COMPARATIVE STUDY OF ANTERIOR CHAMBER DEPTH PRE AND POST PROPHYLACTIC LASER IRIDOTOMY IN ANGLE CLOSURE SUSPECTS

Dissertation submitted to

The Tamil Nadu M.G.R Medical University

Chennai- 600032

In partial fulfilment of the

Regulations of the award of degree of

M.S. Ophthalmology

Department of Ophthalmology

Coimbatore Medical College Hospital

Coimbatore - 641018

DECLARATION

I hereby declare that this dissertation entitled **"COMPARATIVE STUDY OF ANTERIOR CHAMBER DEPTH PRE AND POST PROPHYLACTIC LASER IRIDOTOMY IN ANGLE CLOSURE SUSPECTS"** is a bonafide and genuine research work carried out by me under the guidance of **Dr A RAJENDRAPRASAD MS DO,** Professor of Ophthalmology, Coimbatore Medical College, Coimbatore.

This is submitted to The Tamil Nadu Dr. M.G.R Medical University, Chennai in partial fulfilment of requirement for the M.S., Ophthalmology, Branch III Degree Examination to be held in April 2013.

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CERTIFICATE BY THE GUIDE

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ACKNOWLEDGEMENT

I am grateful to the **DEAN Prof Dr R VIMALA, M.D.,** Coimbatore Medical College Hospital, Coimbatore for permitting me to do this study.

I am extremely thankful to **Prof.Dr A RAJENDRAPRASAD MS DO,** Professor and Head of the Department of Ophthalmology, Coimbatore Medical College Hospital for his valuable guidance in the preparation of this dissertation.

My sincere thanks to **Prof.Dr B ZAIBUNISSA MS DO,**for her valuable advice and encouragement, which helped me in completing this work successfully.

My thanks are to **Dr P Sumathi MS., Dr C Jeevakala MS, DO., Dr J Saravanan MS, Dr E AnithaMS**forhelping and guiding me in completing this work.

Thanks to administrators and nursing staff for helping me whole heartedly during this work.

I thank my husband **Dr P Rajamahendran** for supporting and encouraging me and my mother in law **Mrs P Rajalakshmi** for her immense support without which this work would not have been possible.

Finally, I would like to express my sincere thanks to all patients for their kind co-operation without which this study would not have been possible.

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Period of Study : SEPTEMBER 2011 - SEPTEMBER 2014

College : COIMBATORE MEDICAL COLLEGE

Dissertation Topic : COMPARATIVE STUDY OF ANTERIOR CHAMBER DEPTH PRE AND POST PROPHYLACTIC LASER IRIDOTOMY IN ANGLE CLOSURE SUSPECTS

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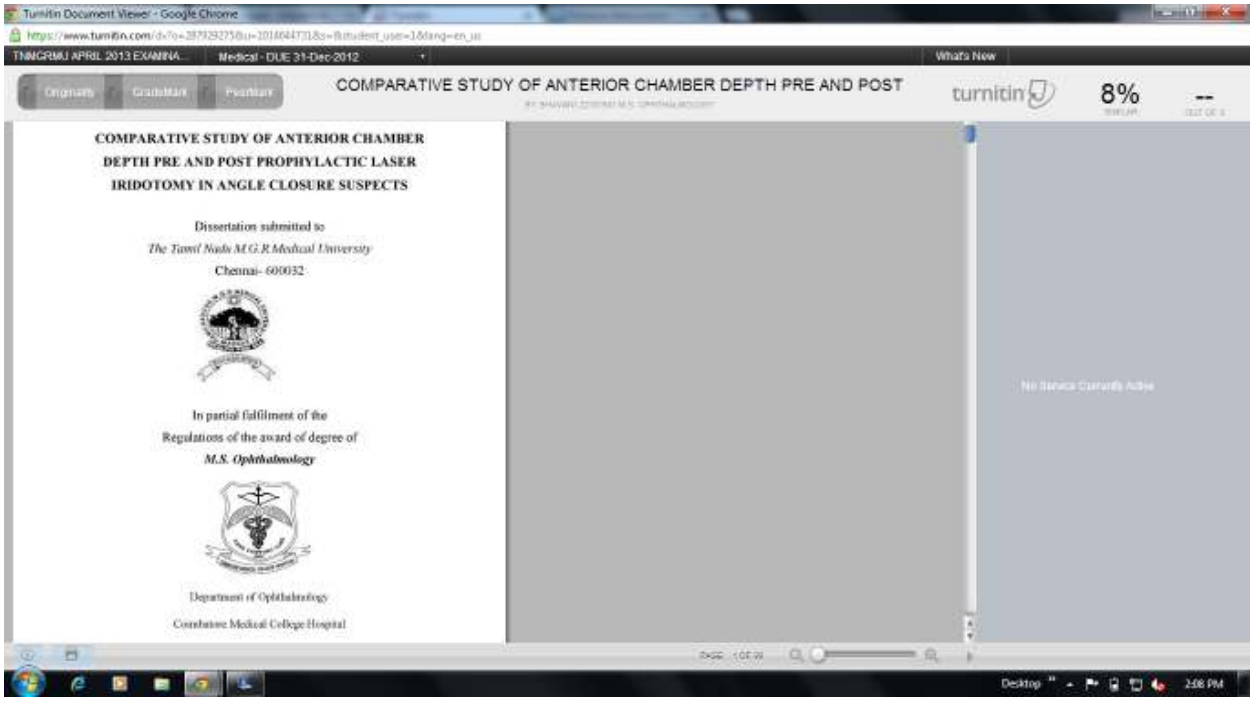
Author	Bhavani 22101941 M.S. Ophthalmology
E-mail	bhavanivk@yahoo.co.in
Submission time	21-Dec-2012 02:01PM
Total words	8752

First 100 words of your submission

COMPARATIVE STUDY OF ANTERIOR CHAMBER DEPTH PRE AND POST PROPHYLACTIC LASER IRIDOTOMY IN ANGLE CLOSURE SUSPECTS Dissertation submitted to The Tamil Nadu M.G.R Medical University Chennai- 600032 In partial fulfilment of the Regulations of the award of degree of M.S. Ophthalmology Department of Ophthalmology Coimbatore Medical College Hospital Coimbatore - 641018 INTRODUCTION afefs Irfao ai Gos iaf aio csmafs alGa cms csmfeafsiaGss colsfeaosc amocualG Ifco a s mw a cyfca fsa s sfeeua a a fmm c ia Ima ioroso y ia aua fi csfc a elv mosaa lGa oscmll sefmafm sm 1 . Angle closure glaucoma is characterized by mechanical obstruction of the trabecular meshwork secondary to pupillary block by an...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INTRODUCTION

Glaucoma is defined as disturbance of structural and functional integrity of optic nerve that can usually be arrested or diminished by adequate lowering of intraocular pressure[1].

Angle closure glaucoma is characterized by mechanical obstruction of the trabecular meshwork secondary to pupillary block by an anterior pulling mechanism or a posterior pushing mechanism[2].

Glaucoma is the leading cause of irreversible blindness worldwide and the second most common cause of blindness after cataracts and is responsible for 14% of blindness worldwide. It afflicts almost 70 million people, of whom 10% are believed to be bilaterally blind[3].

The estimated burden of glaucoma is escalating every decade. It is estimated that by 2020, there would be 79.6million sufferers[4].

Angle closure is regarded as less common than primary open-angle glaucoma, comprises approximately 10% of glaucoma in the West[5].

Earlier angle closure glaucoma was considered to be less common than open angle glaucoma. But now it has been found that angle closure is as common as open-angle glaucoma in South Asia[6].

A landmark study conducted in India by Aravind eye hospital reported a prevalence of 0.5% for PACG[6].

The Chennai Rural and Urban Glaucoma Study concluded overall prevalence of primary angle closures to be 0.8%. Prevalence of PACS was 6-7%[7].

Prevalence of PACG and PACS were similar in both the urban and rural populations. Primary angle closure and PACG were positively associated with increasing age and IOP in both populations[7].

It is now confirmed that not only is ACG more common than originally thought, but also it is associated with a much higher visual morbidity than open angle glaucoma. ACG, if recognized and treated early, results in a good visual prognosis. Visual morbidity can be prevented if ACG is detected early; hence, early detection is the key[2].

The gold standard examination in diagnosing angle closure glaucoma is gonioscopy, which can grade the angle in the four quadrants. It helps to identify the angle closure suspects[2].

Another parameter of great diagnostic value within the context of angle-closure glaucoma is the peripheral anterior chamber depth. Van Herick et al. developed a technique for making this estimation with the

slit-lamp. It compares the peripheral anterior chamber depth with the thickness of the adjacent cornea.

This is commonly referred to as the Van Herick technique. When the peripheral anterior chamber depth is less than one fourth of the corneal thickness, the patient is regarded as an angle closure suspect[9].

Optic nerve damage occurs in the early period after IOP increases, supporting the value of detecting potentially occludable angles and performing prophylactic surgery before an attack[9].

If the angle is deemed occludable prophylactic peripheral iridotomy is warranted. The fellow eye should also be examined, and if deemed occludable, better to proceed with iridotomy at the same sitting[9].

ANATOMICAL CONSIDERATION

The anterior chamber is a compartment filled with aqueous humour, lying behind the cornea and in front of the iris and the lens in the pupillary space[10].

The angle of the chamber is the most peripheral part and gives access to the drainage structure by which the aqueous leaves the eye, hence the term drainage angle[10].

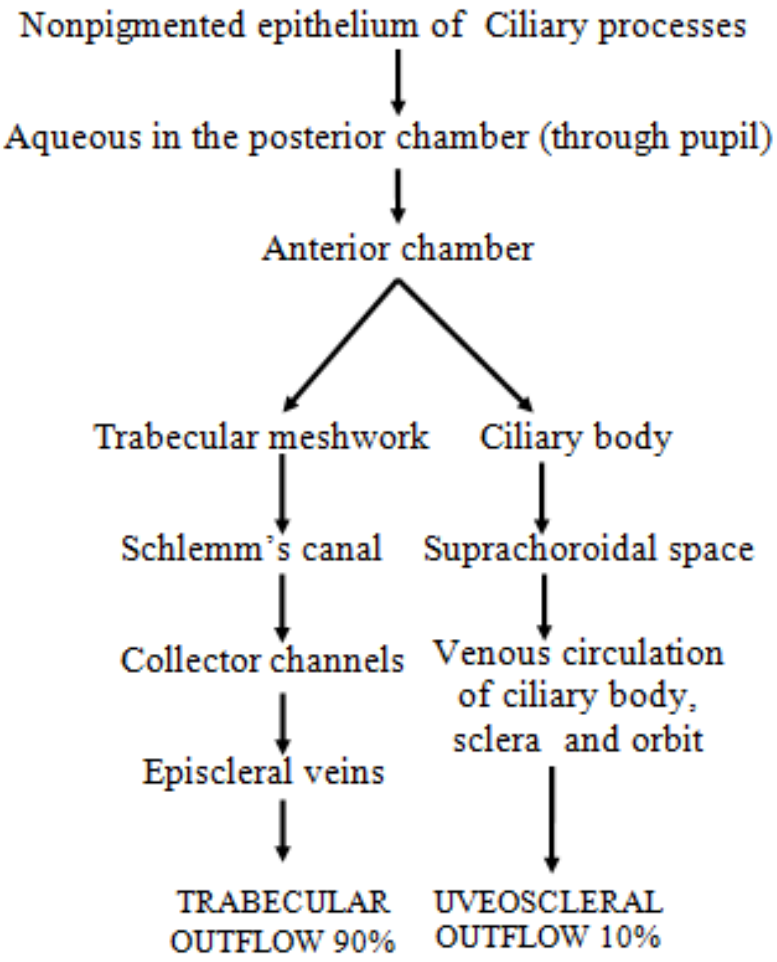
BIOLOGY OF AQUEOUS HUMOR OUTFLOW

Most of the aqueous exits the eye at through the structures in the angle which consists of trabecular meshwork, Schlemm's canal and episcleralveins[12].

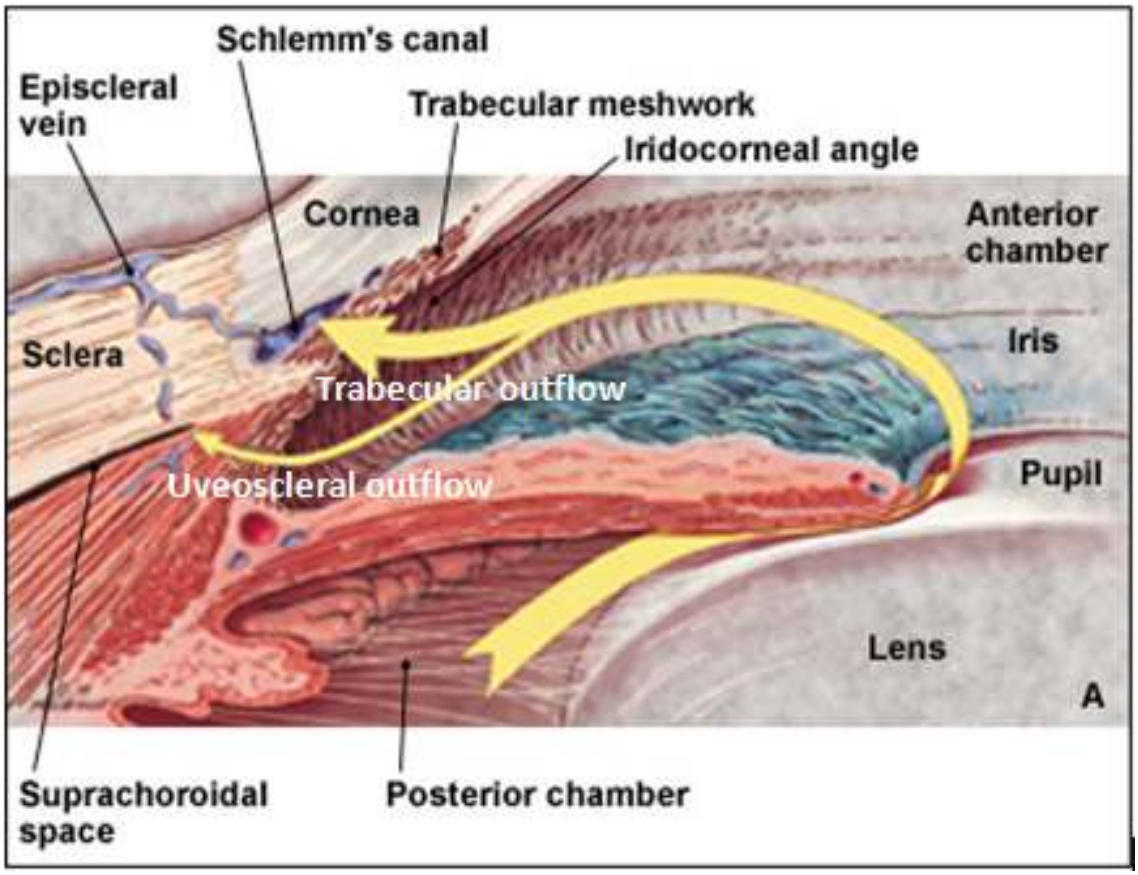
This pathway is referred to as the conventional or trabecular outflow. In the unconventional or uveoscleral outflow, aqueous humor exits by passing through the root of the iris, between the ciliary muscle bundles, then through the suprachoroidal-scleral tissues[12].

The relative contributions of trabecular and uveoscleral outflow show an age-related shift, with a relative increase in the contribution in the former pathway[12].

FORMATION AND CIRCULATION OF AQUEOUS HUMOUR[23]



OUTFLOW PATHWAY



CELLULAR ORGANIZATION OF THE TRABECULAR OUTFLOW PATHWAY

Scleral Spur

The posterior wall of the scleral sulcus is formed by a group of fibers, the scleral roll, which run parallel to the limbus and project inward to form the scleral spur[12].

The width of trabecular spaces is increased by the contraction of the scleral spur which causes a posterior pull of the sclera thereby facilitating the outflow[11].

Schwalbe's Line

The peripheral rim of descemet's membrane is the internal landmark of corneal limbus and marks the anterior limit of drainage angle. It is prominent in 15-20% of individuals[13].

Trabecular Meshwork[14]

The trabecular meshwork consists of a connective tissue core surrounded by endothelium. It is divided into three portions; the uveal, corneoscleral and juxtacanalicular tissue.

Uveal Meshwork

This is the inner most portion. It is arranged in bands that extend from the iris root and ciliary body to the peripheral cornea[14].

Corneoscleral Meshwork

It consists of sheets of trabeculae that have perforations which are elliptical in shape.

Both the uveal and corneoscleral trabecular bands and sheets are composed of four concentric layers which are an inner connective tissue core, elastic fibers, glass membrane and outer endothelial layer[15].

The trabecular endothelial cells are larger, more irregular, and have less prominent borders than corneal endothelial cells joined by gap junctions and desmosomes, which provide stability, but allow aqueous humor to freely traverse the patent endothelial clefts[16].

Juxtacanalicular Tissue

It is 2-20 microns thick separating corneoscleral meshwork from schlemm's canal. It has a ground substance of glycosaminoglycans and glycoprotein[14].

Schlemm's Canal

This is a 360-degree endothelial-lined channel. The outer wall of schlemm’s canal has a single layer of endothelium that lacks pores or vacuoles[17].

Intrascleral Channels

Schlemm's canal is connected to episcleral and conjunctival veins by a complex system of intrascleral channels. Two systems of intrascleral channels have been identified:

A. A direct system of large caliber vessels, which run a short intrascleral course and drain directly into the episcleral venous system, and;

B. An indirect system of more numerous, finer channels, which form an intrascleral plexus before eventually draining into the episcleral venous system[17].

HISTORY OF PRIMARY ANGLE CLOSURE GLAUCOMA

Before the discovery and use of gonioscopy, ophthalmologists did not fully distinguish between open angle glaucoma and angle closure glaucoma. They did not recognise that glaucoma could be sudden and another that was slow in development. In 1857, Von Graefe[20] performed an iridectomy on a staphylomatous eye and demonstrated the first cure for acute inflammatory glaucoma.

But only in 1920 the reason for this cure was understood; that iridectomy relieved the forces of relative pupillary block[21].

It was only following the popularisation of gonioscopy by Barkan that the concept of angle closure glaucoma became widely accepted[22].

Edward Curan in 1920 proposed the mechanism of pupillary block and the importance of an iridectomy in breaking this impeded aqueous flow[21].

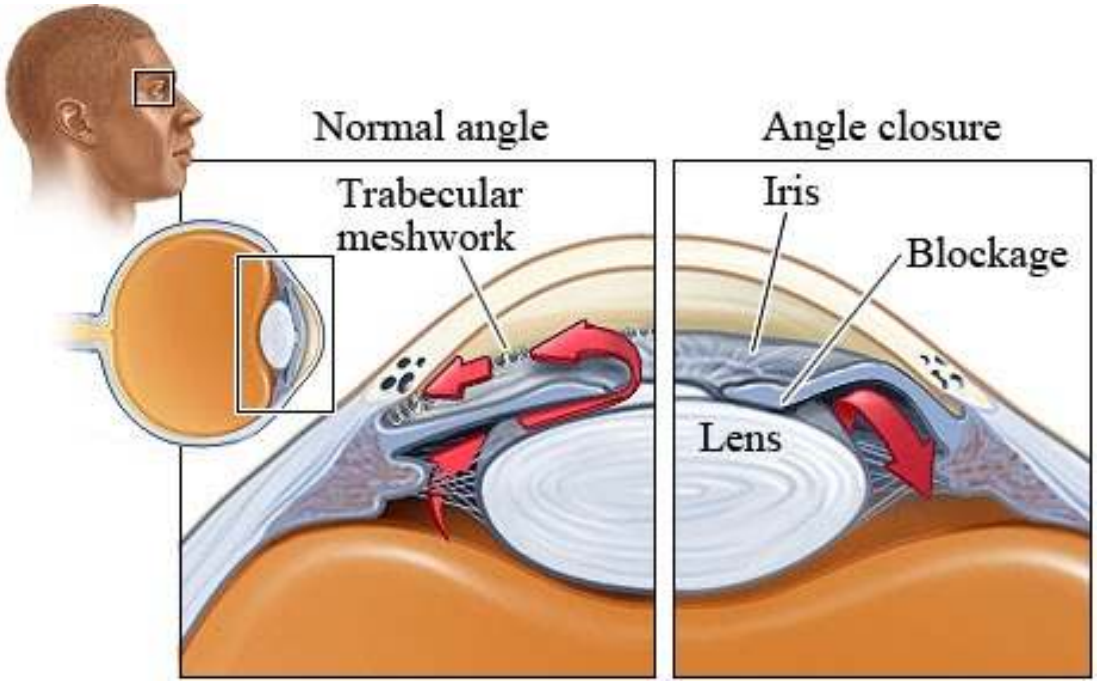
Angle closure glaucoma was first described by St Yves in 1722. He described its symptoms, signs and prognosis[25].

In 1923, Raeder proposed the classification of glaucoma into two types, one with shallow anterior chamber and other with a normal or deep chamber[25].

PUPILLARY BLOCK GLAUCOMA

Pupillary-block glaucoma, a category of angle-closure 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[25].

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[25].



Traditional Classification Of Angle Closure Glaucoma Based On Clinical Presentation And Symptomatology[25]

Acute stage

Sudden onset of IOP elevation resulting from total angle closure, accompanied by symptoms of severe, usually unilateral, ocular pain, red eye, blurred vision, haloes, headache (ipsilateral frontal), nausea and vomiting[25].

Subacute/intermittent/creeping stage

In this stage an episode of sudden IOP elevation occurs that is spontaneously aborted, so that symptoms are mild or even absent. Such subacute IOP elevations may be recurrent and therefore termed intermittent angle closure. Intermittent angle closure can result in progressive PAS formation, termed creeping angle closure[25].

Chronic stage

Chronic IOP elevations due to the presence of PAS may permanently close the anterior chamber angle. Symptoms are usually absent[25].

Latent stage

There is evidence that an open but narrow angle can and does close under certain circumstances. It is usually asymptomatic but PAS may be found on gonioscopy[25].

CLASSIFICATION BASED ON NATURAL HISTORY

(PROPOSED BY FOSTER AND COLLEAGUES) [34]

1. PRIMARY ANGLE CLOSURE SUSPECT (PACS)

An eye in which there is

- Angle in which 180-270 degree of posterior trabecular meshwork cannot be seen gonioscopically.
- It is characterised by an absence of peripheral anterior synechiae, normal IOP, disc and visual field.

2. PRIMARY ANGLE CLOSURE (PAC)

- It has the feature of Greater than 270^0 of irido-trabecular contact with an elevated IOP and/or PAS but a normal disc and visual field.

3. PRIMARY ANGLE CLOSURE GLAUCOMA (PACG)

- It is characterised by a of irido-trabecular contact of more than 270 degrees with an elevated IOP, disc and visual field changes.

CLASSIFICATION BASED ON ANATOMICAL LEVELS OF OBSTRUCTION TO AQUEOUS FLOW[25]

Irido-trabecular contact in angle closure glaucoma may be due to forces acting at 4 anatomical levels-

IRIS

- Pupillary block
- Non pupillary block/angle crowding mechanism, eg: thick peripheral iris roll

CILIARY BODY

- Plateau iris configuration
- Ciliary body cyst

LENS

- Phacomorphic glaucoma
- Phacolytic glaucoma
- Subluxated lens

VECTORS POSTERIOR TO LENS

- Aqueous misdirection (malignant glaucoma)

RISK FACTORS

The main demographic risk factor in developing pupillary-block glaucoma is advanced age and a female sex.

Age

The anterior chamber volume and depth decrease with age due to thickening and forward displacement of the lens. Older individuals have a higher incidence of pupillary block glaucoma[27].

The prevalence of pupillary-block glaucoma also increases with age, although it may peak earlier in life than that of chronic open-angle glaucoma[24].

Race

The relative prevalence of pupillary-block glaucoma among all the glaucoma is increased in various populations of Inuit and individuals with far Eastern Asian extraction[28]. Acute angle-closure glaucoma is less common among blacks, but sub-acute or chronic angle-closure glaucoma is not uncommon and appears to be a regularly missed diagnosis[29].

Gender

There is a statistically significant predominance of females in populations with pupillary block glaucoma, which is probably caused by the shallower anterior chamber among women in general[27].

Refractive Error

The depth and volume of the anterior chamber are related to the degree of ametropia, with smaller dimensions occurring in hyperopes. However, the presence of myopia does not eliminate the possibility of angle-closure glaucoma because rare cases have been reported in such patients, possibly indicting a spherical or anteriorly displaced lens or an increase in corneal curvature[27].

Family History

Kass and Becker were among the first to observe a strong correlation between family history and glaucoma. The potential for pupillary-block glaucoma is generally believed to be inherited. However, aside from a few reported families in which many members developed angle-closure glaucoma, the family history is not very useful in predicting a future angle- closure attack[30].

Anatomical risk factors[25]

- Shallow anterior chamber depth
- Thick/anteriorly positioned/increased anterior curvature of lens
- Short axial length
- Small diameter/increased curvature of cornea
- Plateau iris configuration/thick peripheral iris roll

PRECIPITATING FACTORS

In an eye that is anatomically predisposed to develop angle-closure, several factors may precipitate an attack.

FACTORS THAT PRODUCE MYDRIASIS

Dim illumination

A common history for the development of pupillary-block glaucoma is the onset of an acute attack when the patient is in a dark room, such as a theatre or restaurant[24].

Emotional stress

Occasionally, an acute angle-closure attack follows severe emotional stress. This may be related to the mydriasis of increased sympathetic tone[24].

Drugs

Mydriatics may also precipitate an angle-closure attack in an anatomically predisposed eye.

Anticholinergics (e.g., atropine, cyclopentolate, tropicamide) create a particularly high risk when administered topically[31].

Other systemic drugs with weaker anticholinergic properties (e.g., antihistaminic, anti-parkinsonian, antipsychotic, and gastrointestinal spasmolytic drugs) also present a risk proportional to their pupillary effect[48].

The tricyclic antidepressants have the greatest anticholinergic properties of the various psychoactive drugs. Botulinum toxin, used in the treatment of strabismus and blepharospasm, inhibits acetylcholine release with subsequent mydriasis, and can cause acute angle-closure glaucoma[48].

Adrenergics (e.g., topical epinephrine) may precipitate an angle-closure attack in the predisposed eye. Systemic drugs with adrenergic properties (e.g., vasoconstrictors, central nervous system stimulants, appetite depressants, bronchodilators, hallucinogenic agents) may present a risk in the predisposed eye[49].

Topiramate, a sulfamate- substituted monosaccharide, is an oral medication prescribed as an antiepilectic and antidepressant. In some patients using this medication, a syndrome characterized by acute myopic shift (>6 D) and acute bilateral angle closure glaucoma can occur.

The underlying mechanism for this syndrome is ciliochoroidal effusion, which causes relaxation of zonules and profound anterior displacement of lens-iris complex, causing secondary angle closure glaucoma and high myopia[54].

FACTORS THAT PRODUCE MIOSIS

Miotic therapy may occasionally lead to an acute attack of pupillary-block glaucoma. This has also been observed after the miosis induced by reading or bright lights[24].

Possible mechanisms include an increase in the relative pupillary block due to a wider zone of contact between iris and lens and relaxation of the lens zonules, allowing a forward shift of the iris-lens diaphragm[24].

With strong miotics, such as the cholinesterase inhibitors (e.g., diisopropylfluorophosphate, echothiophate iodide), the mechanism of angle-closure may be the miosis or congestion of the uveal tract[24].

FINDINGS DURING ROUTINE EXAMINATION[24]

Certain observations during the course of a routine ocular examination can help to establish the potential for angle closure. They include the following-

- IOP measurement
- Penlight examination for anterior chamber depth assessment
- Slit lamp examination for Van Herick's grading
- Gonioscopy for Shaffer's grading
- Newer techniques like UBM, scheimpflug video imaging and dual beam partial coherence interferometry have been used recently.

MEASUREMENT OF IOP

GOLDMANN APPLANATION TONOMETRY-

Basic Concept-

The basic concept of applanation tonometry is based on a modification of the Maklakov-Fick law (also referred to as the Imbert-Fick law)[36].

According to this law the external force (W) against a sphere equals the pressure in the sphere (P_t) times the area flattened (applanated) by the external force (A):

$$\mathbf{W = P_t \times A}$$

But the main requirements of this law are that the sphere should be perfectly spherical, dry, and perfectly flexible and infinitely thin.

The cornea does not satisfy these requirements. Apart from this the central thickness of the cornea is around 550 microns, and therefore the outer area of flattening (A) is not the same as the inner area (A_1).

It was, therefore, necessary to modify the Imbert-Fick law in the following manner to account for these characteristics of the cornea:

$$\mathbf{W + S = P_t A_1 + B}$$

When A_1= 7.35 mm^2, S balances B and W=P_t.

The volume of displacement produced by applanating an area with a diameter of 3.06 mm is approximately 0.50 mm^3, so that P_t is very close to P_o.

Description of Tonometer[26]

The instrument is mounted on a standard slit-lamp in such a way that the examiner's view is directed through the centre of a plastic biprism, which is used to applanate the cornea.

Two beam-splitting prisms within the applanating unit optically convert the circular area of corneal contact into semicircles. The prisms are adjusted so that the inner margins of the semicircles overlap when 3.06 mm of cornea is applanated.

The biprism is attached by a rod to a housing, which contains a coil spring and series of levers that are used to adjust the force of the biprism against the cornea.

Technique

The cornea is anesthetized with a topical preparation, and the tear film is stained with sodium fluorescein. With the cornea and biprism illuminated by a cobalt blue light from the slit-lamp, the biprism is brought into gentle contact with the apex of the cornea.

The fluorescence of the stained tears facilitates visualization of the tear meniscus at the margin of contact between cornea and biprism. The fluorescent semicircles are viewed through the biprism, and the force against the cornea is adjusted until the inner edges overlap.

The influence of the ocular pulsations is seen when the instrument is properly positioned, and the excursions must be averaged to give the desired endpoint. The IOP is then read directly from a scale on the tonometer housing.

The staining of the tear film may be accomplished by instilling a drop of topical anaesthetic and touching a fluorescein-impregnated paper strip to the tears in the lower cul-de-sac.

Variations in CCT can lead to errors in the measurement of applanation tonometry because the mathematical calculation is based on a presumed average CCT. Thinner cornea leads to an underestimation of IOP, and if thicker an overestimation occurs.

Central corneal thickness is measured by ultrasound pachymetry and the true IOP is measured.

EVALUATION OF PERIPHERAL ANTERIOR CHAMBER

Penlight Examination

The anterior chamber depth can be estimated with oblique penlight illumination across the surface of the iris.

With the light coming from the temporal side of the eye, a relatively flat iris is illuminated on the temporal and nasal sides of the pupil, whereas an iris that is bowed forward has a shadow on the nasal side[37].

ACD can be graded as follows-

- Grade 1- <1/3rd illuminated
- Grade 2- 1/3rd -2/3rd illuminated
- Grade 3- >2/3rd illuminated
- Grade 4- fully illuminated

Slit-Lamp Examination

Van Herick et al. developed a technique for making the estimation of peripheral ACD with the slit-lamp by comparing the peripheral anterior chamber depth to the thickness of the adjacent cornea.

This is commonly referred to as the van Herick technique[32].

When the peripheral anterior chamber depth is less than one fourth of the corneal thickness, the anterior chamber angle may be potentially occludable.

ANGLE	ANTERIOR CHAMBER DEPTH
GRADE IV	= Corneal thickness
GRADE III	¼ to ½ Corneal thickness
GRADE II	¼ Corneal thickness
GRADE I	< ¼ of Corneal thickness
CLOSED	Absent peripheral anterior chamber

The peripheral anterior chamber can be graded by a modification of the Van Herick test[33].

Instead of the four grades used in the Van Herick method, it has seven grades that are expressed as a percentage fraction of the thickness of the adjacent cornea: 0%, 5%, 15%, 25%, 40%, 75%, and 100%. The limbal chamber depth method has been demonstrated to perform better in the detection of established PACG and is now widely used in epidemiologic research[2].

GONIOSCOPY

Under normal condition light reflected from the angle structure undergoes total internal reflection at the tear-air-interface. Critical angle for cornea-air-interface is approximately 46 degree. Light from anterior chamber angle exceeds this critical angle and so is reflected back into anterior chamber preventing visualization of angle. This is eliminated by goniolens and gonioprism. In both, critical angle is not reached so light gets refracted at the contact lens-air-interface[51].

When the peripheral anterior chamber depth is thought to be shallow, examination of the angle by gonioscopy is a must[24].

By compression gonioscopy angle closure can be identified as being either appositional closure or synechial closure. The patient should be examined in a dark room and with the use of a short, narrow slit beam to avoid constricting the pupil and artifactually opening the angle. The examiner also should take care to avoid extra pressure on the cornea so that the angle does not deepen artifactually[24].

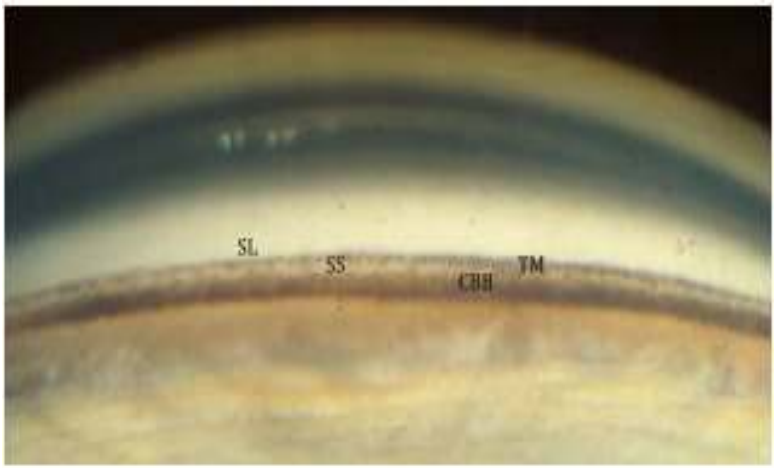
If the peripheral iris is prominent, or the iris is very convex and it is difficult to see angle structures, it is often helpful to have the patient look in the direction of the mirror being viewed so that a more accurate assessment of what angle structures are visible can be made[24].

GONIOSCOPIC APPEARANCE OF THE NORMAL ANTERIOR CHAMBER ANGLE[24]

Viewed starting at root of iris progressing anterior towards cornea

- Ciliary body band
- Scleral spur
- Schlemm canal
- Trabeculum
- Schwalbe line

NORMAL STRUCTURES IN GONIOSCOPY



CBB – Ciliary Body Band

TM – Trabecular Meshwork

SL – Schwalbe's Line

SS – Scleral Spur

CILIARY BODY BAND:

It is formed by anterior portion of the ciliary muscle between the insertion of the iris root and scleral spur. It lies posterior to scleral spur and varies in colour from pink to dark brown. It is wider in myopic individuals and narrower in hypermetropes[39]

SCLERAL SPUR

This is the anterior projection of the sclera and the site of attachment of the longitudinal muscle of the ciliary body. It is usually seen as prominent white line between ciliary body and functional trabecular meshwork[39].

SCHLEMM'S CANAL

Blood can be seen in the schlemm's canal if the goniolens compresses the episcleral vein which causes the episcleral venous pressure to exceed the intraocular pressure[39].

TRABECULAR MESHWORK

It extends from the Schwalbe's line to the sclera spur with a width of 600 micrometer with an anterior nonfunctional part adjacent to Schwalbe's line which is white in color. The posterior functional part lies adjacent to the sclera spur is pigmented. Functional meshwork appearance varies depending upon the amount and distribution of pigment deposition[39].

SCHWALBE LINE

This line is a prominent translucent or white condensation of collagenous tissue at the peripheral termination of Descemet's membrane. It marks the anterior boundary of iridocorneal angle[39].

Numerous grading systems have been suggested in an attempt to correlate gonioscopic appearance with the potential for angle-closure.

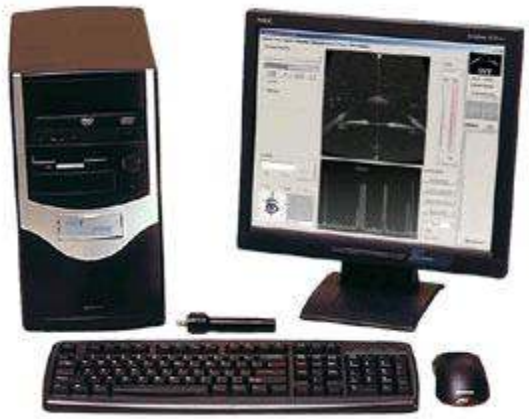
SHAFFERS GRADING[50]

SHAFFER'S SYSTEM OF GRADING THE ANGLE WIDTH

ANGLE GRADE	DEGREES	NUMERIC GRADE	CLINICAL INTERPRETATION
Wide open angle	30 – 40	3 – 4	Closure impossible
Moderately narrow angle	20	2	Closure possible
Extremely narrow angle	10	1	Eventual closure probable
Slit angle	<10	S	Portions appear closed
Closed	-	0	Closure present

Spaeth grading system is based on site of iris insertion, width of the angle recess and configuration of the peripheral iris.It also provides information on pigmentation of trabecular meshwork and indentation gonioscopy.

ULTRASOUND BIOMICROSCOPY



UBM is a high resolution ultrasound technique developed by Pavlin. Sherar and Foster in Toronto in the late 1980's. UBM is a high frequency ultrasound technology that allows non-invasive in-vivo imaging of structural details of the anterior ocular segment at near microscopic resolution[55].

It provides detailed two-dimensional grayscale images of the various structures and evaluates them both quantitatively and qualitatively.

PRINCIPLE

UBM uses a scan transducer that has a high frequency. The transducer frequency of conventional diagnostic ultrasound instruments is in the range of 7.5 to 10 MHz. In contrast, the transducer frequency of UBM is approximately 50 MHz[52]. UBM provides much higher resolution than conventional B-scan ocular ultrasonography. The improved imaging resolution is attributable to the higher transducer frequency of the UBM.

UBM is not able to image as deeply into the eyes as is conventional B scan. This is because improved resolution comes at the expense of reduced depth of penetration of the ultrasound beam. Tissue penetration is 5mm for a 50 MHz UBM instrument[56].

The real time image is displayed on a video moniter and can be recorded. The room illumination, fixation and accommodative effort of the patient should be held constant particularly while doing quantitative evaluation[55].

THEORETIC CONSIDERATIONS AND DEVELOPMENT OF THE ULTRASOUND BIOMICROSCOPE

Vibrations and mechanical waves occurs over a wide range of frequencies called as the acoustic spectrum which extends from the audible range (10 to 20,000 Hz), to the range of phonons (>1012 (10 to the 12th power) Hz) which comprise the vibrational states of matter[55].

The resolution and depth of penetration of tissue of ultrasonography are affected by transducer frequency. In the ultrasound imaging system, the lateral resolution is related to the full width of ultrasound beam at half maximal amplitude and is given by the equation:

$$\mathbf{FWMH = c\ f / (v\ d) = \lambda\ (f\text{ - number})}$$

Where c is the speed of sound, f is the focal length of the transducer, v is the frequency, d is the diameter of the transducer, and λ is the wavelength.

This formula enables achieving high resolution by selecting the appropriate frequency and f number transducer. Increase in resolution is always accompanied by loss of penetration.

INSTRUMENTATION[56]

UBM has a:

1. Front panel consisting large high- resolution LCD screen, and
2. A rear panel which plugs for connection to the probe connector, moniter connector and power connector,
3. HF probes which are light weight, and
4. Immersion cups.

HF probe accept 35 or 50 MHz transducers and scans at 38 or 20 degree scan angles at 15mm maximum scan depth. The probe can be fitted with both 35 and 50 MHz transducers. 35 MHz transducers offer 70 microns of axial resolution and 50 MHz transducers 50 microns of axial resolution.

TECHNIQUE

The technique of eye examination using ultrasound biomicroscopy is similar to conventional B-scan examination of the anterior segment. A fluid immersion technique is required to provide an adequate standoff from the structures being examined. This standoff is necessary to avoid distortion of the image close to the transducer and to prevent contact of the transducer and the eye. Eye cups are used to keep the eyelids open. They are available in various sizes. These eye cups resemble those used in conventional ultrasound biometry, with a lip that slides under the eyelids and holds the cup in place[55].

1% methyl cellulose is an excellent coupling medium with sufficient viscosity to prevent fluid loss during examination. Saline can also be used[56].

Air bubbles must be avoided in the fluid and on the concave surface of the transducer.

Four measurement modes are available in the software[56]-

1. Vector 1550- the cursor is the green and red line running through the image. Linear measurements are made using this.
2. Callipers- a pair of linear cursors is used foe linear measurements of the image.

3. Angle measure- for angle measurements.
4. Biometry- this module provides accurate distance measurements in the anterior segment along the optical axis. Tissue velocities of 1641 m/s for cornea and lens and 1532 m/s for the aqueous are used.

Measuring Ocular Structures

Ultrasound biomicroscopy expands the ability to accurately measure ocular structures. The improved measurement accuracy of ultrasound biomicroscopy has an axial resolution five to ten times that of conventional 10 MHz ultrasound[53].

Stored images can be transferred to a computer via an image capture board and measured using imaging software. Measuring a structure accurately with ultrasound requires knowledge of the speed of sound in the structure being examined[56].

Conventional ultrasound is capable of measuring relatively large distances such as anterior chamber depth. Ultrasound biomicroscopy increases the measurement accuracy of such structures because the shorter wavelength allows a finer positioning of end points and the exact measurement position can be defined more precisely[55].

Ocular structures such as the ciliary body, sclera, and iris cannot be measured by other techniques because of inadequate resolution and the

inability to differentiate these structures from adjacent tissue. Ultrasound biomicroscopy allows clarification of tissue borders and accurate measurement[55].

Anterior chamber depth is easily measured using UBM by measuring the axial distance from the internal corneal surface to the lens surface.

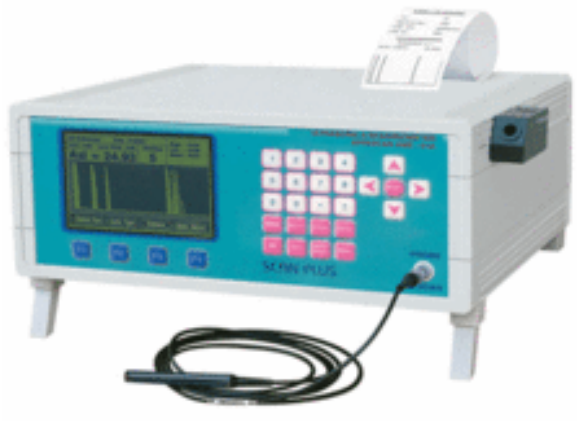
The following parameters can be used for an objective analysis of the anterior chamber angle structures, with the sclera spur as the reference point which can be determined by a 50 MHz UBM[56].

1. Trabecular iris angle
2. Angle opening distance
3. Trabecular-ciliary process distance
4. Iris thickness
5. Iris-ciliary process distance
6. Iris-lens contact distance

DETERMINING PATENCY OF LASER IRIDOTOMY

After Nd:YAG laser iridotomy in shallow angles, UBM can show whether the iridotomy is partial thickness or full thickness and whether the plane of curvature of peripheral iris has changed, compared with the pre-treatment findings.

AXIAL A-SCAN ULTRASONOGRAPHY[54]



The axial ultrasonography is obtained by using the visual or optical axis as the path of examining ultrasound beam,so that echoes are obtained from structures along the path of the central cornea and on posterior through the lens to the retina. Echoes arise from ocular tissue interfaces that produce acoustic impedance mismatches.

These echoes are displayed as vertical deflections.In the optical axial echogram of normal eye, high amplitude echoes are produced by the corneal surfaces, by the lens surfaces and by the vitreoretinal interface.The velocity of sound constants for all of the anatomic structures in the ultrasound beam path are required to convert the round trip time of flight measurements to distance in millimeters.

Time/2 x velocity = distance

The distance between posterior surface of cornea to anterior surface of lens gives anterior chamber depth.

LASER IRIDOTOMY

HISTORICAL BACKGROUND

In 1956, Meyer-Schwickerath[35] first reported the use of light energy to create a hole in the iris.

By the mid-1970s, several reports of successful argon laser iridotomy appeared in the literature[38], and by the end of that decade, laser iriotomy had replaced incisional iridotomy as the surgical procedure of choice for angle-closure glaucomas. During the 1980s, continued study of laser iridotomy techniques led to the popular use of the Nd:YAG laser for this operation.

TECHNIQUES

The basic principle of laser iridotomy is the creation of a hole in the peripheral iris with an argon or Nd:YAG laser, which allows equalization of the pressure between the posterior and the anterior chamber, deepening of the anterior chamber, and opening of the anterior chamber angle.

A contact lens is helpful in performing a laser iridotomy, because it

a) Keeps the lids separated

b) Minimizes corneal epithelial burns by acting as a heat sink

c) Provides some control of eye movement.

In addition, convex-surfaced contact lenses have been designed to increase the power density on the iris[40].

The most commonly used is the Abraham iridotomy lens, which has a 66-diopter Plano convex button bonded to the front surface of the contact lens[40]. This lens doubles the laser beam diameter at the level of the cornea, while reducing it to approximately one-half the original size on the iris, which reduces the power density at the cornea to one-fourth the original level and increases it on the iris by a factor of four.

Preoperative Medication

Topical pilocarpine may be instilled before the procedure, which helps to maximally thin and stretch the peripheral iris. If the patient presents with an acute attack of ACG, it is best to break the attack medically, if possible, and maintain the patient on medication to allow clearing of any corneal oedema and to facilitate constriction of the pupil.

However, if the attack does not respond to medical therapy, laser iridotomy may be effective in breaking the attack[41].

In nearly all cases, only topical anaesthesia, such as proparacaine 0.5%, is required.

It has become a standard practice among most surgeons to also use topical apraclonidine to reduce the risk of a postoperative IOP rise[42].

Apraclonidine 1% was instilled as a single postoperative drop in preventing IOP elevation[43].

Selecting the Treatment Site

Any quadrant of the iris can be used to create the laser iridotomy, although the superior iris is preferable in most cases, because it places the iridotomy beneath the upper lid.

The superior-nasal quadrant has the advantage of directing the laser beam toward the nasal periphery of the retina.

Whichever quadrant is used, the slit-lamp should always be positioned so the laser beam is directed away from the macula. The iridotomy is usually placed between the middle and peripheral thirds of the iris.

Techniques with Nd:YAG Laser

This is now the most commonly used technique for laser iridotomy. The extremely high energy levels and short exposure times of these lasers electromechanically disrupt tissue, independent of pigment absorption and the thermal effect.

As a result, they are particularly useful in creating iridotomies in light blue irides, but are effective in all eyes. The technique usually involves simultaneous perforation of the iris stroma and pigment epithelium with energy levels in the range of 5 to 15 mJ[44].

The pulse duration is fixed for each instrument, in the range of 12 nanoseconds, but the number of pulses per burst can be adjusted in most units, generally one to three pulses per burst are used. With instruments that allow a selected separation between the focal points of the two laser beams, the setting should be such that they are coincident when performing a laser iridotomy.

The indicators of complete patency is seeing the posterior pigment epithelium disrupted, watching for a through and through opening, an immediate flow of posterior chamber aqueous humor through patent

iridotomy carrying pigments with it into anterior chamber, visualization of anterior lens capsule and trans-illumination through the iridotomy accompanied by an immediate deepening of peripheral part of anterior chamber.

Complication of Nd:YAG laser iridotomy:

1. Iritis
2. Pigment dispersion
3. Haemorrhage
4. Transient rise in IOP
5. Lens opacities
6. Rupture of anterior lens capsule
7. Localized corneal odema or scar
8. Failure to obtain patent iridotomy
9. Late closure of iridotomy
10. Transient pain and blurred vision

LASER IRIDOPLASTY FOR MANAGEMENT OF CHRONIC ANGLE CLOSURE GLAUCOMA

INDICATIONS

- Angle still occludable after laser iridotomy (e.g., plateau iris)
- When either the medical treatment has failed or is contraindicated in an acute attack of ACG
- It helps in facilitating the access to the trabecular meshwork in case of requirements of laser trabeculoplasty

PROCEDURE

1. Pre-laser:

   As for laser iridotomy

2. Laser:

   Using an Abraham lens the most peripheral part of the iris is aimed. Argon green or blue-green, or diode laser is used with a setting as 200-500mW, 100-500 μm spot size, 0.2-0.5seconds and a single row of 25-50 burns over 180-360° at one-spot diameter intervals is made. The endpoint is when there is stromal contraction of iris and when there is a progressive deepening of the peripheral anterior chamber as the number of burns is increased.

3. Post-laser topical steroids 4 times/day is used for 7days.

MEDICAL THERAPY

Although most eyes with acute, sub-acute, or chronic pupillary-block glaucoma are managed surgically, it is desirable to first bring the glaucoma under medical control.

An acute attack constitutes a medical emergency, and it should be approached in two stages: reduction of the IOP and relief of the angle closure.

Reduction of Intraocular Pressure

Miotic therapy is frequently ineffective when the IOP is high, presumably due to pressure-induced ischemia of the iris, which leads to paralysis of the sphincter muscle[44].

Oral carbonic anhydrase inhibitors, topical beta-adrenergic blockers, alpha2-adrenergic agonists, and hypotensive lipids can lower the pressure sufficiently to allow effective miotic therapy to open the angle[45].

In difficult cases, hyperosmotics may be used to help in the initial pressure reduction. They may be given orally as glycerol or isosorbide, or if the patient is too nauseated to tolerate oral medication, they may be given intravenously as mannitol or urea.

Topical carbonic anhydrase inhibitors should probably be avoided because they can exacerbate or potentiate corneal edema.

Relief of Angle-Closure Glaucoma

After the IOP has been reduced, a miotic is instilled to break the pupillary block and open the anterior chamber angle. A single drop of pilocarpine approximately 1 to 3 hours after administration of acetazolamide or timolol has been reported to effectively break the angle-closure attack[45].

SURGICAL MANAGEMENT

The Main Aims and Indications for Surgical Treatment in Angle Closure

MAIN AIMS

1. To decrease IOP and reduce risk of optic nerve damage
2. To prevent progressive angle closure
3. To reduce risk of acute angle closure

INDICATIONS

1. Inadequate control of IOP, with progression of optic nerve or visual field damage, despite medical and laser treatment

2. Poor compliance or intolerance to medical treatment
3. Inability to cooperate with laser treatment
4. Worsening angle closure and/or PAS
5. Presence of significant cataract impairing vision
6. Intraocular Pressure; Peripheral Anterior Synechiae.

In patients with acute PACG, surgery is considered only if medications and laser iridotomy have had no effect or laser is unable to penetrate, surgical iridectomyis preferred. If PAS are formed from prolonged acute angle closure,trabeculectomy may be considered.

TRABECULECTOMY

Trabeculectomy is the surgical procedure of choice in patients of chronic PACG. With severe disc damage, surgery may be considered as the definitive therapy, but laser iridotomy and medical management ideally should precede surgical management to minimize the complications of flat chambers and aqueous misdirection.

COMBINED GLAUCOMA AND CATARACT SURGERY

Combined glaucoma and cataract surgery may provide additional benefit by significantly deepening the anterior chamber and improving

the visual acuity and may be used if associated with significant lens change

CYCLODESTRUCTIVE PROCEDURE

Cyclodestructive procedures like trans-scleral cyclophotocoagulation are used for ACG eyes with end-stage disease that do not have any visual potential, especially if they are symptomatic due to high IOP.

AIMS AND OBJECTIVES OF THE STUDY

- To compare the changes in the peripheral ACD by Van Herick's method with the central ACD by UBM in angle closure suspects before and after prophylactic Nd:YAG laser peripheral iridotomy.
- To compare the changes in gonioscopy in angle closure suspects before and after prophylactic Nd:YAG laser peripheral iridotomy.
- To find out the demographic and ocular risk factors of angle closure suspects.

DESIGN

- Prospective interventional study

MATERIALS AND METHODS

107 eyes of 61 patients diagnosed as angle closure suspects were included in the study. The study was conducted in Coimbatore medical college hospital during the period of September 2011 to September 2012.

SELECTION CRITERIA

It includes primary angle closure suspects.Patients with occludable angle were identified by Goldmann single mirror gonioscopy, occlusion criteria being Grade I or II of angle configuration as per Shaffer's Grading.

EXCLUSION CRITERIA-

1. Patients with any other ocular pathology
2. Primary and secondary angle closure glaucoma.
3. Any patient with angle anomalies.
4. Patients who already had peripheral iridotomy (as comparison cannot be made)
5. Primary open angle glaucoma
6. Any forms of secondary glaucoma

7. Congenital glaucoma

8. Prior history of ocular trauma

All the subjects were examined in detail and glaucoma workup was done. Demographic data like age, sex, refractive status and axial length were included. Detailed history of presenting complaints like defective vision, headache, coloured halos, redness, pain, watering and history of any associated systemic conditions (diabetes mellitus and hypertension) were obtained. Family history of glaucoma and history of any topical or systemic medications and past history of ocular surgery, laser procedures and ocular trauma were obtained.

Best corrected visual acuity with refraction was done for all subjects. Intraocular pressure was recorded with Goldmann applanation tonometry.

The anterior chamber depth was first analysed by torch light and graded. Slit lamp examination to determine the Van Herick's grading of anterior chamber was done. Stereobiomicroscopic examination of optic disc was done using + 90D lens. Gonioscopy was carried out using a Goldmann single mirror gonioscopy lens. Visual fields were plotted with Octopus automated perimetry.

A-scan ultrasonic biometry was done to assess the axial length.

For all subjects, Ultrasound biomicroscopic (UBM) examination was done using UBM OTI scan. UBM imaging was performed with the subject in the supine position under topical anaesthesia. An eyecup was used to gently part the lids and retain the normal saline as coupling solution. The probe is held perpendicular to the structure to be scanned.

The central anterior chamber depth by UBM was measured from the corneal endothelium to the anterior surface of the lens.

After getting informed consent, laser iridotomy was done for all these patients with occludable angles in superior quadrant.

Nd:YAG laser iridotomy-

After obtaining consent, under topical anesthesia (4% lignocaine) using Abraham contact lens, iridotomy was done with NdYAG laser iridotomy in the superior quadrant in the peripheral iris. Either a crypt or thin area on iris was selected.

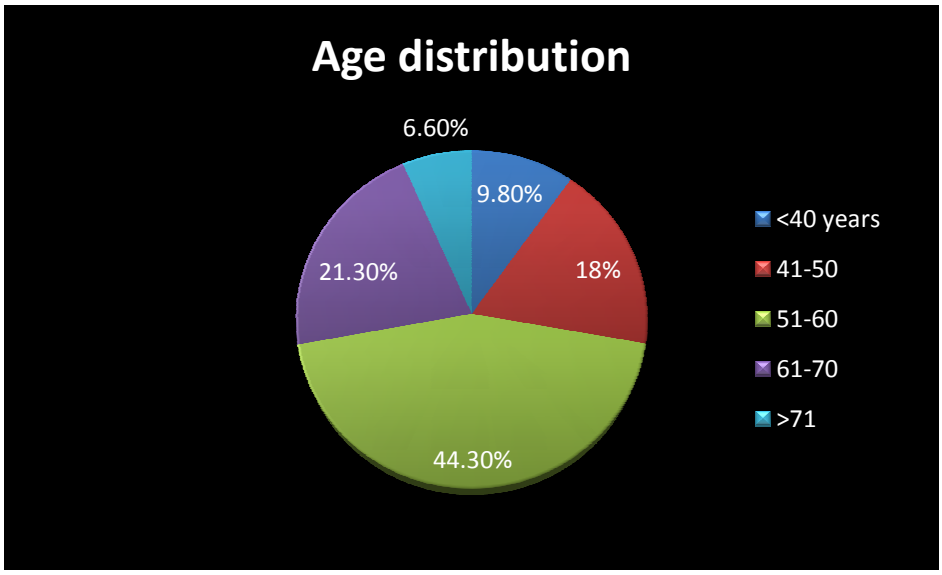
After 2 weeks of LPI, a Slit lamp examination was done to determine Van Herick's grading of anterior chamber and patency and location of iridotomy. Gonioscopic angle evaluation was also done in all the four quadrants.

Repeat UBM was done to assess the central anterior chamber depth.

All these details were entered in the proforma for each patients. The datas were compiled and analysed.

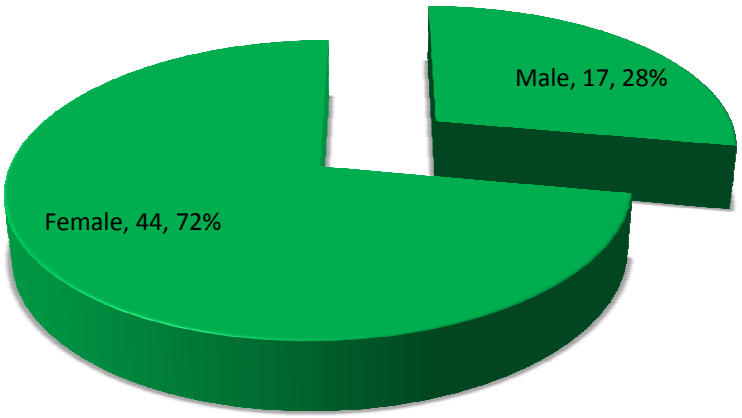
Around 72% of angle closure suspects were above 50yrs.

AGE GROUP	NO OF SUBJECT	PERCENTAGE
–		
–		
-		
>71 years	4	6.6%



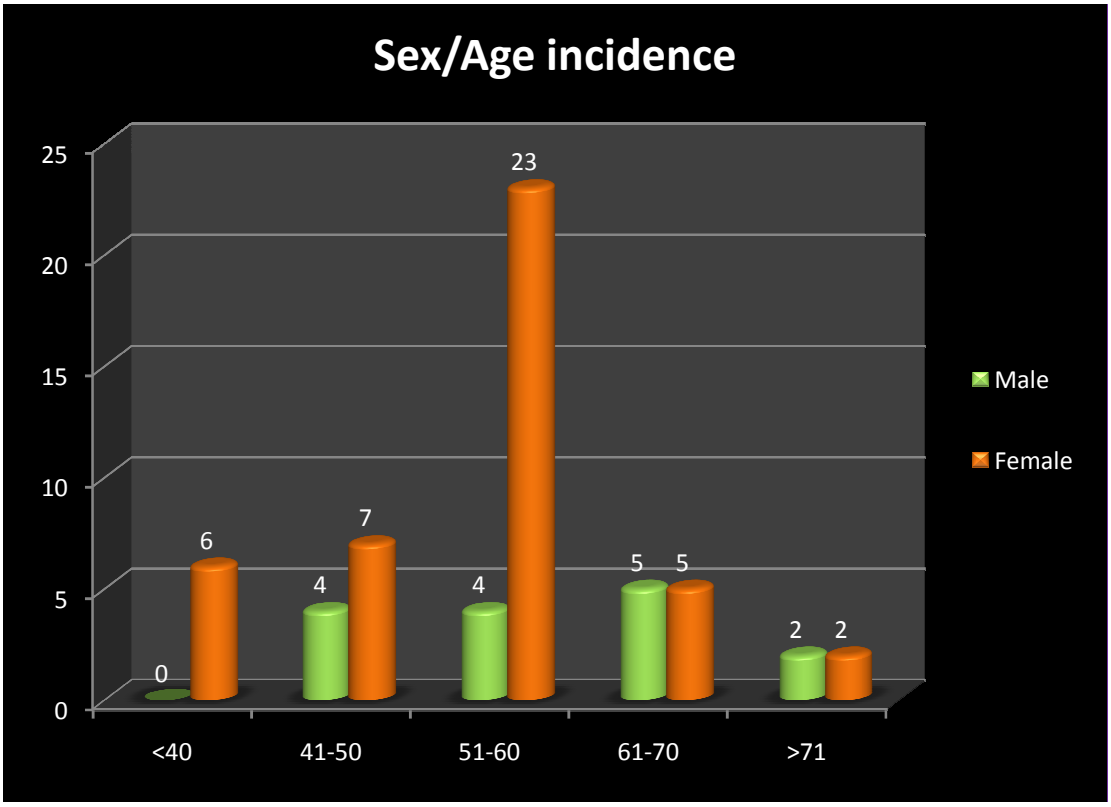
TOTAL NUMBER OF PATIENTS	MALE	FEMALE
61	17	44
100%	39%	61%

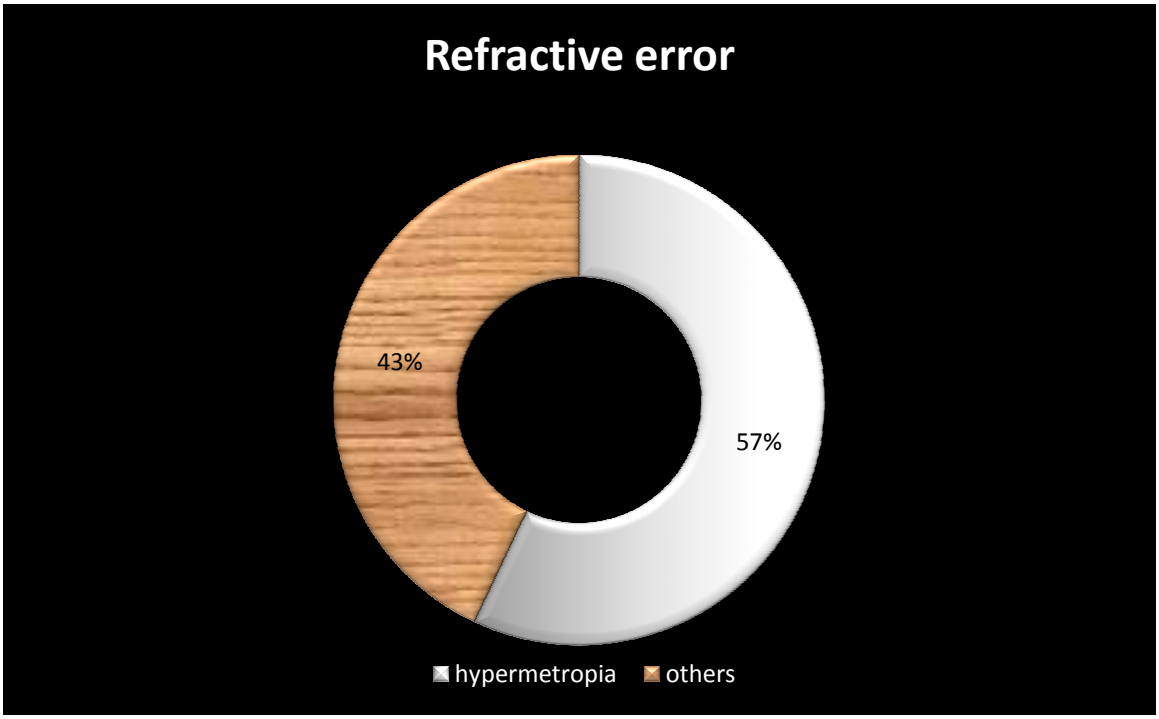
SEX DISRIBUTION



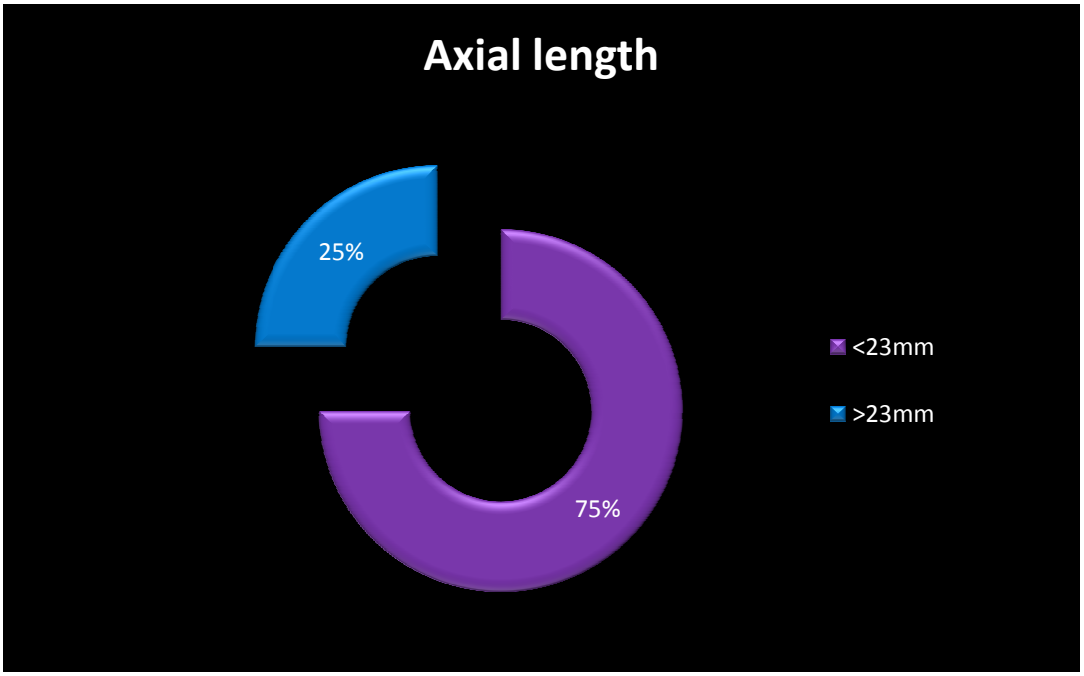
SEX/AGE INCIDENCE

AGE	SEX		PERCENTAGE
	MALE	FEMALE	
<40 years	nil	6	9.8%
41-50 years	4	7	18%
51-60 years	4	23	44.3%
61-70 years	5	8	21.3%
71 years and above	2	2	6.6%




Refractive error
43%
57%
hypermetropia
others

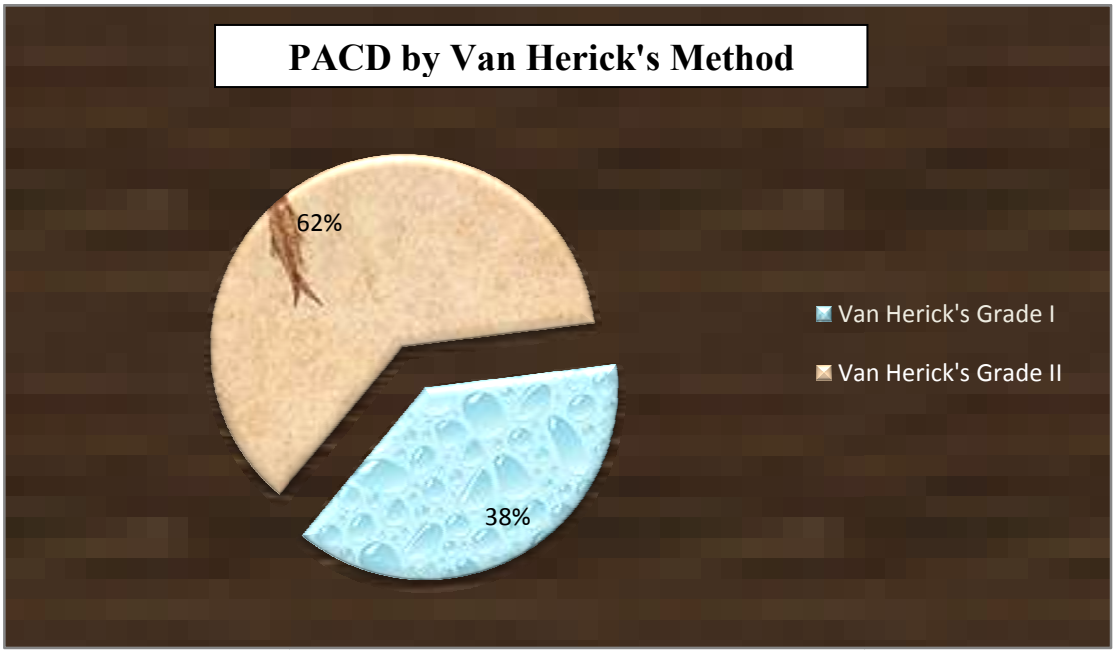
-


Axial length
25%
75%
<23mm
>23mm

PERIPHERAL ANTERIOR CHAMBER DEPTH BY VAN HERICK'S GRADING

Out of 107 eyes, 40 eyes (38%) had a Van Herick's grading of Grade I and 67 eyes (62%) had Grade II.

TOTAL NUMBER OF EYES	VAN HERICK'S GRADE I	VAN HERICK'S GRADE II
107	40	67
100%	38%	62%

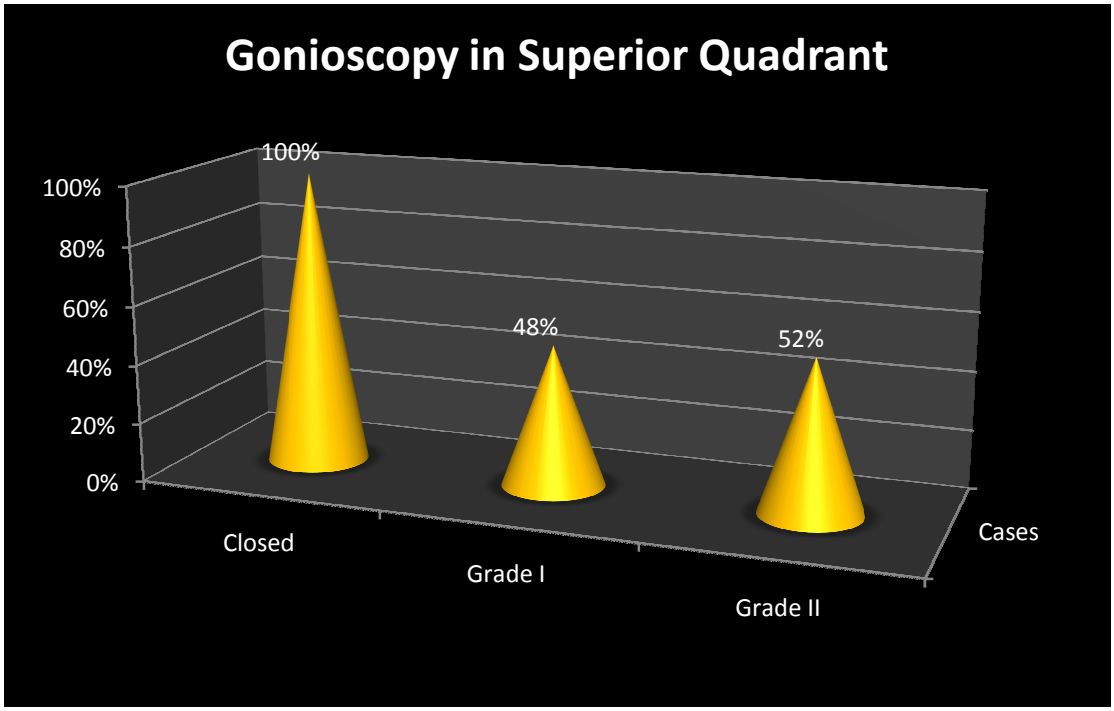


GONIOSCOPY

- Gonioscopy was done and the superior quadrant had Grade I in 48% and Grade II in 52%.
- Temporal quadrant had Grade I in 35% and Grade II in 65%.
- Inferior quadrant had Grade I in 31% and Grade II in 69%.
- Nasal quadrant had Grade I in 51% and Grade II in 48.5%.
- Overall Grade 0 was noted only in less than 1%

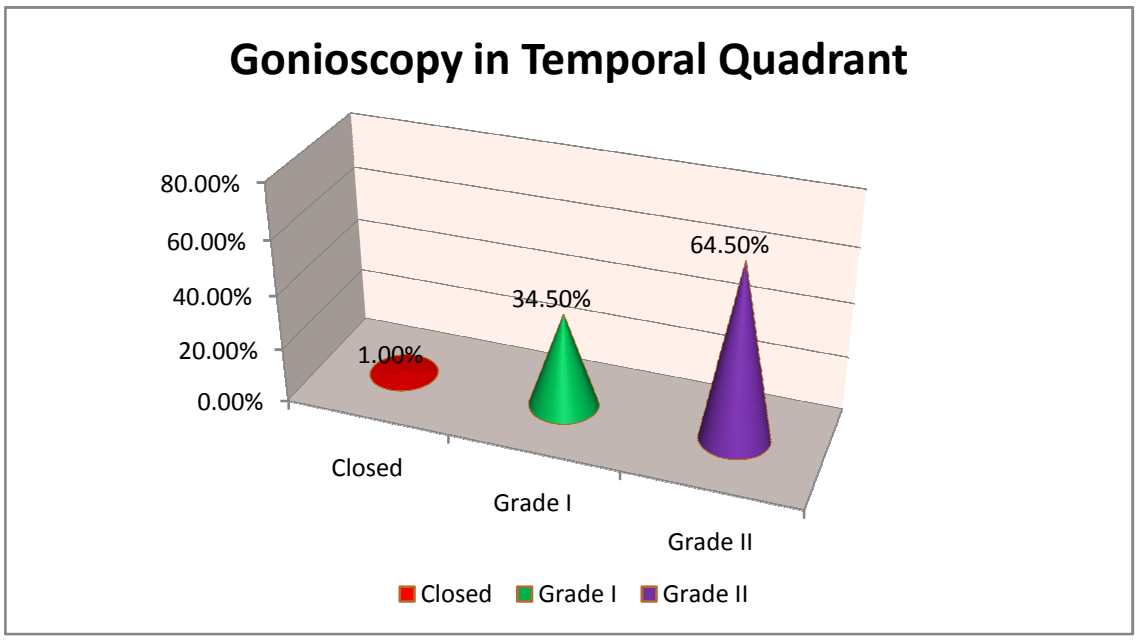
GONIOSCOPY IN SUPERIOR QUADRANT

GRADE	TOTAL NUMBER	PERCENTAGE
Closed	Nil	0%
Grade I	52	48%
Grade II	55	52%
Total	107	100%



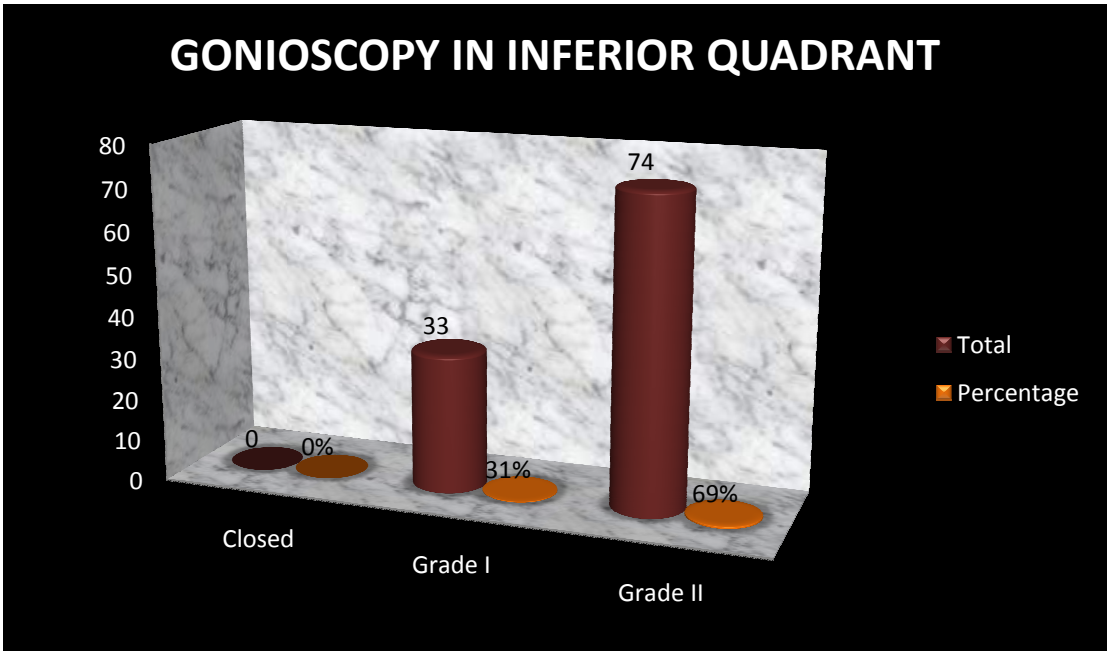
GONIOSCOPY IN TEMPORAL QUADRANT

GRADE	TOTAL NUMBER	PERCENTAGE
Closed	1	1%
Grade I	37	34.5%
Grade II	69	64.5%
total	107	100%



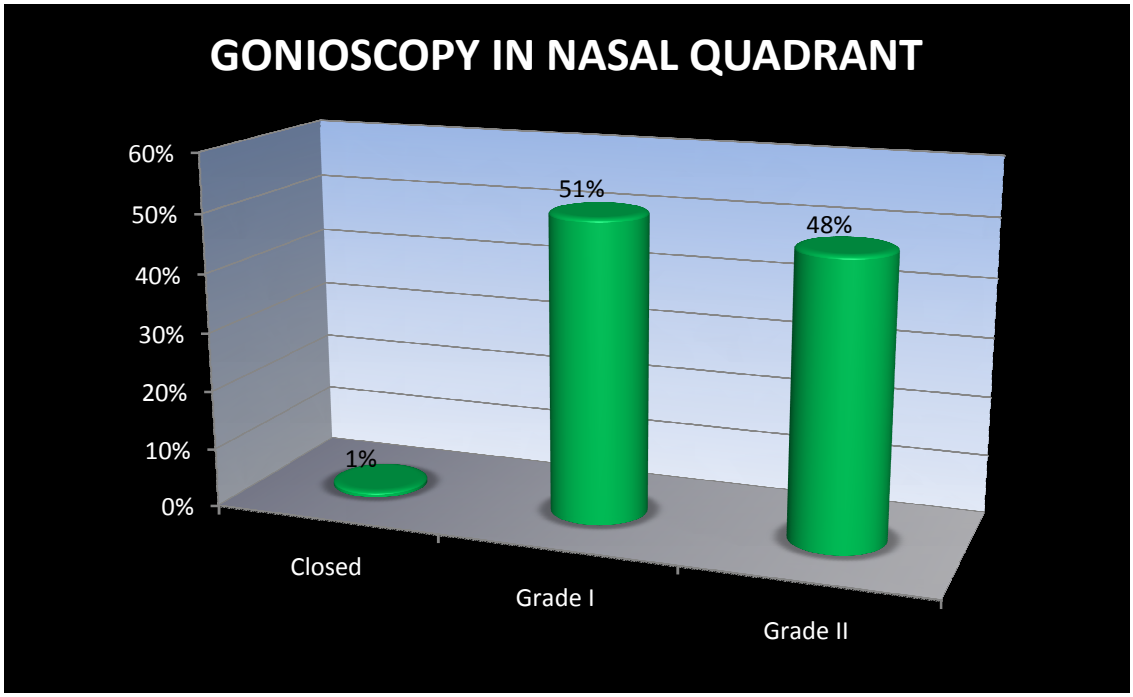
GONIOSCOPY IN INFERIOR QUADRANT

GRADE	TOTAL NUMBER	PERCENTAGE
Closed	nil	0%
Grade I	33	31%
Grade II	74	69%
total	107	100%



GONIOSCOPY IN NASAL QUADRANT

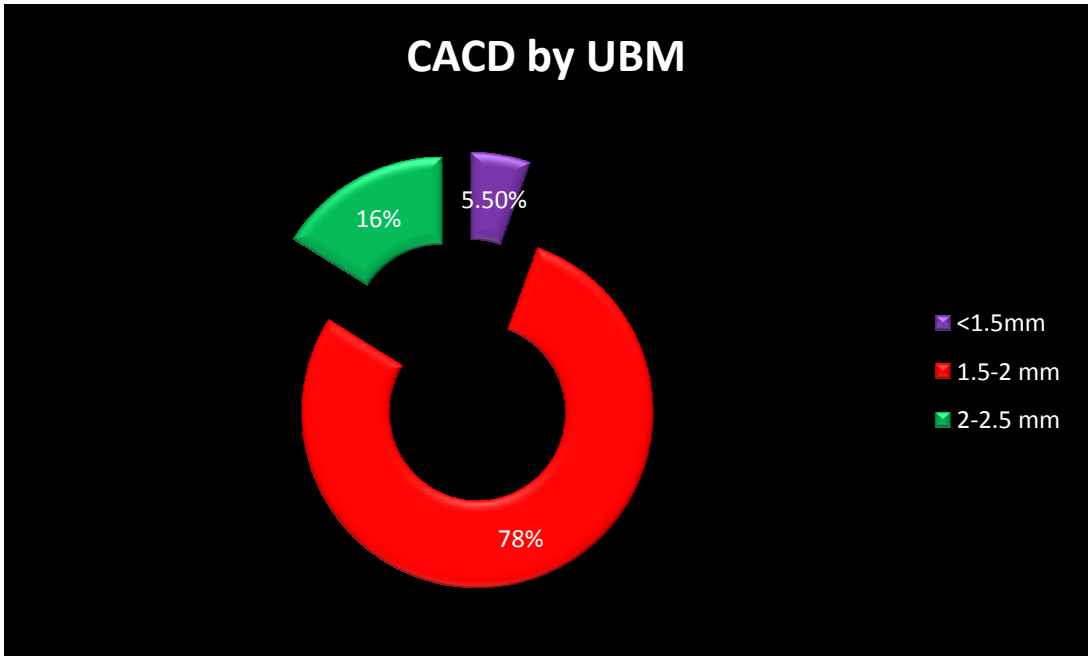
GRADE	TOTAL NUMBER	PERCENTAGE
Closed	3	1%
Grade I	54	51%
Grade II	50	48%
total	107	100%



CENTRAL ANTERIOR CHAMBER DEPTH BY ULTRASOUND BIOMICROSCOPY

About 5.5% of eyes had CACD of <1.5mm. 78.5% had between 1.5mm and 2mm. 16% had CACD of >2.5mm.

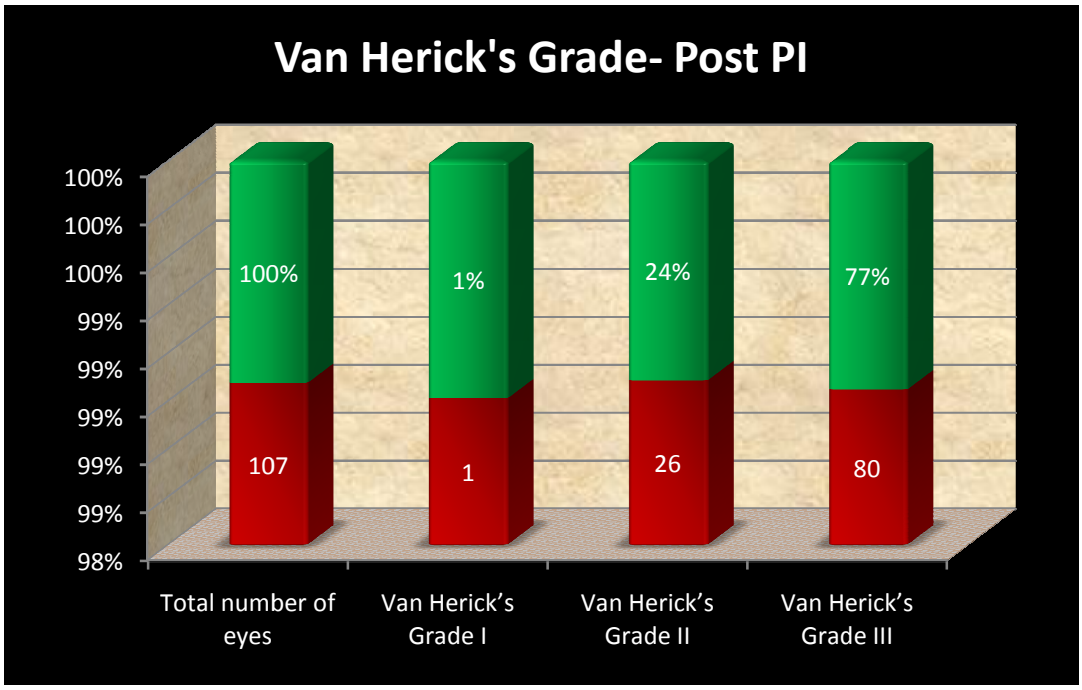
CACD	TOTAL NUMBER	PERCENTAGE
<1.5mm	6	5.5%
1.5mm-2mm	84	78.5%
2mm-2.5mm	17	16%



PERIPHERAL ANTERIOR CHAMBER DEPTH BY VAN HERICK'S GRADING POST PI

Out of 107 eyes, 26 eyes (24%) had a Van Herick's grading of Grade I and 80 eyes (77%) had Grade II.

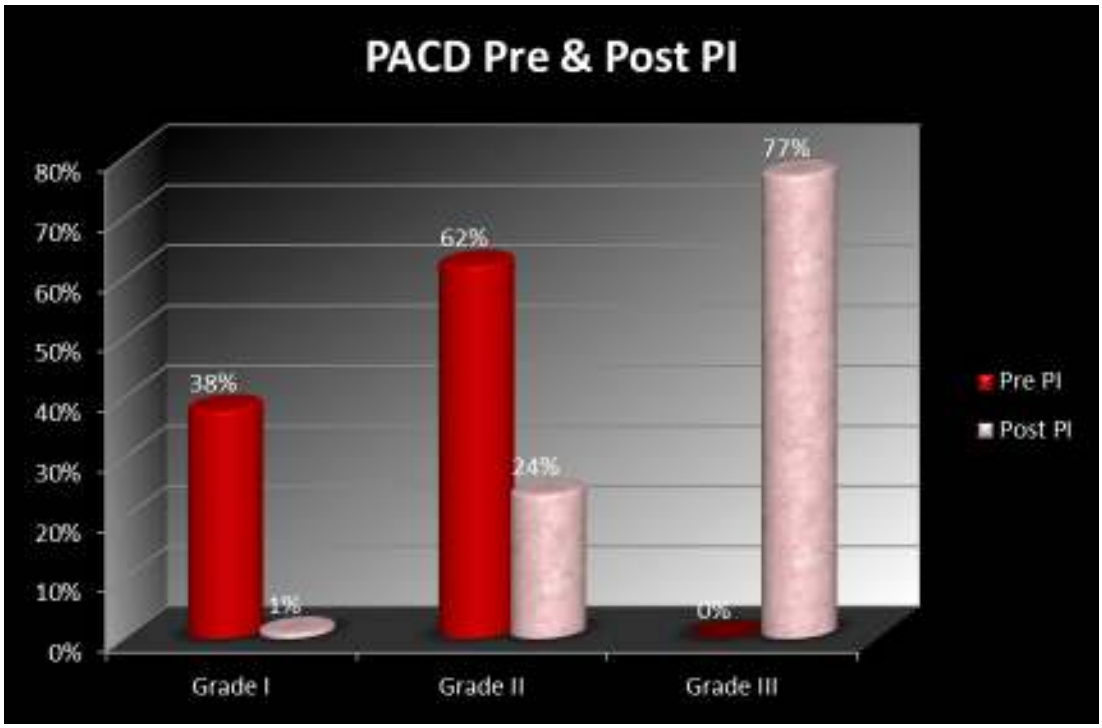
TOTAL NUMBER OF EYES	VAN HERICK'S GRADE I	VAN HERICK'S GRADE II	VAN HERICK'S GRADE III
107	1	26	80
100%	1%	24%	77%



COMPARISON OF ANTERIOR CHAMBER DEPTH BY VAN HERICK'S GRADING PRE AND POST PI

There was a significant increase in the PACD by Van Herick's method after PI. The p value was <0.001.

The PACD from Grade I increased to Grade II in 46.2% and to Grade III in 51.3% following PI. In those who had a Grade II before PI the increase to Grade III was noted in 88.2%. However it remained in Grade II in 11.8%.There was no decrease in the PACD post PI.



CHANGE IN THE GRADE I AFTER PERIPHERAL IRIDOTOMY

VAN HERICK'S GRADE		TOTAL CHANGE IN PERCENTAGE
PRE PI	POST PI	
Grade I	Grade I	2.6 %
Grade I	Grade II	46.2%
Grade I	Grade III	51.3%

CHANGE IN THE GRADE II AFTER PERIPHERAL IRIDOTOMY

VAN HERICK'S GRADE	TOTAL CHANGE IN PERCENTAGE
Grade II remained as Grade II	11.8 %
Grade II changed to Grade III	88.2%

GONIOSCOPY POST PI

After performing a prophylactic peripheral iridotomy gonioscopy in the superior quadrant had Grade I in 16%, Grade II in 40% and Grade III in 44%.

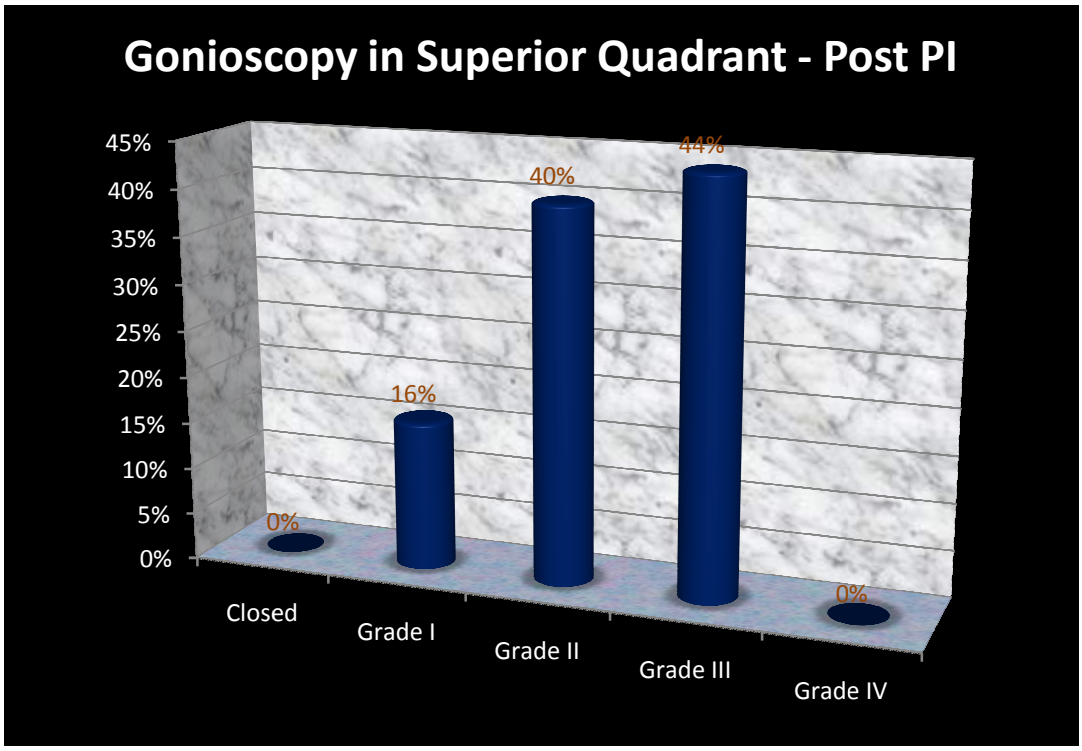
Temporal quadrant had Grade I in 8.4%, Grade II in 28%, Grade III in 61.8% and Grade IV in 1.8%.

Inferior quadrant had Grade I in 1.8%, Grade III in 97.3% and Grade IV in 0.9%.

Nasal quadrant had Grade I in 18.7%, Grade II in 38.3% and Grade III in 43%.

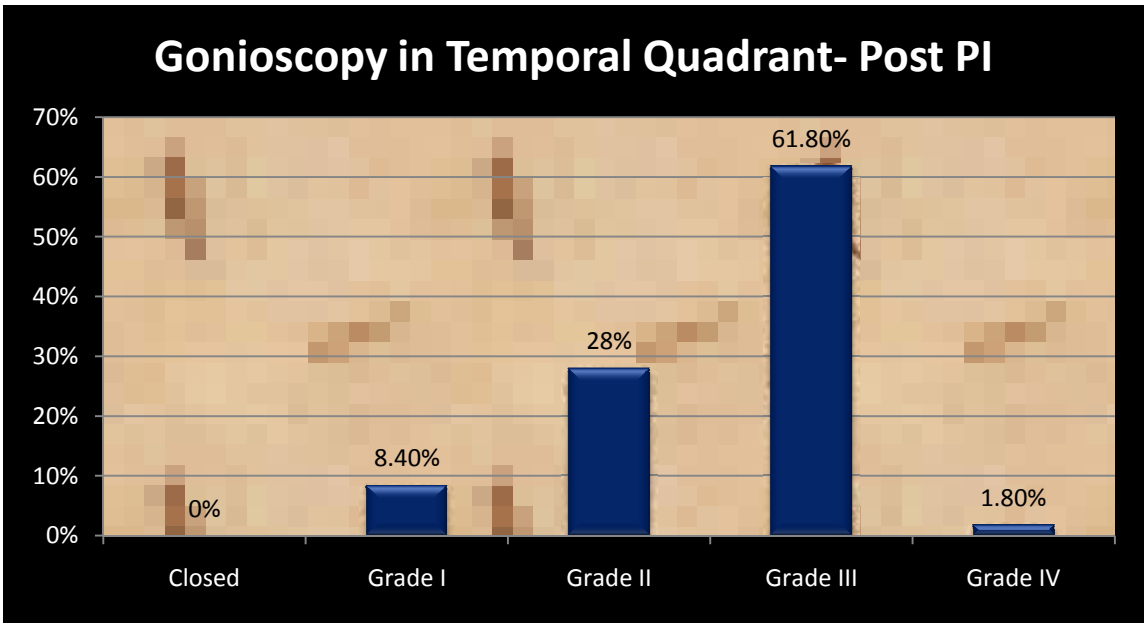
GONIOSCOPY IN SUPERIOR QUADRANT POST PI

GRADE	TOTAL NUMBER	PERCENTAGE
Closed	nil	0%
Grade I	17	16%
Grade II	43	40%
Grade III	47	44%
Grade IV	Nil	0%
Total	107	100%



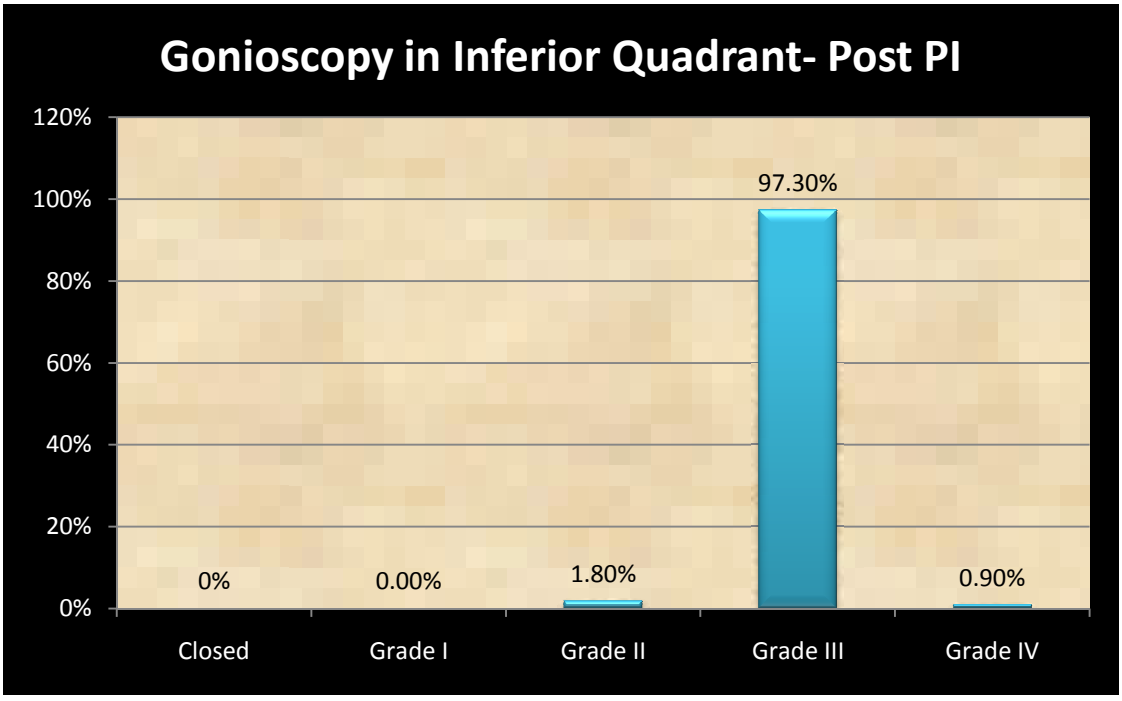
GONIOSCOPY IN TEMPORAL QUADRANT POST PI

GRADE	TOTAL NUMBER	PERCENTAGE
Closed	Nil	0%
Grade I	9	8.4%
Grade II	30	28%
Grade III	66	61.8%
Grade IV	2	1.8%
Total	107	100%



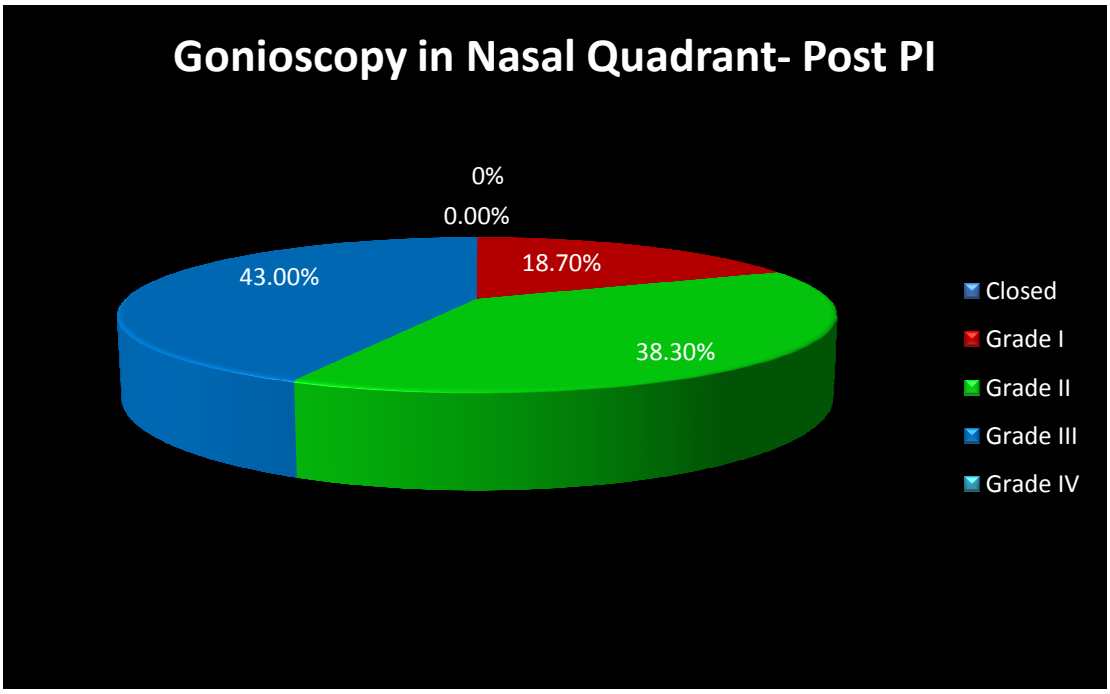
GONIOSCOPY IN INFERIOR QUADRANT POST PI

GRADE	TOTAL NUMBER	PERCENTAGE
Closed	Nil	0%
Grade I	Nil	0%
Grade II	2	1.8%
Grade III	105	97.3%
Grade IV	1	0.9%
Total	107	100%



GONIOSCOPY IN NASAL QUADRANT POST PI

GRADE	TOTAL NUMBER	PERCENTAGE
Closed	Nil	0%
Grade I	20	18.7%
Grade II	41	38.3%
Grade III	46	43%
Grade IV	Nil	0%
Total	107	100%

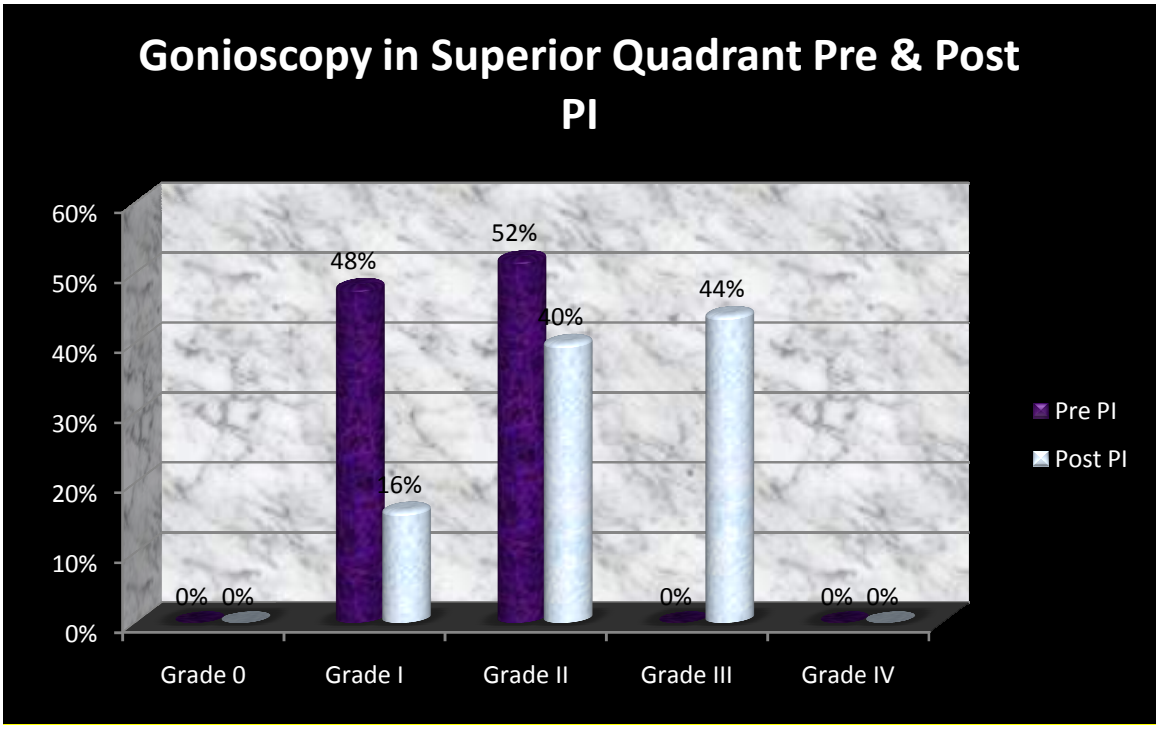


COMPARISON OF GONIOSCOPY BEFORE AND AFTER PI

CHANGE IN THE SUPERIOR QUADRANT AFTER PI

The Shaffer's grade showed a significant change in the superior quadrant following peripheral iridotomy. Grade I increased to Grade II in 50% and to Grade III in 26.9% following PI. In 23.1% it remained unchanged.

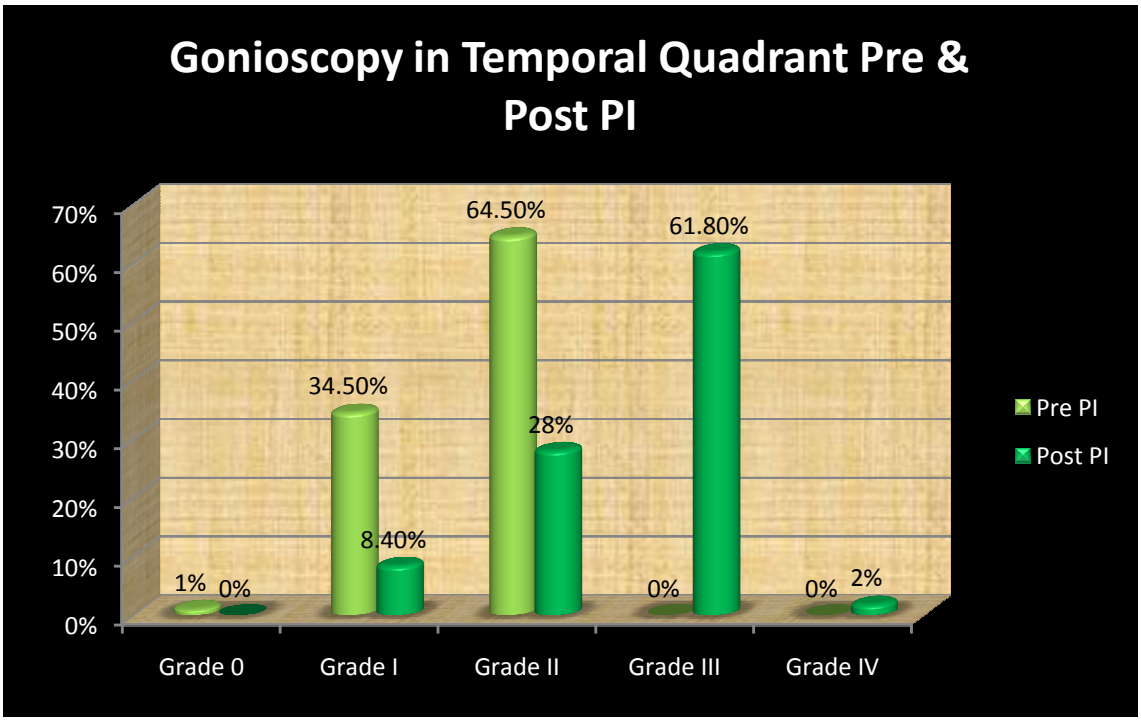
In those who had a Grade II before PI the increase to Grade III was noted in 60%.



CHANGE IN THE TEMPORAL QUADRANT AFTER PI

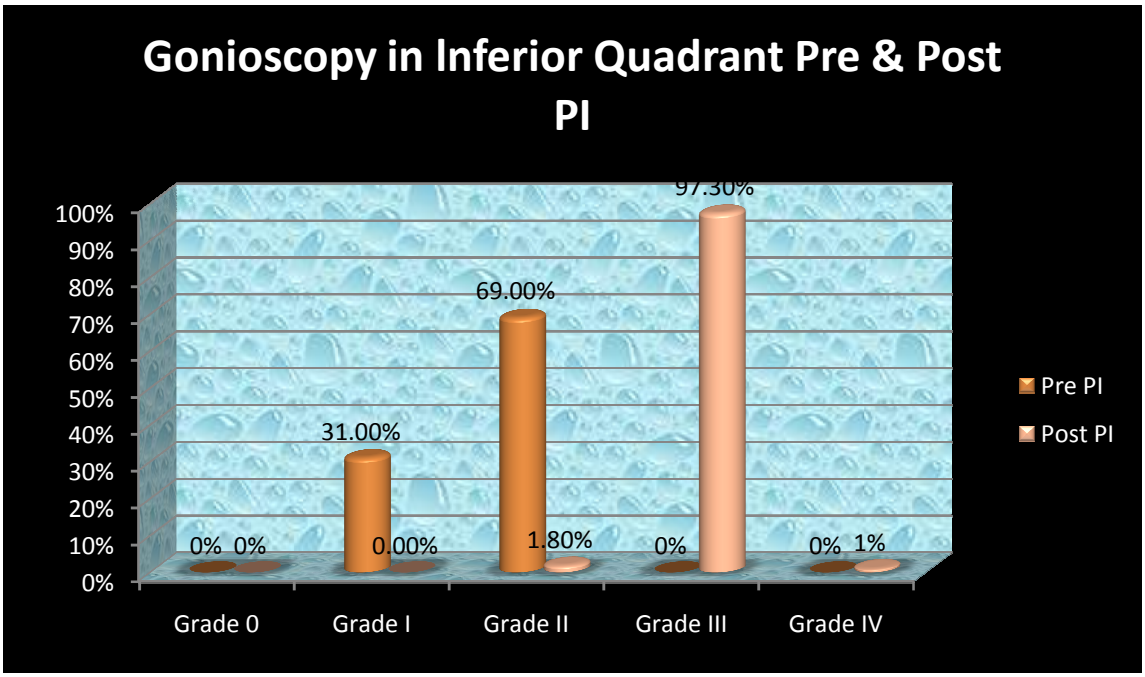
The Shaffer's grade showed a significant change in the temporal quadrant as well following peripheral iridotomy. Grade I increased to Grade II in 35.1% and to Grade III in 43.2% following PI. In 21.6% it remained unchanged.

In those who had a Grade II before PI the increase to Grade III was noted in 69.6% and to Grade IV in 2.9%. The change noted was significant with a p value of <0.001.



CHANGE IN THE INFERIOR QUADRANT AFTER PI

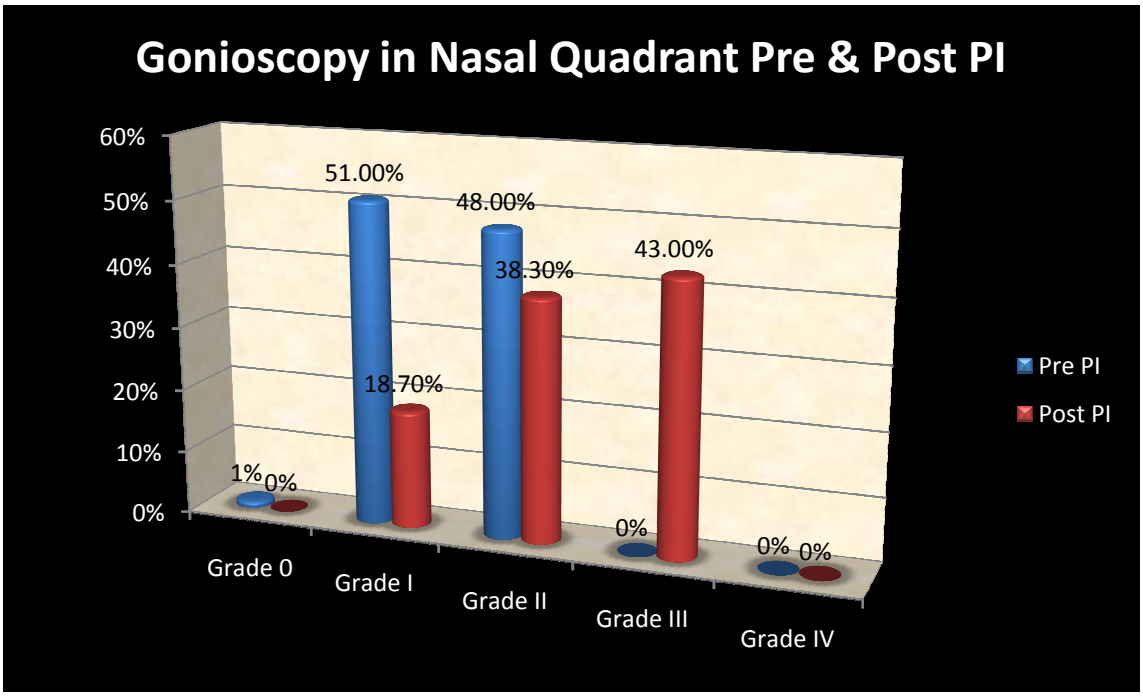
In the inferior quadrant the Grade I increased to Grade III in 97% and to Grade IV in 3% following PI. In those who had a Grade II before PI the increase to Grade III was noted in 97.3%.



CHANGE IN THE NASAL QUADRANT AFTER PI

The Shaffer's grade showed a significant change in the nasal quadrant following peripheral iridotomy. Grade I increased to Grade II in 37% and to Grade III in 31.5% following PI. In 31.5% it remained unchanged.

In those who had a Grade II before PI the increase to Grade III was noted in 58%. In 42% it remained unchanged. The change noted was significant with a p value of <0.001.

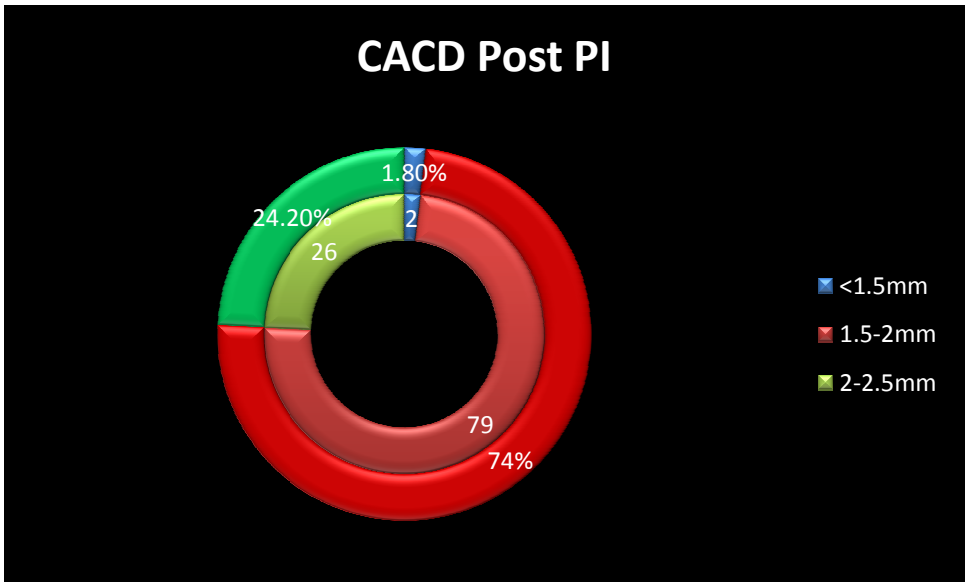


CENTRAL ANTERIOR CHAMBER DEPTH BY ULTRASOUND BIOMICROSCOPY POST PI

About 5.5% of eyes had CACD of <1.5mm. 78.5% had between 1.5mm and 2mm. 16% had CACD of >2.5mm.

CACD	TOTAL NUMBER	PERCENTAGE
<1.5mm	2	1.8%
1.5mm-2mm	79	74%
2mm-2.5mm	26	24.2%
Total	107	100%

COMPARISON OF CACD BY UBM BEFORE AND AFTER PI



The mean ACD before PI was 1.80mm and after PI was 1.85mm. The overall difference seen following peripheral iridotomy was 0.05mm. The p value is <0.001.

CACD	MINIMUM VALUE	MEAN	MAXIMUM VALUE
BEFORE PI	1.43mm	1.80mm	2.20mm
AFTER PI	1.49mm	1.85mm	2.28mm

DISCUSSION

The incidence and prevalence of Primary angle closure disease in a population are influenced by a number of factors including patients age, gender, refractive status of the eye and heredity.

Ocular risk factors cluster around a variety of findings like shallow anterior chamber, decreased anterior chamber volume, short axial length of the globe, small corneal diameter, anterior position of the lens with respect to the ciliary body, increased curvature of the anterior lens surface and increased thickness of the lens.

This study has been done with the aim of analysing the risk factors for Primary angle closure suspects. 90% of the study group were above 40years of age and 10% were below 40 years. This shows the prevalence of angle closure disease increases after the age of 40 years as shown in previous studies[57,58]. The sex distribution was 61% females and 39% males. Female population have a higher incidence of angle closure.

The prevalence of primary angle closure disease is higher in hyperopic eyes, 75% of the eyes in the study were hyperopic.

25% of the eyes had an axial length of less than 23mm which is consistent with other studies showing that patients with short axial length

are at more risk of developing primary angle closure disease than the normal subjects.

Shallow anterior chamber depth is an important risk factor to angle closure. An ACD of less than 2.5mm predisposes patients to primary angle closure. 16% of the eyes had an ACD 2-2.5mm and 78% had an ACD 1.5-2mm.

Gonioscopy remains the mainstay of diagnosing narrow angles. Shaffer grading system is universally used to assess the risk of angle closure. It helps in identifying the patients at risk of angle closure. Eventhough gonioscopy is a subjective method of assessing the angle, it is a reliable and useful method of grading and evaluating the anterior chamber angle when done by an experienced person.

In our study the mean Shaffer's grade increased from 0 to 1 which is similar to the Liwan eye study[57] findings. In our study the Shaffer's Grade increased by 76.4% in the superior angle after PI. According to the Liwan eye study[57] the Shaffer's Grade increased by 72.4% in the superior angle after PI. Other quadrants also showed a similar finding.

The peripheral anterior chamber depth assessed by Van Herick's method although subjective is reliable. In our study 75.6% of the

peripheral anterior chamber depth showed an increase to a higher grade of peripheral anterior chamber depth following PI.

The ultrasoundbiomicroscopy (UBM) of the anterior segment has been used to quantitatively assess the central anterior chamber depth, since it images a cross-section of angle structures similar to that of a low power microscope. The role of UBM as a useful quantitative tool has been evaluated by various authors.

Laser peripheral iridotomy (LPI) is the standard first line intervention for angle closure. It prevents the recurrence of acute episodes and eliminates the risk of acute attacks in fellow eyes. The general configuration of the iris in normal patients is planar or has a gentle anterior convexity. A relative pupillary block results in an anteriorly bowed iris, with a corresponding decrease in angle opening. By allowing aqueous to flow directly through the iridotomy site, LPI equilibrates the pressure between the anterior and posterior chambers. Eliminating this pressure gradient flattens the iris, allowing the peripheral iris to fall backward, resulting in wider angle configuration.

Axial anterior chamber depth increased by a mean of 0.05mm after LPI which is consistent with other studies showing that CACD does not vary significantly following LPI.

However,there is an increase in the peripheral anterior chamber depth following peripheral iridotomy. This is because of flattening of the iris contour following PI.

LPI results in a significant change in angle parameters in eyes in early stages of angle closure as the PI forms an alternate route for the aqueous flow.

SUMMARY & CONCLUSION

- Individuals aged above 40 years and females are at more risk for the angle closure disease.

- Ocular risk factors for angle closure are hyperopia, short axial length and shallow anterior chamber depth.
- Van Herick's method although subjective is reliable when done by experienced person. The peripheral anterior chamber depth shows an increase following laser iridotomy.
- Gonioscopy is reliable and equally effective in grading the anterior chamber angle and aids in identifying those at risk of angle closure.
- Ultrasound biomicroscopy can measure the exact central anterior chamber depth. There is only a minimal increase in the central anterior chamber depth following peripheral iridotomy.
- With a 50 MHz UBM, a quantitative assessment of the iris curvature and degree of angle opening can be identified.It can also be used to find the trabecular iris angle, trabecular-ciliary process distance, iris-ciliary process distance and iris-lens contact distance which can help in detailed evaluation of the anterior chamber angle.
- Laser peripheral iridotomy proves to be a boon for the eyes with angle closure disease in its early stages.

Since visual loss resulting from PACG is potentially preventable, careful surveillance for risk factors of angle closure, widespread use of gonioscopy to identify occludable angles and peripheral iridotomy

performed at an early stage can reduce the morbidity resulting from PACG.

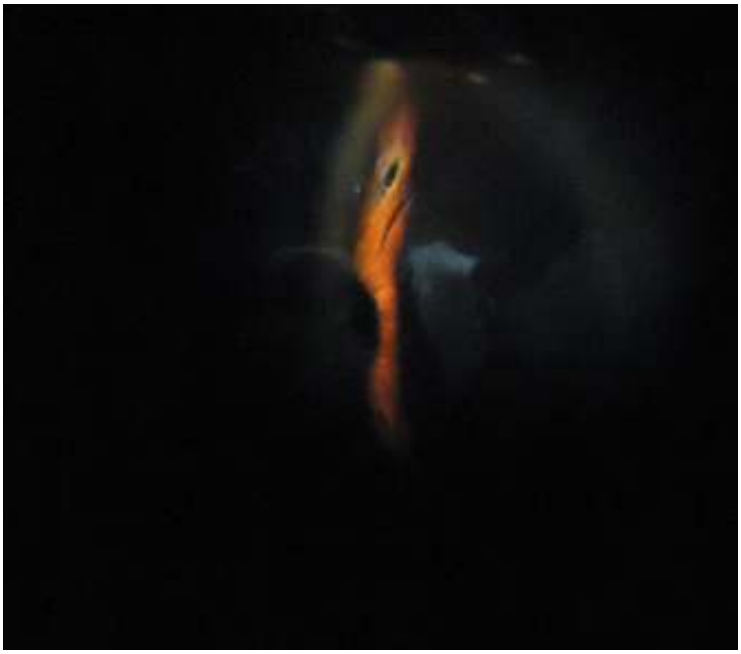
CONCLUSION

- Van Herick's method is useful in primary screening of the peripheral anterior chamber depth.
- Gonioscopy helps in identifying angle closure suspects.
- UBM helps in the exact measurement of central anterior chamber depth.
- Laser peripheral iridotomy prevents angle closure in angle closure suspects.

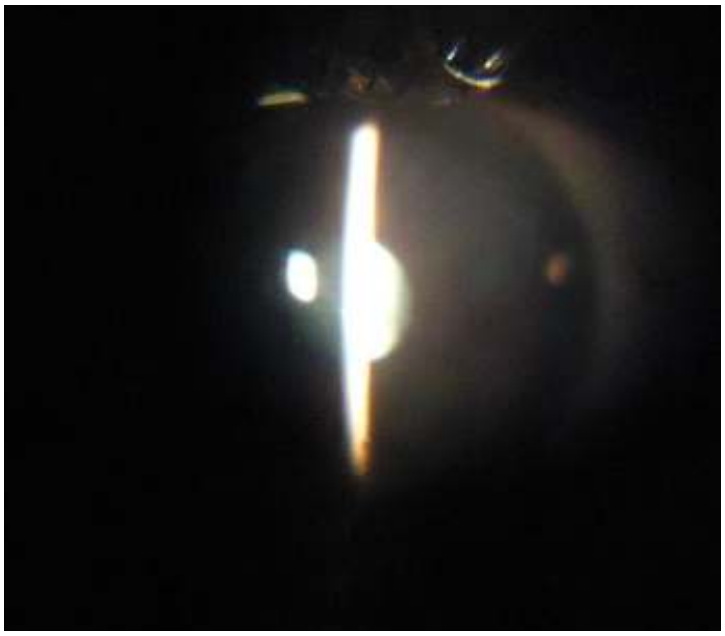
Van Herick's grade I- Before PI

Van Herick's grade III- After PI

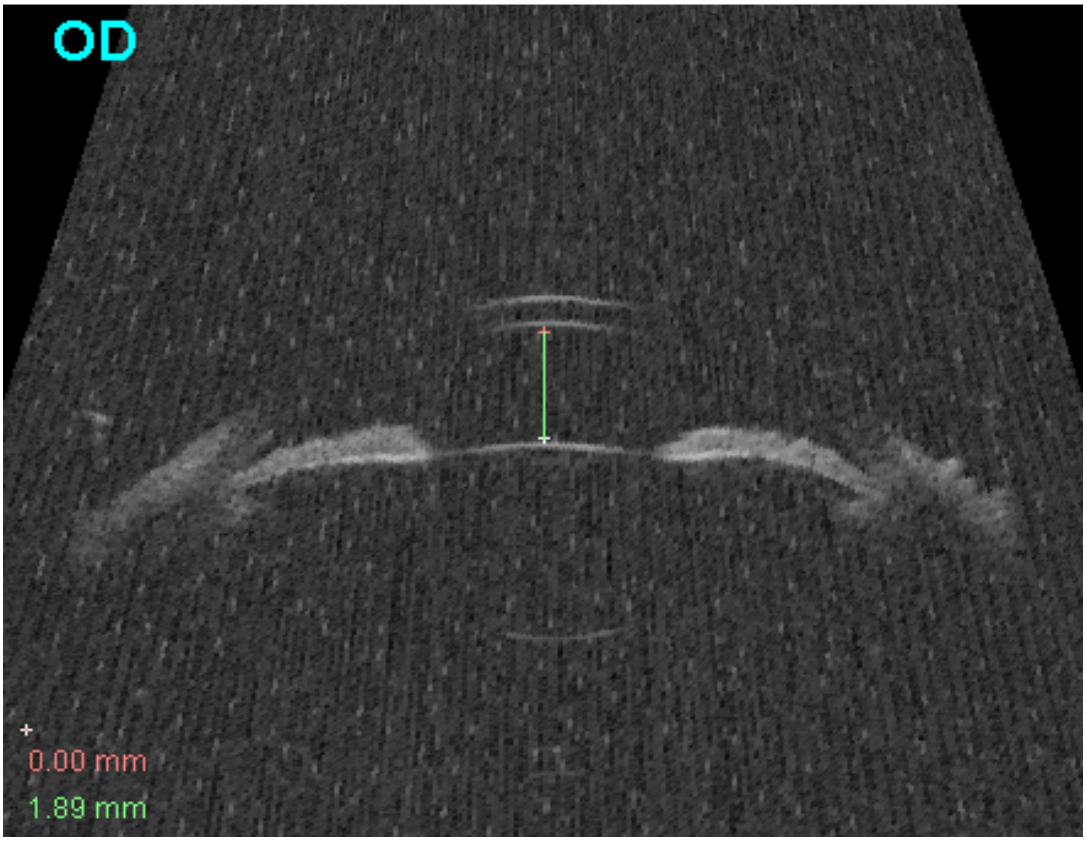
Peripheral Iridotomy- Slit lamp view



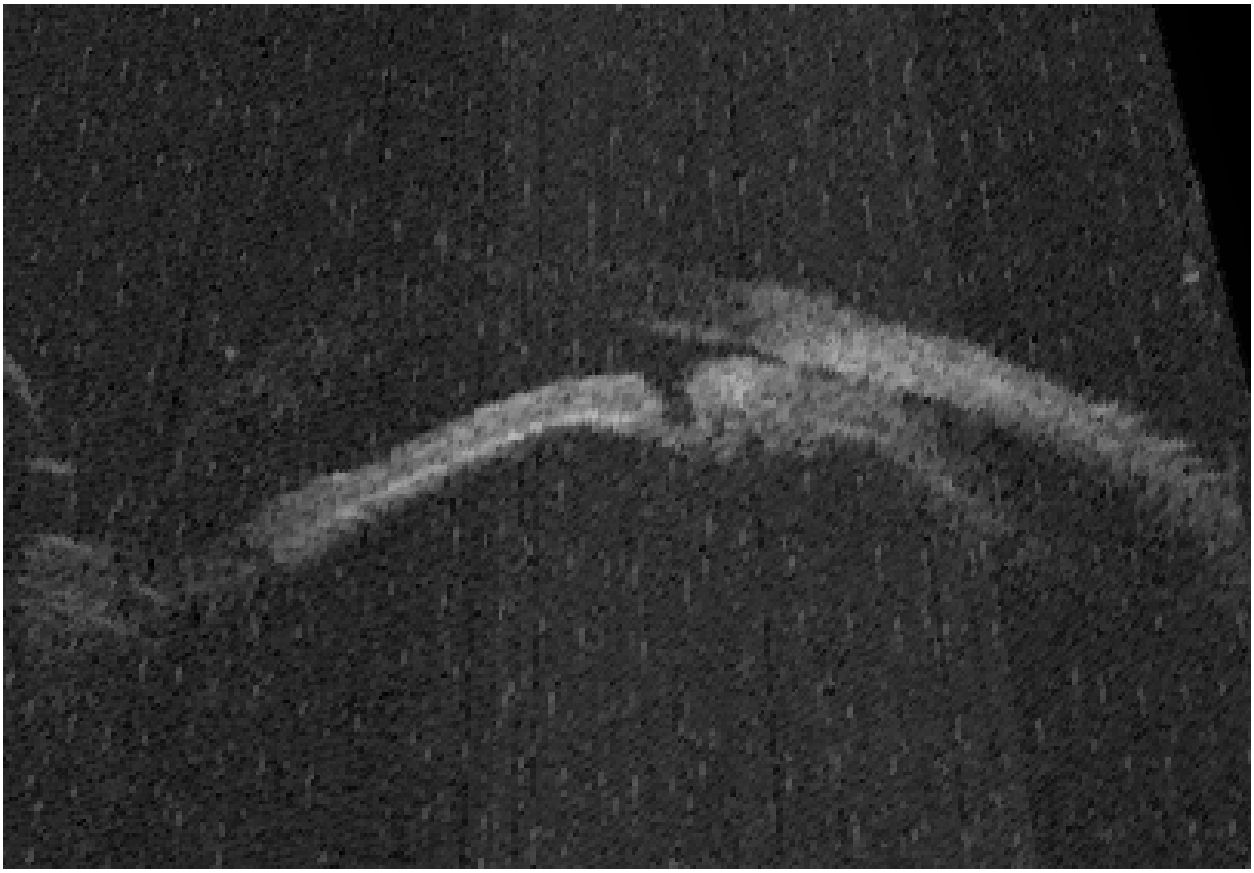
Transillumination



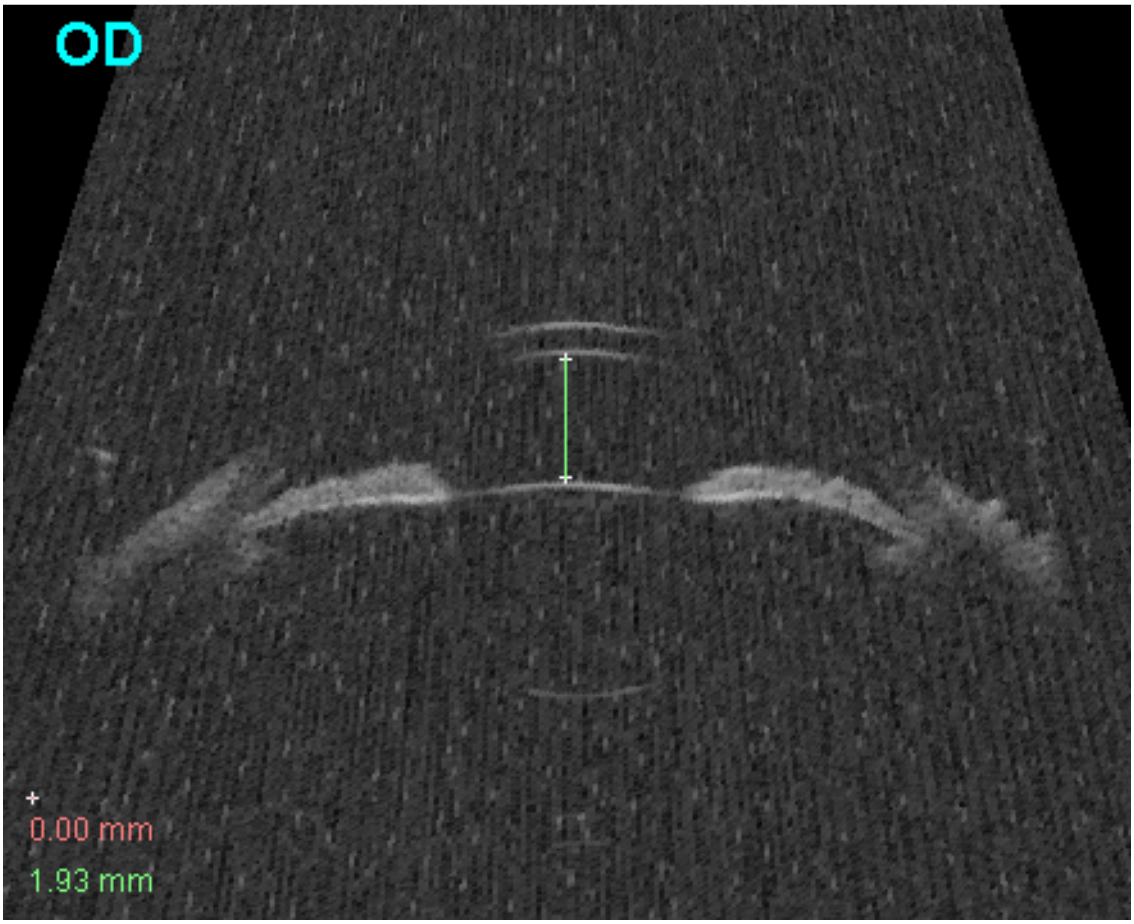
CACD by UBM- Pre PI


OD
0.00 mm
1.89 mm

PI by UBM



CACD by UBM- Post PI



BIBLIOGRAPHY

1. Parson's diseases of the eye, 19th edition, pp 299-321

2. Yanoff and duker ophthalmology, 3rd edition, 10.12, pp1162-1171

3. Quigley HA. Number of people with glaucoma worldwide. Br J Ophthalmol 1996;80:389-93

4. Quigley HA, Broman AT. The number of people with glaucoma worldwide in 2010 and 2020. Br J Ophthalmol 2006; 90:262-7.

5. Foster PJ, Buhrmann R, and Quigley HA, Johnson GJ. The definition and classification of glaucoma in prevalence surveys.Br J Ophthalmol. 2002; 86:238–242

6. Seah SK, Foster PJ, Chew PT, et al. Incidence of acute primary angle-closure glaucoma in Singapore. An island-wide survey. Arch Ophthalmol. 1997; 115:1436–1440.

7. Vijaya L, George R, Arvind H, Baskaran M, Ve Ramesh S, Raju P, *et al*. Prevalence of primary angle closure disease in an urban south Indian population and comparision with a rural population. The Chennai Glaucoma Study. Ophthalmology 2008;115:655-60.

8. Shields textbook of glaucoma, 5th edition, an overview of glaucoma, pp 1,2

9. Shields textbook of glaucoma, 5th edition, pupillary block glaucoma, pp 217-234

10. Wolff's anatomy of the eye and orbit, 8th edition, the eyeball and its dimensions, topographic anatomy, pp 216-227

11. Adler's physiology of the eye, 9th edition, intraocular pressure, pp 248-267

12. Moses RA, Grodzki WJ Jr. The scleral spur and scleral roll.Invest Ophthalmol Vis Sci 1977;16(10):925.

13. Wolff's anatomy of the eye and orbit, 8th edition, 7.1, pp 233-267

14. Shields textbook of glaucoma, 5th edition, cellular and molecular biology of aqueous humour dynamics, pp 5-35.

15. Ashton N. The exit pathway of the aqueous.Trans OphthalmolSoc U K 1960;80:397

16. Spencer WH, Alvarado J, Hayes TL. Scanning electron microscopy of human ocular tissues: trabecular meshwork. Invest Ophthalmol 1968;7(6):651.

17. Rohen JW, Rentsch FJ. (Morphology of Schlemm's canal and related vessels in the human eye.)Albrecht Von Graefes Arch KlinExpOphthalmol 1968;176(4):309.

18. Ascher K. The aqueous veins: biomicroscopic study of the aqueous humor elimination. In: Monograph in the Banner Stone Division of American Lectures in Ophthalmology, American Lectures Series, Pub # 403. Springfield, 1961

19. Albert and jakobiec, principles and practice of ophthalmology, 2nd edition,

20. von Graefe A: Uber die iridectomiebeiglaukom und uber den glaucomatosen process. Graefes Arch ClinExpOpththalmol 3:456, 1857

21. Curran E: a new operation for glaucoma involving a new principle in the aetiology and treatment of chronic primary glaucoma. Arch Ophthalmol 49:131, 1922

22. Barkan O: Narrow angle glaucoma: pupillary block and the narrow angle mechanism. Am J Ophthalmol 37:322, 1954

23. Adler's physiology of the eye, 9th edition, 7, pp 228-247

24. Shields textbook of glaucoma, 5th edition, pupillary block glaucoma, pp 217-230

25. Yanoff and duker ophthalmology, 3rd edition, 10.12, pp 1162-1171

26. Shields textbook of glaucoma, 5th edition, intraocular pressure and tonometry, pp 36- 58

27. Fontana ST, Brubaker RF. Volume and depth of the anterior chamber in the normal aging human eye. Arch Ophthalmol 1980;98:1803.

28. Aung T, Chew PT. Review of recent advancements in the understanding of primary angle-closure glaucoma. CurrOpinOphthalmol 2002;13:89-93.

29. Clemmesen V, Luntz MH. Lens thickness and angle-closure glaucoma: a comparative oculometric study in South African Negroes and Danes. ActaOphthalmol 1976;54:193

30. Perkins ES. Family studies in glaucoma. Br J Ophthalmol 1974;58:529-535

31. Grant WM. Ocular complications of drugs: glaucoma. JAMA 1969;207:2089.

32. van Herick W., Shaffer R.N., Schwartz A.: Estimation of width of angle of anterior chamber: incidence and significance of the narrow angle. *Am J Ophthalmol* 1969; 68:626.

33. Foster P.J., Devereux J.G., Alsbirk P.H., et al: Detection of gonioscopicallyoccludable angles and primary angle closure glaucoma by estimation of limbal chamber depth in Asians: modified grading scheme. *Br J Ophthalmol* 2000; 84:186-192.

34. Foster P J, Buhrmann R, Quigley HA, Johnson GJ. The definition and classification of glaucoma in prevalence surveys.Br J Ophthalmol. 2002;86:238-42

35. Meyer-Schwickerath G. Erfahrungenmit der Lichtokoagulation der Netzhaut und der Iris. Doc Ophthalmol 1956;10:91.

36. Goldmann H, Schmidt TH. Ueber applanations tonometrie. Ophthalmologica 1957;134:221.

37. Vargas E, Drance SM. Anterior chamber depth in angle- closure glaucoma: clinical methods of depth determination in people with and without the disease. Arch Ophthalmol 1973;90:438.

38. Abraham RK, Miller GL. Outpatient argon laser iridectomy for angle closure glaucoma: a two-year study. Trans Am AcadOphthalmolOtolaryngol 1975;79:OP529.

39. Jack j kanski, clinical ophthalmology, a systemic approach, 6th edition, ocular examination technique, pp 1-32

40. Abraham RK. Protocol for single-session argon laser iridectomy for angle-closure glaucoma.IntOphthalmolClin 1981; 21:145.

41. Ritch R. Argon laser treatment for medically unresponsive attacks of angle-closure glaucoma. Am J Ophthalmol 1982; 94:197

42. Lewis R, Perkins TW, Gangnon R, et al. The rarity of clinically significant rise in intraocular pressure after laser peripheral iridotomy with apraclonidine.Ophthalmology 1998; 105:2256.

43. Rosenberg LF, Krupin T, Ruderman J, et al. Apraclonidine and anterior segment laser surgery: comparison of 0.5% versus 1.0% apraclonidine for prevention of postoperative intraocular pressure rise. Ophthalmology 1995;102:1312.

44. Charles ST, Hamasaki DI. The effect of intraocular pressure on the pupil size.ArchOphthalmol 1970;83:729

45. Ganias F, Mapstone R. Miotics in closed-angle glaucoma. Br J Ophthalmol 1975;59:205.

46. Harasymowycz P.J., Papamatheakis D.G., Ahmed I., et al: Phacoemulsification and goniosynechialysis in the management of unresponsive primary angle closure. *J Glaucoma* 2005; 14:186-189

47. Aung T., Tow S.L., Yap E.Y., et al: Trabeculectomy for acute primary angle closure. *Ophthalmology* 2000; 107:1298-1302.

48. Ritch R, Krupin T, Henry C, et al. Oral imipramine and acute angle closure glaucoma. Arch Ophthalmol 1994;112:67

49. Fazio DT, Bateman JB, Christensen RE. Acute angle-closure glaucoma associated with surgical anesthesia. Arch Ophthalmol 1985;103:360.

50. Smith RJH. A new method of estimating the depth of the anterior chamber.Br J Ophthalmol 1979;63:215

51. Shields textbook of glaucoma, 5th edition, 3, pp 59- 72

52. Pavlin CJ, Sherar MD, Foster FS. Subsurface ultrasound microscopic imaging of the intact eye. Ophthalmology 1990;97:244-50

53. Pavlin CJ, Foster FS. Ultrasound biomicroscopy of the eye.In : Byrne SF, Green RL, editors. Ultrasound of the eye and the orbit. St Louis (MO): Mosby; 2002. P 223-35.

54. American academy of ophthalmology, glaucoma, 2006-2007, 5, pp 119-146.

55. Pavlin CJ, Foster FS, Ultrasoundbiomicroscopic outcome of the eye, Newyork: Springer Verlag; 1994.

56. Pavlin CJ, Foster FS, Ultrasoundbiomicroscopy, high frequency ultrasound imaging of eye at microscopic resolution, Radiol Clin North AM, 1998, 36; 1047-58.

57. Mingguang He, David.S.Friedman et al, The Liwan Eye Study, Laser peripheral iridotomy in primary angle closure suspects: Biometric & Gonioscopic outcomes

58. Fea HM, Bertaina L, Consolandi G, Damato D, Lorenzi U et al (2012); angle closure glaucoma: pathogenesis and evaluation.

ABBREVIATIONS

1. AACG - Acute Angle Closure Glaucoma
2. ACD - Anterior Chamber Depth
3. ACS- Angle Closure Suspects
4. C: D ratio- Cup: Disc ratio
5. CACD - Central Anterior Chamber Depth
6. CCC - Circum Corneal Congestion
7. Gr – Grade
8. HF – High Frequency
9. HTR- Hypertensive Retinopathy
10. IOP – Intraocular Pressure
11. LE- Left Eye
12. MHz – Mega Hertz
13. mJ - milli Joules
14. mm - millimetre
15. Nd YAG- Neodymium Yttrium Aluminium Garnet
16. NFLD- Nerve Fibre Layer Defect
17. NPDR- Non Proliferative Diabetic Retinopathy
18. PACD – Peripheral Anterior Chamber Depth
19. PACG - Primary Angle Closure Glaucoma
20. PAS - Peripheral Anterior Synechiae

21. PDR- Proliferative Diabetic Retinopathy

22. PI - Peripheral Iridotomy

23. RE - Right Eye

24. UBM- Ultrasound Biomicroscopy

25. VA - Visual Acuity

PROFORMA

A. Name of the patient: Hospital No.

Age: sex:

B. History of present illness: pain/colored haloes/ blurred vision /headache/ redness

Treatment history :

Optical history :

Family history :

C. Examination findings RE LE

Lids

Conjunctiva

Cornea

Anterior chamber depth: shallow/ normal

PACD grade 4/3/2/1

(using slit lamp technique of van herick)

A C content: clear/ flare/ flare & cells/pigments.

Iris : Pattern: normal/ distorted

Atrophy: yes/ no

Previous laser PI: yes/no

Pupil : size: normal / dilated

Shape: round / vertically oval/ irregular

Reaction: brisk/ sluggish/ non reacting

Synechiae: yes / No

Lens : clear/ pigments over anterior capsule

Visual acuity: snellen's test types.

Fundus: direct ophthalmoscope:

Media:

Disc:

C:D ratio:

Peripapillary area:

Vessels:

Macula:

Back ground retina:

NFLD:

D. I.O.P: applanation tonometry:

E. Gonioscopy Shaffer's grading (0,I,II,III,IV):

Superior:

Temporal:

Inferior:

Nasal:

F. UBM: CACD:

G. A scan biometry:

H. Fields:

I. Laser iridotomy:

Position:

No. of shots:

Total energy:

J. PI patency at end of 2 weeks: Transillumination defect:

K. Van Herick's grading of PACD post PI:

L. Gonioscopy Shaffer's grading (0,I,II,III,IV) post PI:

Superior:

Temporal:

Inferior:

Nasal:

M. CACD by UBM post PI:

CONSENT FORM

Yourself Mr./Mrs./Ms……...are being asked to be a participant in the research study titled "COMPARATIVE STUDY OF ANTERIOR CHAMBER DEPTH PRE AND POST PROPHYLACTIC LASER IRIDOTOMY IN ANGLE CLOSURE SUSPECTS" in CMC Hospital, Coimbatore, conducted by Dr.V.K.Bhavani,Post Graduate Student, Department of ophthalmology,Coimbatore Medical College.You are eligible after looking into the inclusion criteria.You can ask any question you may have before agreeing to participate.

Research Being Done

To assess the effect of laser peripheral iridotomy on central and peripheral anterior chamber depth in angle closure suspects.

Purpose of Research

To determine the changes in the peripheral and central anterior chamber depth and to determine the changes in gonioscopy before and after prophylactic peripheral Nd:YAG laser iridotomy in angle closure suspects.

Procedures involved

- Peripheral anterior chamber depth assessed by Van Herick's method.
- Angle closure suspects identified by gonioscopy by Shaffer's grading.
- Ultrasound biomicroscopy performed to determine the central anterior chamber depth
- Laser peripheral iridotomy performed on angle closure suspects.
- Van Herick's grading, Shaffer's grading and Ultrasound biomicroscopy performed 2weeks after laser iridotomy.

Decline from Participation

You have the option to decline from participation in the study existing protocol for your condition.

Privacy and Confidentiality

Privacy of individuals will be respected and any information about you or provided by you during the study will be kept strictly confidential.

Authorization to publish Results

Results of the study may be published for scientific purposes and/or presented to scientific groups; however you will not be identified.

Statement of Consent

I volunteer and consent to participate in this study. I have read the consent or it has been read to me. The study has been fully explained to me, and I may ask questions at any time.

....

(Date) (Signature/left thumb impression of volunteer)

....

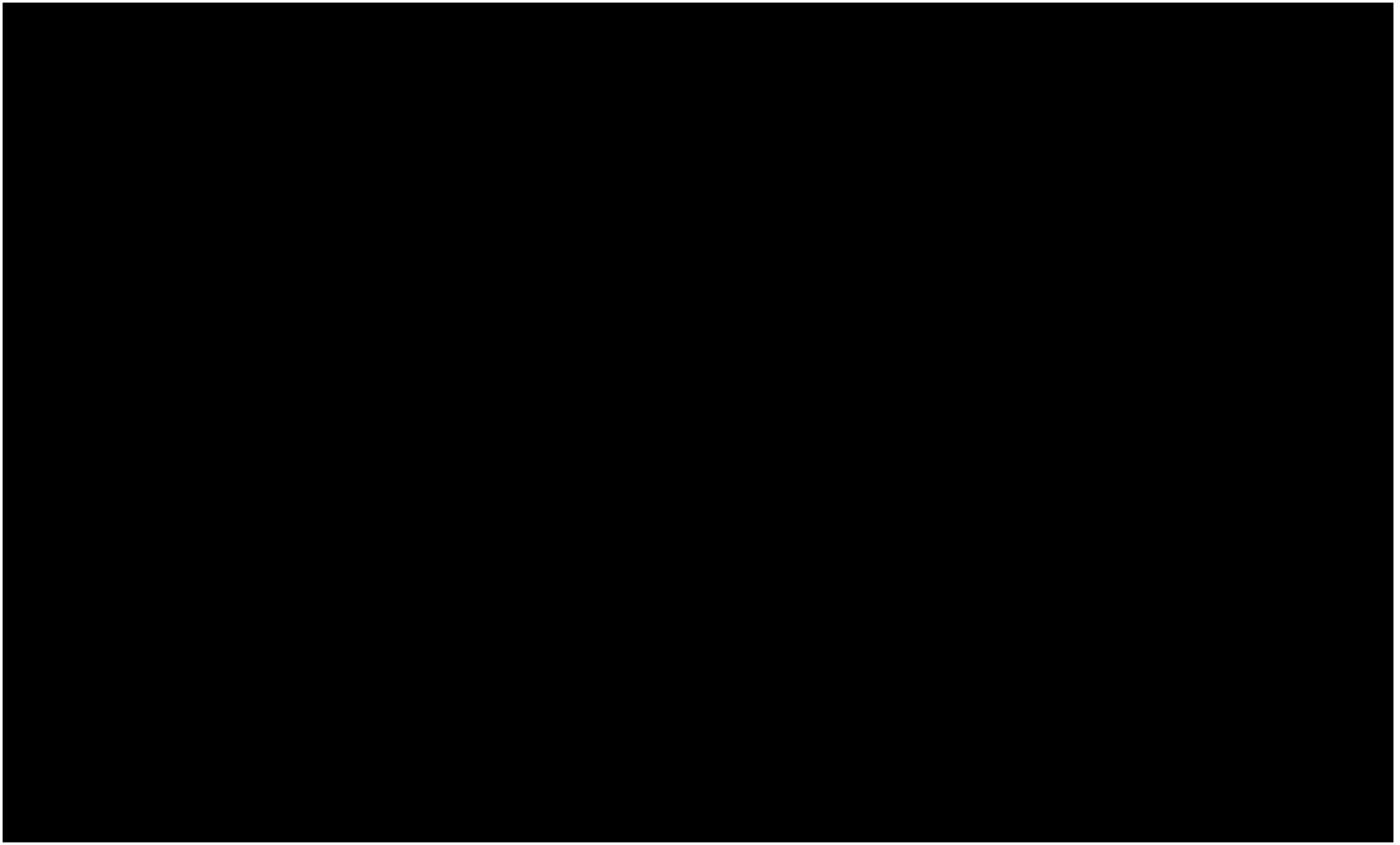
(Date) (Signature/left thumb impression of Witness)

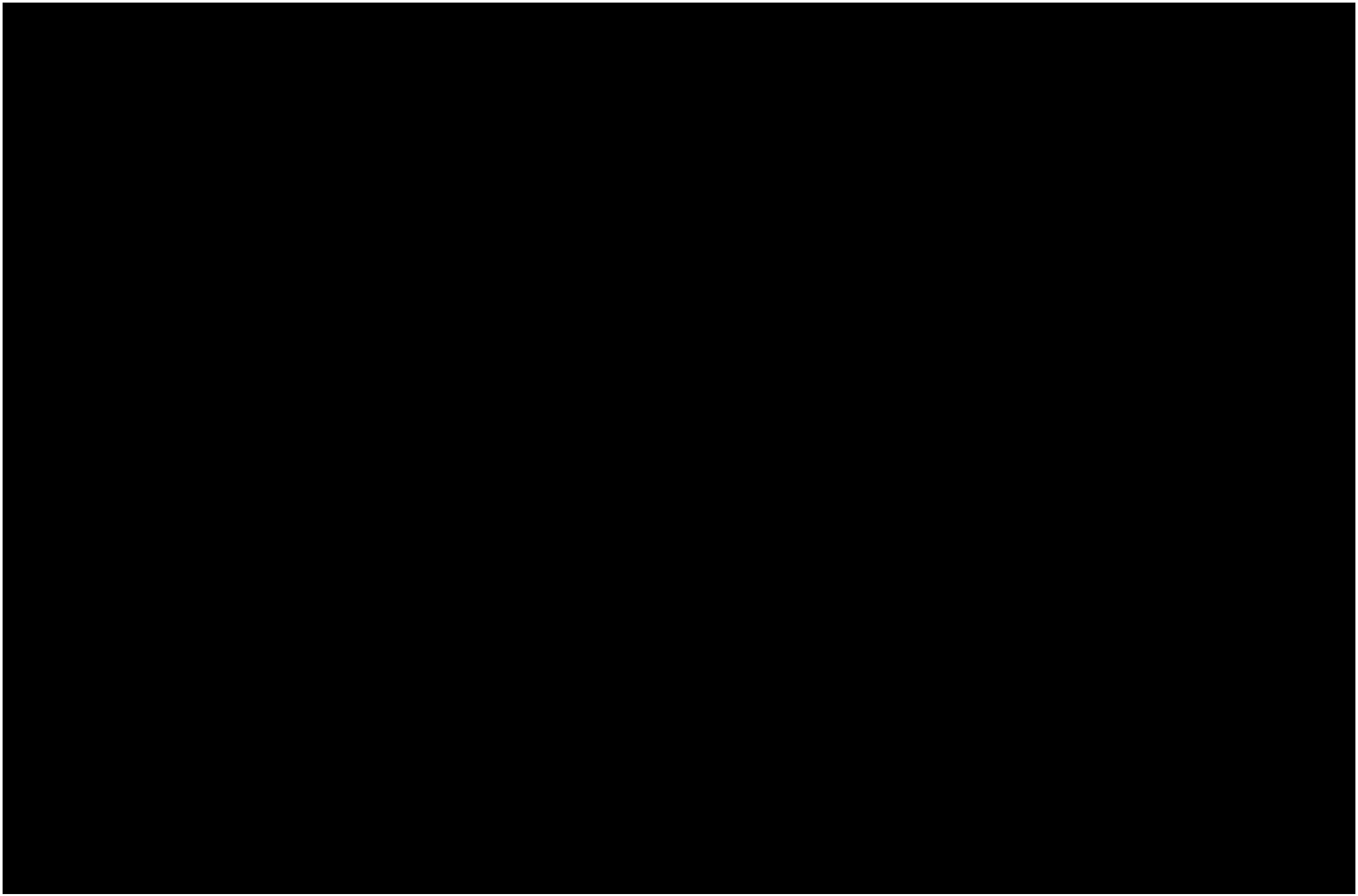
CONSENT FOR Nd:YAG Laser Iridotomy

As my right/left eye is prone for angle closure it can lead to severe pain and decreased vision, so I am willing to undergo laser treatment which will prevent the angle closure. I agree to undergo the procedure knowing the possible complications of the procedure as explained to me by the doctor.

....

(Date) (Signature/left thumb impression)





KEY TO MASTER CHART

1. FAM HIS- FAMILY HISTORY
2. IOP- INTRAOCULAR PRESSURE
3. AL LENGTH- AXIAL LENGTH
4. REF ER- REFRACTIVE ERROR
5. ACD- ANTERIOR CHAMBER DEPTH
6. Pt- PEN TORCH
7. PACD- PERIPHERAL ANTERIOR CHAMBER DEPTH
8. SUP- SUPERIOR
9. TEMP- TEMPORAL
10. INF- INFERIOR
11. NAS- NASAL
12. CACD- CENTRAL ANTERIOR CHAMBER DEPTH
13. PI- PERIPHERAL IRIDOTOMY
14. PPI- POST PERIPHERAL IRIDOTOMY
15. E- EMMETROPIA
16. My- MYOPIA
17. H- HYPERMETROPIA
18. MA- MYOPIC ASTIGMATISM
19. HA- HYPERMETROPIC ASTIGMATISM
20. MOD- MODERATE
21. M- MALE
22. F- FEMALE
23. NPDR- NON PROLIFERATIVE DIABETIC RETINOPATHY
24. GR1 HR- GRADE I HYPERTENSTIVE RETINOPATHY
25. LE- LEFT EYE
26. RE- RIGHT EYE