Dissertation on

"A COMPARATIVE STUDY OF INCREASE IN CENTRAL CORNEAL THICKNESS FOLLOWING CONGENITAL CATARACT SURGERY IN PSEUDOPHAKIC AND APHAKIC EYES"

Submitted in partial fulfillment of requirements of

MASTER OF SURGERY DEGREE

BRANCH – III – (OPHTHALMOLOGY)

GOVT. RAJAJI HOSPITAL, MADURAI MEDICAL COLLEGE

MADURAI- 20

THE TAMILNADU

Dr. M.G.R. MEDICAL UNIVERSITY

CHENNAI

2017

CERTIFICATE

This is to certify that this dissertation entitled **"A COMPARATIVE STUDY OF INCREASE IN CENTRAL CORNEAL THICKNESS FOLLOWING CONGENITAL CATARACT SURGERY IN PSEUDOPHAKIC AND APHAKIC EYES"** is a bonafide record of research work done by **Dr. ANU JOSEPH,** 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.

Dr. P. THIYAGARAJAN, M.S, D.O.,

HOD and Professor of Ophthalmology,

GRH, Madurai Medical College,

Madurai.

Dr. M. R. VAIRAMUTHU RAJU, M.D

The Dean,

GRH, Madurai Medical College,

Madurai.

CERTIFICATE FROM GUIDE

This is to certify that this dissertation entitled **"A COMPARATIVE STUDY OF INCREASE IN CENTRAL CORNEAL THICKNESS FOLLOWING CONGENITAL CATARACT SURGERY IN PSEUDOPHAKIC AND APHAKIC EYES"** is a bonafide record of research work done by **Dr. ANU JOSEPH,** Post Graduate Resident in Department of Ophthalmology, Madurai Medical College, Madurai.

Dr. S. I. THASNEEM SURAIYA, M.S,

Assistant Professor of Ophthalmology,

GRH, Madurai Medical College,

Madurai.

Dr. S. V. CHANDRAKUMAR, M.S, DO.,

Associate Professor of Ophthalmology,

GRH, Madurai Medical College,

Madurai.

DECLARATION

I, **Dr. ANU JOSEPH** hereby solemnly declare that, this dissertation titled **"A COMPARATIVE STUDY OF INCREASE IN CENTRAL CORNEAL THICKNESS FOLLOWING CONGENITAL CATARACT SURGERY IN PSEUDOPHAKIC AND APHAKIC EYES"** 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.

Place: Madurai (Dr. Anu Joseph)

Date:

ACKNOWLEDGEMENT

I express my sincere thanks and gratitude to **Prof. Dr. M R VAIRAMUTHU RAJU M.D,** The Dean, GRH and MMC Madurai for permitting me to conduct this study. I am extremely grateful to **Dr. P. THIYAGARAJAN M.S,D.O,** HOD**,** Professor of Ophthalmology and **Dr. S. V. CHANDRAKUMAR M.S,D.O,** Associate Professor of Ophthalmology, GRH, MMC, Madurai, for his valuable suggestions and guidance throughout the course of my study.. I have great pleasure in thanking my beloved guide **DR. THASNEEM SURAIYA, M.S,** Assistant Professor and all my Assistant Professors of Ophthalmology department at Madurai Medical College, Madurai, for their constant source of cheer and encouragement throughout the study

I express my sincere thanks to **Prof. Dr K MATHIARASAN MD.,** Head of the department of Paediatrics for their constant support, guidance, cooperation in this study.

I thank all my dear friends for their timely help and encouragement to do my study .I express my heartfelt love to my parents, husband and daughter for endless affection and support.

I thank the patients of our hospital for their extreme patience and cooperation without whom the project would have been a distant dream.

Above all, I thank **GOD ALMIGHTY** for all his blessings.

INDEX

S.NO	CONTENTS	PAGE NO.
	PART I	
1.	INTRODUCTION	**1**
2.	DEVELOPMENT OF MACULA	**4**
3.	ANATOMY OF NORMAL LENS	**7**
4.	CONGENITAL CATARACT	**11**
5.	SIDE EFFECTS OF ANTI-GLAUCOMA MEDICATIONS IN CHILDREN	**40**
6.	APPLANATION TONOMETRY	**41**
7.	PACHYMETRY	**46**
8.	VARIOUS POSTULATIONS FOR INCREASE IN CCT	**49**
9.	REVIEW OF LITERATURE	**50**

S.NO	CONTENTS	PAGE NO.
	PART II	
1.	AIMS AND OBJECTIVES	**55**
2.	MATERIALS AND METHODS	**56**
3.	RESULTS AND INTERPRETATION	**59**
4.	SUMMARY	**76**
5.	DISCUSSION	**78**
6.	CONCLUSION	**80**

ANNEXURES

1.	BIBLIOGRAPHY
2.	PROFORMA
3.	MASTER CHART
4.	LIST OF ABBREVIATIONS
5.	ETHICAL COMMITTEE CLEARANCE
6.	ANTI PLAGIARISM CERTIFICATE

PART ONE

INTRODUCTION

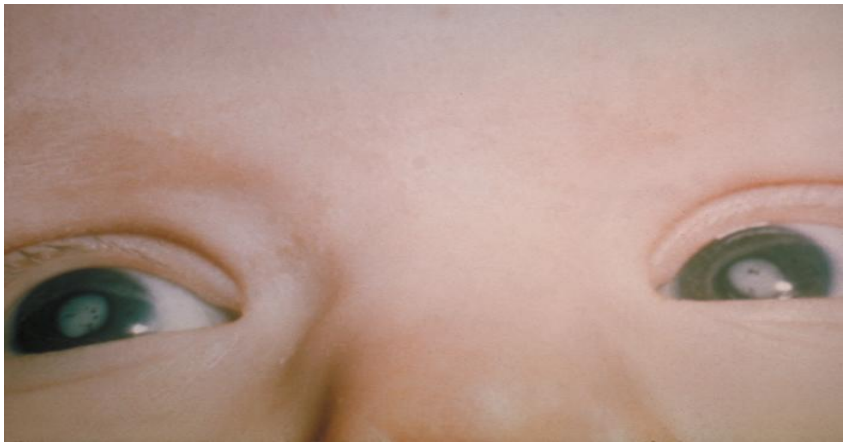
A Congenital cataract is defined as any loss of transparency or opacification of the lens fibres present at birth. The word “cataract” has a Greek origin which means "rapids", "down-rushing", "floodgate" or "waterfall"[1]. Based on the age of onset , cataracts can be classified as congenital, infantile, juvenile, pre-senile and senile. Paediatric cataracts are estimated to constitute more than 1 million childhood blindness in Asia. The incidence rate of paediatric cataracts in developing countries like India is high and 7.4-15.3%[2] of childhood blindness is because of cataract. The prevalence of cataract in children has been estimated to be between 1-15/10,000 children. These statistical numbers are much lower when compared to the total number of cataracts prevailing as they do not take into consideration visually insignificant lens opacities.

Although cataract extraction in children is performed at early ages to prevent stimulus deprivation amblyopia, other complications, such as secondary glaucoma, continue to threaten the visual outcome. The thickened cornea after congenital cataract extraction can lead to overestimation of Intra Ocular Pressure (IOP) readings. This can cause over diagnosis of aphakic glaucoma along with overuse of anti-glaucoma medications. Overestimation or underestimation IOP in these patients can have a significant impact on their treatment and overall prognosis. A study of Central Corneal Thickness (CCT) changes in this particular group may assist in our understanding and management of this unique group of patients. A correction of IOP

readings by considering CCT might be helpful for determining an accurate IOP value prior to the initiation of treatment.

For the normal macular development proper visual sensory input is essential. When the visual axis is obstructed, the amblyopia that develops is called as stimulus deprivation amblyopia. Most common cause for stimulus deprivation amblyopia being congenital cataract[3] or early acquired cataract. This amblyopic type though the least common is the most damaging and difficult to treat among the various types of amblyopia. This kind of amblyopic visual loss occurring from unilateral occlusion of visual axis tends to be much worser than that produced by bilateral stimulus deprivation of similar degree because the inter-ocular effects add to the direct developmental impact of degradation of image formation. Visual acuity can be 20/200 or worser in even bilateral cases.

In children < 6 years of age , dense congenital cataracts that cover the central 3 mm or more of lens should be considered capable of causing severe amblyopia. Anterior capsule opacities in general are visually insignificant unless they obstruct the entire pupillary area blocking out the red reflex. While central / posterior lens opacities of sufficient density and more than 3 mm in diameter are usually visually significant. Presence of strabismus in a unilateral cataract and nystagmus in a bilateral cataract show that the lens opacities are visually significant.



Bilateral congenital cataract

So cataracts capable of producing amblyopia require surgical intervention without any delay. In small children, amblyopia may develop as quickly at a rate of 1 week per age of life. So removal of visually significant congenital lens opacities must be done during 4-6 weeks of life for optimal visual recovery. In bilateral symmetrical congenital cataracts the interval between operation in first and second eyes should not be more than 1-2 weeks.

DEVELOPMENT OF MACULA

At birth , of all structures of the eye, development of macula is incomplete both structurally and functionally. The peripheral retina in a baby is well developed at birth both histologically as well as functionally. But the posterior pole of the eye, especially the macular area is immature at birth and almost non-functional[4]. Macular area continues to grow and develop till approximately 4 years of age. Changes noted during macular development include:

1) Pigmentation in macular region

2) development of annular ring

3) differentiation of foveal reflex

4) differentiation of cone photoreceptors

Isenberg made a study on ophthalmoscopic appearance of macula of infants and found out that in infants less than 33 weeks of gestation[5] , there was no evidence of any macular pigmentation.

→**Macular pigmentation** develops approximately at 34-35 weeks of gestational age giving a dark reddish appearance which makes it distinct from from surrounding retina. The retinal pigment epithelial (RPE) cells in macular region become taller , narrower and more tightly packed. Histological differentiation of RPE cells in this region gets completed by 34 weeks and is responsible for change in macular pigmentation.

→**Annular ring of macula** during its development appears as a circular light reflex of 1.5 mm diameter size around the centre of foveal region. It is by 34-36 weeks of gestational age this annular reflex of macula becomes first visible. Prior to the gestational age of 24 weeks , the ganglion cell layer is of uniform thickness all over the posterior pole of retina . By around 28 weeks of gestational age , these ganglion cells migrate towards the periphery away from the macular region. In the peripheral region of macula , the ganglion cell layer increases in thickness forming a macular mound with a pit in the centre of fovea. These changes in the thickness of retina create a pattern of light reflex from the internal limiting membrane which is visible ophthalmoscopically at the macula as annular reflex.

→Last ophthalmoscopic finding within the eye to mature is **foveal reflex**. It is seen in most infants by 37 weeks of gestational age, but attains maturity by 42 weeks of gestational age.

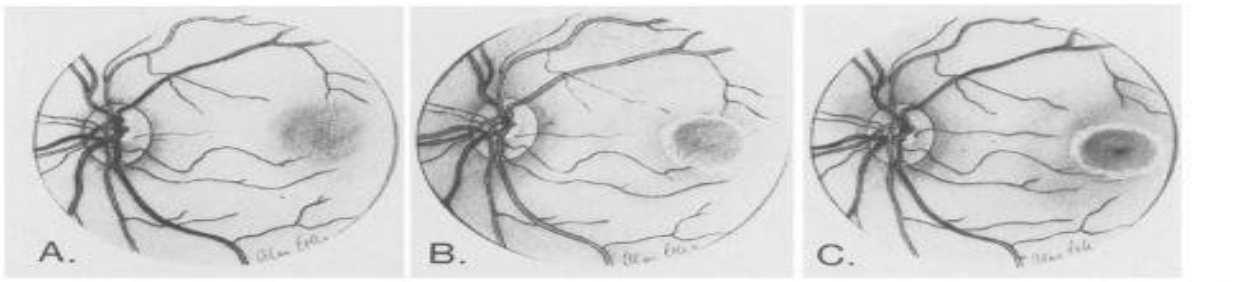


Fig 1 : 3 stages of macular development→A)macular pigmentation B)macular pigmentation with annular reflex C)macular pigmentation, annular reflex and central foveal pit

Although macula appear mature ophthalmoscopically by 42 weeks of gestational age, histological maturity is not attained until early childhood.

Remarkable histological changes during macular development are as follows

-diameter of the foveola (area of rod free region in the macula)

-Shape of the inner and outer segments of the foveal cone

-Density of cones in the foveal region

Size of foveola at birth is 1100 μm[6] approximately. In the next few years of birth , size of the macular rod free zone steadily decreases due to migration and concentration of cone nuclei towards foveola ie the inner region of macula. Size of foveola becomes adult diameter (700-750μm) by 15-45 months (ie 1-4 years) post partum.

Improvement of visual acuity with age after birth occurs due to the following 3 processeses

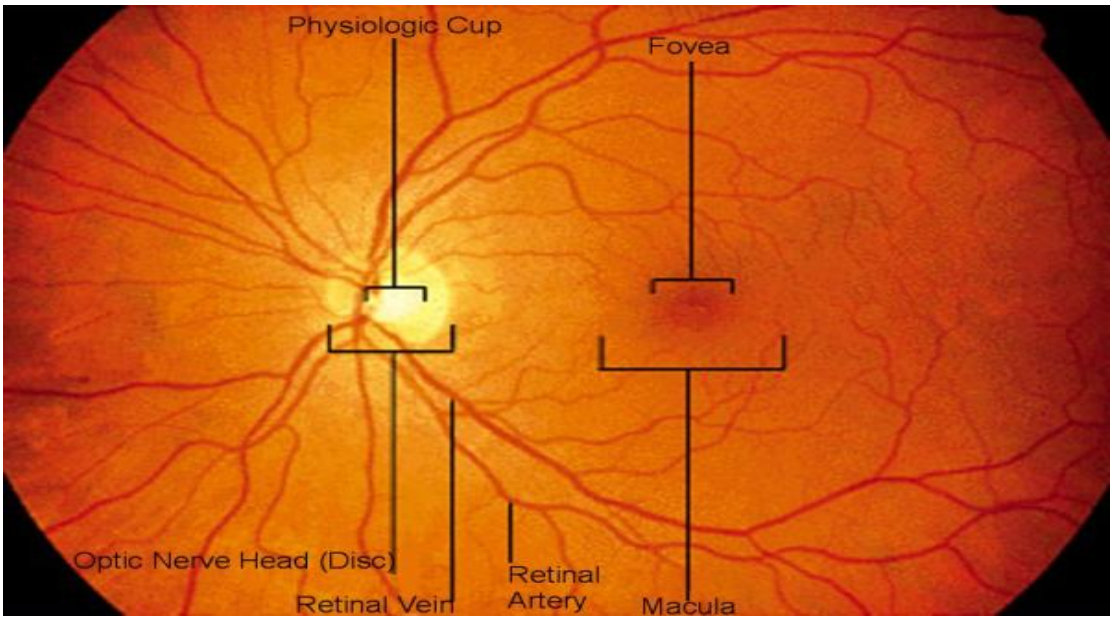
1) Differentiation of foveal cones

2) Reduction in the size of rod free region

3) Increase in cone density in foveal region

Cones have round and thick inner segments with thin, short outer segments. These segments attain maturity at different pace. Inner segments of cones resemble adult size by 15 months of birth whereas outer segment of cones elongate much more slowly. As these segments undergo thinning and elongation , foveal cones become

packed tightly. At birth density of cones in fovea is 22 cones/100µm where as in adults it is 42 cones/100µm. Improvement in recordable visual acuity and visual resolution occurs with this increase in cone density.



Normal appearance of macula

ANATOMY OF NORMAL LENS

Lens is one of the unique tissues in the body that has a purely ectodermal origin. It is an avascular structure that is solely dependant on aqueous humour for its nutritional requirements. Anatomically the lens[7] has the following parts:

A. The lens capsule

B. Lens epithelium

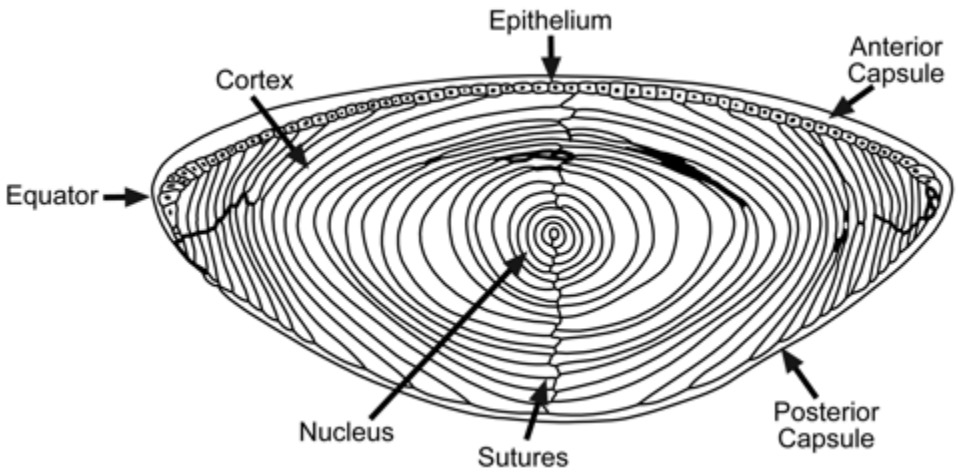
C. Lens fibres

1. Cortex

2. Nucleus.

D. Zonule

ANTERIOR



POSTERIOR

Fig 1 : Anatomy of normal human lens

The **lens capsule** is a false capsule as it is constituted by the basement membrane of underlying lens epithelium. The **lens epithelium** is most metabolically active part of lens consisting of a single layer of cuboidal shaped cells. The size of these cuboidal

cells in the central area of anterior capsule is the smallest and gradually increase in length as it go towards the peripheral areas of the lens. The lens epithelium is confined to an area between the equator and beneath the anterior lens capsule. The posterior capsule of lens lack epithelial cells . The **lens fibers** are of two types (1) Primary lens fibres which develop from the posterior most layer of the lens vesicle are ultimately converted to embryonic nucleus. The equatorial part of the lens epithelium give rise to secondary lens fibres. The peripheral most soft fibers form the **cortex** while relatively harder fibers move towards the centre to form the **nucleus**[8]. Nil histological demarcation exists between the cortex and the nucleus. Within the nucleus the oldest fibers are deepest and the number of fibers keep on increasing throughout the life. The size of the lens continues to remain the same. According to period at which lens fibres develop, lens nucleus has been assigned various terms

(a) Embryonic lens nucleus- This is the innermost and earliest to form upto the third month of gestation.

(b) Foetal lens nucleus- It develops from the secondary lens fibers overlying the embryonic nucleus between third to eighth month of gestation.

(c) Infantile nucleus- Its formation is completed before puberty.

(d) Adult nucleus –It starts forming after puberty, and keep on increasing in size without any much change in the overall dimensions of the lens.

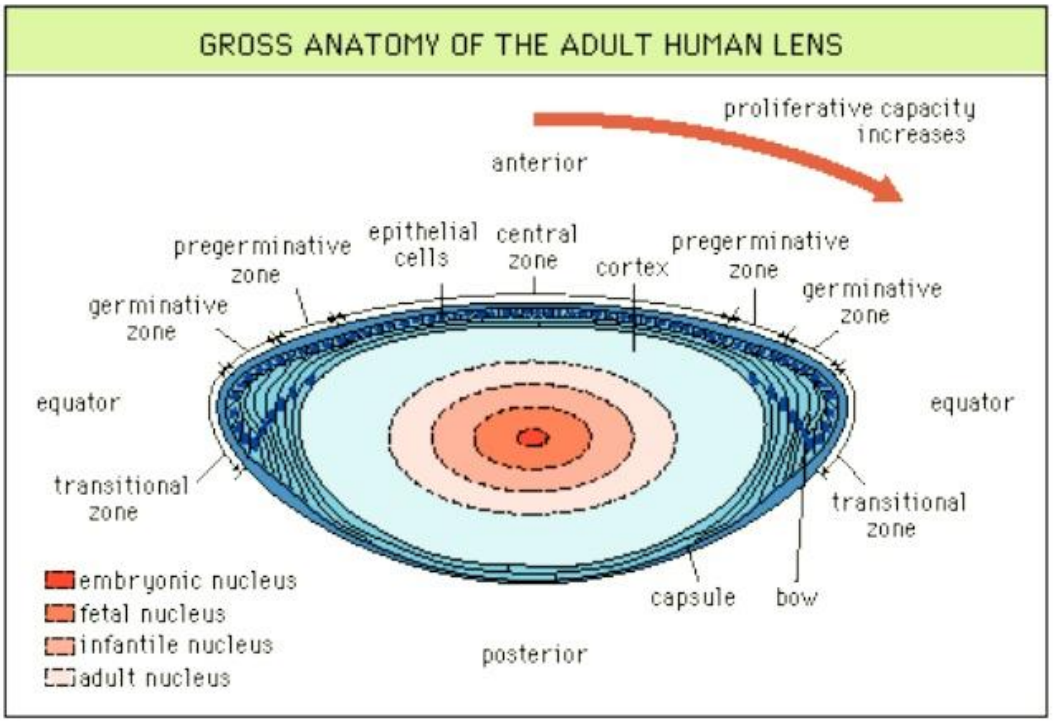


Fig 3 : Cross section of lens showing different lens nuclei

The **lens zonules** extend from the apical processes of the ciliary body to the capsule and play a role in keeping the lens in the pupillary area and help to change curvature of lens during accommodation.

The opacities involving the embryonic and foetal nuclei are called congenital while rest other than traumatic are considered developmental type though it is really difficult to differentiate between the two. The congenital cataracts are generally

central, dense and may be large enough in size to cover the entire pupillary area and, are soft in consistency.

CONGENITAL CATARACT

A broad classification divides these cataracts into:—

A) Capsulo lenticular (Capsulo cortical)

B) Lenticular

Congenital cataracts can be either nuclear or cortical. It is common for both to exist in the same eye. Nuclear cataract can frequently get converted to total cataract.

A. The capsulo lenticular cataracts are—

1. Anterior polar and anterior capsular cataract

2. Posterior capsular— Mittendorf dot, posterior lenticonus

3. Posterior polar cataract

B. The lenticular cataracts are—

1. Zonular cataract

(a) Lamellar cataract

(b) Total Cataract

(c) Cataracta central pulverulenta

(d) Membranous cataract

2. Axial cataract

3. Sutural cataract

According to shape the catracts can be :—

1. Disciform

2. Coronary

3. Coralliform

4. Others—Corkscrew cataract, blue dot cataract , christmas tree cataract, spear head shaped cataract etc

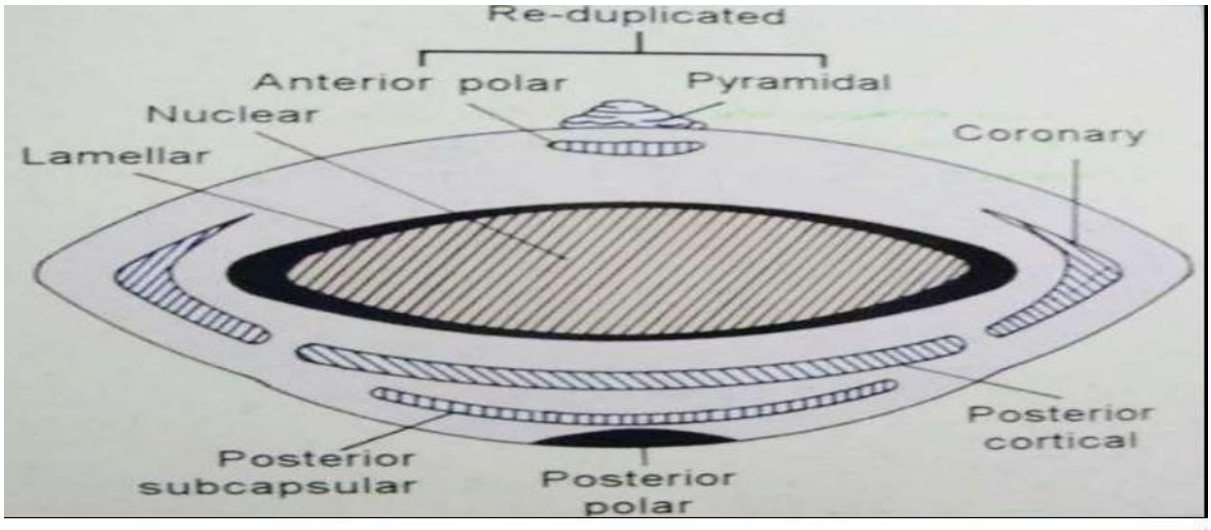


Fig 4 : Morphological types of paediatric cataract

A. The Capsulo lenticular cataracts

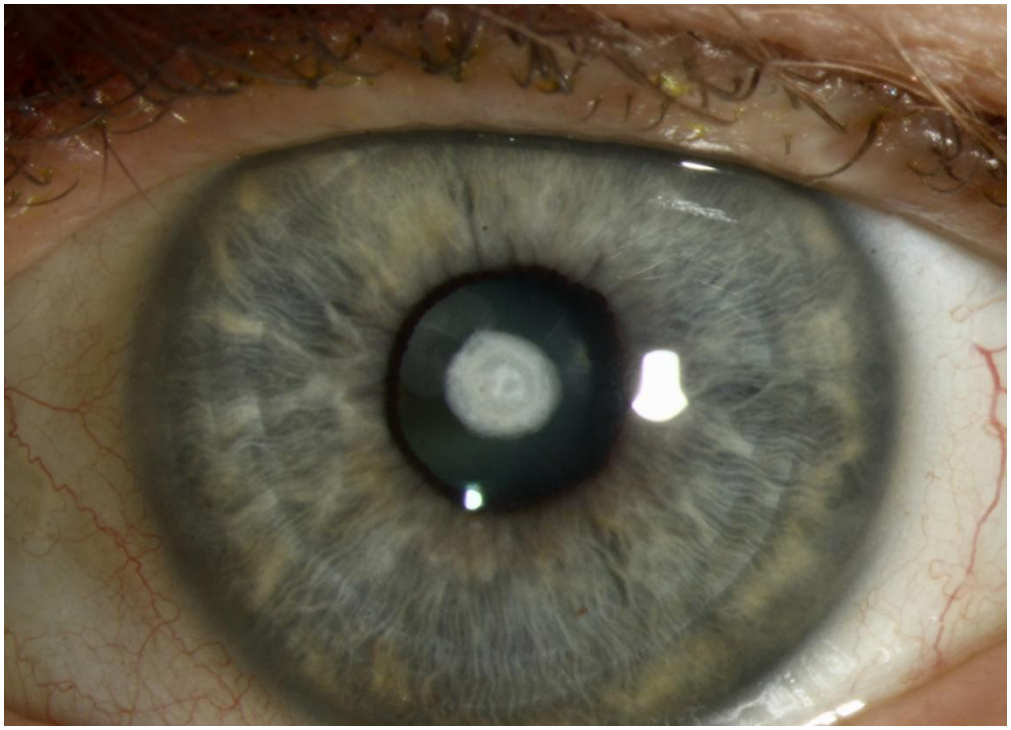
1) Anterior Polar and Anterior Capsular Cataract

The clinical presentation, pathogenesis and management are similar in both these types, hence they are being discussed under one group. Anterior polar cataracts are common but not detected unless they are specifically looked for under magnification. They have a pin point size of 1 to 2 mm in diameter. They are generally small slightly raised plaque, which may project into the anterior chamber as a triangular shaped growth with base at the centre of the anterior capsule .Such forms are called as pyramidal cataract they are of two type:

(a) Developmental →due to delayed separation of anterior capsule of lens from the surface ectoderm.

(b) Acquired→ This occurs mostly in a badly managed case of ophthalmia neonatorum resulting in central perforation, loss of anterior capsule, long duration contact between anterior lens capsule and cornea. They are generally bilateral and almost often associated with nystagmus. It occurs either as localised opacification of anterior lens capsule (true anterior capsular cataract) or imprint or reduplicaion cataract where a secondary opacity develops little below the anterior polar cataract with a clear zone in between.

The anterior polar type of cataract may be seen associated with central corneal opacity or persistent pupillary membrane . These opacities are mostly stationary in nature and do not cause much visual disturbances as it is located away from nodal point of the eye. Hence they mostly do not need any treatment.

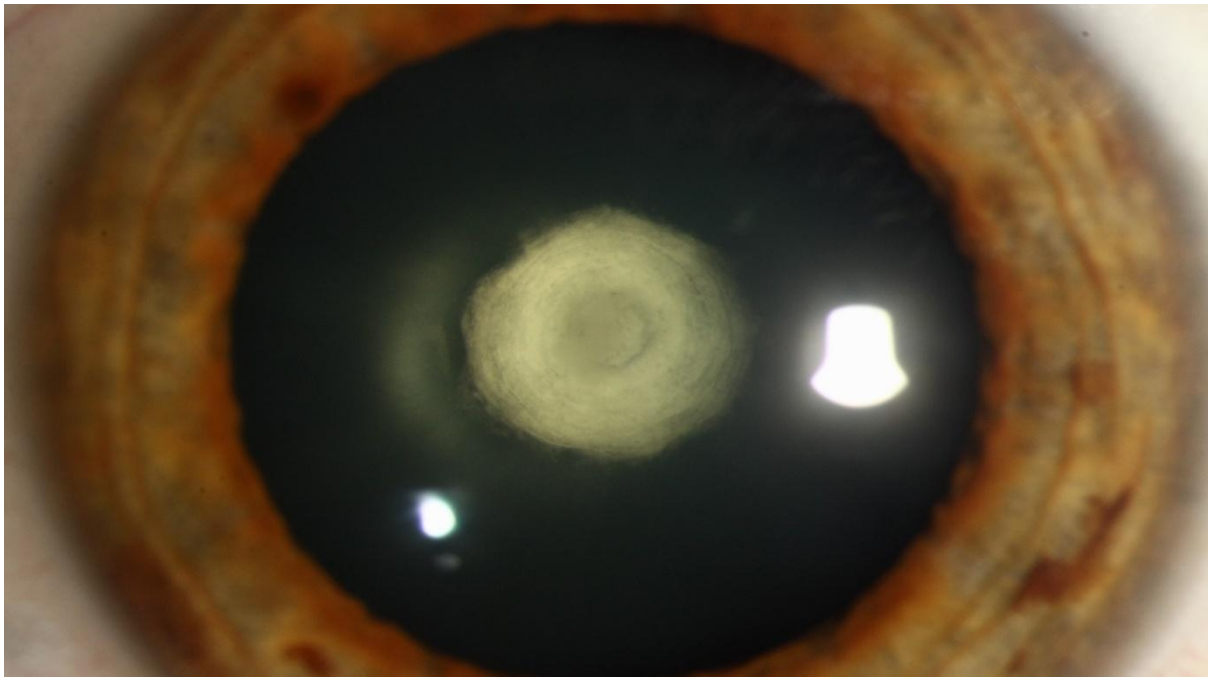


Anterior polar cataract

2) Posterior polar and Posterior capsular cataracts

Posterior polar and posterior capsular opacities have a similar incidence rate as their anterior counterpart. Pathognomonic sign of posterior polar cataract is the bull's eye appearance due to the presence of onion like concentric rings seen around the central opacity in the lens. The posterior polar cataracts are of two forms , one commonly known as Mittendorf dot. This is formed due to incomplete absorption of anterior portion of the hyaloid artery that supplies nutrition to the lens during the first three months of gestation. It is a stationary condition and cause visual disturbance due to its

proximal location to the nodal point of the eye. The other progressive type causes greater visual impairment as the opacity increases in size gradually after birth by developing opacities in the posterior cortex either as a sheet of opacification or radiating opacities from a central opacification. It is not known to involve the lens nucleus.



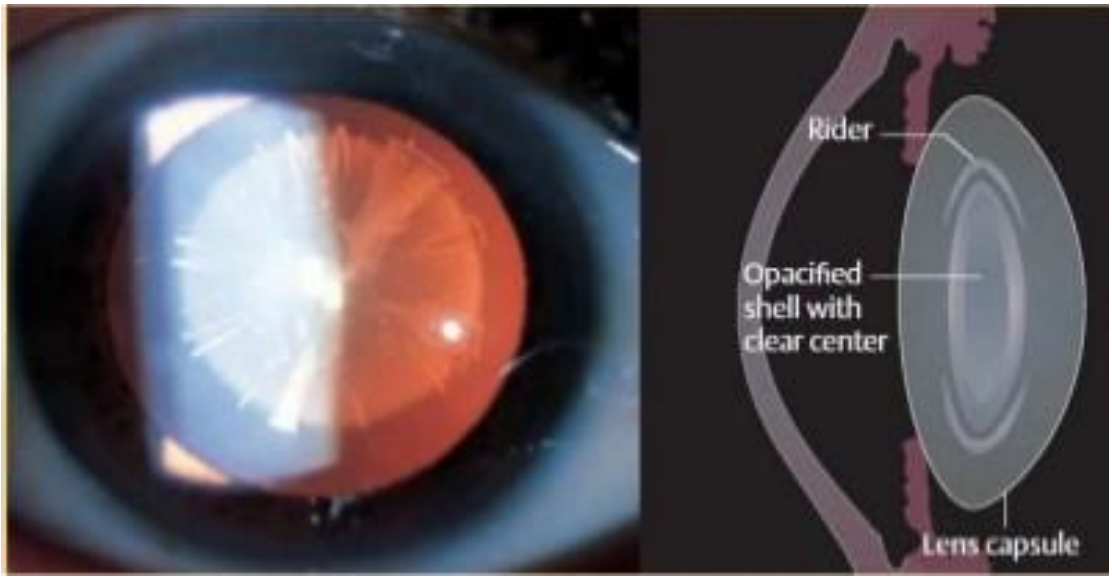
Posterior polar cataract

B) Lenticular cataract

The commonest variety in the group is lamellar or peri-nuclear type also referred to as zonular cataract.

1. Lamellar cataract

It is the commonest congenital cataract. It is generally bilateral, symmetrical and stationary, boys are more affected than girls, it may be prenatal or postnatal. If the lens opacity is smaller than the diameter of the lens of new born i.e. 5.75 mm it is most probably prenatal otherwise it is post natal. The foetal and infantile nuclei undergo opacification in a lamellar pattern. On the surface of the lens opacity many ridges that radiate from the centre are visible on oblique illumination and vary in number. They may be either limited at the periphery of the cataract or may project into the clear cortex with club or spine shaped projections called riders. Most of the lamellar cataracts are hereditary, and have a autosomal dominant pattern of inheritance .It may be present in their parents or in siblings. The sporadic cataracts were due to calcium metabolism derangement in the mothers with vitamin "D" deficiency during developmental period of the lens in foetus. Treatment is based on the size and density of the cataract.



Lamellar / zonular type of congenital cataract

2. Congenital nuclear cataract / Cataracta central pulverulenta

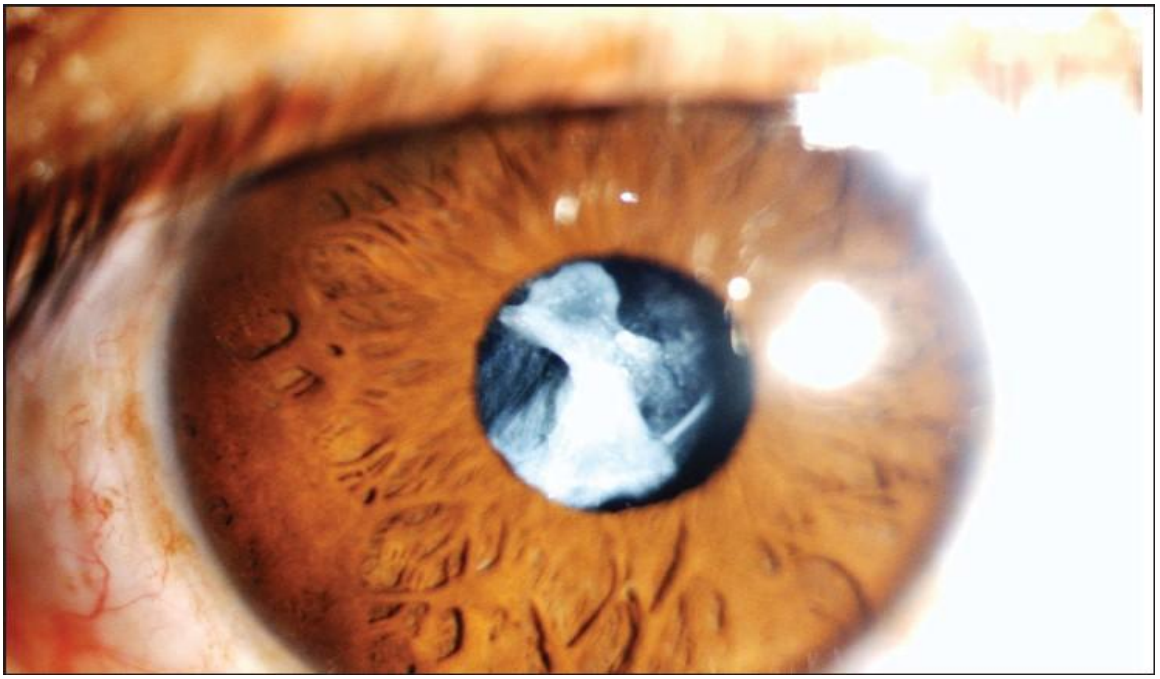
This type of lenticular cataract is confined to the embryonic nucleus of lens due to changes at 3 months gestational age. These are called pulverulent cataract due to their dense, powdery appearance. These are generally bilateral, non- progressive in nature without much visual loss.

3. Total nuclear cataract

It may involve infantile, foetal or embryonic nuclei. The condition is bilateral, symmetrical and stationary may hamper vision.

4. Membranous Cataract

They develop due to absorption of soft cortical material in congenital cataract of long standing duration either spontaneously or following trauma. The two capsules (anterior and posterior) come close and adhere to each other with some opaque lens fibres in between without any nucleus. They generally do not require any surgical correction but if the membrane is thick, it may be needled followed by standard methods of correction of aphakia.

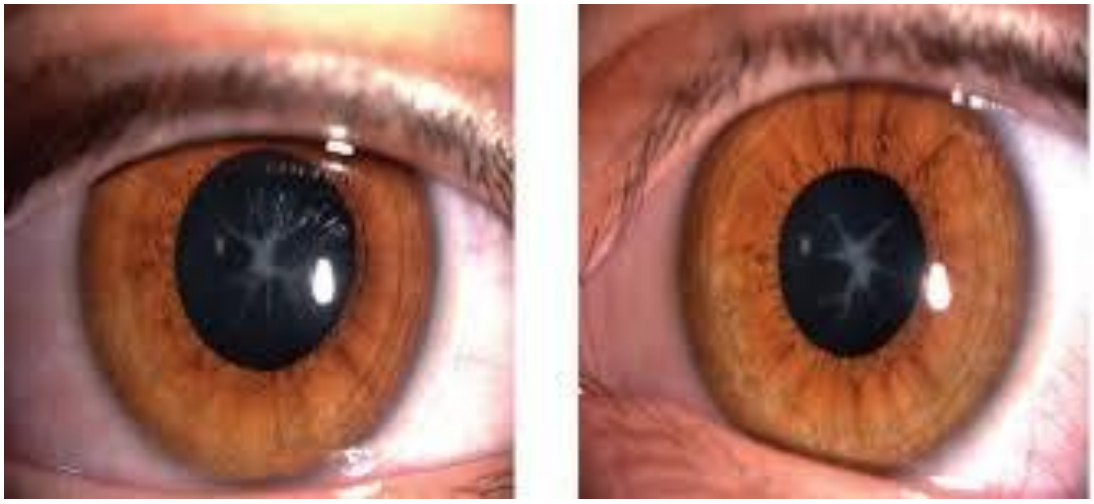


Membranous cataract

Other cataracts include

(a) Sutural /stellate Cataracts

These are discrete opacities in the Y shaped sutures of the embryonic nuclei of lens. They are mostly bilateral and stationary. One or both the sutures of the lens nucleus may be involved but can be symmetrical or asymmetrical. Other variants are : Floriform, Coralliform and spear shaped cataract , anterior embryonic axial cataract.



Bilateral sutural / stellate cataract

(b)Blue dot Cataract

This is a very commonly seen congenital abnormality of lens. The opacities are of various sizes, some of them visible only during slit lamp examination, others may be visible and identified with bright oblique illumination. The opacities are scattered in the centre of the lens. They are not really coloured blue, they are actually white but appear blue due to dispersion of violet light[9].

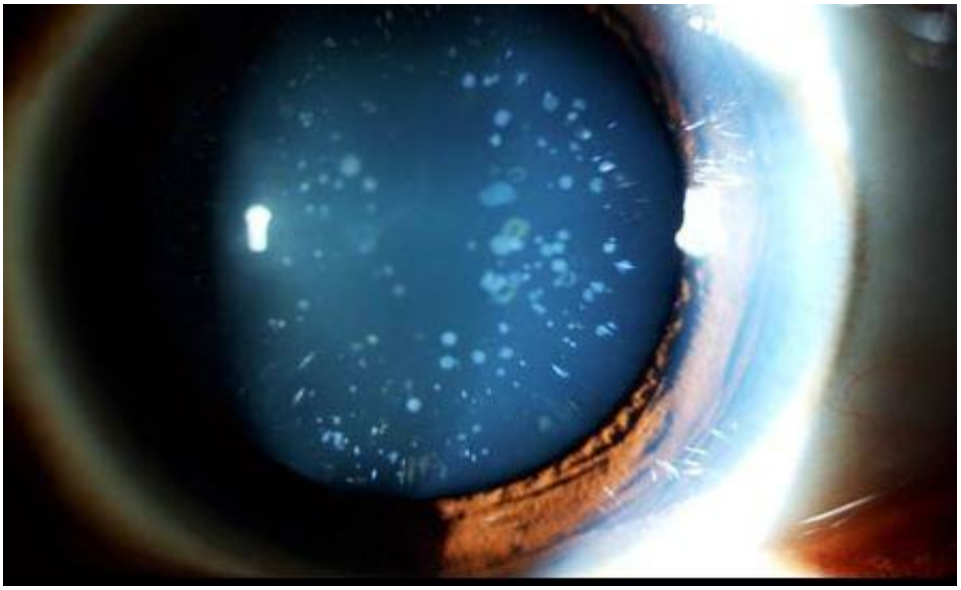


Fig 5 : Blue dot cataract

Etio-pathogenesis of congenital cataracts

Etiology of congenital and developmental cataracts are not very well understood .They can occur either in isolation or can be associated with a large number of genetic and metabolic disorders.

(i) Idiopathic etiology-in 40 % to 50 % of cases. These are generally sporadic[10] in nature.

(ii)Hereditary- one third of all congenital and developmental cataracts are hereditary . Many have an autosomal dominant (AD) pattern of inheritance. Mutations in genes coding for crystallins and connexins proteins have been found to be an implicating factor.

(iii)Maternal factors

→Maternal infections - During pregnancy commonest virus resulting in cataract is german measles/Rubella, others are cytomegalo virus, rubeola, mumps and influenza virus. Maternal syphilis can also cause congenital cataract in babies.

→Maternal malnutrition- dietary deficiency of fat soluble vitamins during pregnancy

→ Drugs : drugs taken in during first trimester can result in foetal cataract eg: thalidomide, steroids

→Exposure to radiation during pregnancy

→ Endocrine abnormalities[11] in mother

(iv) Foetal factors

→ Trauma during birth eg: during instrumental (forceps) delivery

→ Poor oxygen supply to foetus as during placental haemorrhage

→Inborn errors of metabolism like Hypoglycaemia, Galactosaemia, Diabetes mellitus Homocystinuria and other amino aciduria (Low's Syndrome), Hepato lenticular degeneration (Wilson's disease), Hypoparathyroidisionm.

→Various syndromes -trisomy 21 (Downs syndrome), trisomy 18 (Edward syndrome), trisomy 13 (Patau syndrome), Hallerman-Streiff syndrome, Conradi syndrome , Nance-Horan syndrome, Osteopetrosis etc

→ Persistence of anterior hyaloid system

→Prematurity

→ Intra ocular tumours

CLINICAL PRESENTATION

- White reflex in pupillary area.
- Squint (unilateral cases)
- Nystagmus (bilateral cases)
- Diminished vision & glare in older children
- Unilateral cataracts are usually presented late

DIFFERENTIAL DIAGNOSIS

- ❖ Retinopathy of Prematurity
- ❖ Persistent hyperplastic primary vitreous (PHPV)
- ❖ Toxocariasis
- ❖ Toxoplasmosis
- ❖ Retinal detachment

- ❖ Coat’s disease
- ❖ Myelinated nerve fibers
- ❖ Large chorioretinal Coloboma
- ❖ Retinoblastoma
- ❖ Retinal dysplasia
- ❖ Cyclitic membrane
- ❖ Norrie’s disease
- ❖ Incontinentia pigmenti
- ❖ Retinoschisis

CLINICO-INVESTIGATIVE WORK UP

- Detailed family history should be elicited to rule out hereditary causes
- Screening of parents and siblings is mandatory
- Ocular examination:

  -Density/morphology of cataract

  -Visual function assessment

  -Slit lamp examination

  -Direct ophthalmoscopy- red reflex / bruckner’s test after dilatation

  -Indirect ophthalmoscopic examination (IDO)

-B scan utrasonography

-Biometry – Axial length estimation (Immersion technique)

-Keratometry readings are taken- Handheld keratometer

-Corneal diameter is measured

-Intra Ocular Pressure (IOP) is recorded

INTRA OCULAR LENS (IOL) POWER CALCULATION

Based on the results of various studies, IOL power calculation in children is done more accurately with Immersion A scan biometry technique rather than the conventional contact A scan biometry.

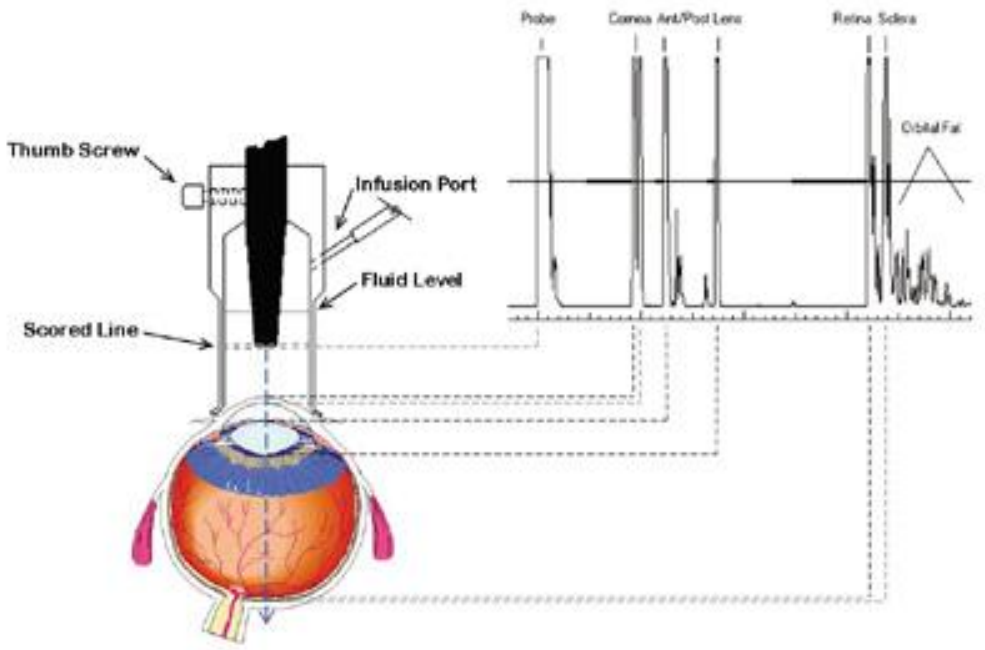
Immersion A-scan Biometry

Contact/applanation method of biometry causes slight indendation of the globe while measuring and is not that accurate as the patients expectations. Hence , nowadays this technique is being replaced by more accurate non-contact instrumentation called Immersion A-scan Biometry[12].

Immersion technique is performed by pacing a small scleral shell (called as Prager shell) between the patient eyelids. The shell is filled with normal saline and the A-scan probe is immersed into the fluid, making sure not to touch the surface of cornea. This is considered more accurate because it doesn't cause compression of cornea. In this ultrasound beam is properly aligned with the centre of the macula. All 6 spikes seen have a steeply rising pattern and are of maximum height.

6 spikes are seen in a normal phakic eye as probe tip and cornea are no longer in touch with each other, thus appearing separate. The spikes correspond to probe tip, Cornea, Anterior lens capsule, Posterior lens capsule, retina and sclera. When all spikes are of high amplitude perpendicularity is achieved. Axial length of eye measured with immersion technique is 0.1-0.3 mm longer than when measured by contact biometry technique. Accuracy of readings is upto +/- 0.12 mm.

Another use of this technique, two peaks will be seen in a corneal spike, each corresponding to epithelium and endothelium. If both these peaks are not of equal height, it means the sound beam is not directed through corneal vertex and is therefore not aligned along the visual axis. Resolution of corneal spike into these peaks is possible at low gain. Another advantage of immersion technique is that it is faster than contact technique and reduce inter technician variation.



Immersion A-scan Biometry of a phakic eye showing probe tip and corneal spikes separate as tip doesn't touch the cornea surface.

IOL power calculation formulas used for adults during cataract surgeries are less accurate when it comes to case of children. Sanders-Retzlaff-Kraff (SRK) formula[13] (P= A- 2.5L-0.9K) is the most commonly used where 'P' is the estimated IOL power in dioptres to be used in emmetropia, 'A' is the IOL specific A constant that varies depending on the lens material, 'L' for axial length of the eyeball in millimeters and 'K' for total corneal power in dioptres. Sanders *et al* have introduced a new SRK-II formula[4] where A constant is modified according to the axial length, and it has shown to reduce the prediction error of the original SRK formula in short (<22 mm) and long (>24.50 mm axial length) eyes. A child's axial length reaches adult size by 7 years. Mean axial length of newborns is 17 mm and in adults it is 23 mm. At 2 years it is

around 20 mm and by 4 years 22 mm. An increase of 0.62mm/month in first 6 months, 0.19mm/month from 6-18 month**s** has been noted. Keratometry values becomes stable by 12-18 months.During calculation , an error in axial length gives a average error of 2.5D/mm of axial length in adults, and 3.75D/mm in children.So care must be taken to measure accurate axial lengths in children.

In children <2yrs , 20% undercorrection from the biometric readings is done to counter the myopic shift, 2-8yrs 10% undercorrection needed and >8 years emmetropia is the target.

- **Child is undercorrected** to compensate for the myopic shift due to ocular growth- emmetropia in adulthood. But the resultant hyperopia is definitely amblyogenic, requiring immediate optical correction.

- **Aim for emmetropia** at the time of lens implantation is done in unilateral cases so as to decrease the incidence of amblyopia, to achieve Binocular Single Vision (BSV) by decreasing anisometropia – but eyes become more myopic with time and might require secondary procedure to eliminate increasing anisometropia.

AGE (YEARS)	UNDERCORRECTION (D)
2-3	3-4
4-5	2-3
6-7	1-2
8-10	0.5-1
>10	Same power

IOL SIZE

The size of the capsular bag at the time of birth is around 7 mm. It attains a size of 9 mm by the age of 2 years. In children >2yrs a standard size of 12-12.75mm diameter IOL is used following cataract surgery for in the bag fixation. Where as in those <2yrs 5.5 mm optic size IOL is preferred, with an overall diameter of 10mm.

TYPES OF IOL MATERIAL:

Single piece Acrylic IOL[14] is preferred for in the bag implantation whereas three piece Acrylic IOL is the choice for sulcus implantation. Ideal IOL of choice for paediatric cataract surgeries is foldable hydrophobic acrylic monofocal IOL.

IOL DESIGN

Earlier Poly Methyl Metha Acrylate (PMMA) lens with modified 'C' shaped haptics were used.Recently**,** single piece foldable square edge hydrophobic acrylic IOL lenses are used which are biocompatible, less inflammation inducing, less posterior capsular opacification (PCO) formation because square edge acts as a barrier to lens epithelial cell migration

MANAGEMENT

Bilateral or unilateral dense cataracts, central or posterior opacities more than 3 mm in size, visually significant cataracts with no view of the fundus are to be surgically intervened. Paediatric cataract surgery differ from that of adults due to many reasons.

→ Paediatric age group have small, soft eyeball

→ Low scleral rigidity

→Increased elasticity of anterior capsule

→High vitreous pressure

→ Increased uveal tissue reaction and fibrin release following surgery

All the above factors contribute to differences in paediatric cataract surgery when compared to the adult counterparts. Long term growth of eye and myopic shift should be borne in mind while choosing the IOL for implantation,

Critical time period for developing fixation reflex is between 2-4months of age. Child should be operated as early as possible to prevent stimulus deprivation amblyopia, provided the child is otherwise medically fit for surgery under general anaesthesia.

- **Unilateral cases**- within first 6 weeks of life.
- **Symmetrical bilateral cases-** other eye operated within 1-2weeks of the first.

- **Asymmetrical cases-** denser cataract removed first, and the surgery of second eye can be deferred until after the first eye receives optical correction.

There are various advances in surgical techniques for paediatric cataract surgery. These include continuous curvilinear capsulorrhexis (CCC), posterior continuous curvilinear capsulorrhexis (PCCC), PCCC with optic capture and capsule staining. Other advanced techniques such as use of high viscosity viscoelastics, pharmacologically treated intra ocular lenses and improved automated vitrectomy.

SURGICAL TECHNIQUES FOR CATARACTS IN INFANTS (<2 YEARS)

At the 10 O' clock and 2 O'clock positions two corneo-limbal incisions are made : one for allowing the insertion of an anterior chamber maintainer connected to an infusion bottle of Balanced Salt Solution (BSS). The bottle contains BSS mixed with 1:500000 adrenaline. The other incision is meant for irrigation or aspiration cannula, phacoemulsification probe or a cutter for anterior vitrectomy depending on the density of the lens nucleus to be removed. The anterior chamber maintainer helps in performing intraocular manipulations in a well-formed eye globe, thus reducing the iatrogenic trauma to the iris during surgery. Under the cover of high viscosity viscoelastic substances, a 4-6 mm diameter central circular anterior capsulotomy is done with the help of a cystitome. The lens material is carefully aspirated making sure to preserve the posterior capsule of lens and an intact anterior capsular rim.

After complete removal of lens material, an elective central posterior capsulotomy of not < 4 mm diameter is done using PCCC method or with the aid of vitrectomy probe. The posterior capsulotomy opening should be of adequate size or it has a chance of getting closed with time especially in infants. Unlike in case of adults , a central posterior capsulotomy in smaller children will not give assurance of a permanently clear visual axis unless until the optic of the IOL placed is made to get captured by PCCC opening, that is smaller in size than optic of the IOL or a generous anterior vitrectomy should be performed with vitrectomy probe. By doing anterior vitrectomy our aim is to remove at least one-third of the anterior vitreous gel , thus eliminating the presence of any vitreous remanants near posterior capsule, that can act as a scaffold for lens fibres to grow on and thereby occluding opening of posterior capsulotomy. When IOL implantation is not planned (as in infantile bilateral congenital cataracts) the operation is completed by suturing the two limbal incisions with tight vicryl or 10-0 nylon sutures. Aphakia is corrected with the help of contact lenses or glasses.

When IOL implantation is planned as in case of unilateral congenital cataract, one piece polymethylmethacrylate (PMMA) lenses or acrylic foldable lenses are recommended. After injecting visco elastic substance into the capsular bag fornices, the posterior chamber IOL is inserted into the capsular bag. The corneo-limbal incision made is enlarged to allow the insertion of the IOL. The corneo-limbal incisions are approximated with tight interrupted sutures to prevent wound dehiscence, which is a common post operative

complication in children. The viscoelastic material in the anterior chamber is aspirated and replaced with BSS.

SURGICAL TECHNIQUE FOR CATARACTS IN CHILDREN (>2 YEARS)

The surgical technique for paediatric cataractous lens extraction and IOL implantation in children > 2 years is almost similar to standard adult cataract removal procedures. As per latest trends surgical technique advocated include a limbal based conjuctival flap, scleral tunnel incision, viscoelastic material guarded capsulorrhexis and irrigation/aspiration of the cataractous lens material using phacoemulsification probe or irrigation/aspiration hand piece or both. A posterior capsulotomy and possibly an anterior vitrectomy is done either before or after the IOL implantation in the capsular bag. This is performed in all children < 15 years of age so as to avoid the herniation of vitreous material in spite of the viscoelastic material.

- Rectus suture and conjuctival incision

  After applying a sterile drape, lid speculum is placed over eyelid and globe is secured with the help of a superior rectus bridle suture. A limbal based conjuctival flap is raised and wet field cautery applied to control bleeding from the episcleral vessels.

- Paracentesis incision

A small , lengthy tunnel incision for paracentesis incision is made temporally at the limbus , large enough to pass two intruments. A second instrument may be helpful in releasing the anterior synechiae and aids in easy placement of an IOL. In children all cortical material must be removed to reduce the post-operative inflammation and prevent secondary cataract formation. Removal of cortical remanants at 12'O clock position is facilitated with the help of this paracentesis. Most paediatric cataracts have a soft consistency and can be aspirated by one-handed technique. A paracentesis is also required to reform the anterior chamber and obtain and test the main incision seal.

- Wound construction and Limbal incision

  Incisions in children often tend to leak as they have thinner and less rigid sclera. Even the corneal tissue has less chance of self sealing in children. Moreover, children tend to get traumatised easily in postoperative period. Hence synthetic absorbable 10-0 sutures are used to solve the above problems. A scleral tunnel wound is required for implanting a rigid IOL where as for foldable IOL implantation , either a corneal or scleral tunnel incision would be enough. A small sized scleral scratch incision of size approximately 2 mm is made at limbus and widened into a 3 or 5.5-6.5 mm tunnel based on the IOL chosen for insertion. A number of paediatric ophthalmic surgeons have switched on to clear corneal incisions as these eyes have less of post-operative inflammation.

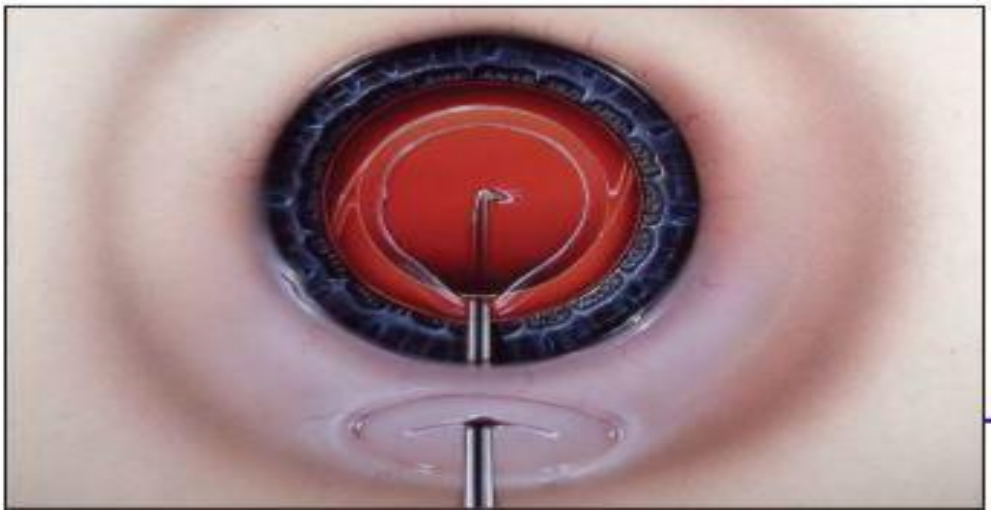
- Use of viscoelastic substances play a very important role in paediatric cataract surgery. They are now often referred to as ophthalmic visco-surgical devices (OVDs) due to their significance in surgery. Mostly a visco-adaptive/super viscous agent is used as it manipulates the difficult intraocular manipulations during paediatric cataract extraction. These agents are cohesive in nature and helps in maintenance of anterior chamber stability and counteracting the increased vitreous upthrust in paediatric eyeball during surgery.
- Capsulorrhexis

  The challenge of performing capsulorrhexis in children is due to the elasticity of sclera and high posterior vitreous pressure resulting in radial tears. In peadiatric eyes CCC is achieved with the help of a bent forceps, cystotome , forceps or a combination of all these. The tip of a sharp cystotome is ideal for making a central puncture. Capsular forceps can be used for frequent regrasping close to the edge of radial tear. Small regrasping manouvres should be done at the leading edge of tear to achieve a desired diameter of capsulorrhexis. The use of trypan blue (0.06%) can help in visualizing opaque capsule during capsulorrhexis. For IOL implantation foldable acrylic is the preferred choice. Mostly a 5.5 mm or 6 mm diameter optic and an overall diameter of 10.5 -12 mm IOL is implanted. A planned primary opening in posterior capsule is made to prevent secondary cataract formation or for removing a posterior plaque associated with the cataract. Posterior

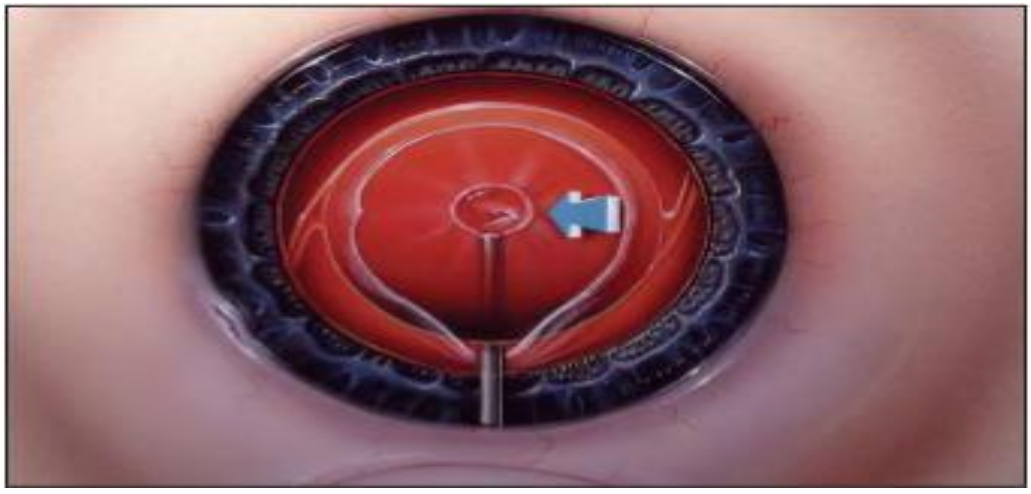
CCC can be performed either before or after posterior chamber in the bag intraocular lens implantation[15]. Posterior CCC is done with the help of a sharp cystotome and a pointed capsulorrhexis forceps. Posterior capsulotomy made is always smaller than anterior capsulotomy. The scleral wound is partially sutured and posterior capture of the optic of IOL is carried out.

- A thorough anterior vitrectomy is done to remove the anterior vitreous face that can act scaffold for fibrosis.
- Scleral wound closure is done with continuous shoelace suturing technique or a combination of continuous and horizontal sutures either absorbable or permanent sutures. Most popularly used suture material for approximating corneo-scleral incision in children is 10-0 nylon material followed by 7-0 polyglactin.

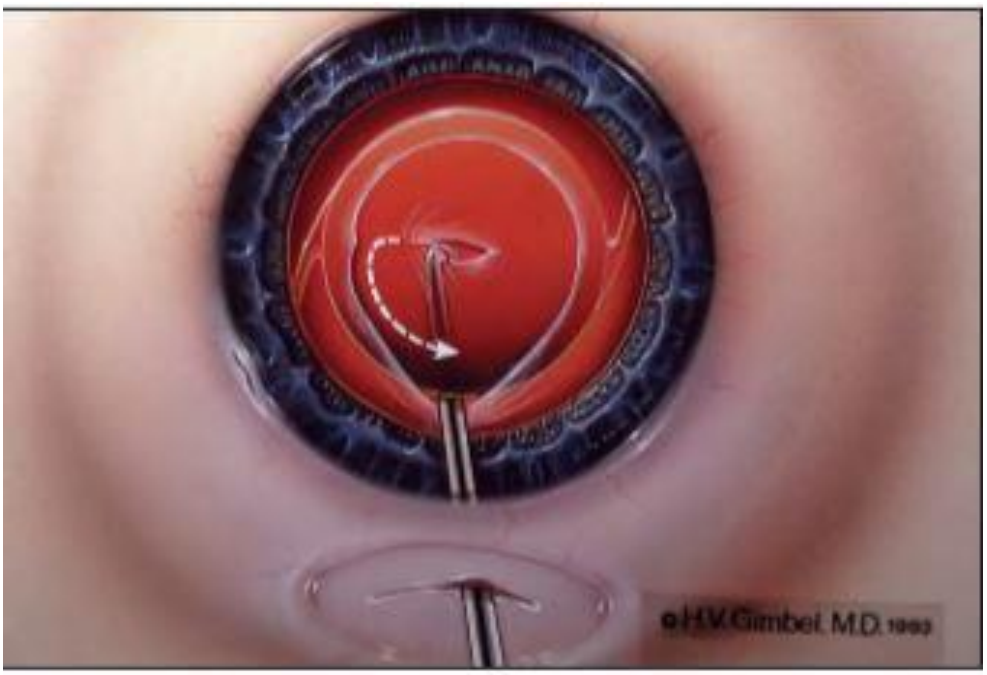
POSTERIOR CONTINUOUS CURVILINEAR CAPSULORRHEXIS (after IOL implantation)



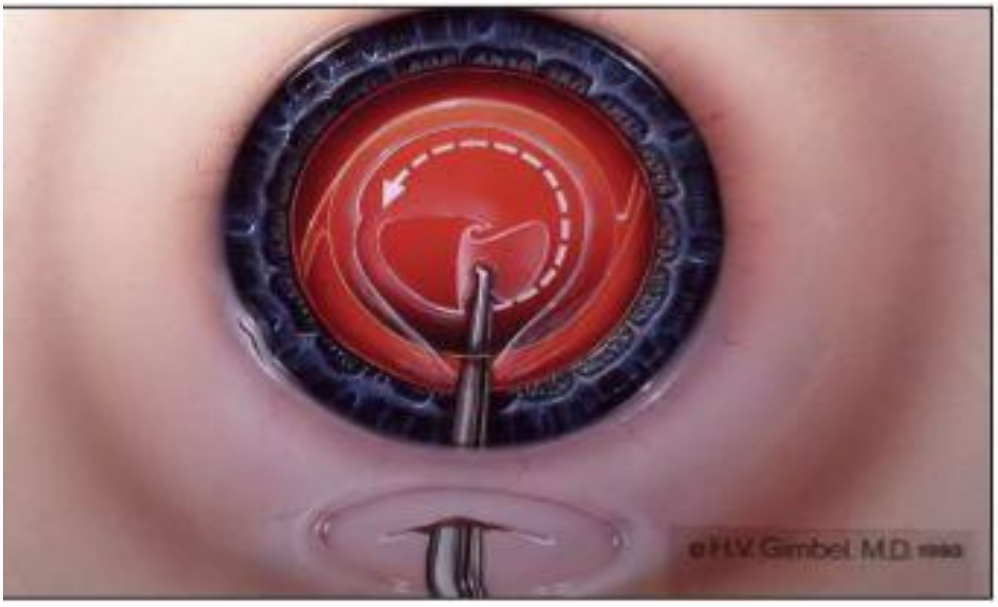
Using a sharp cystotome posterior capsule is punctured



Viscoelastic substance is injected through the opening made to protect the anterior vitreous face



The opening is extended with cystotome to create a flap



Now a circular posterior capsular opening smaller than anterior capsular opening is made.

Paediatric cataracts are soft in consistency. In children <1 year of age choice of surgery is - Lensectomy (pars plana approach / limbal approach), for children between 1-5 years of age primary surgery with anterior approach along with posterior capsulotomy and anterior vitrectomy and for those more than 5 years , may not need posterior capsulotomy. Most accepted technique for paediatric cataract surgery is phaco-aspiration with primary posterior capsulotomy with or without anterior vitrectomy and capsular bag implantation of IOL. Anterior vitrectomy is usually done to decrease the incidence of PCO because anterior vitreous acts as a scaffold and causes lens epithelial cell migration and proliferation. Capsular bag IOL implantation is the best choice to reduce contact with uveal tissue and achieve centration.All incisions in paediatric cataract surgery should be approximated with a suture. Low scleral rigidity in children can cause fish mouthing of incision and anterior chamber collapse – hence wounds need to be sutured with 10-0 absorbable sutures.

POST OPERATIVE MANAGEMENT

Topical steroids for 8 times/day which is then tapered over 6-8weeks.Topical cyclopegics preferably atropine eye ointment twice daily for atleast one month to prevent posterior synechiae formation is advised. Topical antibiotics must be instilled for three times/day for 10-14 days to prevent post-operative infections.

FOLLOW UP

Follow up should be done meticulously on first post operative day ,first week ,first month , third month , every 3 months for 2 years, every 6 months for 3years.Following points shoud be evaluated during each follow up visit- Visual acuity,ocular alignment,IOP,refraction and clarity of visual axis. Post operative visual rehabilitation should be commenced as soon as the inflammation subsides so as to correct the residual hypermetropia. Various modalities like contact lenses , spectacles are available and selected according to the child's age. Amblyopia therapy must be started as soon as possible after cataract surgery. For infants who are bilaterally aphakic , spectacles are the simplest and safest mode for amblyopia prevention available. Spectacles have the advantage that they can be easily changed so as to accommodate the refractive shift that occur with the growth of eyeball. For those with unilateral aphakia, contact lens is the preferred method of correction. Secondary IOL implantation can be fixed for aphakic children on a later date. Post operative complications following a paediatric cataract surgery include uveitis, PCO, secondary membrane formation, pupillary capture, IOL decentration, glaucoma and retinal complications like cystoid macular edema, haemorrhagic retinopathy etc

Aphakic glaucoma continues to be a threatening complication in children following congenital cataract surgery. So a regular check on IOP during follow up visits is mandatory. Goldmann applanation tonometry still continues to be the gold standard method for the measurement of IOP. Central

corneal thickness (CCT) influences IOP readings made using Goldmann applanation tonometer. When the CCT is low, the true IOP value is underestimated and vice-versa. . Treatment and overall prognosis is significantly affected by these overestimated or underestimated IOP values in patients with glaucoma. Overestimated IOP readings can also lead to overdiagnosis of glaucoma and inadvertent use of anti-glaucoma medications.

SIDE EFFECTS OF ANTI-GLAUCOMA MEDICATIONS IN CHILDREN

The usage of anti glaucoma medications[16] in chidren per se have many serious side effects. Children are highly sensitive to the systemic side effects of even topically applied anti glaucoma medications. The chance of risk is higher with younger children and those with low body weight. Beta blockers like timolol can cause pulmonary as well as cardiac side effects. Neonates and infants can develop apnoea if systemically absorbed. Hypoglycemic episodes might be masked in children who is regularly on beta blockers. Carbonic anhydrase inhibitors like dorzolamide can cause poor feeding , thereby leading to poor weight gain. It can even result in metabolic acidosis. Alpha 2 agonists like brimonidine is lipophilic and can cross blood brain barrier. Numerous alpha 2 receptors are found in the brain, which when stimulated can result in increased parasympathetic outflow and decreased sympathetic outflow.Side effects like sedation, respiratory depression , apnoea and even coma can occur.

Increased sensitivity of small children to the adverse effects of these topically administered drugs is because of the smaller plasma volume along with immature metabolic and excretion pathways, that can inturn lead to increased plasma drug concentration

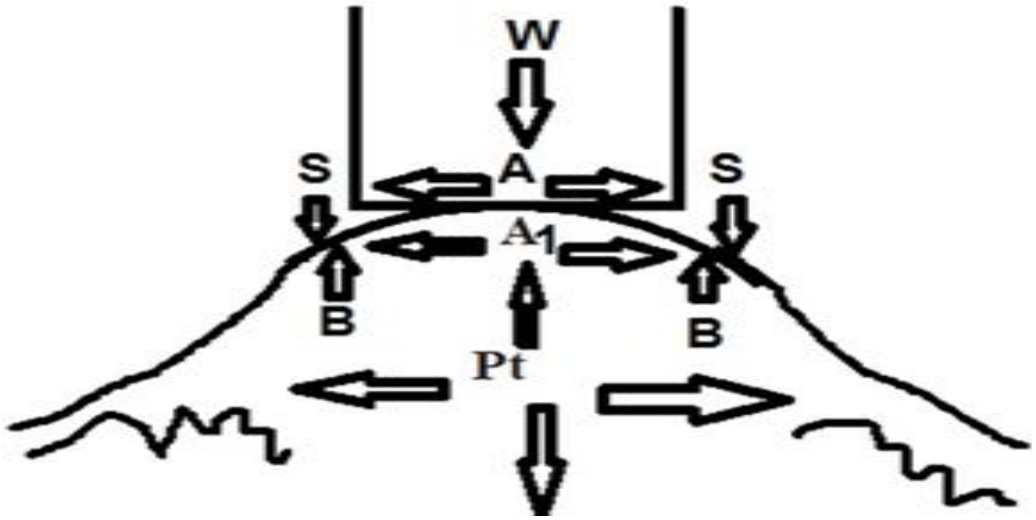
So accurate measurement of IOP and a diagnosis of glaucoma should be made before prescribing these drugs especially in paediatric age group. Since IOP is dependant on CCT readings, care shoud be taken to avoid its underestimation or overestimation. CCT is measured with the help of Ultrasonic pachymetry.

APPLANATION TONOMETRY

The principle of applanation tonometry[17] is to determine the force necessary to flatten (or applanate) an area of the cornea 3.06 mm in diameter – a technique referred to as constant-area applanation.This is the underlying principle of goldmann applanation tonometry which is considered as the gold standard technique till date. It is considered gold standard as reliable and accurate , not influenced by the rigidity of the eye coats and easily reproducible.

The Imbert-Fick principle states that force (F) required to flatten the surface of an ideal ,dry, thin walled sphere divided by the area (A) of surface fattened is equivalent to the pressure (P) inside the sphere ie P=F/A .But cornea being aspherical, wet, and slightly inflexible fails to follow the Imbert Ficks law. The moisture over the surface of cornea creates surface tension (S) or capillary attraction of the tear film for

tonometer head. The lack of flexibility requires a force to bend (B) the cornea which is independent of internal pressure of aqueous humour. Since cornea has a central corneal thickness , the outer area of corneal flattening differs from the inner area of flattening (A1). It is this inner surface area which is of importance during IOP measurement.So here we follow Modified Imbert-Fick law which is as follows (F + S = PA1 + B)



MODIFIED IMBERT- FICKS LAW

When A1 is 7.35 mm^2 , surface tension balances the force required to bend the cornea. This internal area of appanation is achieved when the diameter of the external area of corneal applanation is around 3.06 mm. The grams of force applied to flatten 3.06 mm diameter of cornea is multiplied by ten and directly converted to millimetres of mercury.

The applanating instrument is mounted on a standard slit lamp in such a way that the examiners view is directed through the centre of a plastic bi-prism . The two beam splitting prisms within the applanating unit optically convert circular area of corneal contact into two semicircles.

PROCEDURE

- The patient is seated comfortably on the chair unit infront of the slit lamp.
- The room illumination is reduced and the angle between the illumination and microscope should be approximately 60^0.
- A fixation light may be placed infront of the fellow eye.
- The tension knob is set at 1g mark.If the knob is set at 0, the prism head undergo vibrations when it touches the eye and damage the corneal epithelium.
- After instilling topical anaesthetic agent, the edge of corneal contact is made visible while viewing through the cobalt blue filter by applying fluorescein.
- The patient is asked to bink the eyes once or twice to spread the fluorescein stained tear film over the cornea, and then keep the eyes wide open.

- The bi-prism is made to touch on the corneal surface centered and calibrated by rotating the dial in grams in such a manner that inner margin of semicircles coincide at each other. This occur when 3.06 mm diameter of cornea is applanated.

- The IOP reading is the made directly from a scale on the tonometry housing.

A thinner cornea may require less force to applanate it, leading to underestimation of true IOP while a thicker cornea would need more force to applanate it giving an artificially higher IOP

Perkins Applanation Tonometry

It is variable force type of applanation tonometer using the same biprism as the Goldmann applanator. It has a light source powered by a battery. The readings are consistent and compare quite very well with Goldmann applanator. The various advantages of Perkins tonometer are that it can be used as handheld device both horizontally as wel as vertically. It is useful in estimating IOP in infants, children, pre-operatively on operation theatre table, and also in recumbent patients.

Checking IOP in an infant with the help of Perkins applanation tonometer

Potential errors of applanation tonometry

-Thinner and thicker cornea

-Astigmatism > 3 dioptres

-Inadequate / too much fluorescein

-irregular cornea

-tonometer out of calibration

-elevating the eyes > 15^0

-repeated tonometry

-squeezing of the eyelids

PACHYMETRY

Pachymetry is derived from two Greek words: Pachos = thick + metry = to measure and is used for the measurement of corneal thickness. It was developed by Hendeson and Kremer in 1980.The thickness of the cornea is determined by the density and compressibility of cornea. It is indirectly an important indicator of health status of the cornea especially endothelial pump function of cornea. Cornea is composed of 78% water content. The thickness of the cornea was first reported in ancient textbooks on physiological optics (Helmholtz and gullstrand). Corneal thickness in normal eyes ranges from 700 to 900 microns at the limbus and varies between 480 microns and 520 microns at the centre . The Central corneal thickness (CCT) reading of 700 microns or more is indicative of endothelial decompensation. In newborns and young children corneal configuration is similar to that of the adult cornea.It has been found that cornea at birth is significantly thicker and decreases in thickness as the child grows older. CCT measurement has different roles in clinical practice ,one and the most common of which is in glaucoma, for applying correction factor in calculating corrected IOP readings. Applanation tonometry is based on Modified Imbert Fick's law, which assumes that cornea is a perfect flexible, dry, sphere which is infinitely thin. Therefore increase in the tissue in thicker cornea makes it less compliant and subsequently leading to overestimation of IOP and viceversa .

Ultrasonic pachymetry[18], which is the most commonly used method, which is regarded as the gold standard. The principle of the instrument is that it functions by measuring the amount of time (transit time) needed for ultrasound pulse pass from the one end of transducer to descemet's membrane and back to the transducer. Corneal

thickness = (Transit time × Propagation velocity) / 2 Speed of sound in cornea. Propagation velocity of ultrasound waves in water is around 1524 m/s. Kremer chose 1640 m/s as the standard because the study conducted in 175 eyes gave a corneal thickness of 512 +/- 0.035 with this value. Current standard adopted is 1640 m/sec .The components include a Probe handle, which has piezoelectric crystal piece that emits an ultrasonic beam of ≅ 20 MHz, a transducer that sends ultrasound rays through the probe to the cornea and receives echoes from the cornea, a tip-the diameter of which should not be more than 2 mm.

The advantages are that it is faster, easy to use and simpler , repeatable and consistent between observers thereby eliminating inter observer variation, portable, dry (no coupling medium required) , can be used intra-operatively. The disadvantages are that it is a contact method, accuracy is dependent on the perpendicularity of the probe's application to the centre of the cornea, reproducibility relies on precise probe placement on the center of the cornea, low resolution and not accurate in edematous corneas.

Ultrasonic Pachymetry

Although CCT and measured IOP do not follow a linear pattern of relationship, IOP tends to be overestimated in eyes with thick corneas and with thin corneas , CCT is underestimated. Despite increasing information in the adult literature about CCT and glaucoma risk, less is known in paediatric population about CCT and glaucoma risk and variation of central corneal thickness postoperatively following congenital cataract surgery and how it should be used clinically to assess children at risk for established glaucoma. As in adults, mean CCT has been demonstrated to be slightly lower in normal eyes of black when compared with white children. CCT abnormalities have been reported in paediatric patients with congenital glaucoma, Down syndrome,

Marfan's syndrome, osteogenesis imperfecta and aniridia. In addition, CCT has been reported to be higher in aphakic and pseudophakic eyes of children.

VARIOUS POSTULATIONS FOR INCREASE IN CCT

The origin and evolution of higher CCT in eyes of children after cataract removal, and especially those with glaucoma, remain speculative. Previous studies have suggested that higher CCT in aphakic pediatric eyes is an acquired phenomenon, but longitudinal studies are lacking. In normal eyes without cataract, the central cornea is thicker at birth, rapidly decreases in thickness during the first few months of life, and then stabilizes over time. Thickness of adult cornea is reached by 3 years of age[19]. This change in corneal thickness occurring in the first months of life indicates that corneal development continues after birth. Development of the cornea is affected by the crystalline lens during the embryological period[20]. This effect may continue after birth, and removing the crystalline lens at an early age may stop it. The lens extraction in early childhood affects ocular growth and retardation of axial elongation of the eye ball. Embryological studies have shown that formation and development of cornea is induced by the lens

The substitution of the natural lens with an IOL in paediatric cataract surgery had no effect on CCT because crystalline lens is believed to act as a barrier for the factors released from vitreous humour that cause an increase in CCT. The endothelial cell damage at the time of surgery is another school of thought for increase in CCT after paediatric cataract surgery[21] . Mechanical stress to endothelial cells with

irrigation fluids and unrecognized surgical trauma has been proposed as a cause for endothelial cell dysfunction and increased CCT after pediatric cataract surgery

Children who have undergone cataract surgery are at high risk of developing secondary glaucoma, and the study of CCT changes in this particular group may assist in our understanding and management of this unique group of patients. In adults and in children a thicker central cornea is associated with higher intraocular pressure (IOP) readings by Goldmann applanation tonometry.

REVIEW OF LITERATURE

1) **Acquired Central Corneal Thickness Increase Following Removal of Childhood Cataracts**

L.Zena , W.M Kelly, L. Duncan and S. F. Freedman

This longitudinal study was conducted among 66 children with congenital or developmental cataract to evaluate CCT before and after cataract removal, to find a correlation of CCT with cornea diameters before cataract extraction in the same study group, to determine CCT over time in a separate group of 50 children who have already undergone cataract extraction and are pseudophakic / aphakic at the time of entry into the study.

RESULTS : In group 1 (pre-cataract removal) ,in unilateral cases CCT values showed similar readings between the normal fellow eye and in eyes with cataract. Where as after cataract removal , the affected eyes showed a mean increase in CCT , while

fellow eyes remained the same. Similarly, prior to cataract surgery, in bilateral cases CCT values were found to be similar between the right and left eyes. In group 2 (post cataract removal) , CCT was found to be higher in eyes with glaucoma versus those without , at both first and ast readings.

CONCLUSION : CCT in children with cataracts rises after cataract surgery, while the normal fellow eye remains stable. The increase in CCT is found to occur early after surgery, likely remaining the same thereafter , though glaucoma can accentuate the increase in CCT values.

2) **Changes in central corneal thickness after congenital cataract surgery**

F.Amir MD,J Mohammad Ali MD, J B Mohammad Hossein MD, Mehdi Yaseri, MS

This study was conducted to evaluate the changes in central corneal thickness following congenital cataract surgery with or without intra ocular lens (IOL) implantation. Anterior vitrectomy and anterior lensectomy was done in all eyes with congenital cataract. Eyes which had IOL implantation (pseudophakic group) and others remained aphakic (aphakic group). The CCT and IOP were measured in all cases preoperatively and post-operatively at 1^{st} and 6^{th} months. Age matched normal eyes were chosen as control group.

RESULTS : The study evaluated 47 eyes of 30 patients , 32 pseudophakic and 15 aphakic. The mean CCT was found to be significantly greater in aphakic group than in pseudophakic group at 1^{st} and 6^{th} months post operatively.

CONCLUSION : The CCT was found to be similar in eyes with congenital cataract and normal age-matched eyes. However after cataract removal , CCT was significantly higher in aphakic eyes than in pseudophakic eyes.

3**.Central corneal thickness and intraocular pressure in children undergoing congenital cataract surgery:a prospective, longitudinal study**

M .R Graziela, P C Lupinacci, C. Leite Arieta, V. P Costa

This study was conducted to investigate changes in CCT and IOP in children after congenital cataract surgery as well as the risk factors along with these changes. 37 eyes of 26 children were recruited for the study. IOP and CCT values were recorded before the surgery and at 6,12,18,24 and 36 months post operatively.

RESULTS : Among 37 eyes , 15 became aphakic and 22 were pseudophakic. Mean CCT and IOP were found to be significantly increased during the post operative follow up period. After 3 years of surgery , mean CCT change in aphakic eyes was significantly higher than in pseudophakic eyes studied. Age at lensectomy was inversely correlated to the CCT change , but not to the IOP change.The IOP change was not correlated to the CCT change during the follow up period.

CONCLUSION : In all eyes undergoing congenital cataract surgery , CCT is increasing especially if surgical intervention is performed at an earlier age.

4**. Cataract surgery for congenital cataract: Endothelial cell characteristics, corneal thickness, and impact on intraocular pressure**

N. Nilforushan, MD, K. Ghasemi Falavarjani, MD, M. Reza Razeghinejad, and P. Bakhtiari, MD

This study was conducted to determine the endothelial cell characteristics , corneal thickness and variations in IOP measurement following surgery for congenital cataract. 31 eyes of 17 patients were recruited for the study and CCT, IOP measurements and specular microscopy was performed in all of them.

RESULTS : The mean CCT and IOP values were significantly higher than the normal age and sex matched participants in control group. There was not much significant difference in mean cell area, coefficient of variation and corneal endothelial cell count between operated eyes and those in control group.

CONCLUSION : The central cornea was significantly thicker in eyes with extracted congenital cataract when compared with controls. Therefore in order to differentiate between true glaucoma and ocuar hypertension, CCT measurement should be strongly considered.

5**. Glaucoma and increased central corneal thickness in aphakic and pseudophakic patients after congenital cataract surgery**

Simsek, A Mutluay, Elgin U, Gursel, Batman A

In this study mean CCT among aphakic and pseudophakic patients following congenital cataract surgery was compared with age matched controls. 43 eyes of 43 aphakic and pseudophakic patients following congenital cataract surgery were recruited for the study. After a complete ophthalmological evaluation , CCT and IOP were measured and compared with that of age matched healthy controls.

RESULTS : The concerned study group had 33 aphakic eyes and 10 pseudophakic eyes. The mean CCT showed a significant difference between aphakic eyes and primary pseudophakia. No such significant difference was established between the aphakics and pseudophakic eyes in whom IOL was implanted on a later date .There was a negative correlation between the median age at the time of lensectomy and CCT in the study group.

CONCLUSION : Significantly thicker corneas were noted in aphakic and pseudophakic patients when compared with age matched controls. This difference in CCT is found to have an important impact effect on interpreting IOP in these patients. It is important to study CCT in terms of age at lensectomy for congenital cataract extraction and type of IOL implantation (primary or secondary).

AIMS AND OBJECTIVES

1)To determine the central corneal thickness in pseudophakics and aphakics following congenital cataract surgery in children.

2)To compare the central corneal thickness in pseudophakics and aphakics following congenital cataract surgery with age matched healthy controls.

STUDY DESIGN

This is a comparative cross sectional study and the study was conducted among the post operative cases of congenital cataract attending the OPD as well as wards of department of Ophthalmology as well as Institute of Paediatrics in Government Rajaji Hospital Madurai.

Subjects are evaluated for entry into the study. Subjects who fulfilled all eligibility criteria, and none of the exclusion criteria, were recruited in our study.

STUDY PERIOD

6 months (April –September 2016)

SAMPLE SIZE

32

ETHICAL CLEARANCE

Ethical Committee approval letter obtained

FINANCIAL SUPPORT

Nil

METHODOLOGY

32 cases following congenital cataract surgery , including 19 aphakic eyes and 41 pseudophakic eyes were recruited for the study after obtaining consent from their guardians.

Inclusion Criteria

1) Patients after surgery for congenital cataract , both aphakics and pseudophakics (both primary and secondary)

2) Age group between 6 months to 12 years

Exclusion criteria

1) Previous history of ocular trauma

2) Inflammatory ocular conditions

3) History of glaucoma drainage device surgeries

4) Any other associated congenital ocular anomalies (microcornea, microphthalmos developmental anomalies of angle of anterior chamber etc..)

5) Any central corneal opacities or scars

6) History of refractive surgeries or penetrating keratoplasty

7) History of contact lens use

Written informed consent was obtained from the parents / guardians of the cases recruited into the study.

Visual acuity was recorded in cooperative children. A detailed evaluation of the anterior and posterior segment was carried out. Intra ocular pressure was recorded with the help of Goldmann applanation tonometry in cooperative children and hand held applanation tonometer in uncooperative small children. Central corneal thickness (CCT) measurements were taken with Ultrasonic pachymetry. After explaining the procedure , local anaesthetic drops (0.5% propararcaine) was instilled

into the eyes. After 5 minutes , child is reassured and asked to fix at a distant target.

CCT is measured by placing the tip of the probe gently on the centre of cornea. An average of 5 readings is taken. Uncooperative children were examined under sedation (chloral hydrate syrup 25mg/kg in 3 divided doses)

RESULTS AND INTERPRETATION

STATISTICAL METHOD:

The information collected regarding all the cases were recorded in a Master Chart.

Data analysis was done with the help of computer using Statistical Package for Social Sciences (SPSS) software developed by IBM corporation.

Using this software- range, frequencies, percentages, means, standard deviations, ‘t’ value and ‘p’ values were calculated.

Student’s ‘t’ test was used to test the significance of difference between quantitative variables .

A 'p' value of less than 0.05 is taken to denote significant relation

OBSERVATIONAL ANALYSIS

Table 1: AGE DISTRIBUTION

Age distribution of cases and controls varied from 4-12 years majority being in the range between 6-8 years of age. There was no significant difference in age between the study group and control group.

AGE (in years)	CASES		CONTROLS	
	NUMBER	PERCENTAGE(%)	NUMBER	PERCENTAGE
4-6 years	4	12.5	4	12.5
6-8 years	14	43.8	15	43.9
8-10 years	10	31.2	9	25
10-12 years	4	12.5	4	9.3
TOTAL	32	100	32	100

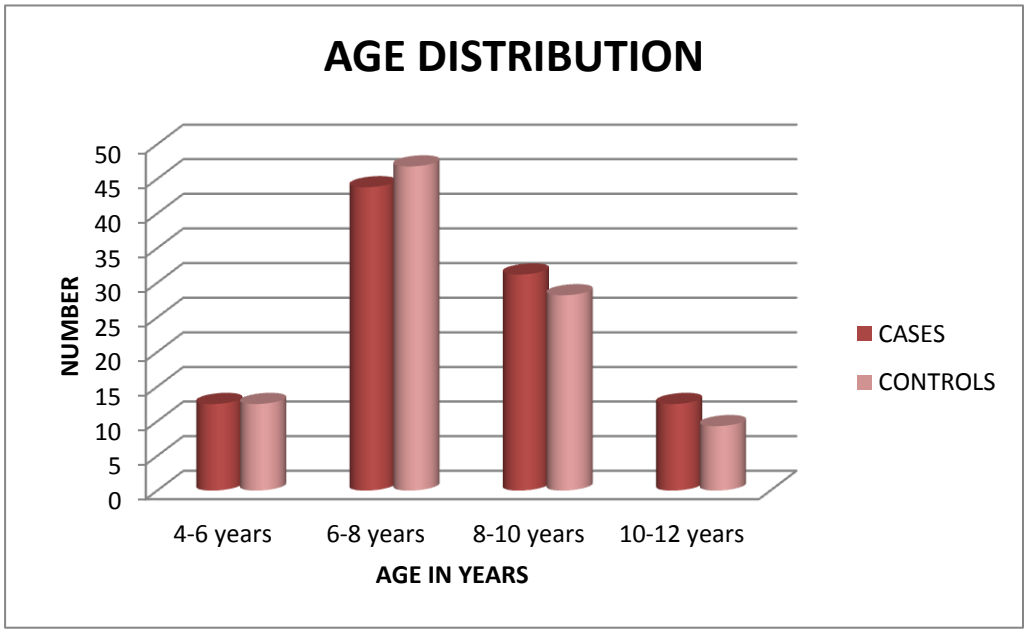


Table 2 : SEX DISTRIBUTION

Among 32 cases , 20 were males and 12 were females. There was a male preponderance in the group. Sex distribution had a similar pattern in both study group and control group.

	CASES		CONTROLS	
SEX	NUMBER	PERCENTAGE(%)	NUMBER	PERCENTAGE(%)
MALE	20	62.50	19	59.37
FEMALE	12	37.50	13	40.63
TOTAL	32	100	32	100

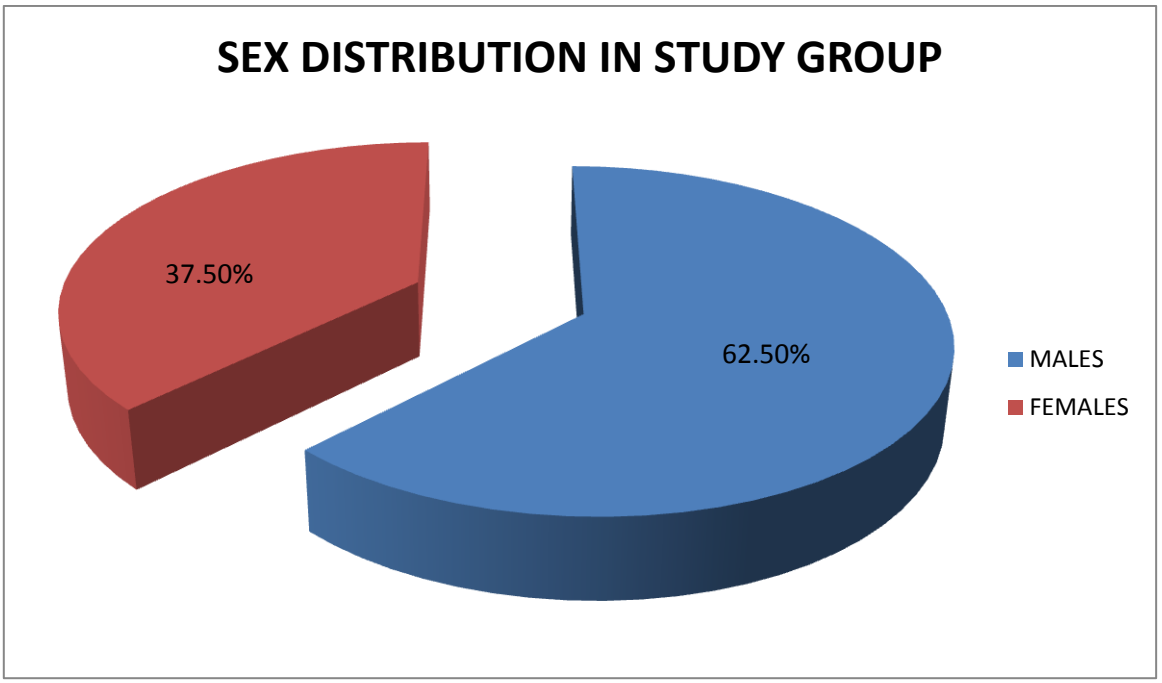


TABLE 3 : STATUS OF LENS

In the study group total number of aphakic eyes were 19 and 41 were pseudophakic eyes. Among the pseudophakic eyes ,14 had it implanted primarily while in 8 cases intra ocular lens was implanted on a later date.

STATUS OF LENS	NUMBER OF EYES
phakic	20
aphakic	19
Primary pseudophakic	14
Secondary pseudophakic	8
Cataractous lens	3

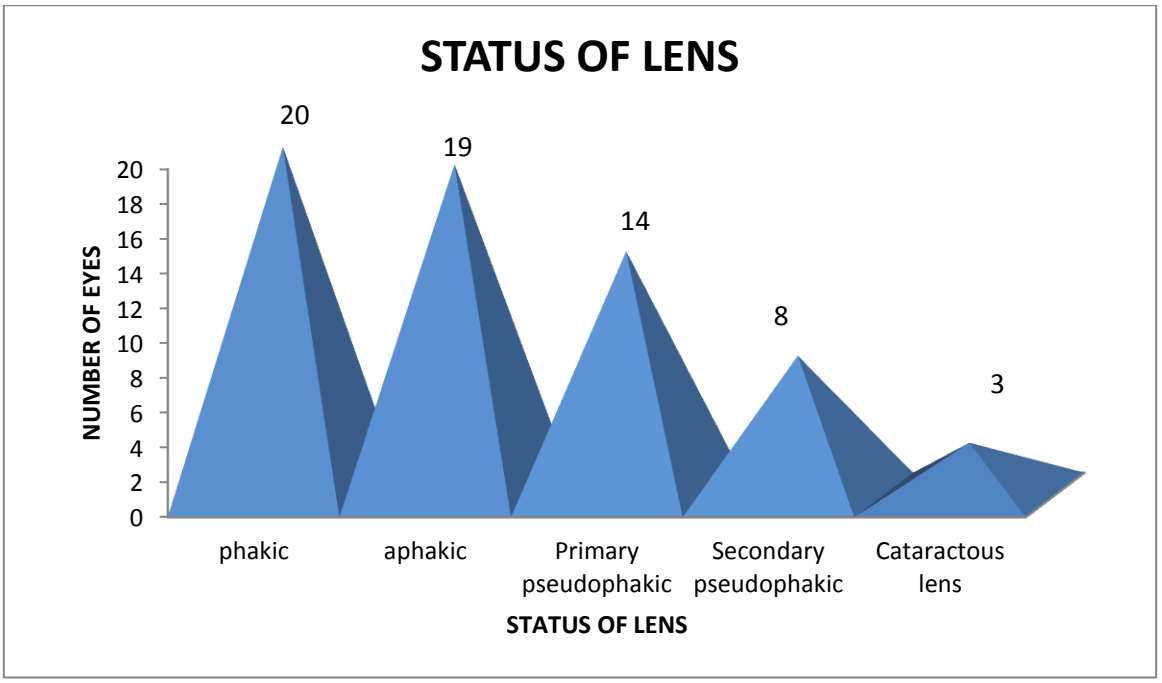


TABLE 4 : AGE AT LENSECTOMY OF DIFFERENT EYES

The age at which lensectomy was done in study group varied from 1-5 years ,most of them being in the range of 2-3 years.

AGE AT LENSECTOMY	NUMBER OF EYES	PERCENTAGE (%)
1-2 Years	5	12.20
2-3 years	15	36.6
3-4 years	14	34.14
>/=4 years	7	17.06
TOTAL	41	100

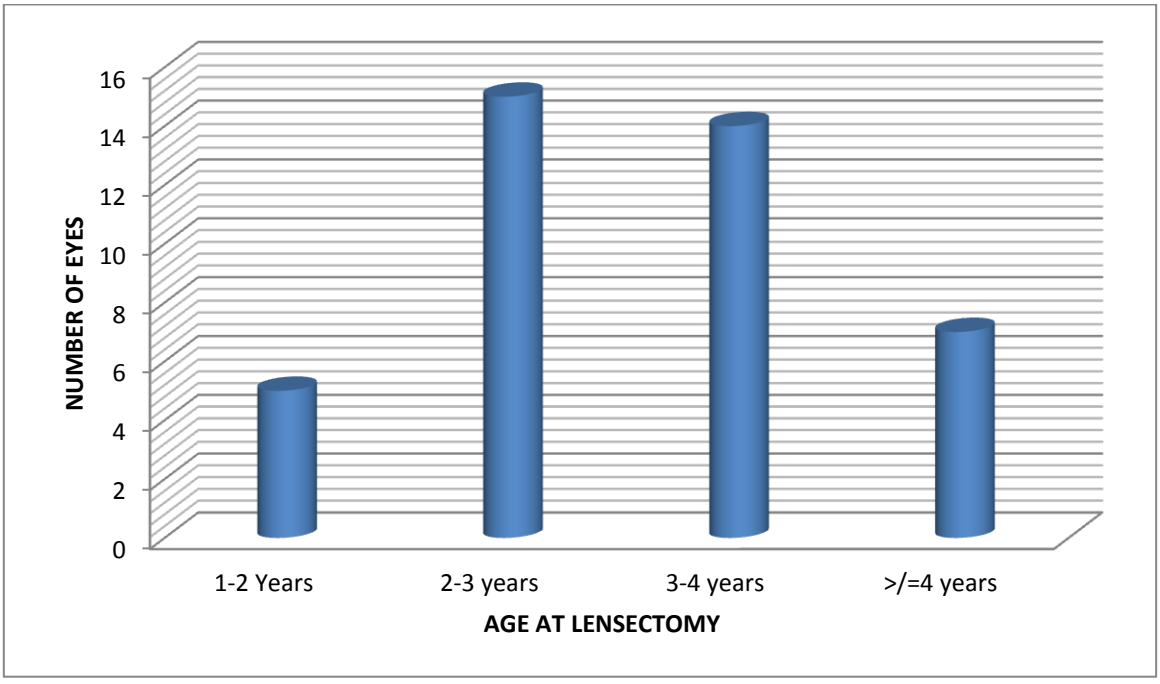


TABLE 5 : CENTRAL CORNEA THICKNESS (CCT) IN STUDY GROUP

The mean CCT of study group was found to be 583.50 µm ranging from 500-612 µm.

CENTRAL CORNEA THICKNESS (um)	NUMBER OF EYES
500-530	13
530-560	4
560-590	7
590-620	17

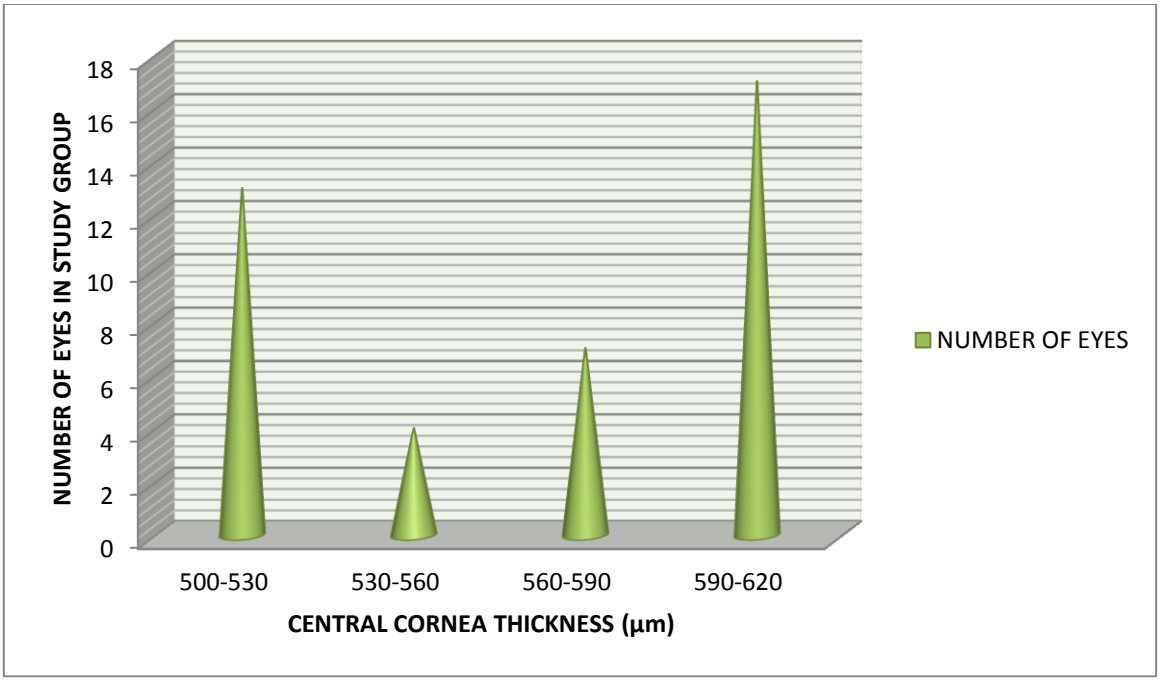


TABLE 6 : CENTRAL CORNEA THICKNESS IN APHAKICS

The central cornea thickness in aphakic group ranged from 550 µm to 612 µm, mean value being 595.68 µm. Maximum number of eyes had CCT in the range of 590-610 µm

CENTRAL CORNEA THICKNESS (µm)	NUMBER OF EYES
550-570	2
570-590	0
590-610	14
610-630	3

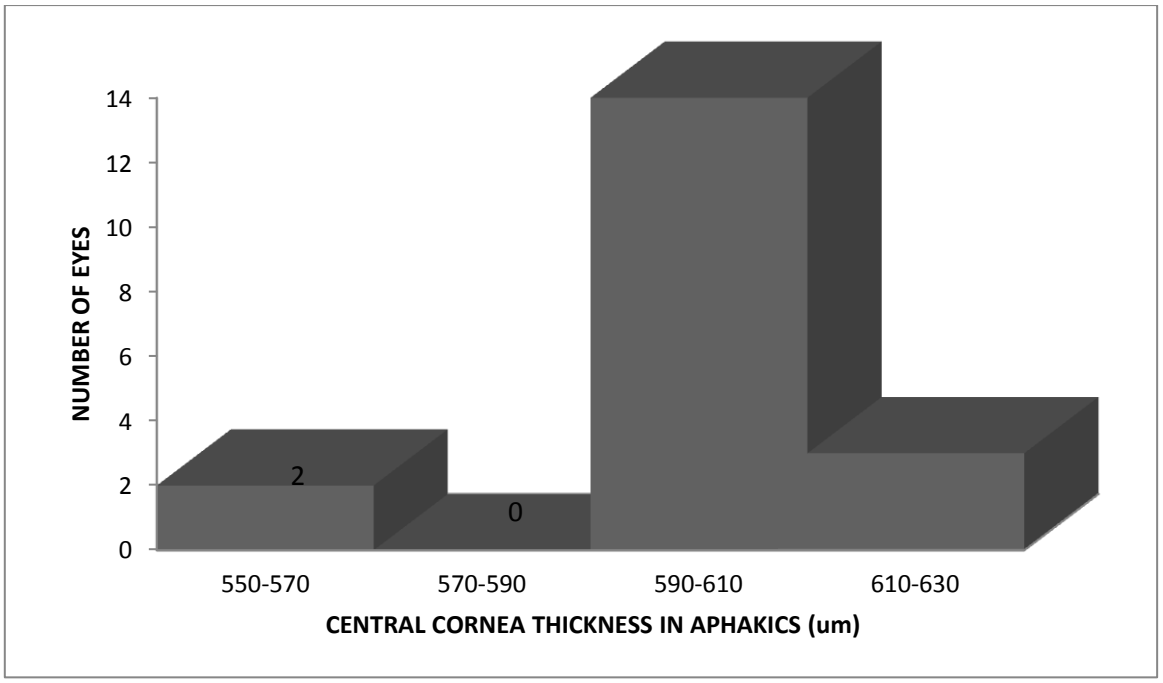
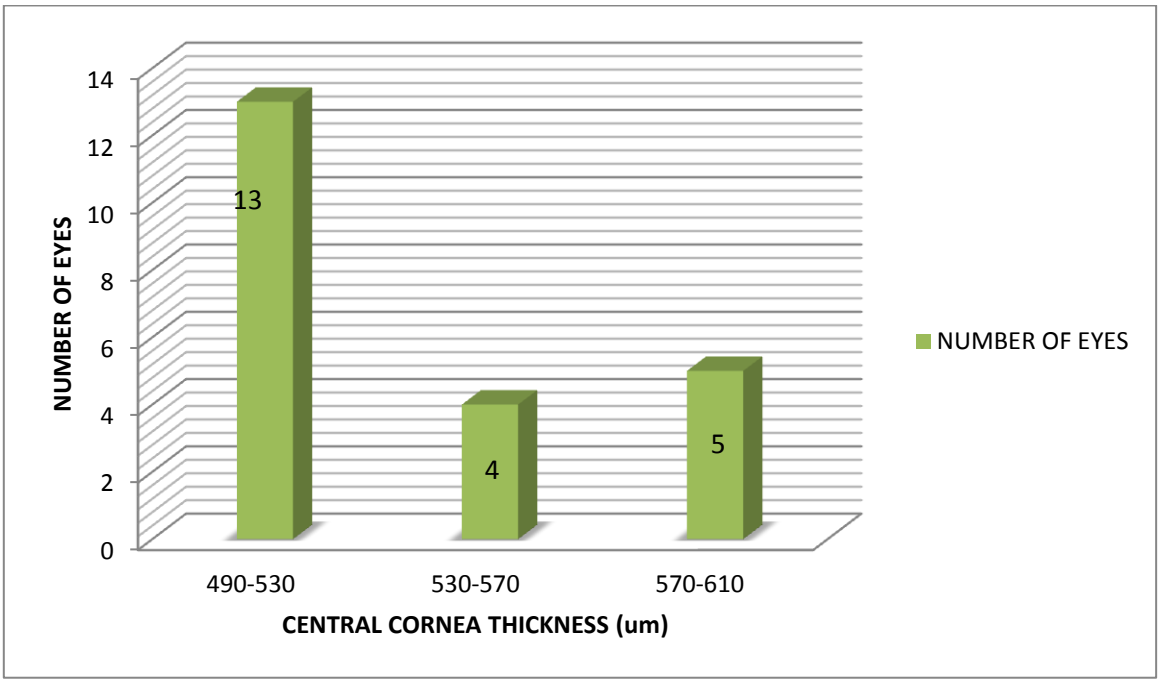


TABLE 7 : CENTRAL CORNEA THICKNESS IN PSEUDOPHAKICS

The central cornea thickness in pseudophakic group ranged from 490 µm to 588 µm, Mean value in primary pseudophakics being 521.42 µm and for secondary pseudophakics it was 554.62 µm. CCT was found to be higher in secondary pseudophakics when compared to their primary counterparts.

CENTRAL CORNEA THICKNESS (µm)	NUMBER OF EYES
490-530	13
530-570	4
570-610	5



COMPARISON OF CCT (µm) WITHIN THE STUDY GROUP

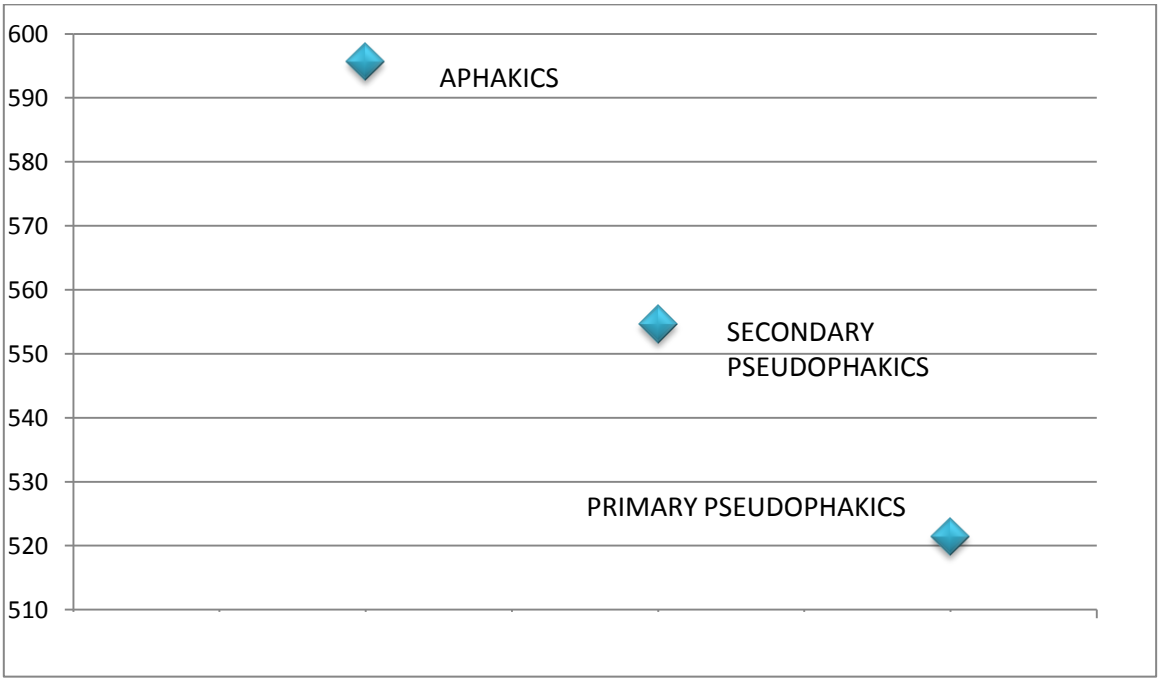


TABLE 8: INTRA OCULAR PRESSURE IN STUDY GROUP

The IOP values in the study group ranged between 12-32 mm of Hg, the mean IOP being 22.88 mm of Hg. Maximum number of eyes in study group had IOP in the range of 22-27 mm of Hg.

INTRA OCULAR PRESSURE (mm of Hg)	NUMBER OF EYES
12-17	7
17-22	12
22-27	15
27-32	6
>/=32	1

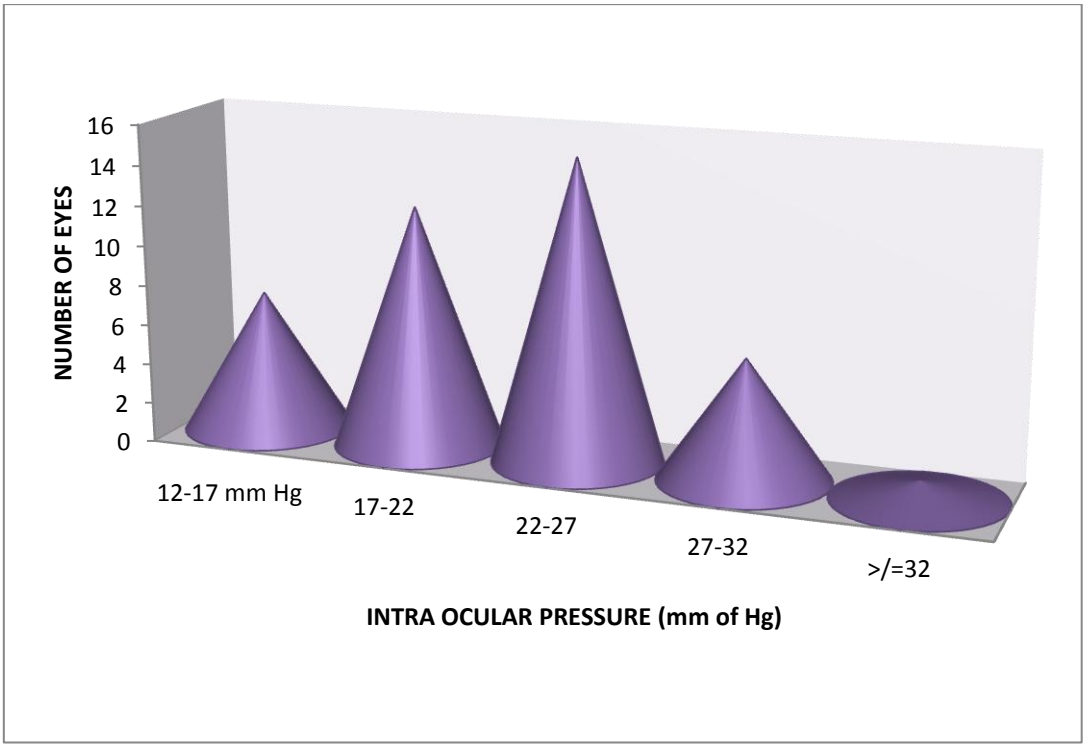


TABLE 9 : INTRA OCULAR PRESSURE PATTERN IN APHAKICS

Among the 19 aphakic eyes studied, IOP varied from 12-32 mm of Hg, mean value being 23.84 mm of Hg.

INTRA OCULAR PRESSURE (mm of Hg)	NUMBER OF EYES
12-18	2
18-24	6
24-30	8
>/=30	3

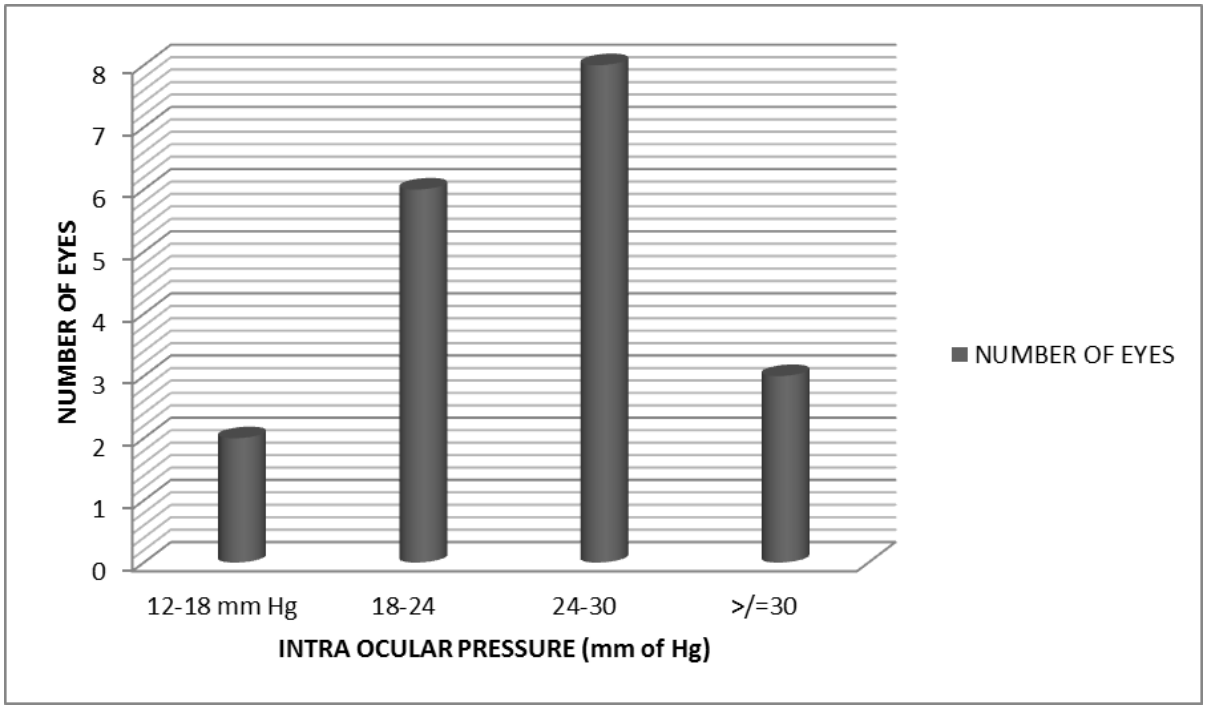
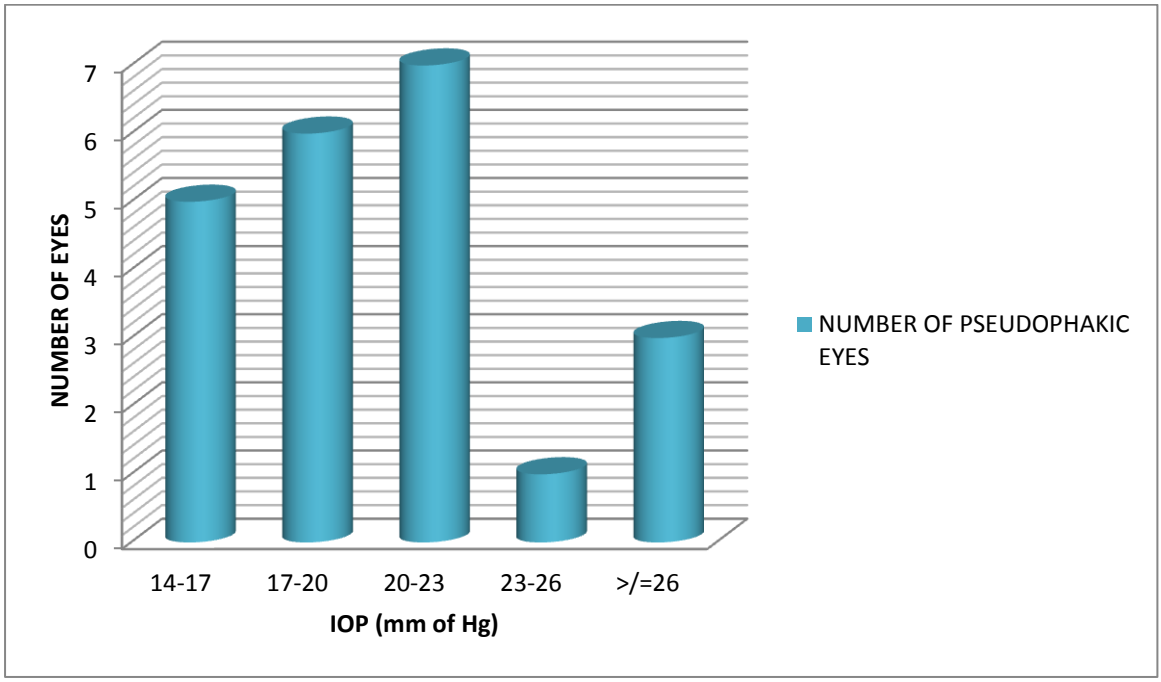


TABLE 10 : INTRAOCULAR PRESSURE PATTERN IN PSEUDOPHAKICS

The IOP measurements in pseudophakic group ranged from 14-26 mm of Hg,mean reading being 19.8 mm of Hg

INTRAOCULAR PRESSURE (mm of Hg)	NUMBER OF EYES
14-17	5
17-20	6
20-23	7
23-26	1
>/=26	3



STATISTICAL ANALYSIS

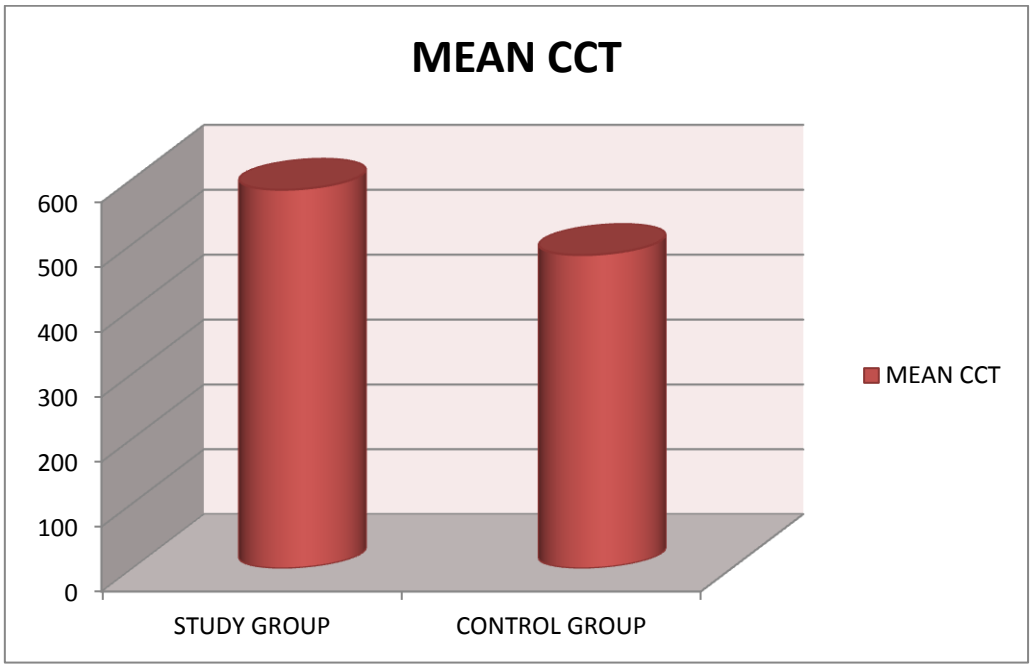
1. CENTRAL CORNEA THICKNESS

a. There was no significant difference in CCT between males and females in both study group as well as control group.

b. The mean CCT was greater in study group than in control group .There was a significant difference in CCT between the study group and control group. (‘p’ value < 0.01)

TABE 11: MEAN CCT IN STUDY GROUP AND CONTROL GROUP

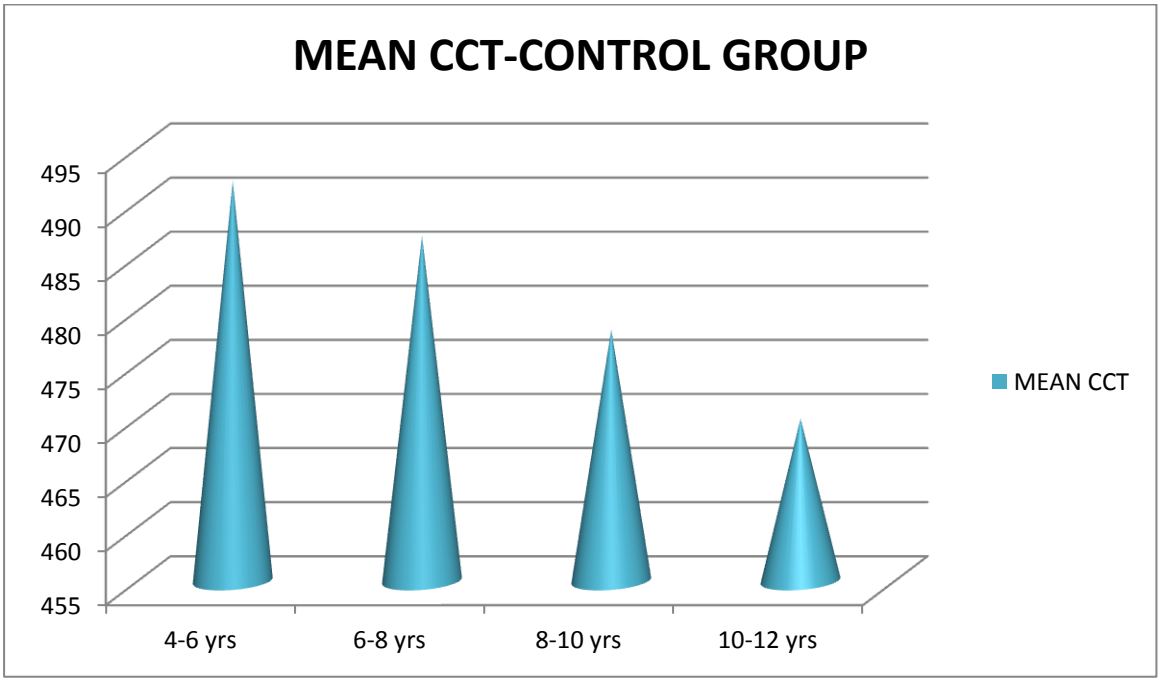
	MEAN CCT (µm)
STUDY GROUP	583.50
CONTROL GROUP	482.90



c. There was no significant relation between age and CCT in study group. But a significant negative correlation was noted between age and CCT in control group ($p < 0.01$)

TABLE 12 : AGE AND CCT IN CONTROL GROUP

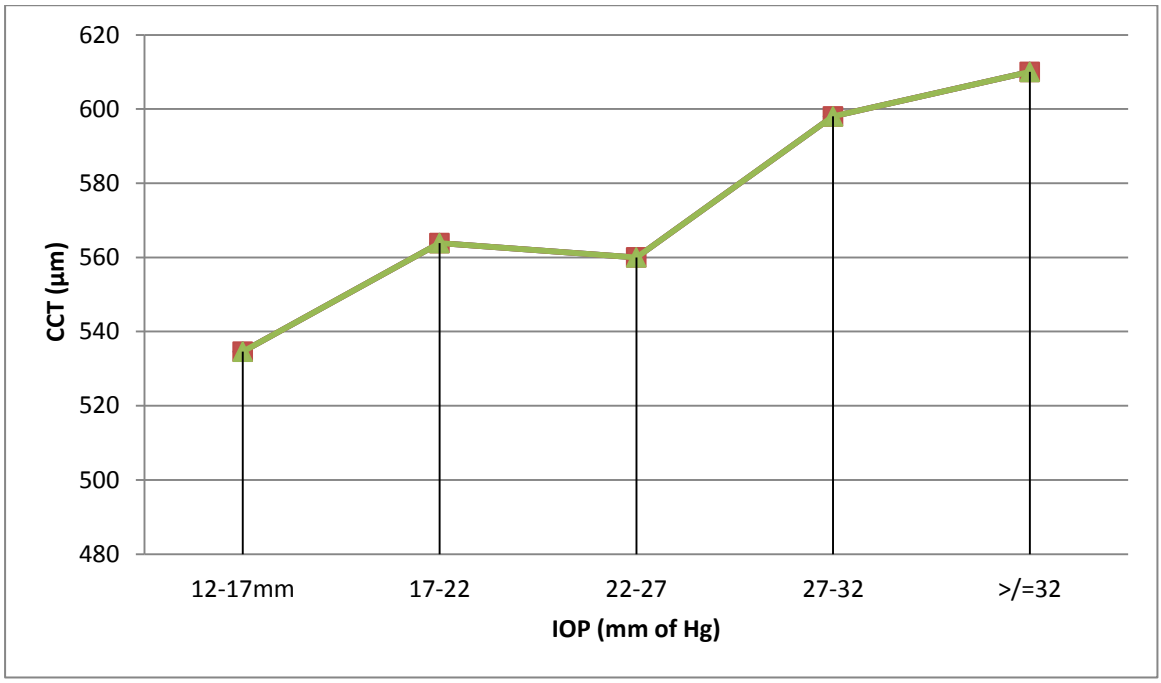
AGE (years)	MEAN CCT (µm)
4-6	492
6-8	486.9
8-10	478.22
10-12	470



d. There was a significant positive correlation (r=0.525) between CCT and IOP in the study group with a “p” value < 0.01. A similar correlation was found between the same variables in control group too (“p” value <0.01).

TABLE 13 : CORRELATION BETWEEN IOP AND CCT IN STUDY GROUP

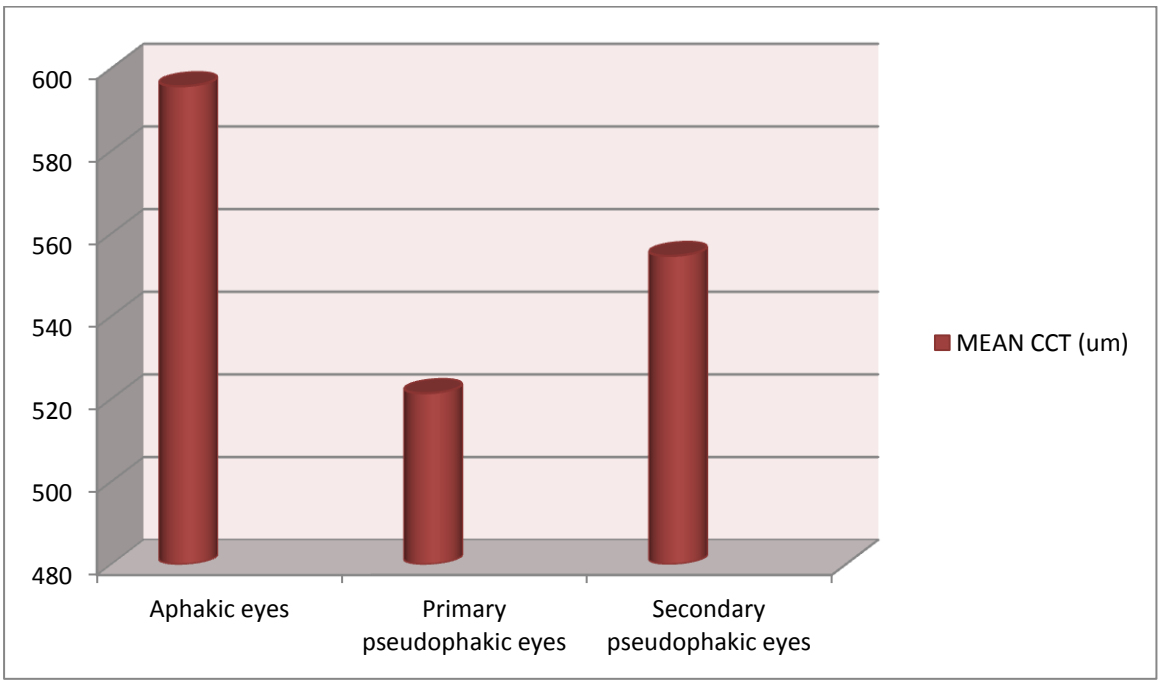
IOP (mm of Hg)	CCT (µm)
12-17	534.57
17-22	563.85
22-27	560
27-32	598
>/=32	610



e. The difference in mean CCT values between aphakic eyes and primary pseudophakic eyes was more when compared to the difference between aphakic eyes and secondary pseudophakic eyes.

TABLE 13 : COMPARISON OF MEAN CCT WITHIN THE STUDY GROUP

STUDY GROUP	MEAN CCT (µm)
Aphakic eyes	595.68
Primary pseudophakic eyes	521.42
Secondary pseudophakic eyes	554.62



f. A significant difference was noted between CCT and IOP in both study group and control group with a “p” value < 0.01

TABLE !4 :

	MEAN CCT (µm)	MEAN IOP (mm of Hg)
STUDY GROUP	583.50	22.8
CONTROL GROUP	482.90	11.4

SUMMARY

→ The age distribution of cases and controls varied from 4-12 years majority being in the range between 6-8 years of age. There was no significant difference in age between the study group and control group.

→ Among 32 cases studied , 20 were males and 12 were females. There was a male preponderance in both the study and control group. Sex distribution had a similar pattern in both study group and control group.

→ In the study group total number of aphakic eyes were 19 and 41 were pseudophakic eyes. Among the pseudophakic eyes , 14 had it implanted primarily (at the time of ens extraction) while in 8 cases intra ocular lens was implanted on a later date (secondary pseudophakia).

→ The age at which lensectomy was done in study group varied from 1-5 years ,most of them being in the range of 2-3 years.

→ The mean CCT of study group was found to be 583.50 µm ranging from 500-612 µm.

→The central corneal thickness in aphakic group ranged from 550 µm to 612 µm, mean value being 595.68 µm. Maximum number of eyes had CCT in the range of 590-610 µm.

→ The central corneal thickness in pseudophakic group ranged from 490 µm to 588 µm, mean value in primary pseudophakics being 521.42 µm and for secondary

pseudophakics it was 554.62 µm. CCT was found to be higher in secondary pseudophakics when compared to their primary counterparts.

→ The IOP values in the study group ranged between 12-32 mm of Hg, the mean IOP being 22.88 mm of Hg. Maximum number of eyes in study group had IOP in the range of 22-27 mm of Hg.

→ Among the 19 aphakic eyes studied, IOP varied from 12-32 mm of Hg, mean value being 23.84 mm of Hg.

→ The IOP measurements in pseudophakic group ranged from 14-26 mm of Hg,mean reading being 19.8 mm of Hg.

→There was no significant difference in CCT between males and females in both study group as well as control group.

→ The mean CCT was greater in study group than in control group. There was a significant difference in CCT between the study group and control group (‘p’ value <0.01)

→ There was no significant relation between age and CCT in study group. But a significant negative correlation was noted between age and CCT in control group (‘p’ value < 0.01). As the age increases, CCT is found to decrease in normal healthy controls.

→ There was a significant positive correlation (r=0.525) between CCT and IOP in the study group with a “p” value < 0.01. A similar correlation was found between the same variables in control group too (“p” value <0.01).

→ The difference in mean CCT values between aphakic eyes and primary pseudophakic eyes was more when compared to the difference between aphakic eyes and secondary pseudophakic eyes.

→ A significant difference was noted between CCT and IOP in both study group and control group with a "p" value < 0.01.

DISCUSSION

The critical time period for developing amblyopia begins approximately at around 4 months of age. Segregation of ocular dominance and sensitivity of binocular correlation begins at this time period of 4 months of age. Hence this is considered as the critical time period for visual development.

The normal anatomy of visual cortex is altered easily if sensory input is abnormal. Other areas of cerebral cortex also depend on this sensory input and stimulation, so as to form proper anatomical circuits essential for normal adult visual function. This fact underscores the significance of providing children with congenital cataract a timely intervention and equally important post-operative visual rehabilitation and follow-up. So removal of cataracts and clearing the obstruction to the visual axis at an earlier age should be done inevitably. Care must be given at the time of follow-up.

Since the children who have undergone cataract removal are highly susceptible to the risk of developing secondary glaucomas , a close monitoring of intra ocular pressure (IOP) and central corneal thickness (CCT) changes should be done. This can be helpful in the management of this unique category of patients. There was

a statistically significant increase in central corneal thickness in all eyes operated for congenital cataract. A longitudinal study conducted by Zena Lim and Kelly et al showed this increase in CCT was noticed in eyes without any evidence of glaucoma. They also found that mean CCT was even more higher in eyes with aphakic or pseudophakic glaucoma. A small case control study on the endothelial characteristics in children who have undergone congenital cataract extraction did not show any significant changes in endothelial cell characteristics when compared to the age and sex matched healthy control eyes, though there was a reduction in endothelial cell count. This finding is in contrast to the study done by Simon et al , who had the viewpoint that surgical trauma at the time of cataract extraction can cause endothelial cell dysfunction and resultant increase in CCT. Another school of thought for risk of developing glaucoma being more in aphakic group rather than in primary pseudophakic group is due to the exposure of the maturing angle structures and maturing cornea to harmful side effects of vitreous components. This access to trabecular meshwork and cornea is less if artificial lens is implanted at the same time as that of cataractous lens extraction.

So increased central corneal thickness in aphakic and pseudophakic eyes following congenital cataract extraction and its effect on intraocular pressure measurement should be borne in mind before making a diagnosis of glaucoma and prescribing anti-glaucoma medications in children.

CONCLUSION

Children who have undergone lens extraction for congenital cataract are found to have a clinically significant increase in central corneal thickness which can in turn provide overestimated intraocular pressure readings by applanation tonometry. Aphakic eyes have a thicker cornea when compared to their pseudophakic counterpart showing primary lens implantation can be a protective factor against this increase.

So measuring central corneal thickness should be made mandatory and necessary intra ocular pressure corrections made before prescribing antiglaucoma medications in children who are highly susceptible to their serious side effects.

ANNEXURES

BIBLIOGRAPHY

1. The Cataracts of Nile, Wikipedia ,The free encyclopedia

2. Yi J[1], Yun J, Li ZK, Xu CT, Pan BR. Epidemiology and molecular genetics of congenital cataracts Int J Ophthalmol. 2011;4(4):422-32. doi: 10.3980/j.issn.2222-3959.2011.04.20. Epub 2011 Aug 18.

3. Paediatric ophthalmology and strabismus (section 6;2011-2012), Stimulus deprivation amblyopia pg 64, AAO series

4. Kenneth .W . Wright, Peter. H .Spiegel ,Post natal development Chapter 2 Pg:46 ,Development of retina ,Paediatric ophthalmology and strabismus

5. Isenberg SJ, Macular development in premature infant, American Journal Ophthalmology 1986;101:74-80

6. Yuodelis C, Hendrickson A, A qualitative and quantitative analysis of human fovea during development, Vision Res 1986; 26:847-855

7. Nancy Anderson Hamming, Apple D. ; Anatomy and embryology of the eye in Principle and Practice of ophthal mology, Edited by Peyman G.A. Sander D.R. and Goldberg M.F. Vol.I pp. 3–12 First India Edition. Jay Pee Brothers, New Delhi, 1987.

8. Sharma P. ; Essentials of Ophthalmology, First Edition pp. 133, Modern Publishers, New Delhi, 2000

9. Dutta L.C. ; Blue Dot Cataract in Ophthalmology Principle and Practice, First Edition Current Book Inter national Calcutta 1995.

10. Khurana A.K. ; Diseases of the lens in Ophthalmology second edition pp. 183–212 New age international, New Delhi 2000.

11. Berger B.B. ; The lens cataract and its management in Principle and practice of ophthalmology, Editors, Peyman. G.A.

12. Rhonda G Waldron, MMSc, COMT, CRA, ROUB, CDOS; Chief Editor: Timothy Jang, MD A-Scan Biometry ,Medscape.

13. Sanders DR[1], Retzlaff J, Kraff MC. Comparison of the SRK II formula and other second generation formulas. J Cataract Refract Surg. 1988 Mar;14(2):136-41

14. Raina UK, Mehta DK,Monga s,Arora R : Functional outcomes of acrylic intra ocular lenses in Paediatric cataract surgery. J Cataract Refract Surg 2004;30 : 1082-1091

15. Gimbel HV , DeBroff BM : Posterior capsulorhexis with optic capture : maintaining a clear visual axis after paediatric cataract surgery. J Cataract Refract Surg 1994 ;20:658-664

16. Cheryl Guttman Krader; Reviewed by Yasmin Bradfield, MD, Ophthalmology Times ,Nov 01,2013

17. Sue Stevens, Clare Gilbert, and Nick Astbury How to measure intraocular pressure: applanation tonometry Community Eye Health. 2007 Dec; 20(64): 74–75

18. Tania Paul, MD,[1] Mira Lim, MD,[1] Christopher E. Starr, MD,[1] Harriet O. Lloyd, MS,[1] D. Jackson Coleman, MD,[1] andRonald H. Silverman, PhD[1,2]

Central Corneal Thickness as Measured by Orbscan II, Ultrasound Pachymeter and Artemis-2. J Cataract Refract Surg. 2008 Nov; 34(11): 1906–1912.
doi: 10.1016/j.jcrs.2008.07.013

19. Niels Ehlers, Torben Sorensen, Thorkild Bramsen, Erik Holk PoulsenCentral Corneal Thickness in Newborns and Chidren , Acta Ophthalmologica, July 1976

20. Laibson PR, Waring GO : Diseases Of Cornea in : Harley RD ed Paediatric Ophthalmology 2nd edition Philadelphia PA, Saunders 1983; 456-514

21. Simon J W, O' Malley R, Central Corneal Thickness and Glaucoma in Aphakic and Pseudophakic children J AAPOS 2005 9; 326-329

PROFORMA

NAME: IP/OP NO:

AGE: RELEVANT ANTENATAL HISTORY:

DATE OF BIRTH:

SEX: FAMILY HISTORY:

INVESTIGATIONS:

OCULAR EXAMINATION:

OD **OS**

ANTERIOR SEGMENT

LID
CONJUNCTIVA
CORNEA
ACD
IRIS
PUPIL
LENS

VISUAL ACUITY
IOP
CCT
GONIOSCOPY

FUNDUS EXAMINATION

OD **OS**

MEDIA
DISC
C:D
VESSELS
A:V
MACULA
FR

MASTER CHART

STUDY GROUP

NO	NAME	AGE (Yrs)	SEX	RE	LE	AGE AT LENSECTOMY		IOP		CCT	
						RE	LE	RE	LE	RE	LE
1	raja	7	M	aphakia	pseudo 2	2	2	20	14	612	500
2	palpandi	10	M	pseudo 2	aphakia	4	5	16	20	520	598
3	karthiga	6	F	pseudo1	normal	3	NA	22	12	534	478
4	selvam	5	M	aphakia	aphakia	4	4	24	22	550	564
5	chinnalagu	7	F	aphakia	pseudo2	5	3.5	21	18	596	588
6	selvi	9	F	pseudo1	pseudo1	2	3	16	18	522	512
7	manikam	7	M	pseudo1	normal	3	NA	20	12	516	476
8	pandi	9	M	aphakia	normal	4	NA	28	14	590	460
9	muthu	4	M	aphakia	cataract	2.5	NA	18	10	610	492
10	malar	8	F	normal	aphakia	NA	3	12	26	478	598
11	kumar	6	M	pseudo1	normal	2	NA	22	12	522	488
12	sundari	5	F	aphakia	aphakia	1.5	2	26	24	600	592
13	saravanan	7	M	normal	pseudo2	NA	3	10	26	500	586
14	sankar	6	M	aphakia	normal	3	NA	30	14	598	470
15	ramu	7	M	pseudo2	normal	2	NA	22	14	550	486
16	keerthika	8	F	aphakia	normal	3	NA	28	14	600	496
17	kashi	7	M	normal	pseudo1	NA	3	14	18	480	574
18	krishna	6	M	normal	aphakia	NA	2.5	12	32	484	610
19	murali	8	M	pseudo1	normal	3	NA	32	16	504	478

20	anupriya	7	F	aphakia	aphakia	4	4.5	28	30	598	602
21	bala	6	M	pseudo2	cataract	2	NA	26	14	580	478
22	kumari	9	F	aphakia	normal	3	NA	14	12	602	480
23	arun	8	M	pseudo1	cataract	1.5	NA	14	12	500	476
24	sinitha	10	F	normal	pseudo2	NA	2.5	12	26	468	545
25	sriram	7	M	normal	pseudo1	NA	3	10	22	486	510
26	ahmed	8	M	normal	pseudo1	NA	1.5	12	16	466	500
27	meeradevi	8	F	normal	aphakia	NA	3.5	14	28	468	604
28	rajan	9	M	pseudo1	pseudo1	1.5	2	18	18	520	524
29	jayram	11	M	pseudo2	normal	3	NA	20	12	568	466
30	priya	10	F	pseudo1	normal	2	NA	24	10	490	460
31	sindhu	7	F	pseudo1	normal	2	NA	18	14	572	478
32	arush	5	M	aphakia	aphakia	1	2	20	22	598	596

CONTROL GROUP

NO	NAME	AGE	SEX	RE (LENS)	LE (LENS)	IOP		CCT	
						RE	LE	RE	LE
1	balram	7	M	N	N	10	8	490	488
2	rema	11.5	F	N	N	12	14	470	472
3	darshan	6	M	N	N	10	12	486	484
4	meena	6.5	F	N	N	10	12	480	480
5	kumar	7	M	N	N	10	8	494	490
6	haree	7	M	N	N	14	16	460	456
7	lokesh	9	M	N	N	12	12	462	460
8	pushpa	9	F	N	N	12	14	484	482
9	sai krishna	4.5	M	N	N	8	8	496	494
10	neelam	8	F	N	N	10	12	466	468
11	mani	6	M	N	N	8	8	489	490
12	manish	8	M	N	N	10	12	478	480
13	hari	7	M	N	N	10	12	488	490
14	pandi	11	M	N	N	14	12	461	465
15	minu	10	F	N	N	14	16	474	476
16	jai	7	M	N	N	8	12	488	486
17	bijisha	5	F	N	N	8	10	492	490
18	amit	8	M	N	N	10	8	489	488
19	arun	10	M	N	N	14	16	472	470
20	anjali	7	F	N	N	8	10	492	494
21	vivek	8.5	M	N	N	12	14	480	479
22	mani	4	M	N	N	10	8	492	488
23	kumar	8	M	N	N	12	14	488	486
24	krithika	6.5	F	N	N	8	10	490	490
25	arunima	5	F	N	N	8	10	494	490
26	athira	7	F	N	N	10	10	487	488
27	ameen	8	M	N	N	12	14	484	486
28	remya	7	F	N	N	8	8	492	494
29	dinesh	6	M	N	N	8	10	486	488
30	sundar	8.5	M	N	N	14	12	478	476
31	hima	6.5	F	N	N	8	8	491	492
32	sudha	7	F	N	N	10	12	488	490

LIST OF ABBREVIATIONS

IOP-Intra Ocular Pressure

CCT-Central Corneal Thickness

RPE-Retinal Pigment Epithelium

AD-Autosomal Dominant

PHPV-Persistent Hyperplastic Primary Vitreous

IDO-In Direct Ophthalmoscope

IOL-Intra Ocular lens

PMMA-Poly Methyl Metha Acrylate

PCO-Posterior Capsular Opacification

PCCC-Posterior Continuous Curvilinear Capsulorrhexis

BSS-Baanced Salt Solution

OVD-Ophthamic Viscosurgical Devices

RE-Right Eye LE-Left Eye

Pseudo1-Primary pseudophakia

Pseudo2-Secondary pseudophakia

N-Normal

MADURAI MEDICAL COLLEGE
MADURAI, TAMILNADU, INDIA -625 020
(Affiliated to The Tamilnadu Dr.MGR Medical University, Chennai, Tamil Nadu)

ETHICS COMMITTEE CERTIFICATE

Name of the Candidate	:	Dr.Anu Joseph
Course	:	PG in MS., Ophthalmology
Period of Study	:	2014-2017
College	:	MADURAI MEDICAL COLLEGE
Research Topic	:	comparative study of increase in central corneal thickness following congenital cataract surgery in pseudophakic and aphakic eyes
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
Madurai-20

10 JUN 2016

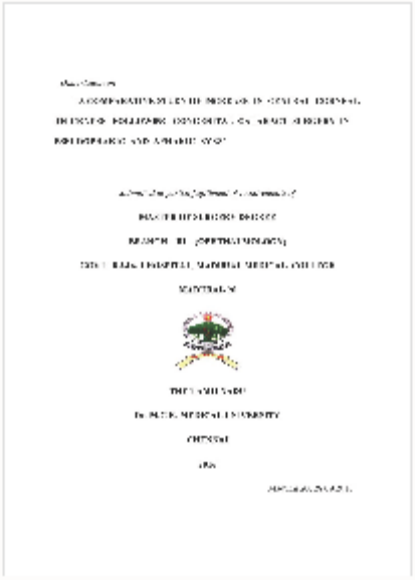
turnitin

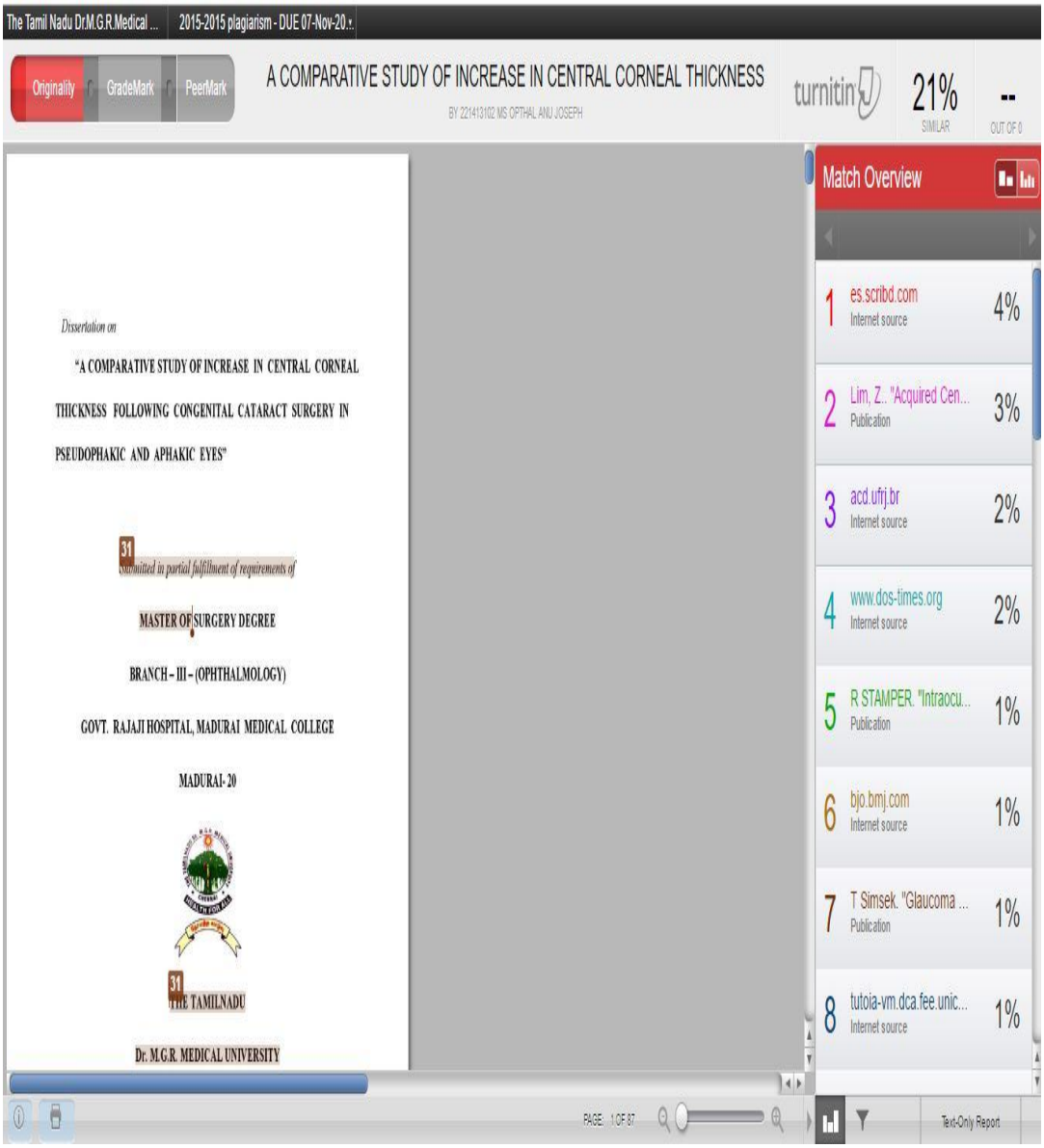
Digital Receipt

This receipt acknowledges that Turnitin received your paper. Below you will find the receipt information regarding your submission.

The first page of your submissions is displayed below.

Submission author:	221413102 Ms Opthal ANU JOSEPH
Assignment title:	2015-2015 plagiarism
Submission title:	A COMPARATIVE STUDY OF INCR...
File name:	THESIS_MAIN.docx
File size:	2.12M
Page count:	87
Word count:	11,052
Character count:	60,264
Submission date:	22-Sep-2016 02:17PM
Submission ID:	707558173




The Tamil Nadu Dr.M.G.R.Medical ...
2015-2015 plagiarism - DUE 07-Nov-20...
Originality
GradeMark
PeerMark
A COMPARATIVE STUDY OF INCREASE IN CENTRAL CORNEAL THICKNESS
BY 22141102 MS OPTHAL ANU JOSEPH
turnitin
21%
SIMILAR
--
OUT OF 0
Dissertation on
"A COMPARATIVE STUDY OF INCREASE IN CENTRAL CORNEAL THICKNESS FOLLOWING CONGENITAL CATARACT SURGERY IN PSEUDOPHAKIC AND APHAKIC EYES"
Submitted in partial fulfillment of requirements of
MASTER OF SURGERY DEGREE
BRANCH - III - (OPHTHALMOLOGY)
GOVT. RAJAJI HOSPITAL, MADURAI MEDICAL COLLEGE
MADURAI- 20
THE TAMILNADU
Dr. M.G.R. MEDICAL UNIVERSITY
Match Overview
1 es.scribd.com Internet source 4%
2 Lim, Z.. "Acquired Cen... Publication 3%
3 acd.ufrj.br Internet source 2%
4 www.dos-times.org Internet source 2%
5 R STAMPER. "Intraocu... Publication 1%
6 bjo.bmj.com Internet source 1%
7 T Simsek. "Glaucoma ... Publication 1%
8 tutoia-vm.dca.fee.unic... Internet source 1%
PAGE: 1 OF 97
Text-Only Report