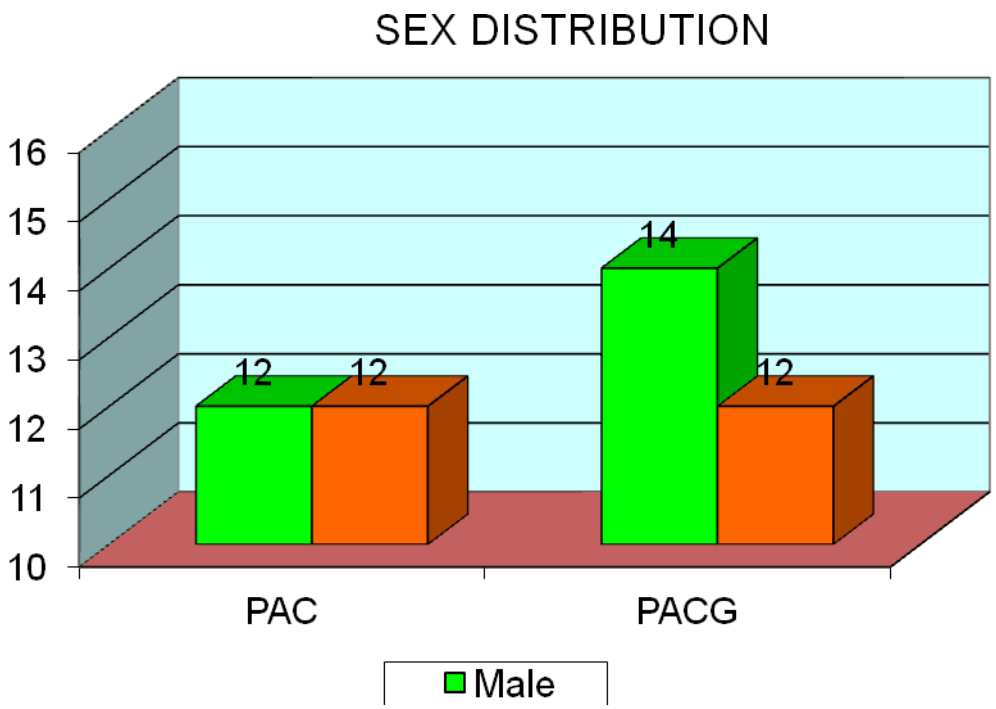


TABLE 3

SEX DISTRIBUTION

Among the 50 studied population in the PAC group 50% were males and remaining 50% were females.

Sex	**PAC**	**PACG**
Male	12	14
Female	12	12
Total	24	26



Among the PACG group, 53.8% were males & remaining 46.2 % were females.

TABLE 4

ACD : PRE vs POST LPI

Among the PAC group, the mean AC depth increased from an average of 2.199±0.04 to 2.32 ± 0.00 .

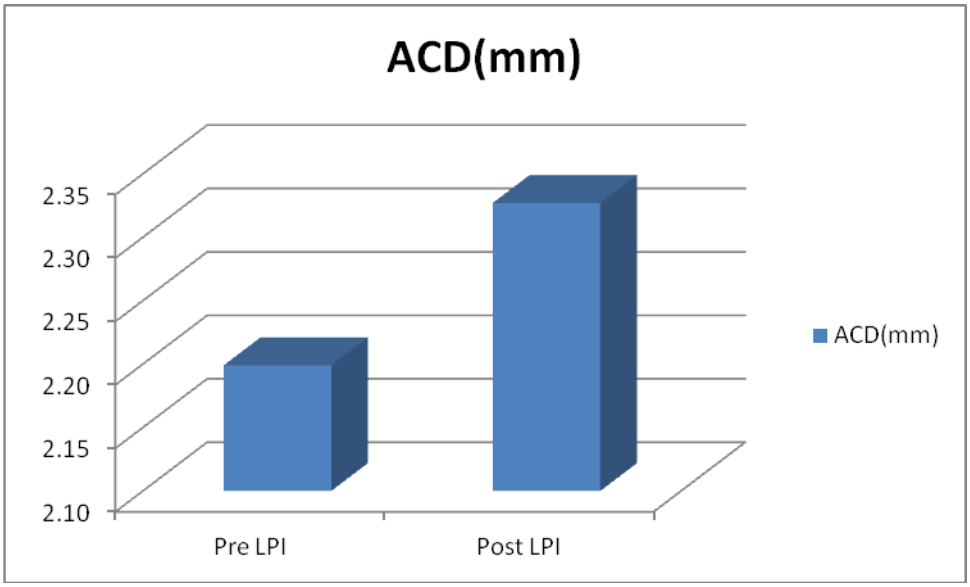


TABLE 5

PAC :

AOD 500 : PRE vs POST LPI

AOD 500 (Angle opening distance mm) increased from an average of 0.106 ± 0.0 to 0.209 ± 0.0

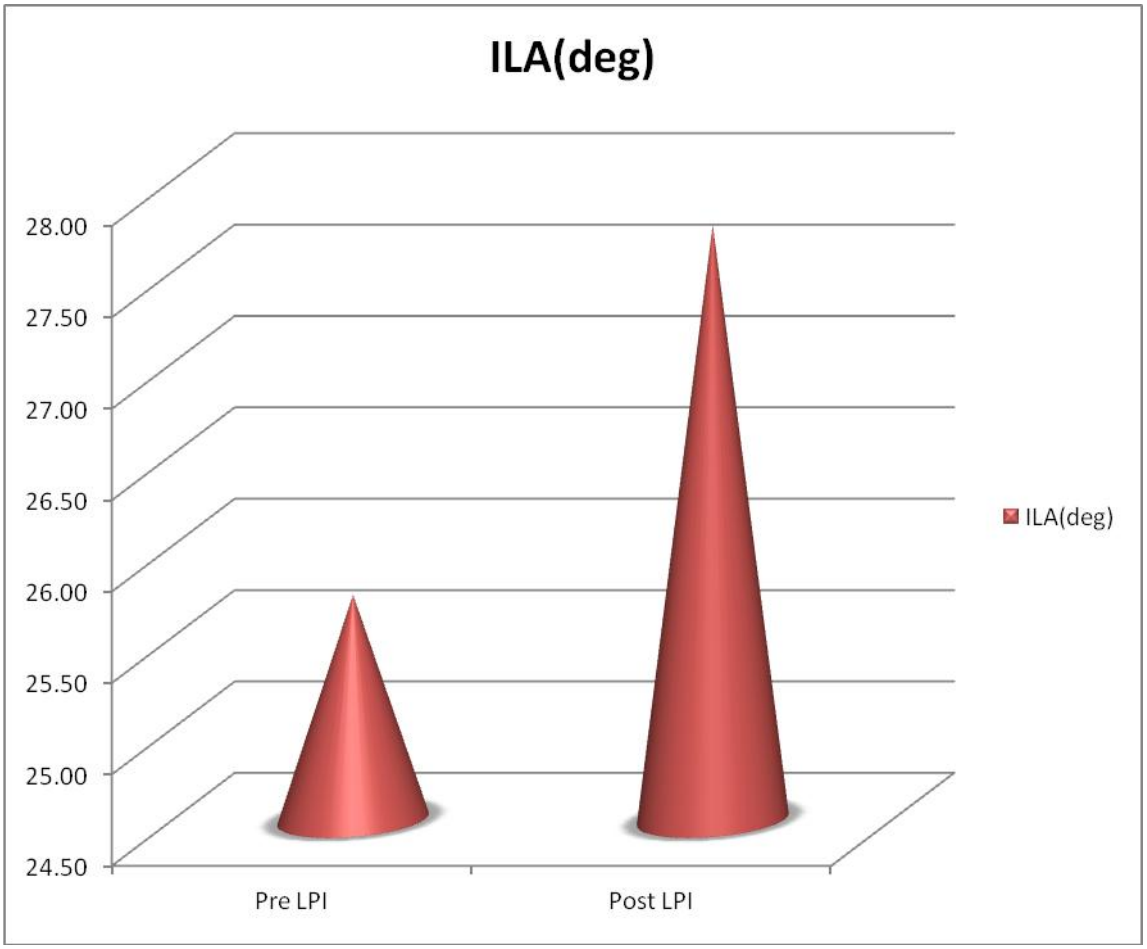


TABLE 6

PAC : SUP TIA : PRE vs POST LPI

Sup TIA (deg) increased from an average of 8.252±0.16 to 16.081±0.23 with a p value of < 0.001.

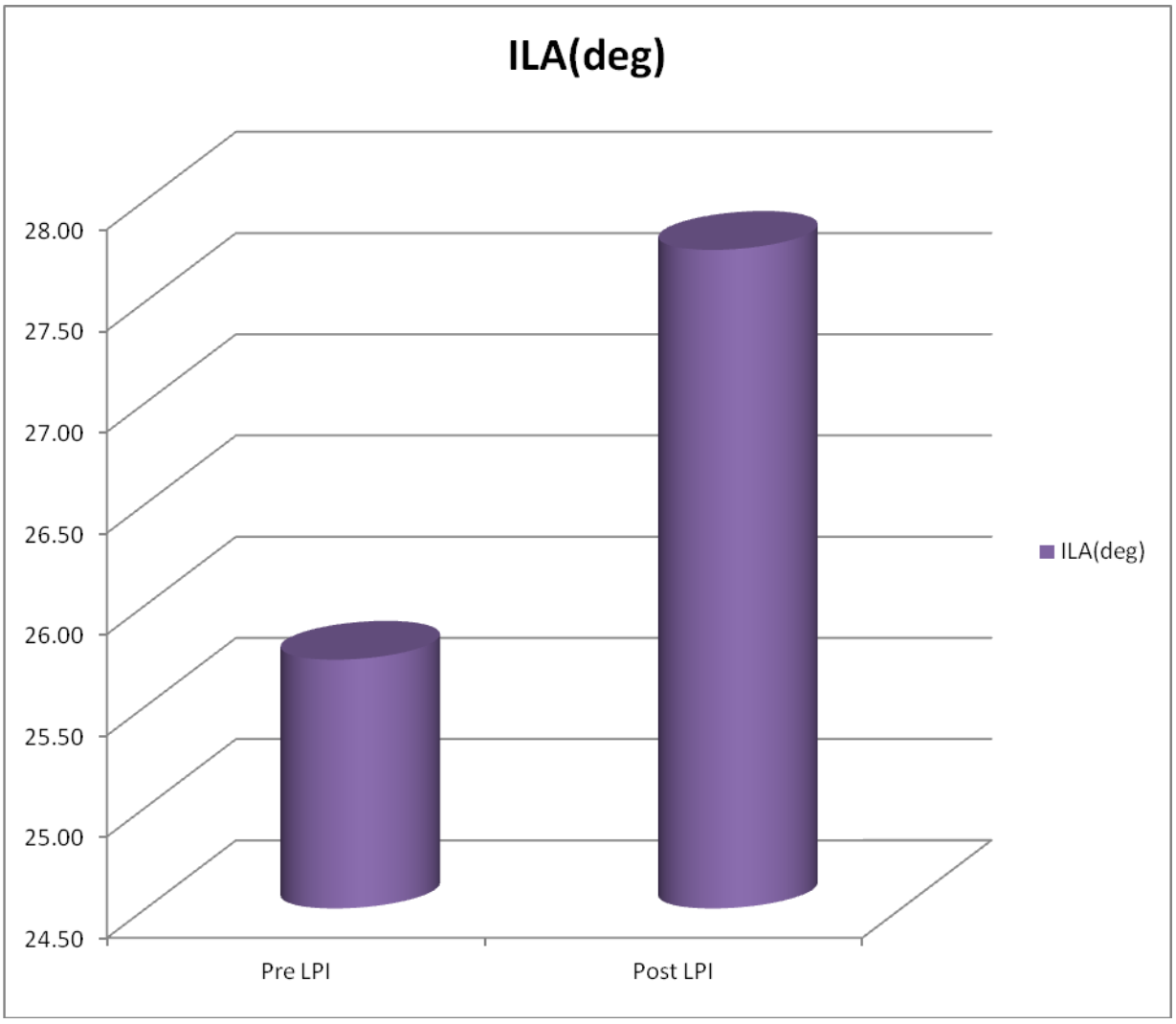


TABLE 7

PAC

INF TIA : PRE vs POST LPI

Inf TIA (deg) increased from an average of 9.125±0.04 to 16.118±0.24 with a p value of < 0.001.

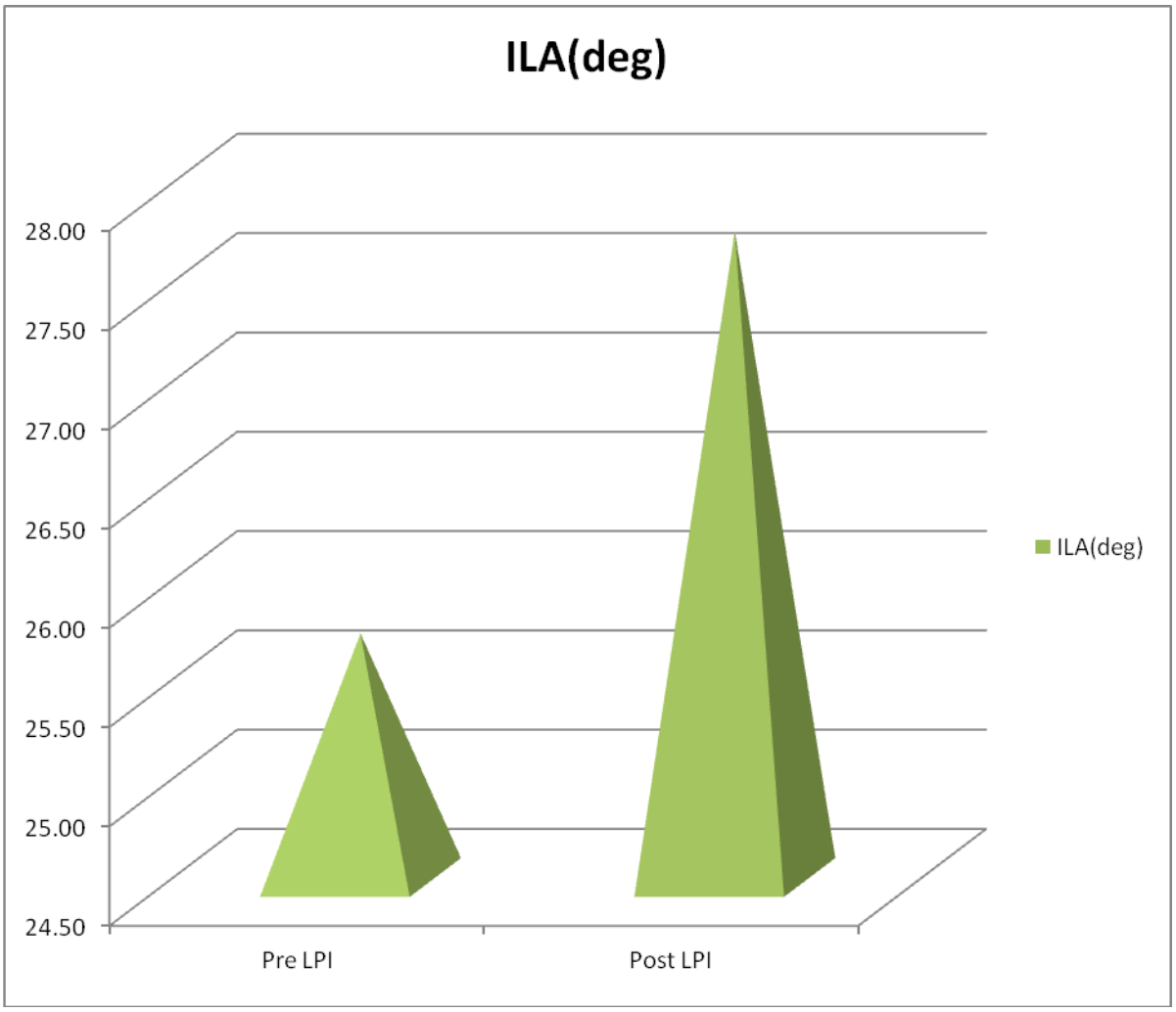


TABLE 8

PAC

PRE VS POST LPI TCPD(mm)

TCPD (TRABECULAR CILIARY BODY DISTANCE mm) increased from an average of 0.745 ± 0.0 to 0.82 ± 0.01 with a p value of < 0.001.

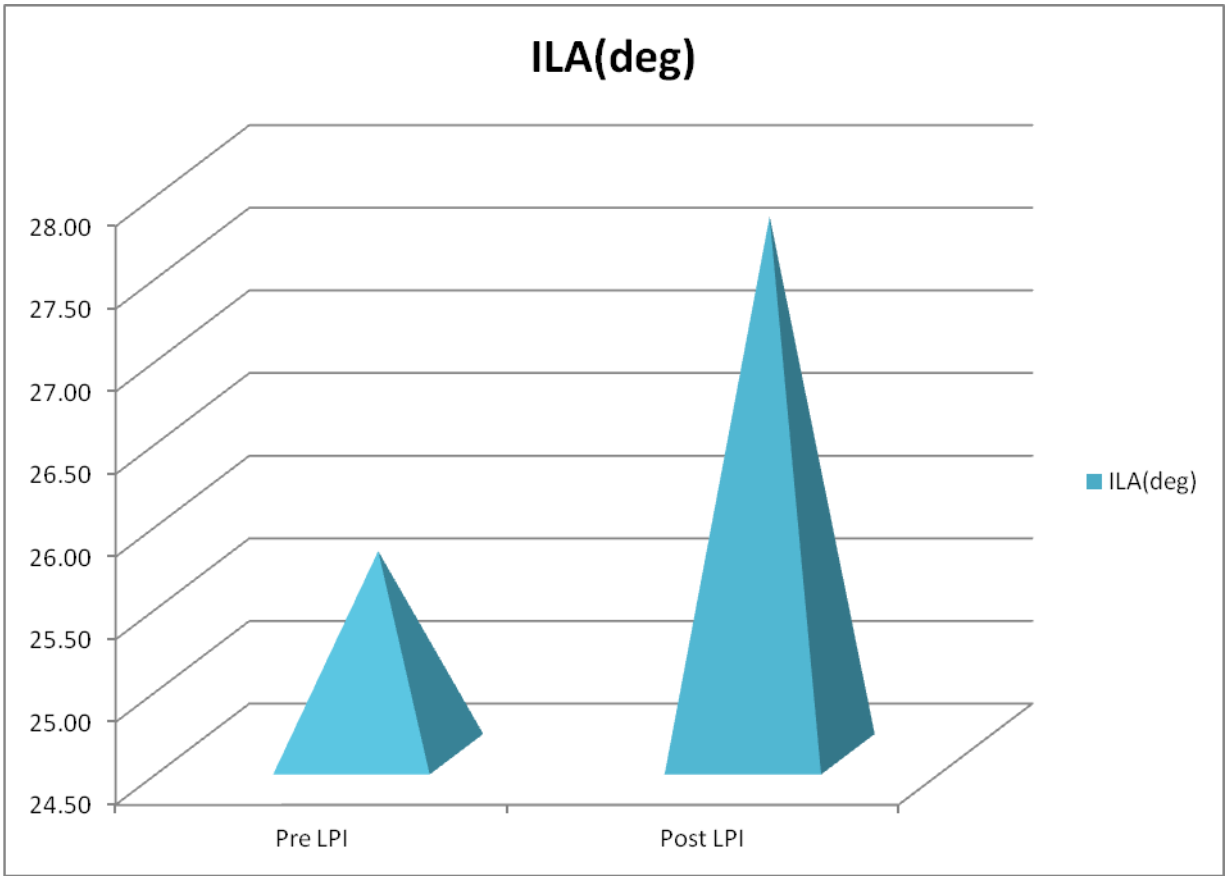


TABLE 9

PAC

PRE VS POST LPI IRIS THICKNESS(IT)

IT(IRIS THICKNESS mm) increased from an average of 0.459 ± 0.01 to 0.487 ± 0.00 with a p value of < 0.001

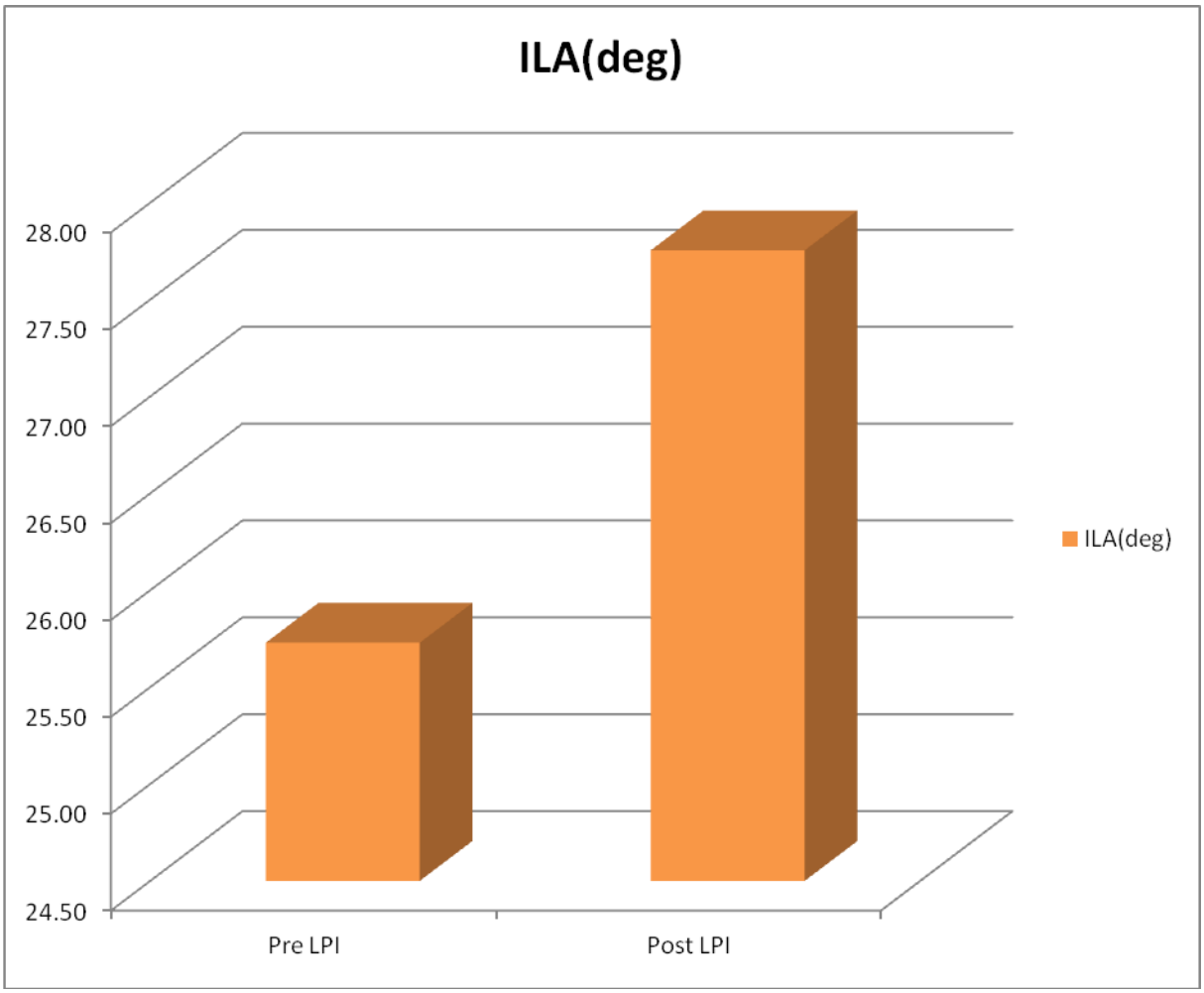


TABLE 10

PAC

PRE VS POST LPI ILCD (IRIS LENS CONTACT DISTANCE)

ILCD (IRIS LENS CONTACT DISTANCE mm) decreased from an average of 1.217 ± 0.05 to 1.162 ± 0.02 with a p value of < 0.001.

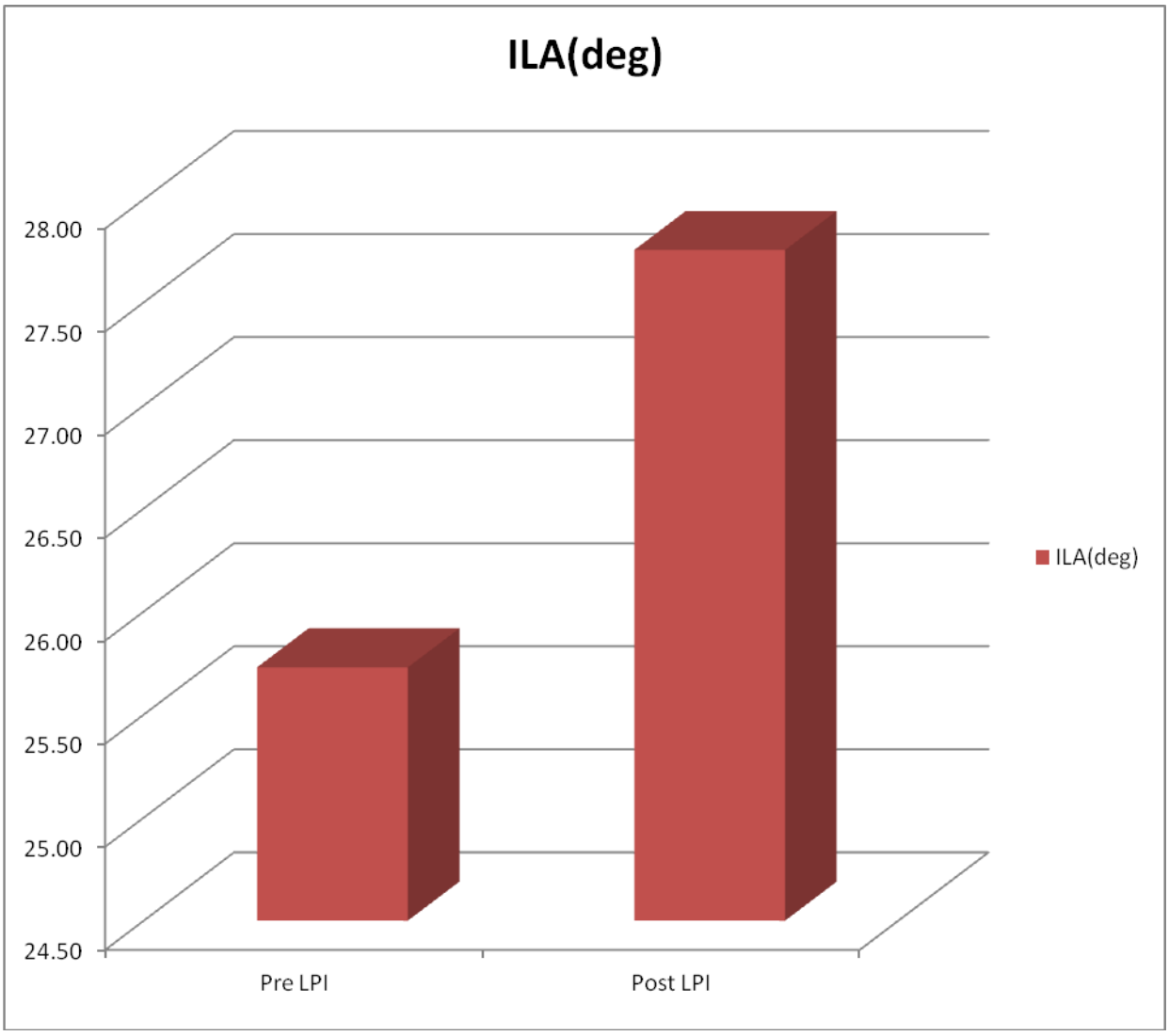


TABLE 11

PAC

PRE VS POST LPI ILA

ILA (IRIS LENS ANGLE deg)) increased from an average of 25.729 ± 0.52 to 27.754 ± 0.57 with a p value of < 0.001

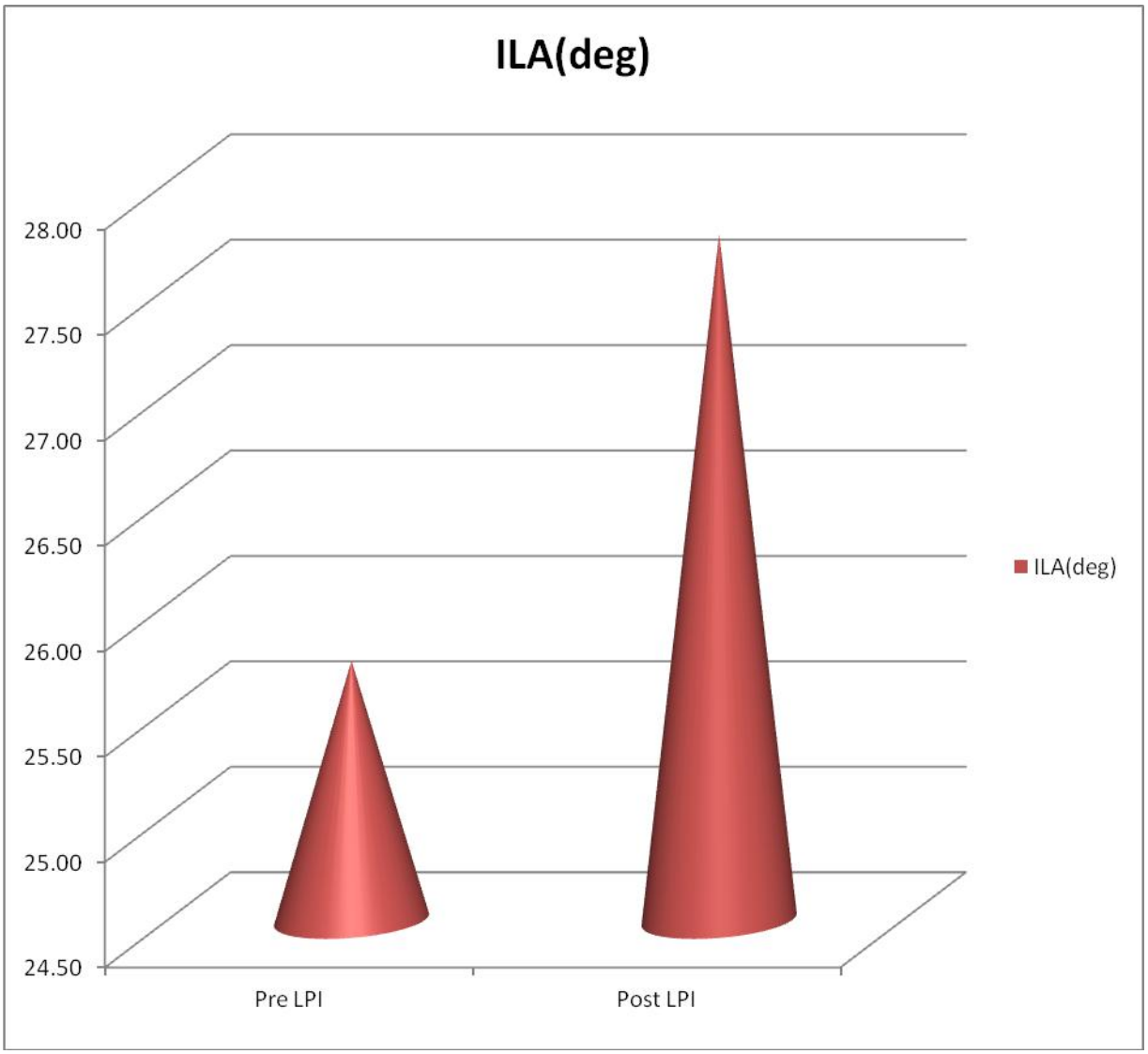


TABLE 12

PACG

PRE VS POST LPI ACD(mm)

ACD(mm) changed from an average from 1.657 ± 0.11 to 1.698 ±0.02 with a p value of 0.06 .

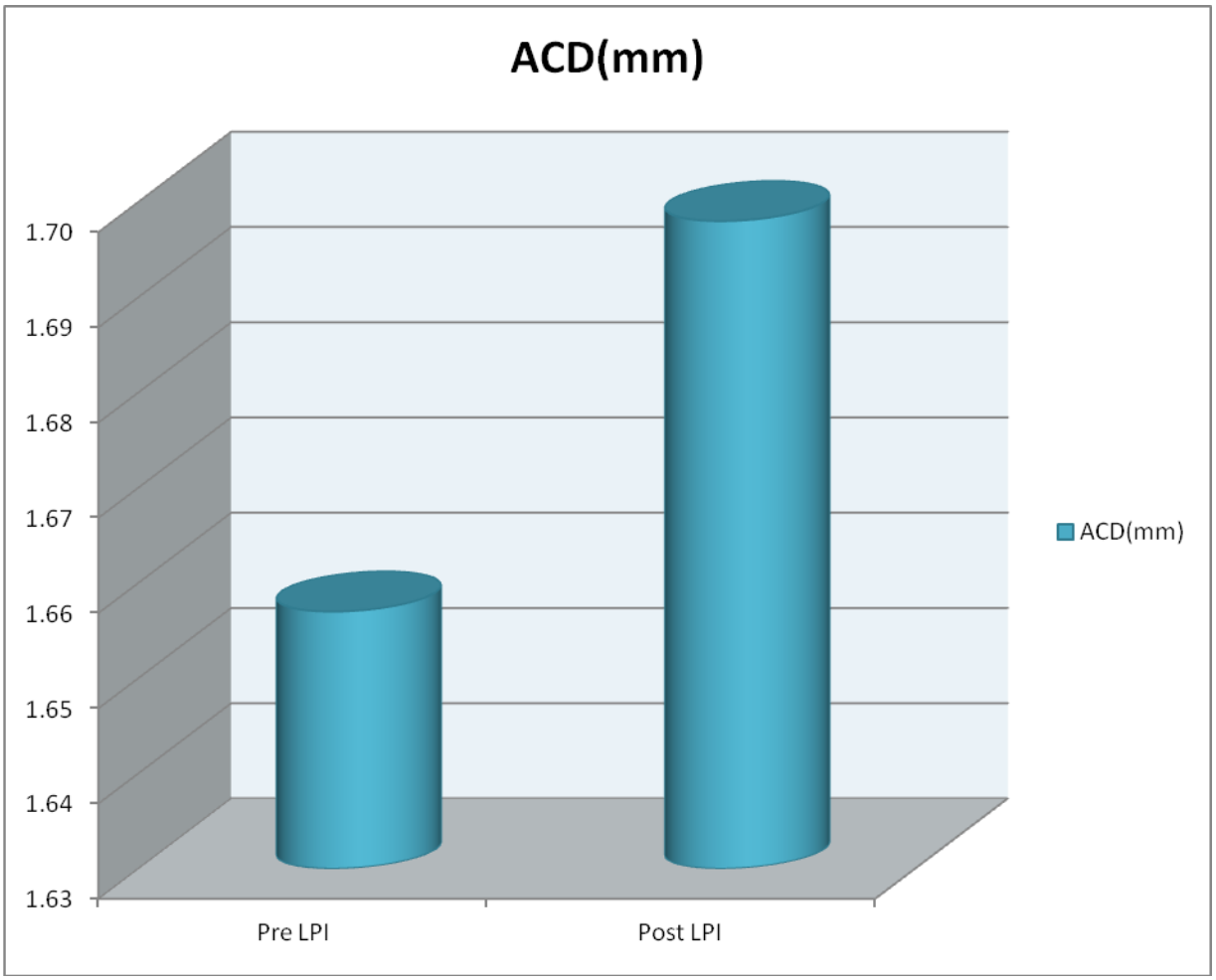


TABLE 13

PACG

PRE VS POST LPI AOD 500(ANGLE OPENING DISTANCE)

AOD 500 (Angle opening distance mm) changed from an average of 0.00631 ± 0.01 to 0.0664 ± 0.0 with a p value of 0.074

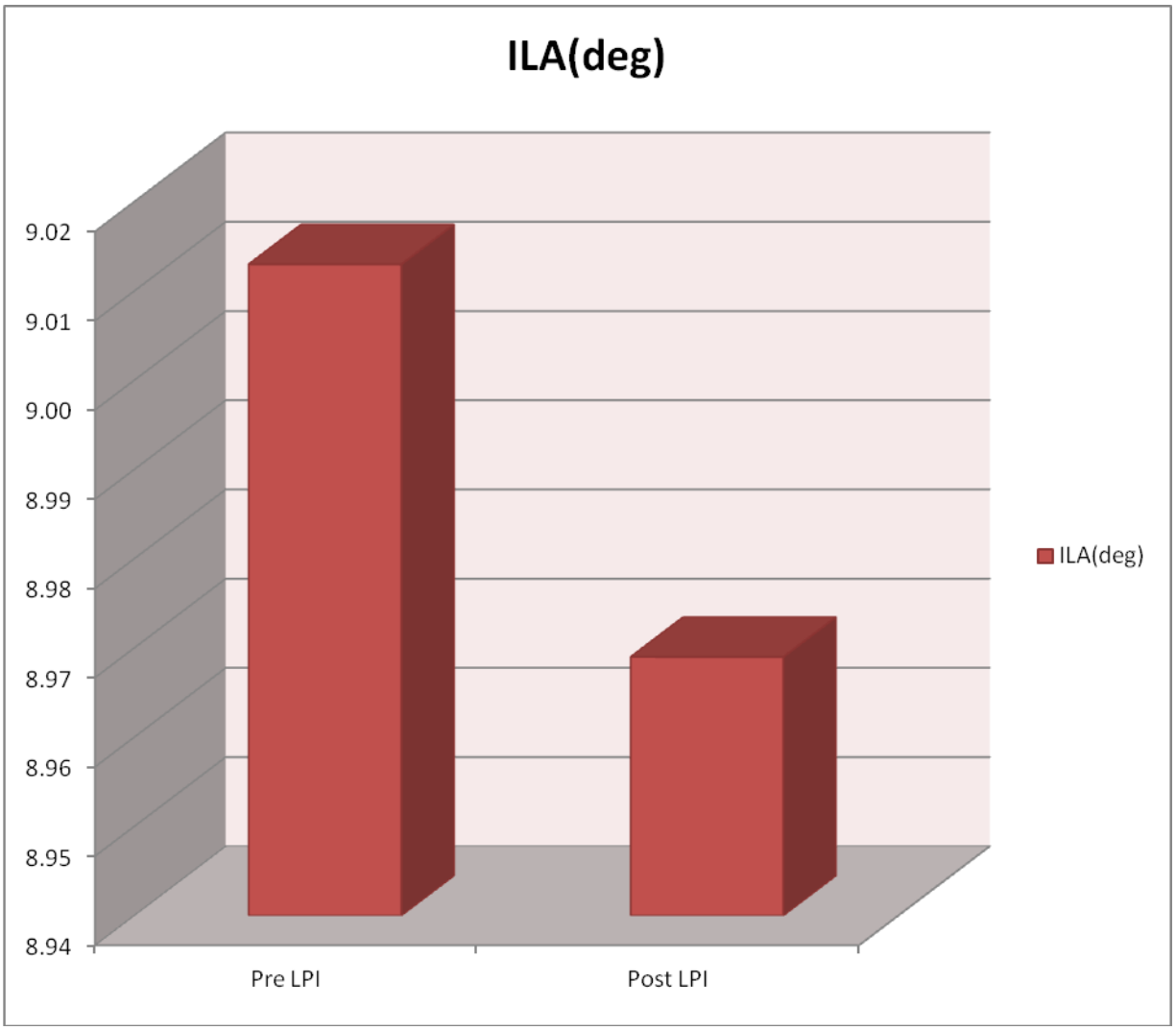


TABLE 14

PACG

PRE VS POST LPI SUPERIOR TIA

Sup TIA (deg) changed from an average of 4.109 ± 0.86 to 4.385 ± 0.14 with a p value of 0.113.

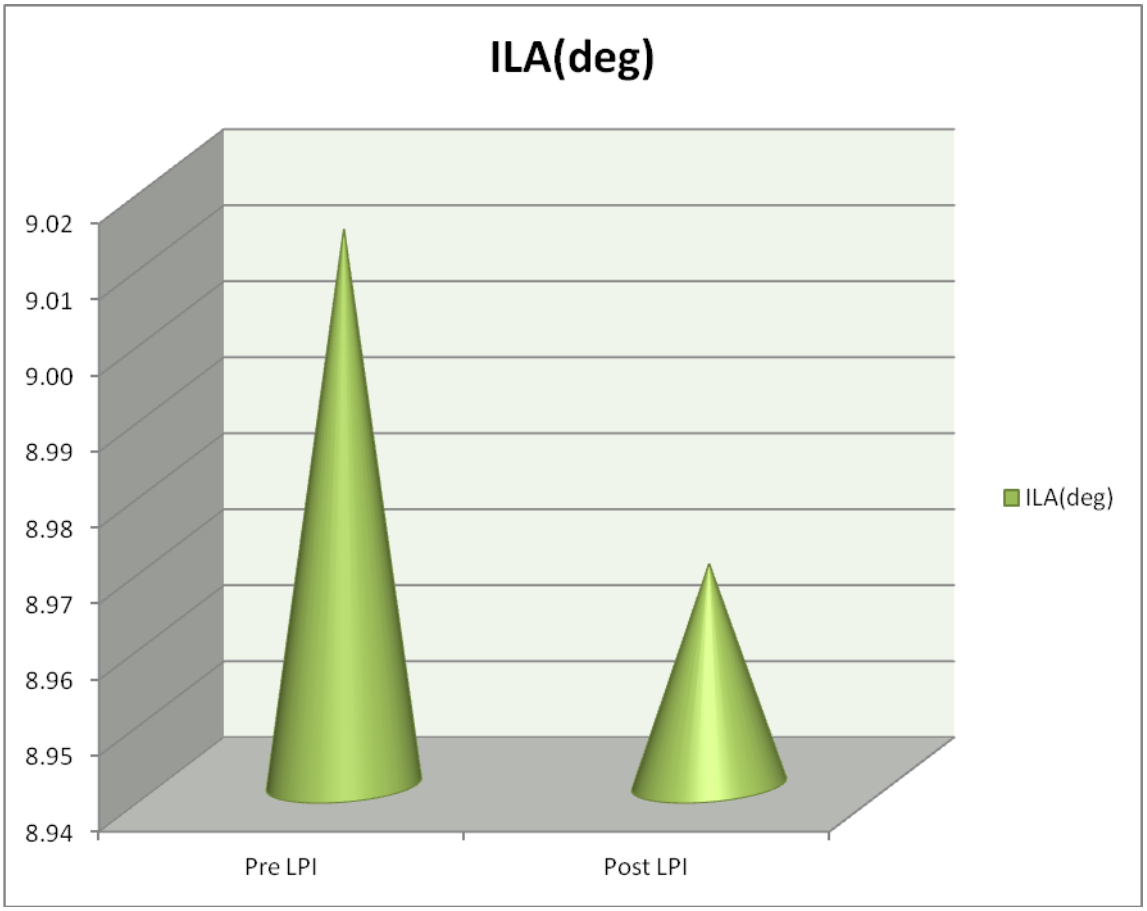


TABLE 15

PACG

PRE VS POST LPI INFERIOR TIA

Inf TIA (deg) increased from an average of 4.365 ± 0.97 to 4.587 ± 0.20 with a p value of 0.258

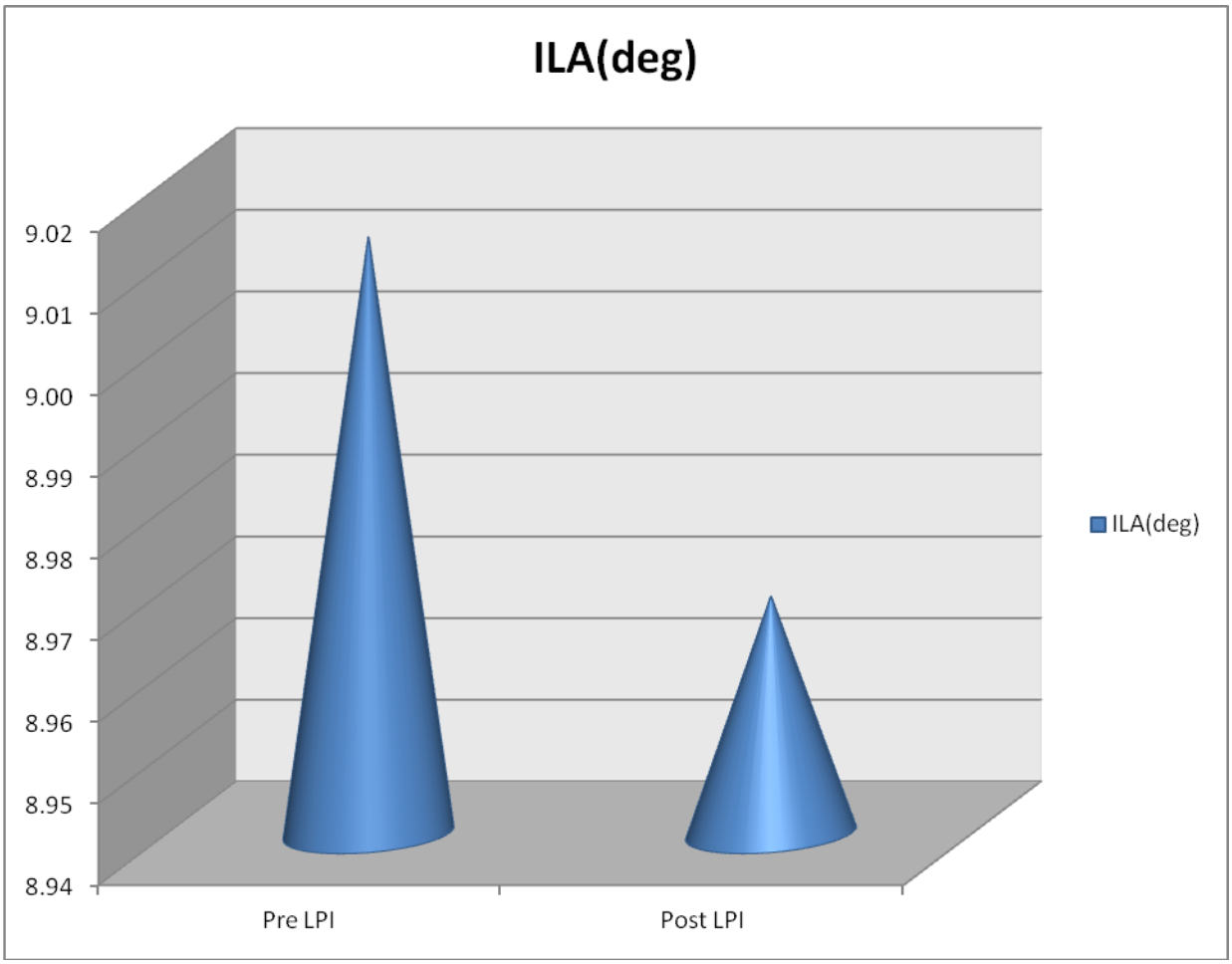


TABLE 16

PACG

PRE S POST LPI TCPD(TRABECULAR CILIARY BODY DISTANCE)

TCPD (TRABECULAR CILIARY BODY DISTANCE mm) increased from an average of 0.655 ± 0.02 to 0.66 ± 0.01 with a p value of 0.224

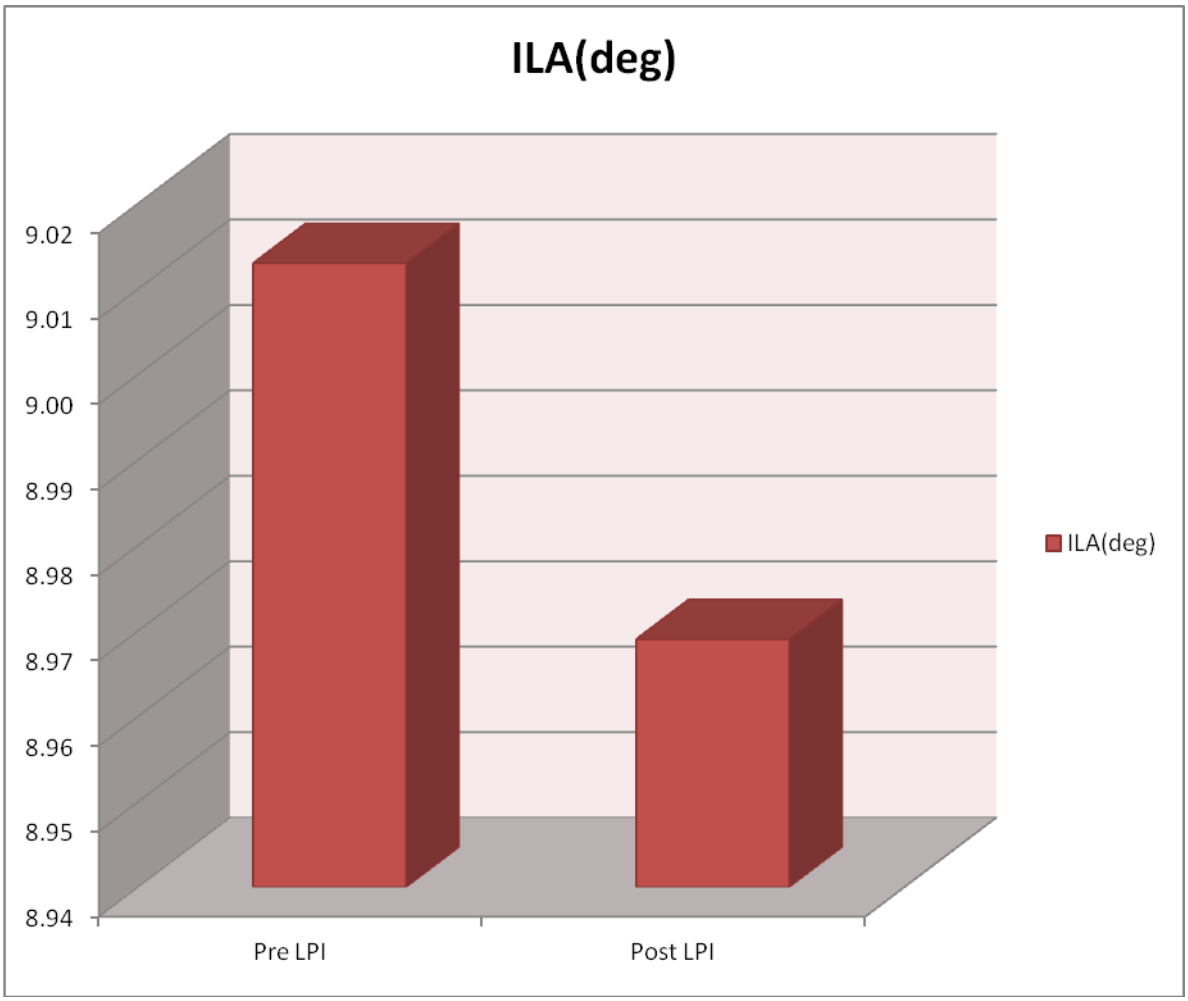


TABLE 17

PACG

PRE VS POST LPI IT(IRIS THICKNESS)

IT(IRIS THICKNESS mm) decreased from an average of 0.482 ± 0.01 to 0.478 ± 0.01 with a p value of 0.258

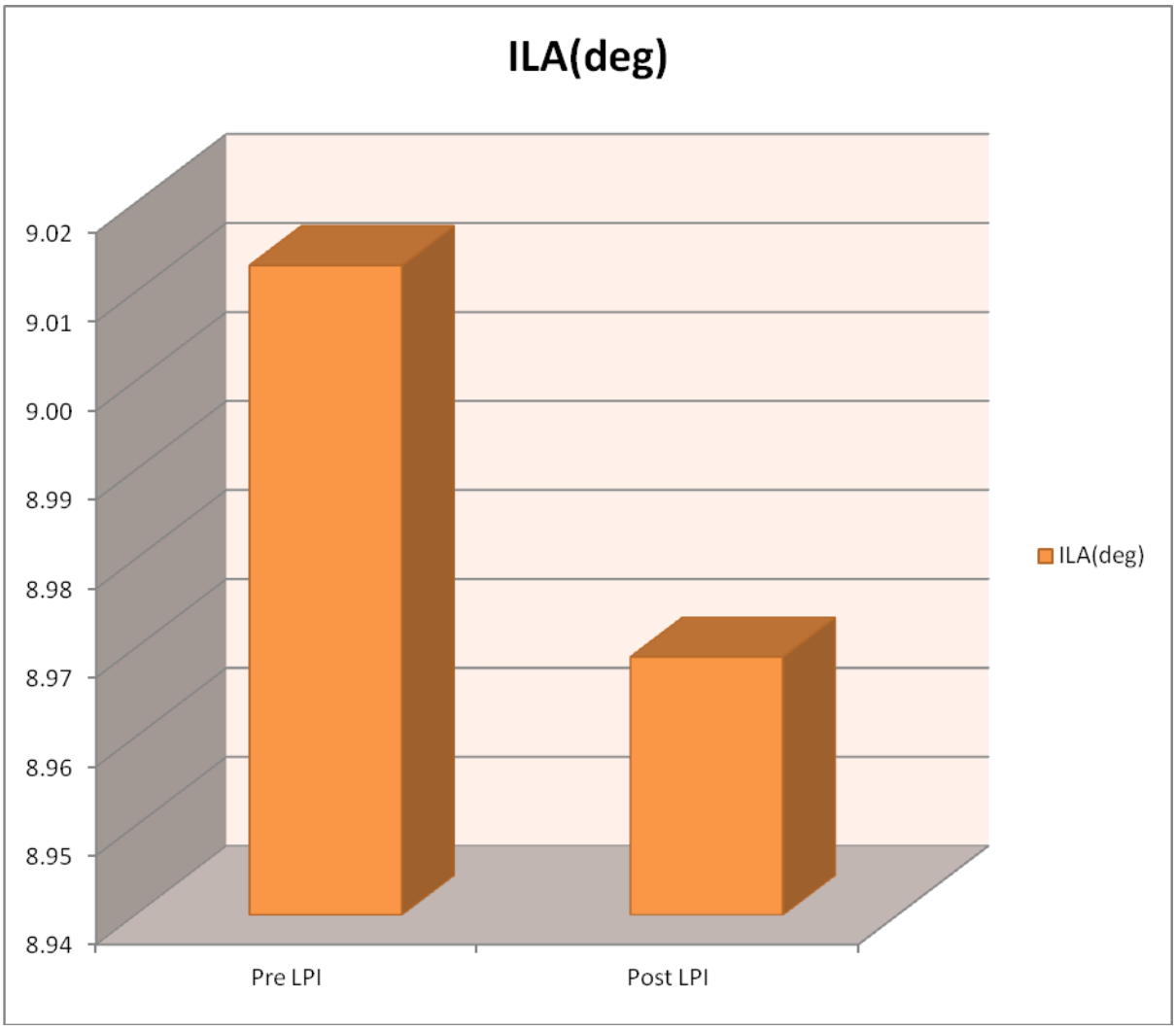


TABLE 18

PACG

PRE S POST LPI ILCD (IRIS LENS CONTACT DISTANCE)

ILCD (IRIS LENS CONTACT DISTANCE mm) decreased from an average of 1.374 ± 0.03 to 1.367 ± 0.02 with a p value of 0.365

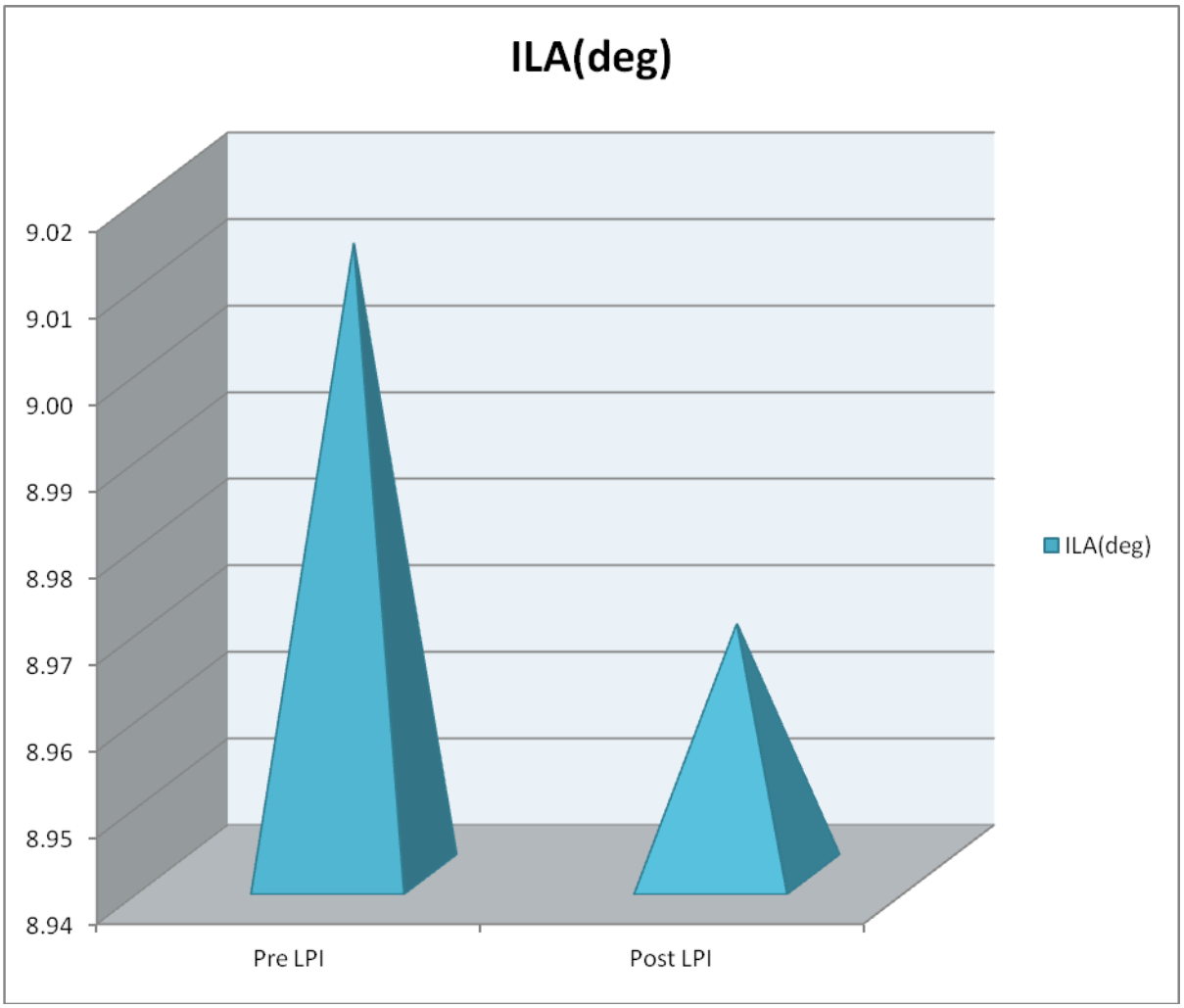


TABLE 19

PACG

PRE VS POST LPI ILA(IRIS LENS ANGLE)

ILA (IRIS LENS ANGLE deg) changed from an average of 9.013 ± 3.32 to 8.969 ± 3.89 with a p value of 0.965

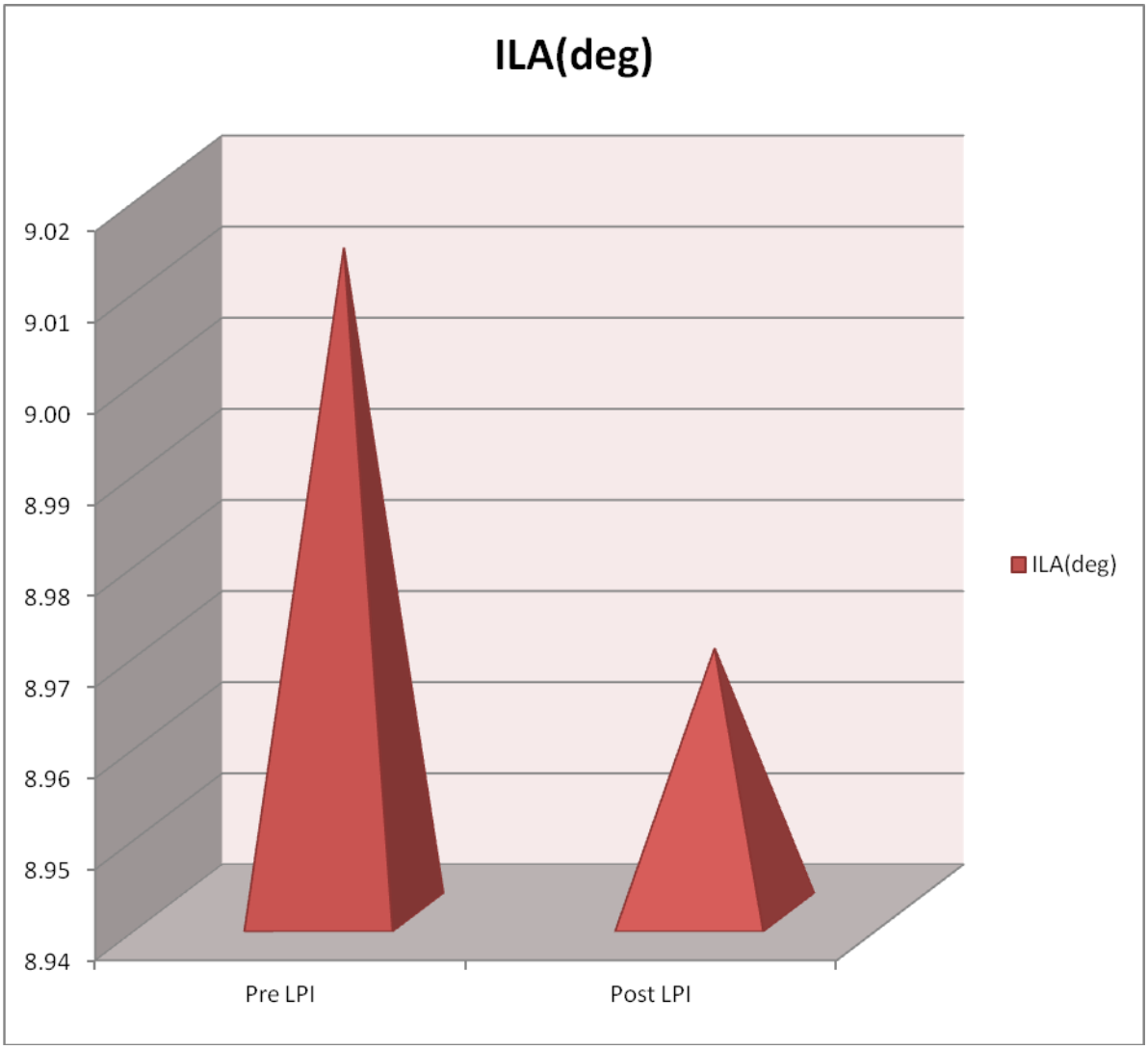
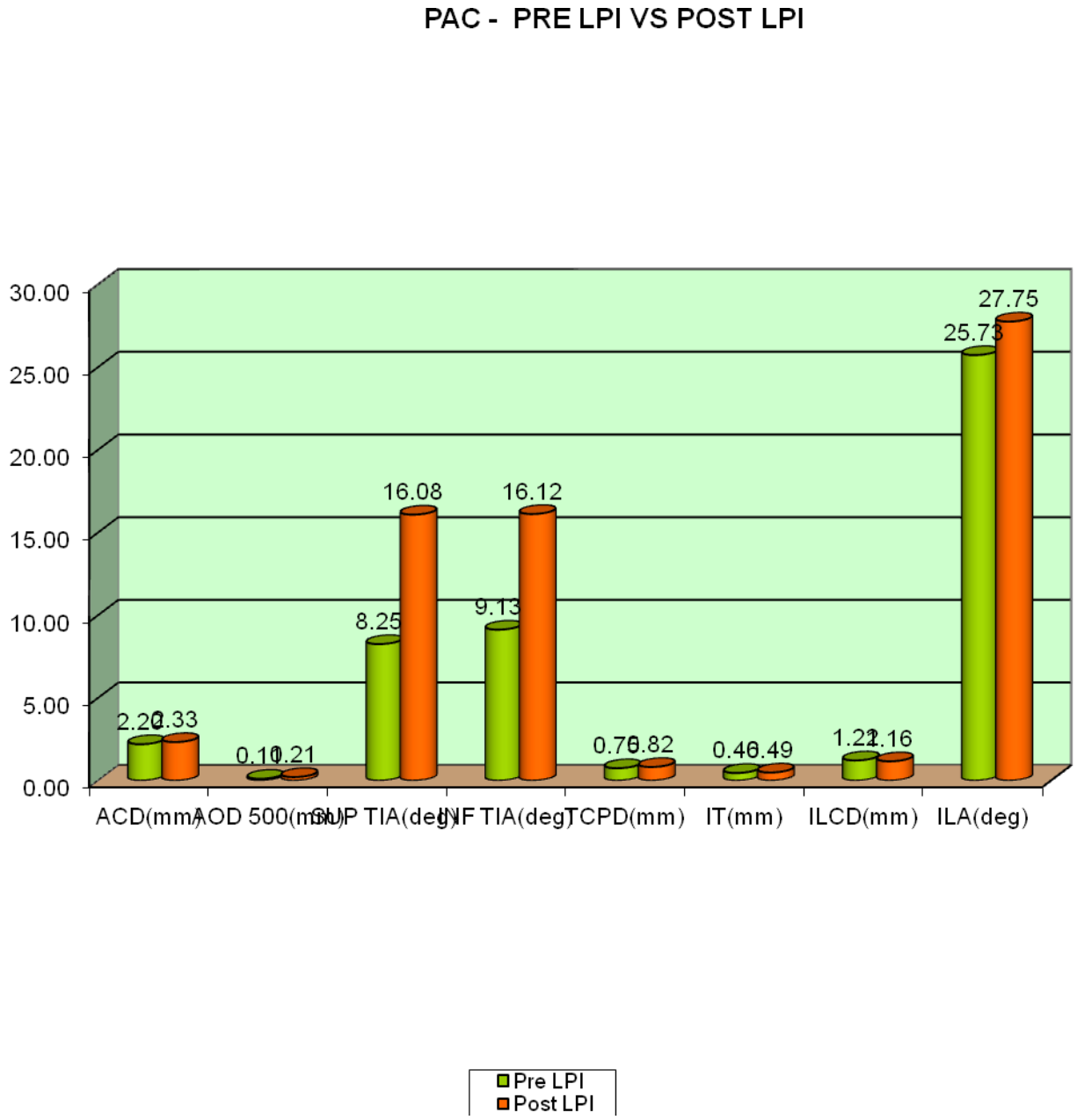


TABLE 20

PAC- PRE VS POST LPI ANGLE PARAMETERS

Among the group of PAC patients studied there was statistically significant change in all the parameters.

PAC	Pre LPI	Post LPI	MEAN	SD	P
ACD(mm)	2.20	2.33	2.199	0.04	<0.001
AOD 500(mm)	0.11	0.21	0.106	0.00	<0.001
SUP TIA(deg)	8.25	16.08	8.252	0.16	<0.001
INF TIA(deg)	9.13	16.12	9.125	0.04	<0.001
TCPD(mm)	0.75	0.82	0.745	0.00	<0.001
IT(mm)	0.46	0.49	0.459	0.01	<0.001
ILCD(mm)	1.22	1.16	1.217	0.05	<0.001
ILA(deg)	25.73	27.75	25.729	0.52	<0.001



There was an increase in the values of angle opening distance,anterior chamber depth, TIA,TCPD & ILA. There was a significant decrease in ILCD (IRIS LENS CONTACT DISTANCE).

TABLE 21

PACG- PRE VS POST LPI ANGLE PARAMETERS

Among the studied PACG patients, there was no significant significant change in any of the angle parameters following laser peripheral iridotomy.

PACG	Pre LPI	Post LPI	MEAN	SD	P
ACD(mm)	1.66	1.70	1.657	0.11	0.056
AOD 500(mm)	0.06	0.07	0.0631	0.01	0.074
SUP TIA(deg)	4.11	4.39	4.109	0.86	0.113
INF TIA(deg)	4.37	4.59	4.365	0.97	0.258
TCPD(mm)	0.66	0.66	0.655	0.02	0.224
IT(mm)	0.48	0.48	0.482	0.01	0.258
ILCD(mm)	1.37	1.37	1.374	0.03	0.365
ILA(deg)	9.01	8.97	9.013	3.32	0.965

ACD(mm) changed from an average from 1.657 ± 0.11 to 1.698 ±0.02 with a p value of 0.06

AOD 500 (Angle opening distance mm) changed from an average of 0.00631 ± 0.01 to 0.0664 ± 0.0 with a p value of 0.074

Sup TIA (deg) changed from an average of 4.109 ± 0.86 to 4.385 ± 0.14 with a p value of 0.113.

Inf TIA (deg) increased from an average of 4.365 ± 0.97 to 4.587 ± 0.20 with a p value of 0.258

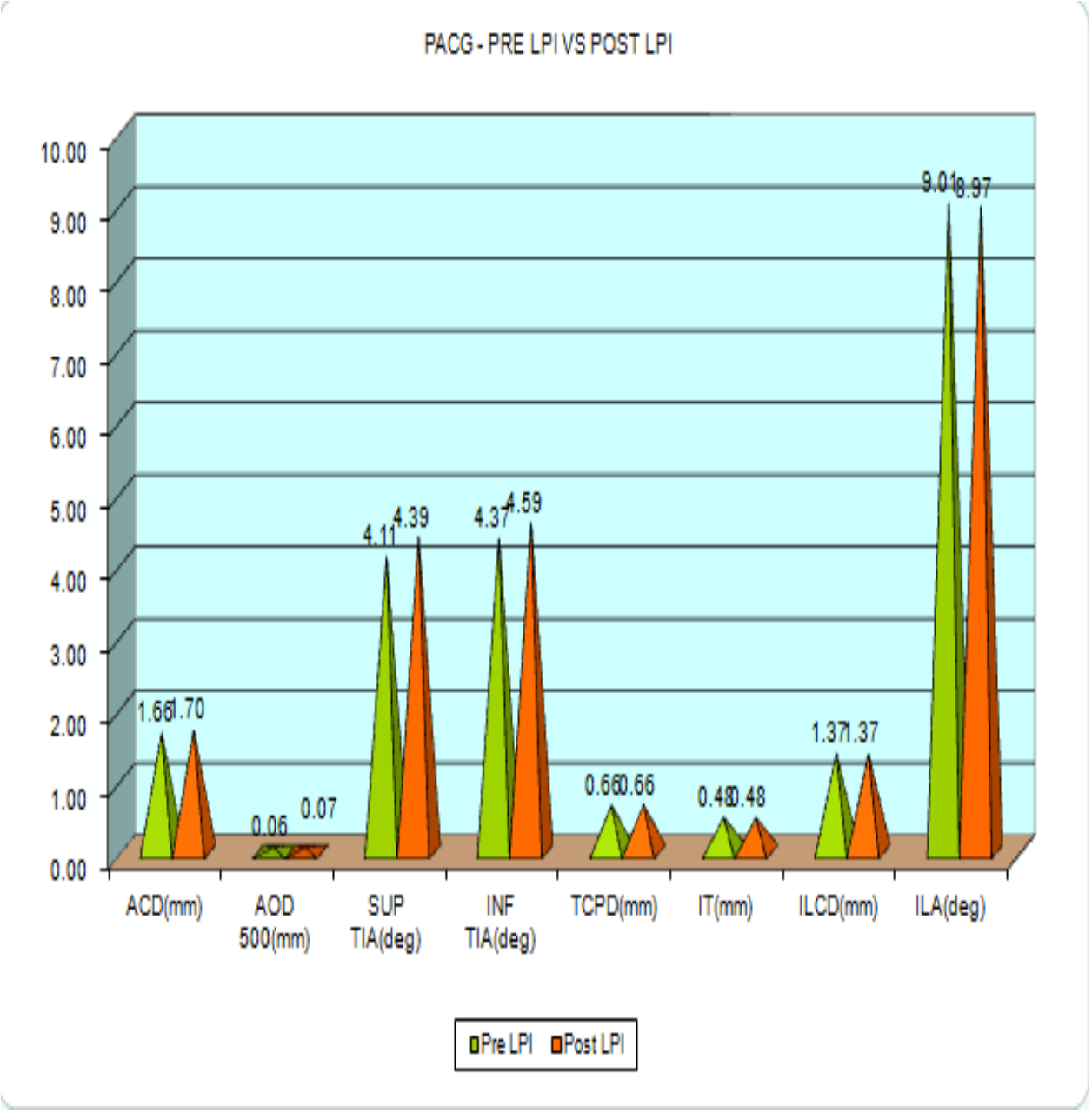
TCPD (TRABECULAR CILIARY BODY DISTANCE mm) increased from an average of 0.655 ± 0.02 to 0.66 ± 0.01 with a p value of 0.224

IT(IRIS THICKNESS mm) decreased from an average of 0.482 ± 0.01 to 0.478 ± 0.01 with a p value of 0.258

ILCD (IRIS LENS CONTACT DISTANCE mm) decreased from an average of 1.374 ± 0.03 to 1.367 ± 0.02 with a p value of 0.365

ILA (IRIS LENS ANGLE deg) changed from an average of 9.013 ± 3.32 to 8.969 ± 3.89 with a p value of 0.965.

PACG-PRE VS POST LPI



Summary

Of the total of 50 patients in the study group, 7 were below 50yrs, 20 were between 51-60 yrs & remaining 13 were above 60 yrs of age.

Among the PAC group having 24 patients , 6 patients ie 25% were below 50 yrs of age, 16 patients ie 66.6% were between 51-60 yrs of age & only 2 patients ie 8.3% were above 60 yrs.

Among the PACG group having 26 patients , only 1(3.8%) was below 50 yrs, 14 (53.8%) were between 51-60 yrs of age. 11 (42.3%) patients were above 60 yrs of age.

There was almost an equal number of males and females with males constituting 52% and females constituting 48% of the total study group.

Among the primary angle closure group, there were an equal number of males & females with 50% each and in PACG group, there were 14 males ie 53.8% & 12 females ie 46.1%.

Among the total studied population of 50 patients, 48% were diagnosed to have primary angle closure & remaining 52% had primary angle closure glaucoma.

In the PAC group:

There was a siginificant change in all the parameters measured.

ACD(mm) changed from an average from 2.199±0.04 to2.32±0.00 with a p value of < 0.001.

AOD 500 (Angle opening distance mm) increased from an average of 0.106 ± 0.0 to 0.209 ± 0.0 with a p value of < 0.001.

Sup TIA (deg) increased from an average of 8.252±0.16 to 16.081±0.23 with a p value of < 0.001.

Inf TIA (deg) increased from an average of 9.125±0.04 to 16.118±0.24 with a p value of < 0.001.

TCPD (TRABECULAR CILIARY BODY DISTANCE mm) increased from an average of 0.745 ± 0.0 to 0.82 ± 0.01 with a p value of < 0.001.

IT(IRIS THICKNESS mm) increased from an average of 0.459 ± 0.01 to 0.487 ± 0.00 with a p value of < 0.001

ILCD (IRIS LENS CONTACT DISTANCE mm) decreased from an average of 1.217 ± 0.05 to 1.162 ± 0.02 with a p value of < 0.001.

ILA (IRIS LENS ANGLE deg)) increased from an average of 25.729 ± 0.52 to 27.754 ± 0.57 with a p value of < 0.001.

In the **Primary angle closure glaucoma group :**

There was no significant change in any of the measured parameters.

ACD(mm) changed from an average from 1.657 ± 0.11 to 1.698 ±0.02 with a p value of 0.06

AOD 500 (Angle opening distance mm) changed from an average of 0.00631 ± 0.01 to 0.0664 ± 0.0 with a p value of 0.074

Sup TIA (deg) changed from an average of 4.109 ± 0.86 to 4.385 ± 0.14 with a p value of 0.113.

Inf TIA (deg) increased from an average of 4.365 ± 0.97 to 4.587 ± 0.20 with a p value of 0.258

TCPD (TRABECULAR CILIARY BODY DISTANCE mm) increased from an average of 0.655 ± 0.02 to 0.66 ± 0.01 with a p value of 0.224

IT(IRIS THICKNESS mm) decreased from an average of 0.482 ± 0.01 to 0.478 ± 0.01 with a p value of 0.258

ILCD (IRIS LENS CONTACT DISTANCE mm) decreased from an average of 1.374 ± 0.03 to 1.367 ± 0.02 with a p value of 0.365

ILA (IRIS LENS ANGLE deg) changed from an average of 9.013 ± 3.32 to 8.969 ± 3.89 with a p value of 0.965.

DISCUSSION

Primary angle closure glaucoma has a significantly high incidence & forms half of all adult primary glaucomas seen in a hospitals in India. The development of primary angle closure to primary angle closure glaucoma can be prevented by performing a laser peripheral iridotomy(LPI).In eyes with PAC ,an LPI may help in reversing appositional angle closure & control the intraocular pressure(IOP) .the primary aim of performing a peripheral iridotomy is to relieve pupillary block by creating an opening in the peripheral iris and equalising the intraocular pressure in anterior & posterior chambers, widening the angle recess & flattening the iris.

Though laser peripheral iridotomy is being routinely done for all cases of angle closure disease, there are very few studies which have established the exact changes that occur following LPI in PACG .

Traditionally angle morphology following laser peripheral iridotomy is studied using gonioscopy but the angle morphology assessed by gonioscopy is limited by observer bias & also does not allow accurate estimation of angle recess. Ultrasound biomicroscopy (UBM) is a high resolution imaging of anterior segment which allows objective & reproducible method of evaluation of angle morphology. It gives two dimensional gray scale images with a depth of penetration of about 5mm and hence the structures from the conjunctiva, cornea , angle, to the ciliary body & anterior layers of lens zonules & pars

plana can be visualised . Hence the etiological factors causing glaucoma can be assessed. It also allows quantitative analyses of angle relationships.

In our study group there was equal number of females and males . This may be attributed to small study group.

Among the age distribution ,there was a higher number(60%) of primary angle closure disease in the age group of 51-60 yrs . Multiple studies have demonstrated that the incidence of PACD increases with age.

"In the study titled Comparison of ultrasound biomicroscopic parameters after laser iridotomy in eyes with primary angle closure and primary angle closure glaucoma done by T Dada, S Mohan, R Sihota, R Gupta, V Gupta and R M Pandey at Glaucoma Research Laboratory, Dr Rajendra Prasad Centre for Ophthalmic Sciences, All India Institute of Medical Sciences, New Delhi, India Department of Biostatistics, All India Institute of Medical Sciences, New Delhi, India the authors have concluded that LPI leads to a widening of the anterior chamber angle and a deepening of the anterior chamber in eyes with PAC. It does not significantly change any anterior segment parameters in eyes with PACG[25]"

In our study there was a significant increase in ACD among the primary angle closure patients following iridotomy.

This was similar to the study conducted by Gus Gazzard, MA et al, who concluded that In Asian eyes at high risk of developing PAC, sequential LPI produced a significant widening of the anterior chamber.[26]

Also According to the LIWAN EYE STUDY , conducted by Mingguang He, MD, MPH et al which was done To assess the short-term effect of laser peripheral iridotomy (LPI) on anterior segment anatomy in angle-closure suspects using ultrasound biomicroscopy (UBM) the authors have found that there was a significant change in angle parameters following laser peripheral iridotomy in angle closure suspects[27].

There was a significant decrease in iris thickness & iridolenticular contact distance in our study .

"In the study conducted by Yoon KC et al ,Laser peripheral iridotomy results in a significant increase in the angle width in Chinese people with narrow angles. In those with iridotrabecular contact even with a patent iridotomy they found that they had smaller anterior chamber angle dimensions and a thicker iris[28]."

In the prospective study done by Kaushik et al, Kumar et al to evaluate anterior chamber angle by UBM and gonioscopy the anterior chamber angle widening following laser peripheral iridotomy in eyes with early chronic primary angle closure glaucoma and concluded that LPI resulted in significant widening of the anterior chamber angle in the quadrant with LPI and the quadrant furthest away in patients of PACG with established glaucomatous damage. This change was *much better appreciated by the UBM than gonioscopy*.[29]

This demonstrates the usefulness of UBM in angle morphology assessment.

The effectiveness of laser peripheral iridotomy in primary angle closure has been established.hence early institution of LPI is essential in primary angle angle closure disease prior to synechiae formation ,the formation of which usually warrants other more invasive modalities like surgery for its correction.

Thus there is a significant change in angle parameters following laser peripheral iridotomy in primary angle closure patients but no such change has been demonstrated in our study in PACG.This difference may be attributed to the synechial angle closure that occurs in primary angle closure glaucoma patients which prevents any significant change in the angle configuration following a laser peripheral iridotomy. Thus timely laser peripheral iridotomy is essential to prevent synechial closure which may need further medical therapy or invasive surgical procedures.

CONCLUSION

Among the studied population, observation in the angle characteristics showed that there was statistically significant change in the UBM parameters noted in the primary angle closure group , however no such significant change was noted in the primary angle closure glaucoma group.

Hence effective strategies should be adopted in order to identify angle closure at an early stage so that they can be treated prior to development of irreversible angle closure glaucoma.

PART III

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ABBREVIATIONS

LPI- LASER PERIPHERAL IRIDOTOMY

UBM-ULTRASOUND BIOMICROSCOPY

PACD- PRIMARY ANGLE CLOSURE DISEASE

PAC-PRIMARY ANGLE CLOSURE

PACG-PRIMARY ANGLE CLOSURE DISEASE

IOP-INTRAOCULAR PRESSURE

MASTER CHART

S. No	NAME	AGE	SEX	DIA GNOSIS	PRE LPI							
					ACD (mm)	AOD 500 (mm)	SUP TIA (deg)	INF TIA (deg)	TCPD (mm)	IT (mm)	ILCD (mm)	ILA (deg)
1	SHEELA	47	F	PAC	2.18	0.105	7.55	9.2	0.749	0.481	1.43	26.3
2	SHANTHI	55	F	PAC	2.21	0.106	8.3	9.1	0.745	0.471	1.21	26.4
3	MURUGAN	50	M	PAC	2.2	0.104	8.2	9.2	0.745	0.47	1.2	26.3
4	SAMI	57	M	PAC	2.19	0.107	8.3	9.1	0.744	0.48	1.21	25.3
5	SHANMUGAM	60	M	PAC	2.18	0.105	8.4	9.1	0.745	0.471	1.21	26.3
6	ARAMMAL	56	F	PAC	2.21	0.106	8.3	9.1	0.745	0.471	1.21	26.4
7	THAMBI	60	M	PAC	2.18	0.107	8.3	9.1	0.744	0.483	1.21	25.3
8	ARUMUGAM	58	M	PAC	2.2	0.106	8.3	9.1	0.744	0.481	1.21	25.3
9	KANDAN	59	M	PAC	2.21	0.106	8.3	9.1	0.745	0.471	1.21	26.4
10	KARUPPU	60	M	PAC	2.2	0.106	8.3	9.1	0.744	0.484	1.21	25.3
11	MEENAKSHI	54	F	PAC	2.18	0.107	8.3	9.1	0.744	0.476	1.21	25.3
12	PANTHANAM	62	F	PAC	2.2	0.104	8.2	9.2	0.745	0.47	1.2	26.3
13	KANDAIYA	60	M	PAC	2.31	0.106	8.3	9.1	0.744	0.486	1.21	25.3
14	JAKKAMAL	58	F	PAC	2.18	0.107	8.3	9.1	0.744	0.485	1.21	25.3
15	KALIRAJAN	65	M	PAC	2.2	0.106	8.3	9.1	0.744	0.481	1.21	25.3
16	SANTHAMMAL	60	F	PAC	2.16	0.107	8.3	9.1	0.744	0.484	1.21	25.3
17	SARAVANAN	57	M	PAC	2.2	0.106	8.3	9.1	0.744	0.478	1.21	25.3
18	CHANDRAN	55	M	PAC	2.31	0.106	8.3	9.1	0.744	0.479	1.21	25.3
19	MUGIL	54	F	PAC	2.16	0.107	8.3	9.1	0.744	0.486	1.21	25.3
20	SEKHAR	47	M	PAC	2.2	0.104	8.2	9.2	0.745	0.487	1.2	26.3
21	LATHA	47	F	PAC	2.2	0.104	8.2	9.2	0.745	0.47	1.2	26.3
22	THANGAMMAL	48	F	PAC	2.16	0.107	8.3	9.1	0.744	0.479	1.21	25.3
23	VAIRAM	50	F	PAC	2.2	0.104	8.2	9.2	0.745	0.47	1.2	26.3
24	GURUVAMMAL	56	F	PAC	2.16	0.107	8.3	9.1	0.744	0.475	1.21	25.3
25	PETCHIYAMMAL	62	F	PACG	1.62	0.06	3.9	4.1	0.652	0.48	1.38	8.4

S. No	NAME	AGE	SEX	DIA GNOSIS	PRE LPI							
					ACD (mm)	AOD 500 (mm)	SUP TIA (deg)	INF TIA (deg)	TCPD (mm)	IT (mm)	ILCD (mm)	ILA (deg)
27	JOSEPH	67	M	PACG	1.65	0.062	3.89	4.2	0.651	0.48	1.381	8.39
28	THAYAMMAL	55	F	PACG	1.61	0.06	3.9	4.1	0.652	0.48	1.38	8.4
29	AVUDAYAMMAL	54	F	PACG	1.63	0.063	4.1	4.2	0.655	0.5	1.382	8.2
30	LAKSHMI	55	F	PACG	1.65	0.062	3.89	4.2	0.651	0.48	1.381	8.39
31	PANDIYAMMAL	55	F	PACG	1.63	0.058	3.9	4.1	0.652	0.48	1.38	8.4
32	MEGAM	58	M	PACG	1.65	0.062	3.89	4.2	0.651	0.48	1.381	8.39
33	KARMEGAM	60	M	PACG	1.65	0.062	3.89	4.2	0.651	0.48	1.381	8.39
34	SHANMUGAM	54	M	PACG	1.65	0.062	3.89	4.2	0.651	0.48	1.381	8.39
35	SHANTHA	64	F	PACG	1.63	0.063	4.1	4.2	0.655	0.5	1.382	8.2
36	RAMAIYA	50	M	PACG	1.65	0.062	3.89	4.2	0.651	0.48	1.381	8.39
37	PANDIYAN	67	M	PACG	1.65	0.062	4.1	4.2	0.651	0.48	1.381	8.39
38	PASUPATHI	58	M	PACG	1.65	0.062	3.88	4.19	0.651	0.48	1.381	8.39
39	CHANDRAN	68	M	PACG	1.61	0.06	3.9	4.1	0.652	0.48	1.38	8.4
40	LAKSHMIAMMAL	69	F	PACG	1.63	0.059	3.89	4.22	0.651	0.48	1.381	8.39
41	MANIKKAMAL	65	F	PACG	1.632	0.062	3.88	4.19	0.651	0.48	1.381	8.39
42	CHANDRASEKHAR	57	F	PACG	2.18	0.107	8.3	9.1	0.744	0.45	1.21	8.4
43	CHINNAPONNU	60	F	PACG	1.62	0.06	3.9	4.1	0.652	0.48	1.38	8.42
44	CHANDRA	62	F	PACG	1.63	0.063	4.1	4.2	0.655	0.5	1.382	8.2
45	GURUVAMMAL	60	F	PACG	1.65	0.062	3.89	4.2	0.651	0.48	1.381	8.39
46	CHINNAIYA	60	M	PACG	1.65	0.062	4.1	4.2	0.651	0.48	1.381	8.39
47	PERIYATHAMBI	61	M	PACG	1.65	0.062	3.88	4.19	0.651	0.48	1.381	8.39
48	RAJU	65	M	PACG	1.61	0.06	3.9	4.1	0.652	0.48	1.38	8.4
49	PARAMASIVAM	63	M	PACG	1.63	0.059	3.89	4.22	0.651	0.48	1.381	8.39
50	SINGARAJ	57	M	PACG	1.632	0.062	3.88	4.19	0.651	0.48	1.381	8.39

MASTER CHART

S. No	NAME	POST LPI							
		ACD (mm)	AOD (mm)	SUP TIA (deg)	INF TIA (deg)	TCPD (mm)	IT (mm)	ILCD (mm)	ILA (deg)
1	SHEELA	2.2	0.208	16	15.9	0.835	0.483	1.23	28
2	SHANTHI	2.31	0.204	16.2	16.1	0.825	0.485	1.165	28.2
3	MURUGAN	2.32	0.203	15.65	15.9	0.825	0.486	1.164	28.3
4	SAMI	2.3	0.213	16.2	16.1	0.815	0.488	1.155	27.9
5	SHANMUGAM	2.31	0.204	16.3	16.1	0.825	0.485	1.165	27.8
6	ARAMMAL	2.31	0.204	16.2	16.1	0.825	0.485	1.165	28.2
7	THAMBI	2.3	0.213	16.2	16.1	0.815	0.488	1.155	27.9
8	ARUMUGAM	2.3	0.213	16.2	16.1	0.815	0.488	1.155	27.9
9	KANDAN	2.31	0.204	16.2	16.1	0.825	0.485	1.165	28.2
10	KARUPPU	2.3	0.213	16.2	16.1	0.815	0.488	1.155	27.9
11	MEENAKSHI	2.3	0.213	16.2	16.1	0.815	0.488	1.155	27.9
12	PANTHANAM	2.32	0.203	15.65	15.9	0.825	0.486	1.164	28.3
13	KANDAIYA	2.6	0.213	16.2	16.1	0.815	0.488	1.155	26.9
14	JAKKAMAL	2.3	0.213	16.2	16.8	0.815	0.488	1.155	27.9
15	KALIRAJAN	2.3	0.213	16.2	16.89	0.815	0.488	1.155	27.9
16	SANTHAMMAL	2.3	0.213	16.2	16.1	0.815	0.488	1.155	26.8
17	SARAVANAN	2.3	0.213	16.2	16.23	0.815	0.488	1.155	27.9
18	CHANDRAN	2.6	0.213	16.2	16.1	0.815	0.488	1.155	26.9
19	MUGIL	2.3	0.213	16.2	16.1	0.815	0.488	1.155	26.8
20	SEKHAR	2.32	0.203	15.65	15.9	0.825	0.486	1.164	28.3
21	LATHA	2.32	0.203	15.65	15.9	0.825	0.486	1.164	28.3
22	THANGAMMAL	2.3	0.213	16.2	16.1	0.815	0.488	1.155	26.8
23	VAIRAM	2.32	0.203	15.65	15.9	0.825	0.486	1.164	28.3
24	GURUVAMMAL	2.3	0.213	16.2	16.1	0.815	0.488	1.155	26.8
25	PETCHIYAMMAL	1.79	0.07	6	6.1	0.677	0.46	1.213	7.9

S. No	NAME	POST LPI							
		ACD (mm)	AOD (mm)	SUP TIA (deg)	INF TIA (deg)	TCPD (mm)	IT (mm)	ILCD (mm)	ILA (deg)
27	JOSEPH	1.78	0.071	6	6.1	0.677	0.46	1.213	7.9
28	THAYAMMAL	1.79	0.07	6	6.1	0.677	0.46	1.213	7.9
29	AVUDAYAMMAL	1.75	0.07	5.9	6.2	0.673	0.47	1.203	8
30	LAKSHMI	1.78	0.071	6	6.1	0.677	0.46	1.213	7.9
31	PANDIYAMMAL	1.79	0.07	6	6.1	0.677	0.46	1.213	7.9
32	MEGAM	1.78	0.071	6	6.1	0.677	0.46	1.213	9.1
33	KARMEGAM	1.78	0.071	6	6.1	0.677	0.46	1.213	7.9
34	SHANMUGAM	1.78	0.071	6	5.45	0.677	0.46	1.213	9.1
35	SHANTHA	1.75	0.07	5.9	6.2	0.673	0.47	1.203	8
36	RAMAIYA	1.78	0.071	6	6.1	0.677	0.46	1.213	7.9
37	PANDIYAN	1.78	0.071	6	6.1	0.677	0.46	1.213	7.9
38	PASUPATHI	1.78	0.071	6	5.7	0.677	0.46	1.213	9.1
39	CHANDRAN	1.79	0.07	6	5.34	0.677	0.46	1.213	7.8
40	LAKSHMIAMMAL	1.78	0.071	6	6.1	0.677	0.46	1.213	8.1
41	MANIKKAMAL	1.78	0.071	6	5.2	0.677	0.46	1.213	9.1
42	CHANDRASEKHAR	2.3	0.213	16.2	16.1	0.815	0.488	1.155	27.9
43	CHINNAPONNU	1.79	0.07	6	6.1	0.677	0.46	1.213	7.9
44	CHANDRA	1.75	0.07	5.9	6.2	0.673	0.47	1.203	8
45	GURUVAMMAL	1.78	0.071	6	6.1	0.677	0.46	1.213	7.9
46	CHINNAIYA	1.78	0.071	6	6.1	0.677	0.46	1.213	7.9
47	PERIYATHAMBI	1.78	0.071	6	6.1	0.677	0.46	1.213	9.1
48	RAJU	1.79	0.07	6	5.8	0.677	0.46	1.213	7.8
49	PARAMASIVAM	1.78	0.071	6	5.4	0.677	0.46	1.213	8.1
50	SINGARAJ	1.78	0.071	6	5.5	0.677	0.46	1.213	9.1

KEY TO MASTER CHART

M-MALE

F-FEMALE

LPI-LASER PERIPHERAL IRIDOTOMY

UBM-ULTRASOUND BIOMICROSCOPY

ACD- ANTERIOR CHAMBER DEPTH(CENTRAL)

AOD 500- ANGLE OPENING DISTANCE 500

SUP TIA- SUPERIOR TRABECULAR IRIS ANGLE

INF TIA- INFERIOR TRABECULAR IRIS ANGLE

TCPD- TRABECULAR CILIARY BODY DISTANCE

IT- IRIS THICKNESS

ILCD- IRIS LENS CONTACT DISTANCE

ILA- IRIS LENS ANGLE

PROFORMA

NAME:

AGE:

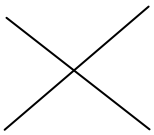
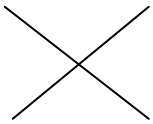
SEX:

IP/OP NUMBER:

PRESENT COMPLAINTS:

ON SLIT LAMP EXAMINATION:

	Right eye	**Left eye**
Lids		
Conjunctiva		
Cornea		
Anterior chamber		
Iris		
Pupil		
Lens		

	Right eye	**Left eye**
Visual acuity		
IOP by AT		
Gonioscopy		
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ETHICS COMMITTEE CERTIFICATE

Name of the Candidate	:	Dr.Noorul Hidaya
Course	:	PG in M.S., Ophthalmology
Period of Study	:	2014-2017
College	:	MADURAI MEDICAL COLLEGE
Research Topic	:	Ultrasound Biomicroscopic Assessment of Anterior chamber angle before & after laser peripheral Iridotomy in primary angle closure & Primary angle closure glaucoma
Ethical Committee as on	:	10.06.2016

The Ethics Committee, Madurai Medical College has decided to inform that your Research proposal is accepted.

Member Secretary Chairman Dean / Convenor

DEAN
Madurai Medical College
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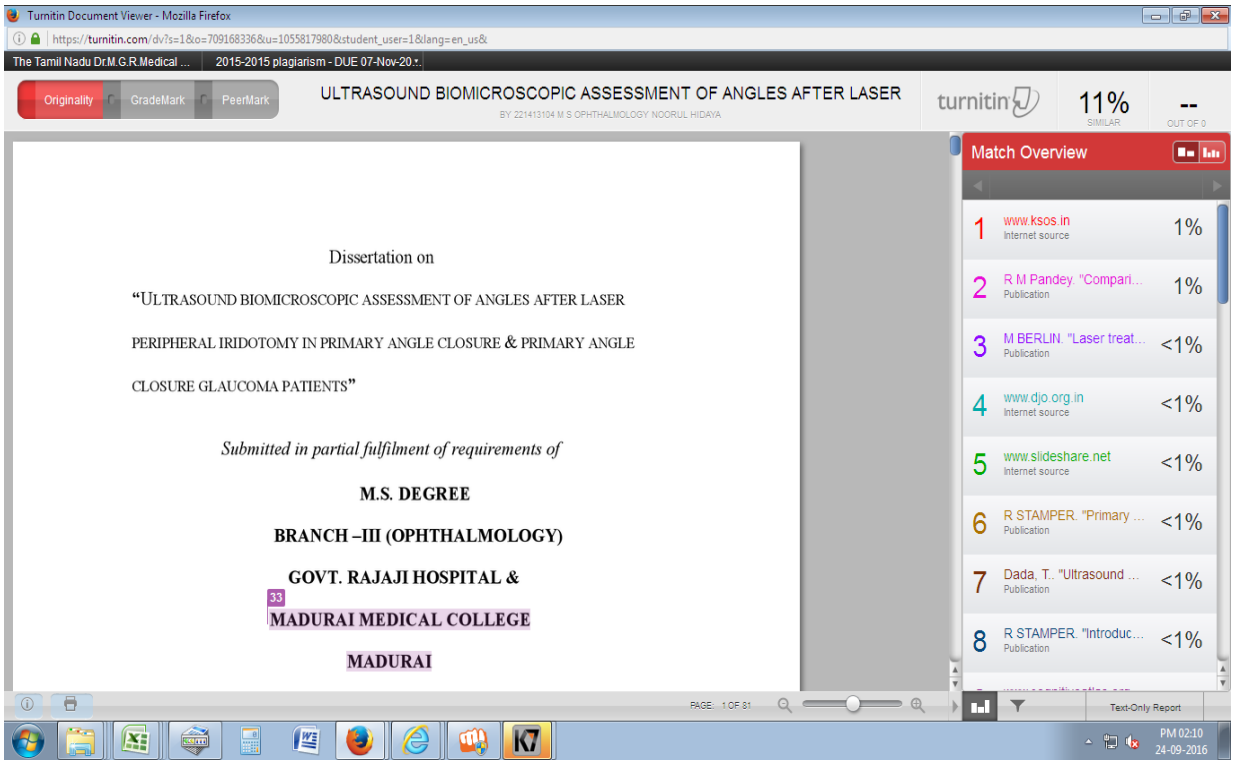
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Submitted in partial fulfilment of requirements of
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