"COMPARATIVE STUDY OF GENDER VARIATIONS IN OCULAR PARAMETERS BY A-SCAN IN AGE MATCHED ADULTS"

By

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Dissertation submitted to the

SRI DEVARAJ URS ACADEMY OF HIGHER EDUCATION AND RESEARCH CENTRE, KOLAR

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MASTER OF SURGERY

IN

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Under the guidance of

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LIST OF ABBREVIATIONS

SL NO.	ABBREVIATION	FULL FORM
1.	AL	Axial length
2.	ACD	Anterior chamber depth
3.	LT	Lens thickness
4.	IOL	Intra ocular lens
5.	A-SCAN	Amplitude scan
6.	B SCAN	Brightness scan
7.	PACG	Primary Angle Closure Glaucoma
8.	AS	Anterior segment
9.	AC	Anterior chamber
10.	PCI	Partial Coherence Interferometry
11.	D	Diopters
12.	OCT	Optical Coherence Tomography
13.	MRI	Magnetic Resonance Imaging
14.	MHz	Mega hertz
15.	LCOR	Low-coherence optical reflectometry
16.	CCT	Central corneal thickness
17.	ELP	Effective lens position
18.	IOP	Intraocular pressure
19.	RE	Right Eye
20.	LE	Left Eye
21.	PSC	Posterior subcapsular cataract

ABSTRACT

PURPOSE

Multiple ocular diseases are significantly correlated with ocular parameters. Gender is well thought-out to be a predictor of the ocular biometrics. Biological parameters like anterior chamber depth, lens thickness, axial length are of great significance in calculation of IOL power before cataract surgery, diagnosis and management of angle closure glaucoma, staphyloma and various other conditions. These parameters are significant variables for refractive errors also where the A scan biometry is most widely used method for measurement of these parameters. The purpose of this study is to compare gender differences in axial length, anterior chamber depth and lens thickness in age matched adults.

AIMS AND OBJECTIVES

- To compare gender differences in axial length in age matched adults.
- To compare gender differences in anterior chamber depth in age matched adults.
- To compare gender differences in lens thickness in age matched adults.

MATERIAL AND METHODS

A cross sectional comparative study conducted in Department of Ophthalmology in R.L.J Hospital and Research Centre attached to Sri Devaraj Urs Medical College from December 2019 and May 2021. A total of 192 eyes of 48 males and 48 females were evaluated. After obtaining consent, demographic details were noted & then subjected for detailed ophthalmic examination of both eyes including Visual acuity, Slitlamp biomicroscopy, IOP by Goldmann

Applanation Tonometry, Fundus examination and Axial length, Anterior chamber depth and Lens thickness measurement by A-scan using contact technique.

RESULTS

Mean axial length among males and females was 23.78 ± 0.84mm and 22.65 ± 0.95mm respectively. Mean axial length among males was significantly higher in comparison to females. Mean anterior chamber depth among males and females was 2.52 ± 0.15 mm and 2.48 ±0.12 mm respectively. Statistically insignificant results were obtained while comparing the mean anterior chamber depth among males and females. Mean lens thickness among males and females was 4.72 ± 0.38 mm and 4.82 ± 0.31mm respectively. Statistically insignificant results were also obtained while comparing the mean lens thickness among males and females.

CONCLUSION

The mean axial length among males is higher compared to females, while other parameters may show variable results among gender. Our study concluded that the normative data obtained can help in accurate assessment of ocular biometry and different pathological conditions of eye.

Key words: Axial length, Anterior chamber depth, Lens thickness, Biometry, A-scan

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INTRODUCTION

INTRODUCTION

Multiple ocular diseases are significantly correlated with ocular parameters.[1] Gender is well thought-out to be a predictor of the ocular biometrics.[2] Biological parameters like anterior chamber depth (ACD) , lens thickness (LT) , axial length (AL) are of great significance in diagnosis as well as treatment of primary angle closure glaucoma (PACG).[3] Eyes with PACG present with the smaller anterior chamber depth, thicker lens, anteriorly placed lens and a shorter axial length if related to the normal eyes.[4,5] PACG is a common cause of blindness in Asia.[6] With respect to gender, it is supposed that PACG is more commonly seen in females.[7,8]

Axial length is an elementary ocular parameter and a significant variable for various refractive errors and for diagnosing various ocular pathologies like posterior staphyloma and evaluation of risk of retinal detachment before refractive surgery.[9] Determining normal range of these ocular parameters will give beneficial information that can support in upgrading cataract surgical outcomes.[8] Biometry plays a very important role in intra ocular lens(IOL) power calculation. Any mistake in this calculation will leave patient with significant refractive error post operatively."[9]

Intraocular lens (IOL) power calculation and deciding refractive status of eye can be supported with axial length and anterior chamber depth measurements.[9] The correlation between axial length and depth of anterior chamber has been studied over time. They have been related to various ocular parameters. The axial length is a significant biometric variable in the calculation of IOL power as a 0.1mm error in measurement of axial length will lead to about 0.25 Diopters (D) change in post-operative refraction.[10]

AL is a quantifiable variable which can be measured either by ultrasonography {Amplitude (A) Scan or brightness (B) Scan} or by optical methods such as Partial Coherence Interferometry(PCI).[11]

"Axial length is defined as the distance between the anterior and the posterior poles of the eye or the distance from the anterior curvature of the cornea to the retinal pigment epithelium (RPE) along the optical axis of the eyeball ." [12] At birth, the axial length of eye is 17-18mm approximately; later it increases by about 5mm (till 23mm) from birth to age of 3 to 6 years till it reaches to an average value of 24 mm in adulthood.[13] In a study by Tanjong Pagar et al conducted in China mean axial length was 23.23mm.[14] It has been correlated to previous studies, that it can be affected by age and sex and anterior chamber depth.[15-17]

The anterior chamber depth (ACD) is defined as distance measured from the posterior surface of the cornea to the anterior surface of the crystalline lens along the optical axis of eye.[18] ACD is considered to be a significant biometric measurement. It is approximately measured around 3.5mm (1.99-4.75mm). In a study done in Central India by Jonas et al, mean ACD was noted to be 3.2mm.[19] Anterior chamber depth varies with age and gender.[17]ACD measurement and dimensions are said to be very important in the diagnosis of angle closure glaucoma, as shallow anterior chamber is noted to be a significant ocular risk factors for angle closure glaucoma.[20] There is a linear correlation between anterior chamber depth and axial length up to 27 mm after which there is a decline and the linear relationship ceased to exist. In a study, carried out in North America on 1968 older white persons, AL was found to positively correlated with ACD.[21]

Refraction is a complex phenotype that involves various biometric variables of the eye, including AL, curvature of cornea, anterior chamber depth, lens thickness, vitreous chamber depth, and refractive power of the structures.[22] Hence, under the light of above mentioned data, the present study was undertaken for documenting gender differences in axial length, anterior chamber depth and lens thickness among age matched adults.

AIMS & OBJECTIVES

OBJECTIVES

OBJECTIVES OF THE STUDY

- To compare gender differences in axial length in age matched adults.
- To compare gender differences in anterior chamber depth in age matched adults.
- To compare gender differences in lens thickness in age matched adults.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

ANATOMY OF EYE

Eye ball is a cystic structure kept distended by pressure inside it. Eye ball is not a sphere but an oblate spheroid which consists of two modified spheres fused together.

Eye ball has anterior and posterior curvature. The central point on maximum convexities in both curvatures is respectively called as anterior and posterior pole. Circumference of adult eyeball is 75mm and volume of eyeball is 6.5ml. Weight of adult eyeball is 7gms.

COATS OF EYEBALL

The eyeball comprises of three coats – outer fibrous coat , middle vascular coat and inner nervous coat.

1. FIBROUS COAT- It is a compact strong wall which protects the contents of eye. Anterior $1/6^{th}$ of outer coat is transparent and called cornea. Posterior $5/6^{th}$ part that is opaque is called sclera. Junction of sclera and cornea is called Limbus.
2. VASCULAR COAT-middle vascular coat of eye is called Uveal tissue which supplies nutrition to various parts of eye.

   It is divided into three parts - a) Iris

   b) Ciliary Body

   c) Choroid
3. NERVOUS COAT- Inner nervous coat is called as Retina. It is responsible for visual functions and via visual pathway it projects to visual cortex.[24,25]

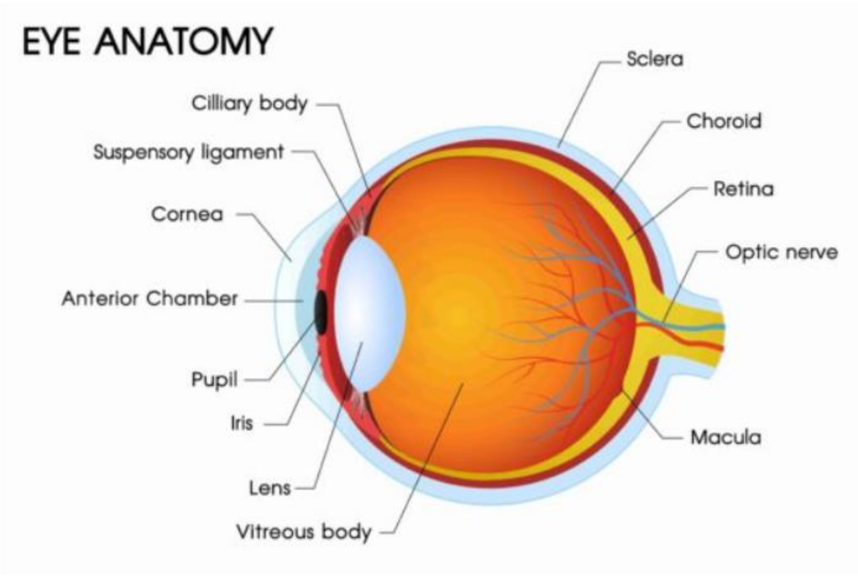


FIGURE 1 – GROSS ANATOMY OF EYEBALL

SEGMENTS AND CHAMBERS

Eye ball is divided into two segments by Iris.

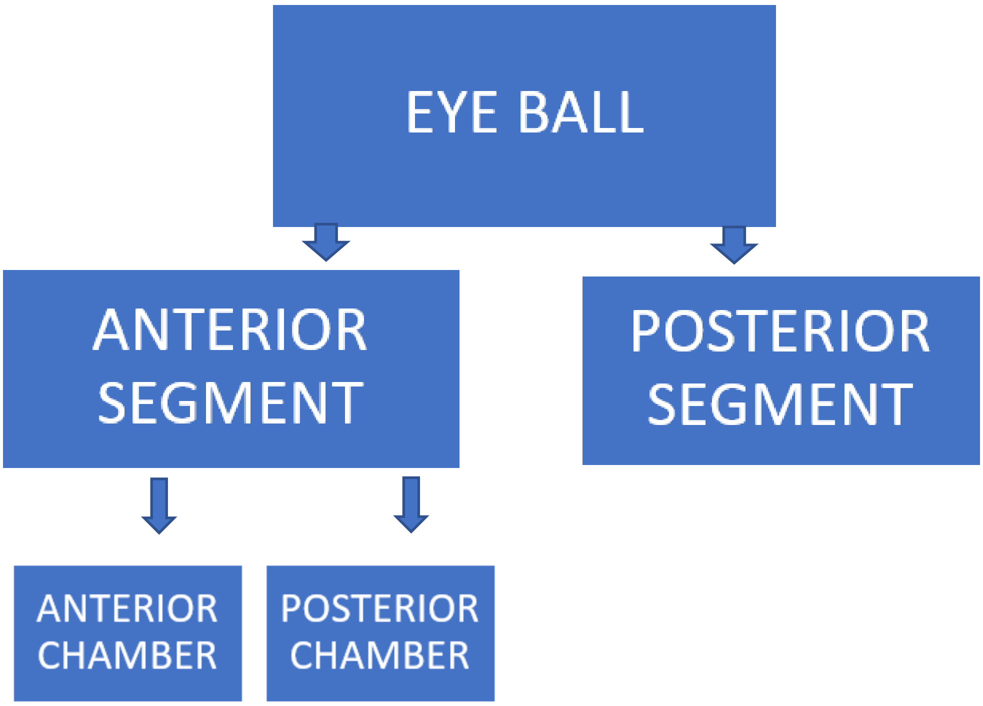


FIGURE 2 – SEGMENTS OF EYE BALL

a) **ANTERIOR SEGMENT-** includes cornea, anterior chamber, iris, lens and posterior chamber.

Anterior Chamber – it is confined anteriorly by the endothelium of cornea and posteriorly by the anterior surface of iris and a part of ciliary body. Normally, it is around 2.5 mm deep in the centre in humans, but it is somewhat shallower in hypermetropes and deeper in myopes. One thing to note is that it is of almost equal dimensions in both the eyes in any normal healthy individual. It holds about 0.25ml of aqueous humor and communicates with the posterior chamber through the pupil.

Posterior Chamber – It is a triangular space containing approximately 0.06ml of aqueous humor. It is bounded anteriorly by posterior surface of the iris and a part of the ciliary body, posteriorly it is restricted by the crystalline lens and its zonules, and laterally by the ciliary body.

b) **POSTERIOR SEGMENT –** It includes the structures posterior to the lens, that are – a gel-like vitreous humor, the retina, choroid and the optic disc.

AXIAL LENGTH

There are four ocular structures causative to the refractive status of the human eye which include the cornea, aqueous humour, lens and the vitreous humour. Myopia and other refractive-error disorders are due to the uncoordinated contributions of the different parts of eyeball.[26]

The lens and cornea fail to compensate for axial length (AL) elongation as in cases of myopia or shortening in cases of hyperopia. Parameters closely related to measurements of these parts such as curvature of cornea, Anterior chamber depth (ACD), thickness of lens, depth of vitreous chamber and Axial Length are widely studied in various eye disorders. The Axial Length is measured from the surface of cornea to retinal pigment epithelium /Bruch's membrane at its interference peak.[27]

Newborn's eyeball has axial length of about 16 millimeters. In a child less than 1 year, the eye grows to a length of 19.5 millimeter approximately. The eye grows slowly to the length of about 24-25 millimeters (adult size).[28]

Mostly increase in axial length takes place in the first three to six months of life and a gradual decrease of growth occurs in the next two years, and adult size is reached by 3 years. It is studied that the depth and volume of the anterior chamber diminishes with age and are related to the degree of ametropia.[29]

Among biometry components of eye, Axial Length is considered to be most significant biometry parameter as it is a main factor for both myopia and hypermetropia.[30]

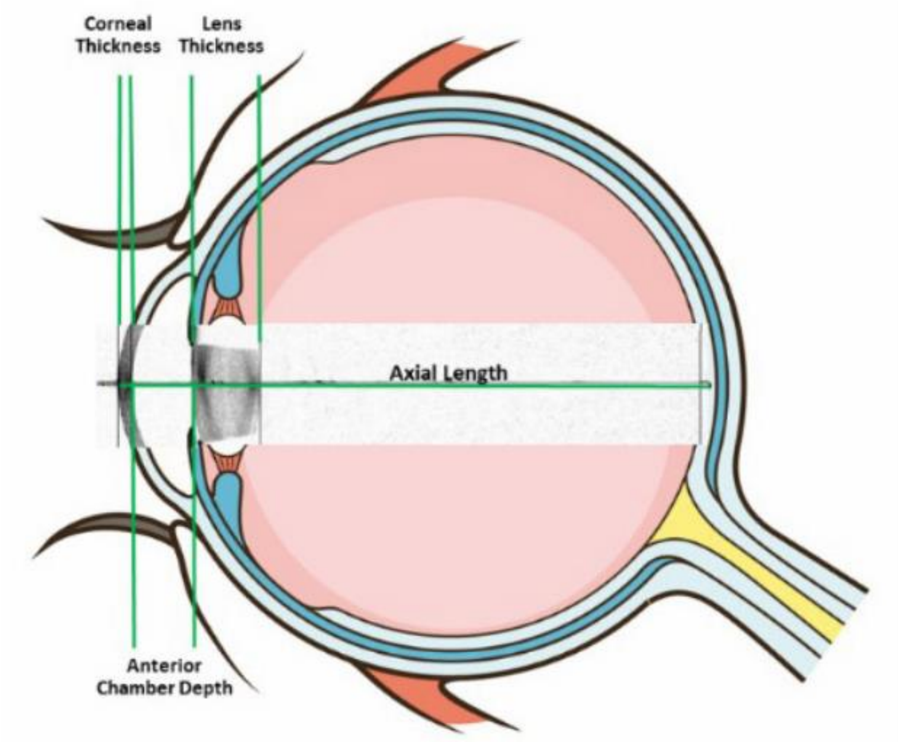


FIGURE 3 – BASIC OCULAR BIOMETRY PARAMETERS

Studies have revealed that Axial Length shows a bi-modal distribution in adult myopes.[31] When samples were divided into two groups, first spike is noted at around the Axial length of 24 mm for low myopia (–6 D < refractive error< 0 D) while the second spike appears approximately at the Axial Length of 30 mm for high myopia (refractive error < -6 D).The distribution of AL is stated to be positively skewed and is under a normal distribution in some selected cohorts in general population.[32]

Recently, ophthalmologists have utilized ultrasonic velocity reading machinery and optical partial coherence interferometry to measure Axial Length of eye to assess the severity of myopia. Many researchers found that Axial length is the major factor of refractive error.[33] Severity of the myopia increases with increase in axial length. Olsen et al stated that Axial

Length, power of lens and power of cornea together, contribute to 96% of the variation of refraction in populations.[34]

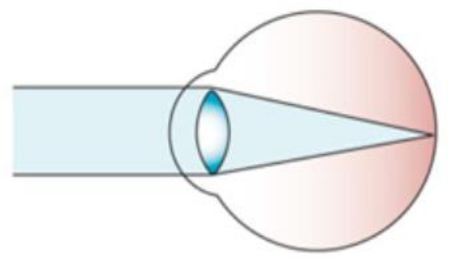
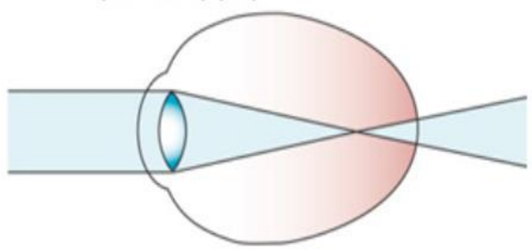
	**Emmetropic eye** Axial length is about 24mm. The image is reflected by cornea and crystalline lens and clearly focuses on the neural retina
	**Eyes with Pathological Myopia** Axial length exceeds 27mm. Due to the excessive increase of axial length, the image focus is in front of neural retina

FIGURE 4 – COMPARISON OF AXIAL LENGTH IN EMMETROPIC AND MYOPIC EYES

Axial Length differences were found to be age related in few investigations. Shorter Axial Length was noted in elderly than the younger participants.[35] Studies suggested that these differences were related to cohort effects. For example, in younger age group near work was more intensive, which is a factor increasing Axial Length probably due to a defocus-induced disturbance of emmetropisation.[36,37]

Clinic based studies have suggested that eyes with occludable angles and angle closure glaucoma have a shorter axial length, shallower anterior chamber, and a thicker lens.[38] A cross-sectional comparative study was done in Mechi Eye Care Centre, Nepal including 40 eyes of 20 diagnosed cases of PACG and 40 eyes of 20 normal subjects selected by random sampling. Axial length was measured using ultrasound A-scan biometry. The mean AL and standard deviation of PACG were 21.93±1.16 mm and those of control group were 23.01 ± 0.49mm. The axial length of less than 23 mm was found as a risk determinant for angle closure glaucoma.[39]

Multiple studies have referred to the eye's ''average'' or ''normal'' axial length, to be of an accepted value of around 23.50 mm. In 1980, first reported publication of a large series of 7500 cataractous eyes, using immersion A-scan ultrasound biometry, stated a mean Axial Length of 23.65 ± 1.35mm. [40]

Mean axial length values have been used for various purposes such as schematic eyes used in optics and the deriving intraocular lens (IOL) power formulas such as the Holladay 2 formula. Studies done earlier did not differentiate biometry values between gender or racial groups. Few studies have reported that taller and heavier individuals usually have greater axial length values. Tan et al in a study of 1845 Asian eyes, reported that for every 10 cm (3.94 inches) increase in height, AL increases by 0.30 mm. It could therefore be conjectured that as males are usually taller, this is the major cause of longer AL.[41] However, Lim et al showed in 2788 Asian eyes, when corrected for height, males still had a statistically longer eye than females.[42] Females have also been shown to have significantly smaller corneal diameters than males in a large 23,239 eye study by Hoffmann .[43]

The results of study done in Italy have led to a fifth generation IOL power calculation formula, the Hoffer H-5, which uses these gender and racial averages to replace the ones used in the Holladay 2 formula. It was suggested that generally, men have longer eyes, flatter corneas, deeper anterior chamber and similar LTs as compared with women, except in Asian eyes where men have steeper corneas than females. On the basis of the voluminous data, it seems that use of 23.50 mm as the average AL of the human eye has to be reconsidered so that there can be more specific data as to which group of eyes are being discussed; male or female and their specific racial characteristics.[44]

Many studies stated that by the age of thirteen years, eye reaches its adult emmetropic axial length.[45] Studies reported that by 15 years of age, the anterior chamber attains its maximum depth, and lens its minimum thickness, because the lens power decreases during the slow harmonized growth period of the ocular tissue in childhood .[46,47]

Axial length remains unaltered in adults. There is a mild change towards hypermetropia after the age of 40. After birth, there is substantial growth of eyeball.[48] A term baby's eye has a mean axial length of 16-18mm & mean anterior chamber depth of 1.5-2.9 mm. The mean adult values for AL are from range 22 to 25 mm and mean refractive power ranges from -25.0 D to +1.0 D. The mean ACD in an adult eye which is emmetropic is 3-4 mm.[49]

Accumulating reports from multiple studies concluded that both genetic and the environment factors are responsible for power of the eye. It has been studied that newborn and children less than 1 year of age shows refractive errors and later refractive error decreases with the increase in age.[48]

Different axial length measurements lead to differences in calculation of power of IOL. Axial Length (AL) and Anterior Chamber Depth (ACD) measurement helps in assessment of the refractive power of the eye and deriving of intraocular lens power for patients before cataract surgery.[50]

The axial length is the most important anthropometric variable in the measurement of intraocular lens power as a 0.1mm error in the measurement of axial length will result in as much as 0.25Diopters change in post-operative refraction.[51] Axial length is calculated either by ultrasonography (contact or immersion techniques of amplitude A-Scan or Brightness Scan) or by optical methods (Partial Coherence interferometry).

Various studies have been reported that there is negative relationship between axial length and occurrence of retinal vein occlusions, primary angle closure glaucoma and hypermetropia while longer axial lengths have been associated with an increased incidence of cataracts and myopia.[52,53]

Axial length is also said to have significance on normal refractive status of the eye.[54] It is also the most important parameter in the assessment of intra-ocular lens power before cataract surgery and aids in the detecting conditions like staphyloma and retinal detachment [55]. Thus, it is important to know the normal range of the axial length to detect abnormal values, and later screening should be done to assess pathological conditions.

Oliveira C et al investigated the relationship between AL and optic disc area in normal eyes of white and black individuals. Eligible normal subjects were selected. Ocular biometry was measured using A-scan ultrasonography, and image of the optic disc using a confocal scanning laser ophthalmoscope was taken. The relationship between optic disc area and AL was measured using univariate and multivariate models. Larger disc was seen in black subjects with mean disc area 2.12 ± 0.5 mm^2 than white subjects 1.97 ±0.6 mm^2. Area of optic disc increased with AL for the whole study population. Multivariate regression models including race, disc area and AL show that a significant but weak linear relationship exists between Axial Length and disc area and with race and disc area when adjusted for the effects of other terms in the model. The study also concluded that increased disc area is associated with longer Axial Length calculations and African ancestry which may have implications for pathophysiology and risk measurement of glaucoma.[56]

Jivrajka R et al reviewed 750 eyes and evaluated the calculation of biometry (first eye developing cataract) with nil retinal pathology. All calculations were done with the I3 system A-scan (Innovative Imaging, Inc.) using an immersion technique. In relation to age, sex, and keratometric readings the axial length (AL), anterior chamber depth (ACD), and lens thickness (LT) measurements were also calculated. The mean Axial Length was 23.46 mm ±1.03 (SD), the mean ACD was 2.96 ±0.45 mm, and the mean Lens Thickness was 4.93±0.56 mm. For operation men presented at former age than women with a longer Axial Length (23.76 ±1.00 mm versus 23.27±1.01 mm). The Axial Length tended to be longer in younger patients, ACD tended to be deeper in younger patients and in longer eyes. The LT was noted to be thicker in older patients and in shorter eyes, with large scatter in the distribution. They concluded that there was a positive correlation between Axial Length and ACD and an inverse relation between Axial Length and LT. Also, AL was inversely correlated with age and corneal power.[57]

Study done in a multi-ethnic elderly Asian population, determined the prevalence rates of refractive errors and ocular biometry pattern. The major predicting factor of ocular biometrics was gender. Study concluded that there is a high prevalence of myopia in elderly Singaporeans, consistent with trends seen in younger populations in Asia. Male gender and higher education were independent risk factors for myopia.[58]

Posterior staphyloma is commonly seen in pathologic myopia. At the edge of the staphyloma there is scleral thinning, a significant disorganisation of scleral collagen fibrils and a noticeable choroidal thinning. [59]

Edge R, Navon S. et al evaluated 371 men and 258 women with a mean age of 62.4± 15.7 years. Posterior staphyloma was found in 67 patients (10.7%). The presence of staphyloma was not significantly related to patient sex or age. Although the mean AL in eyes with staphyloma (27.43±2.36 mm) was significantly higher than in those without (23.18 ±1.64 mm), 9.3% of eyes without staphyloma had an axial length longer than 25.0 mm. No staphylomas were present in eyes with an axial length shorter than 23.3 mm. The highest value of axial length in an eye without a staphyloma was 32.5 mm.[60]

ANTERIOR CHAMBER DEPTH

It represents the distance between anterior surface of cornea to anterior surface of lens. The mean ACD of an adult emmetropic eye is 2.5-4 mm.[61] It is observed that depth of anterior chamber is not a stationary dimension; it can undergo rapid and transient change.[62] It is necessary to evaluate the depth of anterior chamber (AC). In a normal AC depth, the iris can be well lit by a lateral source of illumination. In a shallow AC, the iris will have a more medial shadow compared to normal or deep anterior chambers. The dilatation of pupil should be avoided in people with shallow AC because of the danger of advancing an attack of glaucoma. Adult people with small hypermetropic eyes are at a greater risk for development of a glaucoma attack owing to their shallow anterior chambers.

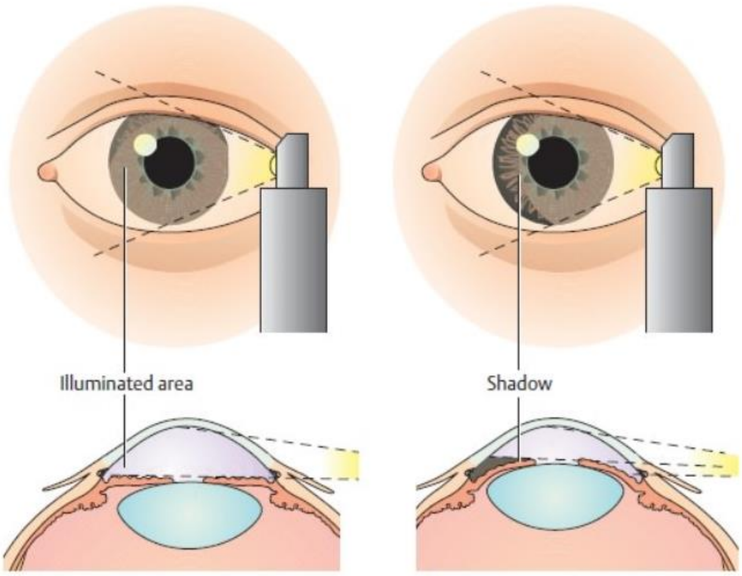


FIGURE 5 – TORCH LIGHT EXAMINATION FOR AC DEPTH

a) Normal anterior chamber depth : iris can be illuminated by a lateral light source

b) Shallow anterior chamber : a medial shadow is visible on iris.

The ACD is a measure of the axial location of the IOL (so-called Effective Lens Position, ELP) postoperatively. Position of IOL with respect to the refractive status of eye (effective lens position-ELP) is important in the final refractive outcome. Errors in calculation of effective lens position (ELP) may account for twenty to forty percent of the final refractive prediction error. This ELP was assumed same for all eyes and the manufacturers of IOL suggested values are often based on this.[61] IOL manufacturers published that ACD measurements are totally different from postoperative ACD measurements. Mean ACD values before operation which were estimated with PCI or raytracing methods, associated well with actual ACD values after operation. Recent formulae for IOL power estimation (Holladay, Hoffer Q and Haigis) aim to decrease this error by using further preoperative biometric values of the eye, i.e., central ACD, corneal diameter and the refractive error, thus making personalized ACD constants definite for surgeon, IOL and for each eye.[63]

METHODS TO MEASURE ACD

Different methods used for the calculation of central ACD are USG (applanation and immersion), partial coherence interferometry (PCI), scanning-slit topography and other less useful optical methods. Contact ultrasound is the most commonly used method presently. Ultrasound biometry with a transducer probe of around 10 MHz incorporates a resolution of around 200 to 300µm and a preciseness of 150µm. [64] The Orbscan II topography system (Orbtek Inc.), which works on scanning-slit method, primarily designed for corneal topography is one of the important tools in anterior segment biometry. This system is claimed to provide exact and reproducible calculation of ACD. PCI is now being accepted as the best way for ACD measurement. The Carl Zeiss' IOL Master is one of such devices. Anterior segment biometry with such devices has been described to possess high preciseness (5µm), high resolution (~12µm), and better reliability.[65]

DIFFERENCES AMONG VARIOUS METHODS

Auffarth compared Orbscan with immersion USG measurements of AC depth in eyes before cataract surgery and revealed a high connotation between the two methods. Vetrugno and others, used applanation ultrasound in their study, and reported a constant underestimation in the AC depth values with the Orbscan in relation with ultrasound. Whether the corneal thickness was included in the Orbscan measurement or not is not cited. A good comparison between three optical methods (Orbscan, Scheimpflug Imaging [Nidek EAS-1000], and optical pachymetry [Haag-Streit]) in measuring the ACD has been studied by Koranyi and his co-authors. This study compared the three common methods, i.e. scanning slit topography (Orbscan II), partial coherence interferometry (IOL Master) and contact ultrasound A-scan, with all calculations done by the same observer. Applanation ultrasound gave constantly lower measurements for AC depth in relation to Orbscan II and IOL Master. Even though a high degree of promise between Orbscan II and IOL Master was noted, further studies are required to evaluate the interchangeability of measurements in clinical practice.[66]

PITFALLS IN ACD MEASUREMENT

The anterior chamber depth (ACD) refers to the distance between the anterior surface of the cornea and the anterior surface of the lens which is an indicator of the axial position of the IOL (so-called ELP) postoperatively. Ultrasound measurements can be affected by several factors like operator's experience, the variations in handling of probe, alignment errors, etc. Higher intra- and interobserver variability in measurements with applanation ultrasound, higher chances of corneal abrasion and infections, and difficulty in rapidly sterilizing the contact probe to an adequate degree make non-contact optical devices a common alternative. However, sophisticated non-contact optical devices (like PCI) are costly. A more cost effective yet precise technique is immersion ultrasound. The central corneal thickness needs to subtracted from the value so that it is relatable with values obtained by PCI. Further studies are required to evaluate the interchangeability of measurements (obtained by various methods) in clinical practice. A constant audit of refractive outcome helps recognize any drawbacks in biometric measurements of the eye.

Effective Lens Position could predict that anterior deviation of the IOL can cause myopia, conversely causing hyperopia. Olsen found that 42% of Intraocular lens power calculation errors were caused by incorrect estimation of the postoperative AC depth, which means that considering AC depth into the calculation of the Intraocular lens power is probably an effective method to decrease postoperative errors.[67] Among the current formulas for calculation of IOL power, SRK/T only measures the AL and keratometry, while the newer formulas (such as Haigis, Olsen, Holladay 2) often takes into consideration the preoperative AC depth measurement, which is useful in envisaging the postoperative ELP and Refractive error.[68]

Cataract remains one of the major causes for loss of vision, and its incidence increases with increasing age. Cataract removal and IOL implantation is an effective treatment, and the one most frequently used. With the development in technology, the aim of surgery is not only to get back vision but also to have a vision which is clear and comfortable, which means letting patients to have a better refractive status and visual outcome.[69] Postoperative emmetropia is the important evaluating factor for patient satisfaction after cataract operation. The AC depth is a parameter that reflects the actual position of the IOL, which means that the prediction errors of the postoperative AC depth will cause myopia or hyperopia shift after cataract operation. Therefore, ACD plays an effective role in forecasting postoperative Refractive error post cataract surgery.[70]

One study showed that cataract operation increases the AC depth and that it tends to stabilize slowly 15 days after operation. The variation in the AC depth derived from cataract operation had an effect on refractive errors; hyperopic shift usually occurs when there was less change in ACD, and a myopic shift was relevant to a major change in AC depth. They conferred the variables that affect changes in the AC depth and concluded that the preoperative ACD and AL were corelated to variations in ACD and performed a correlation study of the postoperative eye and amount of change in ACD with some possible factors.[71] The postoperative refractive error was inversely related to post op variations in the AC depth and directly related with the axial length. In the same way, the postoperative variations in the AC depth were inversely related with the preoperative axial length and AC depth. They anticipated possible formulas for calculating the postoperative AC depth: "postoperative ACD = 3.524 + 0.294 × preoperative ACD and postoperative ACD = 3.361 + 0.228× (preoperative ACD + 1/2 LT)". [72]

ROLE OF ACD IN CATARACT SURGERY

One of the issues with phacoemulsification surgery is operating in the tight restrictions of the anterior segment of the eye. The volume of this working space is less than 1 cubic centimetre, with subtle ocular structures just millimetres away.

PRE-OPERATIVE EVALUATION

Before operation, the anterior chamber should be wisely examined under the slit lamp microscope as well as measured by biometry. A shallow AC can be seen in physiologically normal but small eyes with small Axial length and also even in smaller nanophthalmic eyes. In these eyes, lens measurements are accurately done with the Holladay 2 formula due to the anterior effective lens position.[73]

A shallow AC can be due to pathologic disease in the eye, like glaucoma. In narrow angle glaucoma, the AC is shallow due to the arrangement of the angle anatomy.[74] As cataracts develop, the axial diameter of the lens can increase, further shallowing the angle. In these eyes, cataract operation not only recovers vision, but it can also help to open the angle which can treat the glaucoma.

The disease process in which the zonules that hold the lens can become loose, allowing the lens-iris diaphragm to push the iris anterior and cause a shallow AC. Biometry of an eye with pseudoexfoliation, that shows a normal to long AL but a small ACD is a sign that the zonules will be mostly loose during cataract operation.[75]

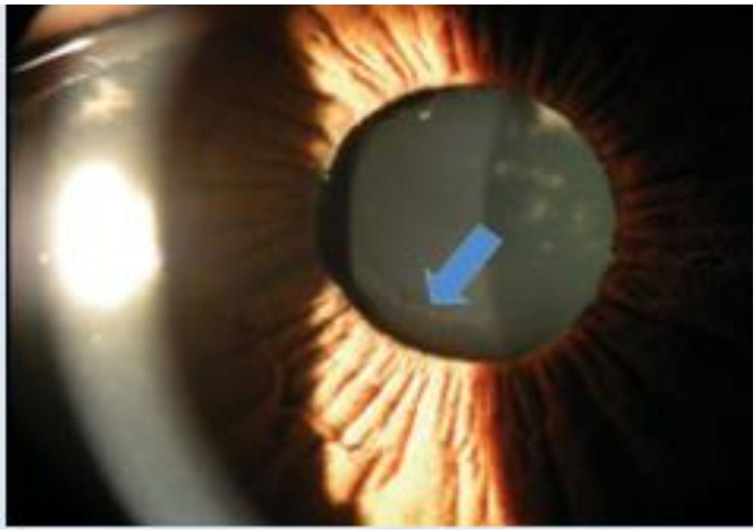


FIGURE 6 – PSEUDOEXFOLIATION MATERIAL IS SEEN ON THE ANTERIOR CAPSULE OF LENS IN AN EYE WITH A SHALLOW ANTERIOR CHAMBER.

A very deep AC is most often seen in large myopic eye having a longer AL. Even though it can offer additional space during phacoemulsification surgery, these eyes are supposed to have more elastic scleral tissue and are likely to an overly deep anterior chamber during operation. Increase in Anterior chamber depth is also seen in patients of trauma in which ocular structures such as the zonules, lens or angle of the AC can become damaged. Identification of the ocular trauma extent is helpful in formulating a suitable surgical plan.[76]

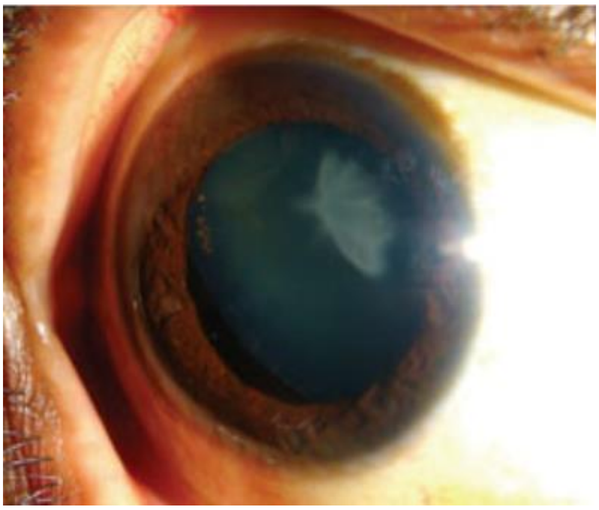


FIGURE 7 – EYE WITH AN EXCESSIVELY DEEP AC AND A TRAUMATIC CATARACT

As shown in the figure, eyes with deep AC should be carefully examined for damage to ocular structures. A breaking of zonules, causes the lens to be displaced posteriorly.

INTRAOPERATIVE MANAGEMENT

With a shallow AC, doing a capsulorhexis at the start of the cataract operation is not easy due to poor manoeuvrability and deficiency of making the anterior lens capsule flat. In most conditions, this can be managed by injecting viscoelastics at the time of surgery. Cohesive viscoelastics do a better job of making and preserving space. In such cases, strongly cohesive Ophthalmic viscosurgical devices such as Healon GV (1.4% sodium hyaluronate, Abbott Medical Optics) or viscoadaptive products such as Healon5 (2.3% sodium hyaluronate) are found to be the most effective options.

Rarely if the AC is very shallow, a limited anterior vitrectomy can be tried to remove volume from the vitreous cavity. This permits the anterior chamber to be further deepened during the time of operation but may pose further risks to the retina. Therefore, this method should be used carefully. [81] During phacoemulsification, the bottle height can be increased in order to raise the infusion pressure into the AC, thereby making it more deeper.[77]

In large myopic eyes with extremely large AC, bottle height can be reduced during operation. However, the common cause of the additionally deep AC in these eyes is a reverse pupillary block. The iris and anterior capsule of lens form a tight seal that avoids infusion fluid from equalizing with the posterior chamber. This can be fixed by breaking the reverse pupillary block via lifting the iris with the chopper or second instrument. A single nasal iris hook can be positioned in order to prevent an excessively deep AC for the entire time in a prolonged surgery.[78]

In eyes with pseudoexfoliation, an ACD lower than 2.5 mm was related with a risk of 13.4% for intraoperative complications compared with a total incidence of intraoperative complications of 6.9% and an incidence of 2.8% for an ACD of 2.5 mm or more. A small ACD may show weakness of zonules in eyes with pseudoexfoliation syndrome and should aware the surgeon.[79] While the working space within the Anterior segment is smaller, careful assessment and management of surgical indices can allow us to modify its size and operate safely.

The correlation between a shallow AC and primary angle closure glaucoma (PACG) is well noted.[80] The calculation of axial ACD may have potential in screening for PACG.[81] The requirement for public health services to contest PACG was emphasized by an approximation that almost half of the 67 million people suffering from primary glaucoma worldwide have Primary angle closure glaucoma. It has been calculated that 6.7 million people globally have been irreversibly lost their vision as an effect of glaucoma. Half of them are Asian, the majority being ethnic Chinese.[82]

A means of evaluating those at risk (patients with occludable drainage angles) is a form of a prevention program. If an effective test can be identified, PACG may meet the criteria for viable population screening.[83] Nd:YAG laser peripheral iridotomy (PI) possibly signifies effective and safe preventive treatment.[84]The most commonly used methods of ACD measurement in population-based study has been optical pachymetry and ultrasound biometry.[85]

In the Asian population, PACG is a common cause of vision loss.[86] Out of the ocular risk factors for PACG, shallow AC is the most sustained risk factor.[87,88] Gender, Race and age are seen as the important demographic factors for PACG and all of these factors are directly related to ACD.[89] Increasing in age results in increased lens thickness, hence shallow AC. Caucasians have AC deeper than Eskimo and Asian people.[90] In respective to sex, it is noted that in various races, males have deeper AC than females.[91] The causes of these include females' shorter stature and probably underlying genetic variation.[92] Various researches that are population based had shown that sex is self-sufficiently related with anterior chamber depth after the modification for height of the body (BH) according to multivariate linear regression.[93] However, an additional indices for the adjustment differed in these studies, which can probably affect the results of the regression analysis. Thus further studies are needed to clarify the association of anterior chamber depth with age, Body height and sex.[94]

Study done in 2013 in China determined that body height and age remained independent anthropometric, demographic correlating features of ACD but, sex wasn't. Shorter ones and aged people probably had shallower anterior chamber depth, and due to this they remained susceptible to PACG. The predictability of ACD by age and body height solely was low, and adding sex did not increase it.[95]

Al-Mubrad et al concluded that the Smith-method (Just Touch Slit Lamp method) could be used as a non-invasive, assessable, fast screening technique to recognize patients at risk of developing angle-closure, during routine evaluation of patients in the ophthalmology clinic, especially in primary eye-care centres, where sophisticated machines are not available.[96]

The creation of normal reference values for ACD is difficult due to the contributions of different variables. ACD is influenced by gender and inversely related with age, while the effect of refractive error has been inconsistent. ACD also is an inheritable trait which is affected by race. Using geography as a proxy for race, one can estimate differences in ACD across many regional studies globally. However, an organized study to evaluate normal ACD values and variation across various races and countries has not been done. Study done in 2011 studied 1077 eyes of 568 normal adult subjects from nine countries spanning six continents. ACD did not vary significantly between both eyes. Mean ACD for all eyes ranged from a less in New Zealand of 2.91 (2.83–2.98) mm to more in US of 3.24 (3.17–3.31) mm, with a collective mean of 3.11 (3.09–3.14) mm.[97]According to research done in Japan, the AC depth was significantly deeper in men (3.60 ± 0.28 mm) than in women (3.79 ± 0.25 mm).[98]

Study done in India concluded that environmental factors, nourishment and education does not play any significant role in the development of refractive error and so on axial length and anterior chamber depth. [99]

LENS THICKNESS

Lens is a biconvex, transparent, encapsulated, crystalline and avascular structure placed between iris and vitreous in patellar fossa. It divides eye into anterior and posterior segments. Its main function is to refract light with cornea and to provide accommodation.[91] It maintains its own clearity. It is composed of 64% water, 35 % proteins and 1 % of lipids, carbohydrates and other trace elements. Structurally it can be divided into capsule, epithelium and fibres.[100]

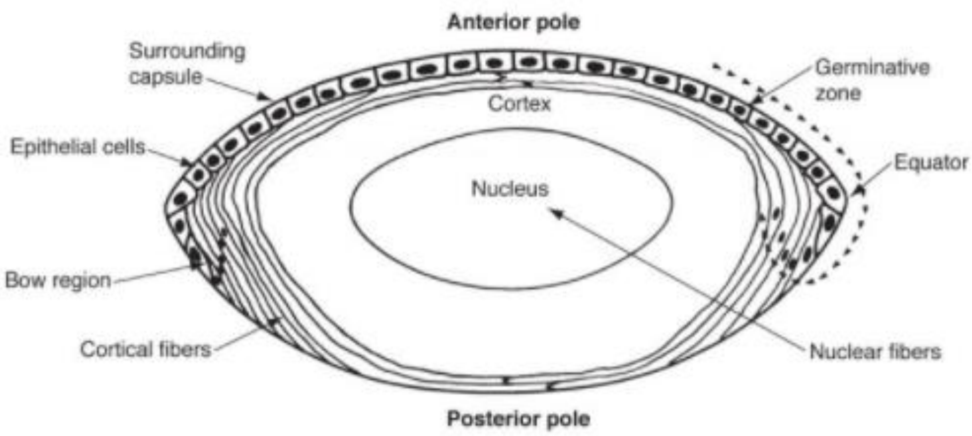


FIGURE 8 – LENS SHAPE AND STRUCTURE

Crystalline lens weighs about 65 mg at birth, the lens increases in weight to about 160 mg by 10 years of age at which time growth slows substantially so that it weighs about 250 mg at the age of 90.[101]

Lens thickness is measured as distance between anterior and posterior surface of lens, also called as antero-posterior diameter of lens. The human lens endures to generate new cells and grow throughout life. Several studies using ultrasound biometery, Scheimpflug photography, Partial Coherence Interferometry (PCI), and MRI have concluded that the lens thickness increases with the age.[102,103]

Lens thickness increases linearly by 13 to 29 μm/year after childhood.[104]

The range in lens thickness values reported in the literature are due not only to differences among individuals but also from the assumptions and limitations of the various techniques used. All *ex vivo* studies are limited by the dimension change and water content of the lens that occur within a few hours post-mortem.[105]

In vivo techniques such as Scheimpflug photography, ultrasound biometry and PCI depends on conventions of refractive indices or speed of sound through lens. Scheimflug photography is further compromised by the need to pharmacologically dilatation of the pupil. MRI allows imaging of the lens without distortion or pharmacological disruption, positioning of the subject in the prone position required for MRI may alter the natural movement of the lens, as it was demonstrated as the amplitude of accommodation is affected by head position.[106]

PCI offers extraordinary resolution of less than 10 μm and is widely used for measurements of axial length,but there are no commercially available PCI systems to measure lens thickness. Immersion ultrasound is habitually considered the best for ocular biometry, but it requires the subject to be in a supine position with an eye bath.[107]

"The Visante OCT (Carl Zeiss) was designed to provide quick, high resolution, cross-sectional images of cornea, anterior chamber. It is a commercial time-domain OCT system with a spatial resolution of less than 20. This technology does not need contact with the eye or dilation of pupil besides can also be altered to provide a variable accommodative stimulus.[108] " It is an accepted fact that the lens becomes thicker with advancement in age, as lens fibres are continually added over time.[109]

A few studies had mentioned that even after the globe length stabilizes in the second decade of life, there would be a continuous increase in thickness of lens of about 0.15–0.20 mm per decade.[110]

In other study, decrease in the lens thickness was noted specially in eyes with cortical and subcapsular opacities. According to a report, it was said that the lens thickness is increased as the axial length became shorter. [111]

It is suggested that cataractous and even clear lenses thicken with age. From age 70 years onwards, the changes caused by a cataract or clear lens usually have no effect on the change in thickness of the lens. Similar observations were observed in one study with a significant positive trend in lens thickness in all types of cataract after correcting for age. There was a significant variance in LT among clear lens, cortical cataract and PSC. In 'Beaver Dam Eye Study', cataractous lens thickness was found to be less as compared to clear lenses. [111]

In other studies also similar conclusion was given on the mean thickness of the lens in patients with cortical cataract or posterior subcapsular cataract, it was found that cataractous lens thickness was remarkably lesser than that in age-matched controls with clear lens .[112]

"Goldman and Favre concluded in their study that lens individuals with cortical cataract had lesser lens thickness when compared to clear lenses. The reverse relationship between LT and cortical cataract is supposed to be due to decrease in the formation of normal cortical fibres, causing a decreased thickness in cortical cataract."[113]

A study concluded, this difference in lens thickness was due to less fibre formation, less protein synthesis in those with senile cataracts. Other studies also found that cataract lenses are absolutely thinner than clear lenses. [114]The difference in LT between PSC and clear lenses was found significantly more whereas the difference in LT between clear lenses and nuclear cataract was not much. [115]

Lens thickness as a biometry parameter is usually not used clinically in assessing the presence or absence of cataract. Cataractogenesis depends on multiple factors and latency period of the time from the beginning of cataract and to the time of its first clinical symptom is not properly defined in literature.[111] Therefore lens thickness can also be used as a probable sign to the latency period. Due to the direct association between age and LT, it is possible to compare the LT of a given individual with the expected thickness for the age. If there are various variations in the anterior segment due to any injuries, inflammation, or previous cornea surgeries, prediction of axial length is difficult where former biometry is not accessible. Lens thickness and depth of vitreous chamber helps in predicting Axial length in such eyes, when planning for penetrating keratoplasty.[116]

One study concluded that after adjustment of all the parameters, the lens thickness is suggestively more in the eyes with clear lens if compared with isolated cataract types. In human cataractous eyes, lens thickness was highest with nuclear type of cataract and lowest values were seen with posterior subcapsular cataract. Age was strongly associated with LT for all three cataract types and clear lenses. Increase in the Axial length affected the decrease in lens thickness among cataractous lens and also in clear lenses. A significant reduction in ACD was related to increase in lens thickness irrespective of lens status.[117]

The association of LT with CCT agrees with other reports, suggesting that the thicker lens may correspond with a thicker cornea. A negative correlation between LT and ACD was also noted.[118] With the progression of cataract, the lens tends to thicken both anteriorly and posteriorly, that results in a shallower anterior chamber.[119]

Due to this correlation, IOL formula bias can be expected when the preoperative ACD is used alone rather than in combination with the Lens thickness, however the statistical correlation between the preoperative Anterior chamber depth and the postoperative position of the IOL has been widely established.[120]

“Another interesting observation is the positive correlation between LT and White To White (WTW). In clinical practice, the WTW can provide supportive evidence for capsular bag sizes since measuring the capsular bag size is difficult due to the lack of convenient measurement devices. Large WTW may be related with the growth of larger anterior segments, which also indicates the mismatch between fixed-size IOLs and large capsular bags, which further affects IOL stability". In cataract patients with a thicker lens, the IOL should be also chosen with caution. The relationship between LT and corneal curvature have also been studied, which may provide a clue to the role of thickness of lens in the anatomy of anterior segment.[121]

Distribution of LT in dependence of Axial length is not simply linear in all studies. For short eyes, the correlation between LT and AL is positive but weak, may be because of the development of lens which could either be normal or abnormal in the early stages of these eyes. [122]

Moderate myopic eyes are supposed to have thinner lenses than emmetropic eyes. The thinning of lens in myopic eyes can be a sign of lens trying to control overall refractive status towards emmetropia or achieve a clear image on the retina.[123]

In myopic eyes with $AL \leq 26$ mm, the LT increases with increase in AL , though further studies are required to identify whether the increase of LT is related with the global expansion of highly myopic eyes or resulted from metabolic changes in the lens.[124]Nonlinear change of LT with AL may, to some extent, contribute to the prediction errors of the previous formulas that did not include LT.[125]

The impact of thickness of lens on IOL calculation has been confirmed in various studies. Hyperopic shift is related with a thicker lens, while a myopic shift is related with a thin lens, especially for the Haigis formula which did not include Lens thickness.[126,127]

Even for other Intra ocular lens calculation formulas that included Lens thickness, the effect of Lens thickness on refractive error is diversed with different Axial Length, with the greatest effect seen in eyes having Axial length less than 22 mm.[128]

There is a positive relation between LT and postoperative Intra ocular lens position. The nonlinear change of LT with the AL of eye ball may account for some bias in intraocular lens power calculation for short or long eyes, and the regression models for predicting IOL position in normal eyes may not fit in the eyes with extreme Axial lengths.[129] Although the choice of Intra ocular lens power formulas in short or long eyes has been given much attention, the contribution of Lens thickness to the bias of IOL power calculation is not recognised. Studies concluded that Lens thickness may be a important variable to be measured during IOL calculation in short or long eyes. The individualized selection of IOL formulas and optimization of the formula coefficient or constant may be needed to reduce prediction bias.[130]

Based on a large sample of Chinese cataractous population, thicker lens was found to be associated in older age, the male gender, thicker central cornea, shallower Anterior chamber depth, larger white to white, and flatter anterior corneal curvature. The dispersion of Lens thickness against Axial length is not simply linear, with the thickest lens seen in eyes with AL ranging 20.01–22 mm and thinnest lens in eyes with AL ranging 26.01–28 mm. Future study is needed to analyse the refractive prediction error of different IOL formulas using preoperative LT in eyes with very thick or thin lenses and short or long AL.[131]

The main outcome from the study of changes in lens thickness over 11 years of myopia progression and stabilization in the COMET cohort was that the outline of lens thinning which was followed by thickening was the same in all individuals irrespective of myopia progression.[132]

For the overall cohort, the lens thickness was noted to be least at an average age of 11.56 years and then subsequently it increased. Study also showed that the minimum lens thickness in each child was not correlated with the amount of myopia . These conclusions propose that changes in LT is not related to the course of myopia, but instead it changes with the age.[132]

Study done by Wong et al. showed a two phase process in growth of the lens in all refractive groups, lens thinning was noted in the early school years, reaching a minimum thickness at 10 years in myopes, and after 10 years it gets thicker. [133]But in a study children were followed until the age of 12 years only. Cross-sectional data by Shih et al. concluded that the lens thinning was noted till age of 11 years in myopes and then lens became thicker, but limitation of study was the lack of longitudinal data.[134]

A common finding seen in various studies is that eyes of myopic children first showed a pattern of thinning of lens , with the lens reaching its thinnest value between 10 and 11.5 years of age, followed by thickening up to the age of 18 years, after which it is studied that the lens continues to thicken from the age of 18 to 75 years.[135,136]

Various studies have shown that with increase in the age before the development of nuclear cataract, emmetropia in the adult is mostly maintained in spite of continuing lens growth with increasing thickness of lens and increasing curvature of lens .[137,138] This phenomenon is also called as the lens paradox, which was suggested to be due to changes in the refractive index (RI) of lens, due to refractive index differences between lens nucleus and lens cortex, or due to gradient changes within the cortex of lens.[139]

PACG is a significant cause of blindness all over the world, and a main type of glaucoma among Asians.[140] Geographic or Ethnic differences in the prevalence of primary angle closure glaucoma are known well, with a comparatively high prevalence rates in Chinese, Singaporean Chinese and Mongolian.[141]The influencing factors for PACG are widely correlated to the configuration of AS anatomy of the eye. Biometric studies have found that Acute PACG eyes have shallower AC and shorter AL.[142]

Therefore, it is suggested that smaller biometry of eye is a risk factor for APACG. There can be other anatomical factors that are significantly triggering the acute attack. It is also suggested that the absolute size and position of lens have a major role in the pathogenesis of angle closure. [143] With the increase in age, thickness of lens is increased, and a more anterior lens position (LP). In eyes of hyperopic patients with smaller AS, resulting is congested angle and a greater tendency to pupillary block due to apposition of iris and lens. Therefore, primary lens extraction, which deepens the AC and widen chamber angle, can be done for PAC management.[144]

Biometric parameters of eye can be influenced by race, ethnicity, and genetics; the difference across the different populations can probably explain differences in the refractive errors in these populations. According to a study done in India mean lens thickness among age group 25 to 40 years was noted to be 3.99±0.33.[117]

Saxena S et al conducted a study on ACD and LT in PACG. In a tertiary care centre, a case-control based study, mean (+/- S.D.) ACD and LT in the cases and the controls were noted to be 2.28 +/- 0.19, 2.87 +/- 0.10; 4.57 +/- 0.34 and 4.13 +/- 0.19 mm respectively.[145]

A-SCAN BIOMETRY

A-scan ultrasound biometry, commonly referred as A-scan (short for Amplitude scan), is type of diagnostic test widely used in optometry and ophthalmology. The A-scan delivers data on the length of eye, which is a key factor for common sight disorders and required for calculation of IOL power before cataract surgery.

In ophthalmology, the frequency used in A-scan and B-scan ultrasound probes are of around 10 MHz. This high frequency permits for not only restricted depth of penetration of the sound into the body but also excellent resolution of small structures. This meets unique needs, because the probe is placed directly on the eye, and its structures are quite small, demanding excellent resolution. [146]

In 1956, A-scan was used first to demonstrate various ocular diseases by Mundt and Hughes. Basic principles of ultrasound i.e. Pulse Echo Technique was first described by Oklasa et al. In 1960, Jansson and associates in Sweden used ultrasound to find the distance between structures in eyes. In 1972 first commercially available immersion B scan instrument was made and refined techniques for measuring Axial length, depth of AC and thickness of lens.[147]

PRINCIPLE OF A-SCAN

The mechanism applied in functioning of Amplitude Scan is "Time Amplitude Recording" in which echoes received from the various ocular interfaces appear as a graph on screen. Time taken for the waves of ultrasound from the transducer through the eye to the reflecting interfaces and then back again to the transducer is measured. The peaks represent the reflections from various ocular interfaces and time taken by ultrasound wave to pass between interfaces is represented by the linear distance between the peaks.[148]

In A-scan ultrasound biometry, a crystal oscillates to create a high-frequency wave of sound that penetrates into the eye. When this sound wave encounters a media interface, part of the sound wave is reflected back toward the probe.[149] These echoes allow us to assess the distance between the probe and various structures in eye. The resolution of wavelength-based measurement is inversely proportional to the wavelength of the measuring device being used.

Elapsed time is represented by the horizontal axis, nearer objects give earlier spikes and far away interfaces give later spikes. The time taken is a measure of the distance and these instruments have inbuilt calibration for the same. Y Axis represents amplitude of the spike and the strength of echo. Reflectivity is maximum when the beam is perpendicular to the interface.[148]

The determination of intraocular distances thus depends on the speed of ultrasound wave in various medias of the eye.

MEDIUM	VELOCITY (Meter/second)
Water	1480
Cornea	1550
Aqueous / Vitreous	1532
Silicone lens	1486
Crystalline lens	1641
PMMA lens	2718
Silicone oil	986
Soft Tissue	1550
Bone	3500

TABLE 1 - ULTRASOUND WAVE VELOCITIES THROUGH VARIOUS MEDIA

A-SCAN BIOMETRY INSTRUMENTATION

A wide variety of A-scan equipments are available. Some intruments are specifically dedicated for measurement of axial length i.e. Biometers whereas others have capabilities for both diagnostic and biometric examinations.

Basic features of biometry instrumentation

- **i.** Screen display
- **ii.** Contact and immersion capabilities
- **iii.** Choice of average or individual sound velocity settings
- **iv.** Measuring gates
- **v.** Numeric values displayed for axial length , anterior chamber depth , lens thickness and vitreous chamber depth with standard deviation of AL.

Documentation of measurements is important and therefore newer biometers offer option of a printer attached with it. Also, recent biometers are programmed with variety of formulas for facilitating IOL power calculation.

INSTRUMENT SETTING includes measurement mode which can be manual or automatic , eye type , position of electronic gates or cursors and gain.

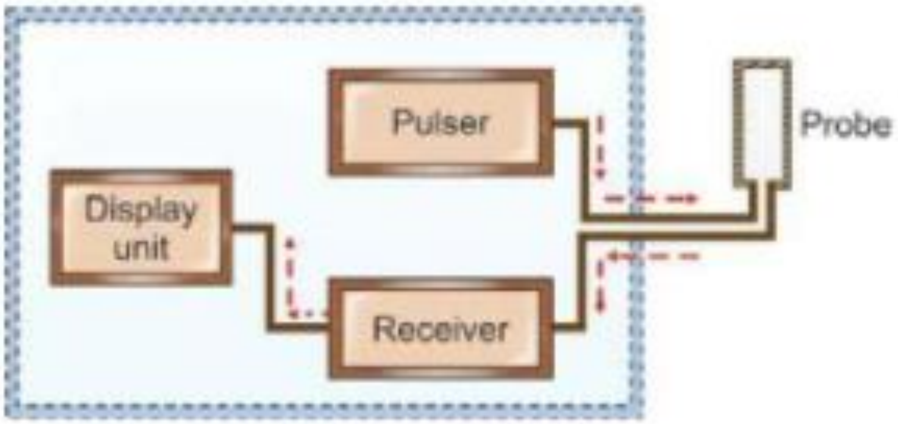


FIGURE 9 – INSTRUMENTATION OF ULTRASOUND BIOMETRY

GAIN SETTING

Gain is defined as degree of echo amplification in an ultrasound system. The adjustable gain setting controls the effective sound beam width sensitivity, resolution and depth of penetration. Errors can occur if gain is too high or too low. [150]

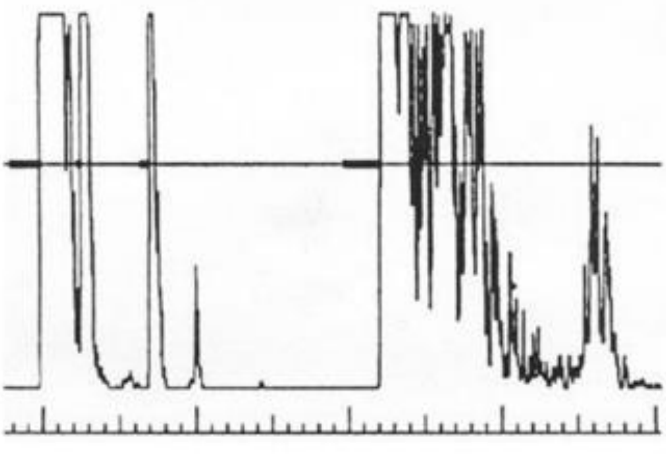


FIGURE 10- TOO HIGH GAIN SETTING RESULTING IN LOSS OF SEPARATE SCLERAL AND RETINAL SPIKES

Two types of instruments:

1. Instruments with rigid probe tips
2. Instruments with distensible tips or with water baths.

Those instruments with distensible membranes on the front of the probe are approximately 5 percent more accurate in making measurements than those with the rigid tip.

The explanations why the distensible tip is better are as follows:

- The distensible tip prevents indenting the cornea when the measurement is done, and does not cause the eye to appear artificially shortened. A rigid tip cause corneal indentation between 0.1 and 0.3 mm, resulting in error from 0.3 to 1.0 Diopters.
- The distensible tip helps to separate the signal from the corneal reflection sent out from the front surface of the transducer, i.e. it makes it more exact to determine where the front surface of the cornea is, and when it is not in direct contact with the transducer.[151]

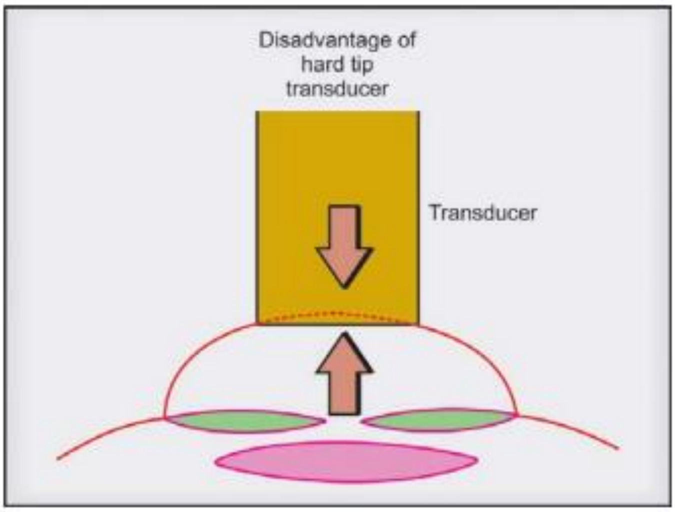


FIGURE 11- DISADVANTAGE OF HARD TIP TRANSDUCER— NOTE INDENTATION ON THE CORNEA.

TECHNIQUES OF A-SCAN BIOMETRY-

- **A.** Contact technique
- **B.** Immersion technique

CONTACT TECHNIQUE

In contact technique, probe is gently placed on the center of cornea after instillation of topical anaesthetic eye drops and the sound beam is directed towards the macula. This technique can be performed either by placing probe in chin rest device (applanation method) or by holding probe in hand (hand held method).

Steps should always be taken to minimize corneal abrasion and compression. This can be done by taking measurement as soon as probe touches center of cornea. After removing probe, patient is asked to blink a few times to keep the cornea moist. This on and off procedure is repeated few times till 3 quality readings are obtained.

SOURCES OF ERROR IN CONTACT METHOD

- Corneal compression
- Fluid meniscus between probe and cornea
- Misalignment of sound beam

  Most common potential error with contact technique is corneal compression which results in shortening of axial length. To minimize this error a gentle on and off technique is recommended. It is studied that it is more difficult to control compression when using hand held technique than when using applanation method. Significant compression can be usually detected by monitoring anterior chamber depth and by viewing cornea from the side. When cornea is indented, anterior chamber depth decreases which indicates compression.

A fluid meniscus trapped between tip of the probe and the cornea may result in a falsely long reading. This can even occur with a small drop of fluid retained on probe or if there is unusually thicker tear film.Other important sources of error include improper gate position and incorrect eye type setting. [152]

FIGURE 12 – HAND HELD A-SCAN BIOMETRY AND A-SCAN BIOMETRY PROBE

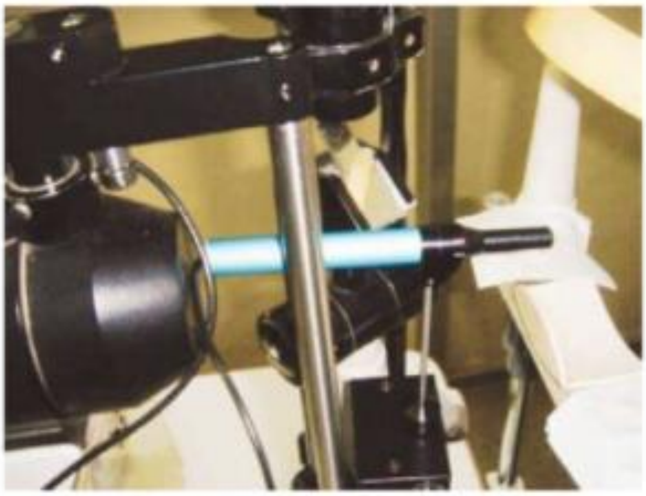


FIGURE 13 – APPLANATION TYPE OF A-SCAN BIOMETRY

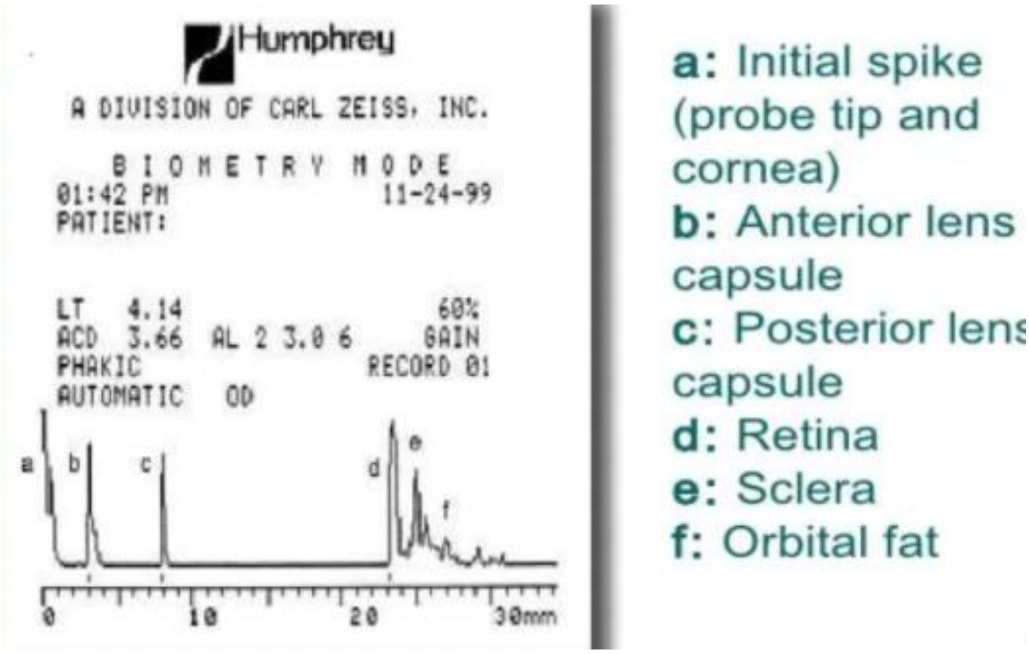


FIGURE 14 – ECHOGRAM OF CONTACT A-SCAN BIOMETRY

IMMERSION TECHNIQUE

- With the immersion A-scan technique, the probe tip does not come into contact with the cornea.
- The ultrasound beam is coupled to the eye through fluid. Because there is no corneal compression, the displayed result more closely represents the true axial length.

The immersion technique requires the use of a Prager Scleral Shell or a set of Ossoinig or Hansen Scleral Shells.

The patient lies supine, looking up at the ceiling and the scleral shell is placed between the eyelids and centered over the cornea. The scleral shell is then filled with a 40-60 mixture of Goniosol and Dacriose and the probe tip is placed into the solution. Align the ultrasound beam with the macula by having the patient look at the probe tip fixation light, then readings are taken.[152]

FIGURE 15 – SCLERAL SHELLS

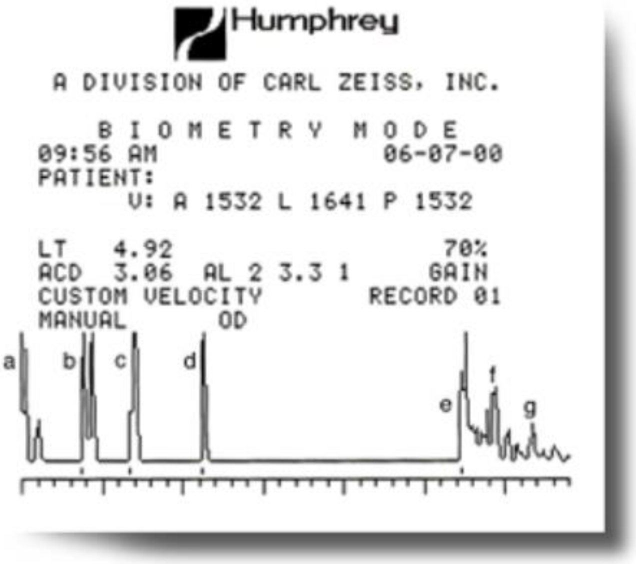


FIGURE 16- BREAK-DOWN OF PHAKIC AXIAL LENGTH MEASUREMENTS USING THE IMMERSION TECHNIQUE.

a: Probe tip. Echo from tip of probe, now moved away from the cornea and has become visible.

b: Cornea. Double-peaked echo will show both the anterior and posterior surfaces.

c: Anterior lens capsule.

d: Posterior lens capsule.

e: Retina. This echo needs to have sharp 90 degree take-off from the baseline.

f: Sclera.

g: Orbital fat

POTENTIAL SOURCES OF ERROR WITH IMMERSION TECHNIQUE

The primary source of error with the immersion technique is presence of small air bubbles within the fluid between the probe and cornea. These bubbles can result in display of additional spikes in the echogram to the left of the corneal spike. Misinterpretation of one of these spikes as corneal spike can result in falsely long measurement. This error can be avoided by identifying double peaked corneal spike. If too many bubbles are present or if a bubble is persistently adherent to surface of cornea , it may be necessary to remove and reapply the scleral shell . Other source of error includes improper gate and selection of inappropriate eye type setting.

CONTACT TECHNIQUE	IMMERSION TECHNIQUE
Patient is in more comfortable sitting position	Patient is in supine or reclining position
Variability from one test to next is present due to inconsistent corneal compression	No variability
Probe is directly in contact with cornea	Probe tip is placed in solution in scleral shell
Single corneal spike in echogram	Double corneal spike
Axial length measured is shorter by an average of 0.24mm	Axial length measured is closer to true value

TABLE 2 – DIFFERENCES BETWEEN CONTACT AND IMMERSION TECHNIQUE

Most common use of A-scan is to calculate the length of the eye for calculation of IOL power. Briefly, the total power of the emmetropic eye is approximately 60 D. Of this power, the cornea provides roughly 40 D, and the crystalline lens 20 D. When a cataractous lens is removed, it is replaced by an artificial lens implant. By measuring both the AL of the eye (A-scan) and power of the cornea (keratometry), a simple formula can be used to calculate the power of an IOL needed.[153]There are several different formulas can be used depending on the actual characteristics of an eye. This is often termed quantitative A-scan. Variations in AL measurement have a significant impact on the final calculated Intraocular lens power. The other major use of the A-scan is to calculate the size and ultrasound characteristics of masses in eye, in order to determine the type of mass.[154]

Currently, the axial length can be obtained by using either the A-scan ultra sound or the partial coherence laser interferometer.

NON-CONTACT OPTICAL BIOMETRY

Recent developments in the biomedical field have led the availability of novel devices, such as the laser partial coherence interferometry (PCI) and the low-coherence optical reflectometry (LCOR). A-mode ultrasound biometry had been considered the gold standard for AL and ACD measurement. The PCI-based IOL Master (Carl Zeiss Meditec AG, Jena, Germany) was introduced in 1999.

More recently, a new biometry device, the Lenstar LS 900 (Haag Streit AG, Bern, Switzerland) using LCOR technology was introduced in 2008. Given the heightened patient expectations, it is of utmost importance to accurately predict the correct IOL power. The recent technological developments have stimulated continuous modifications in biometry.

Optical biometry for accurate assessment of the AL is increasingly becoming popular, as it is rapid, easy to use, and a contact-free method. The PCI-based IOL Master uses a 780 nm laser diode infrared light to measure AL. The ACD is measured through a lateral slit-illumination with this device, and the anterior corneal curvature is calculated at 6 reference points in a hexagonal pattern at approximately the 2.3 mm optical zone. The new Lenstar LS 900 is

LCOR-based and uses a 820 nm super luminescent diode. In addition to AL, it measures central corneal thickness (CCT), as well as LT. ACD measurements differ between the IOL Master and the Lenstar, as Lenstar measures ACD from the corneal endothelium to the anterior lens surface while IOL Master measures ACD from corneal epithelium to the anterior lens surface. The Lenstar also measures crystalline LT and retinal thickness, as well as the size and centricity of the pupil. K readings are calculated by analyzing the anterior corneal curvature at 32 reference points orientated in 2 circles at approximately the 2.30 mm and 1.65 mm optical zones. These IOL Master and Lenstar LS 900 are in good agreement in terms of mean AL, ACD, and K readings.[155]

The main limitation with the A-scan is poor image resolution due to the use of comparatively a long, low-resolution wavelength(10MHz) to measure a relatively short distance. In addition, variations in retinal thickness surrounding the fovea contribute to inconsistency in the final measurement.

Ultrasound biometry (A-Scan) and partial coherence interferometer (PCI)- based devices are the most commonly used methods for determining IOL power. Previous comparisons of ultrasound biometry and optical biometry reported equal or better results with optical biometry.[156] However, ultrasound biometry remains the preferred method of calculating the AL in the most practices, especially in dense ocular media”

The LT is currently not measured on the IOL Master, but can be obtained using the immersion A-scan. A prospective study done by Fouad R. Nakhli, to observe the relationship between optical biometry and applanation ultrasound measurement of the AL of the eye among 55 cataract patients. The study showed that there was strong repeatability (99.4%) and agreement between both devices; the difference between devices was mainly in short eyes.[156]

The Holladay1, Hoffer Q, and SRK/T are third generation theoretical IOL power calculation formulas. They are two-variable formulas that mainly differ in the way they calculate the final position of the IOL. Their main limitations include making assumptions based upon normal schematic eye parameters that may not apply to all eyes, and predicting the final position of the Intraocular lens based solely on AL and central corneal power.[157]

The Haigis-L formula represents a significant improvement over other two variable formulas. It uses three IOL and surgeon-specific constants and a measured ACD to alter and more accurately find the shape and the position of the IOL power prediction curve. The main limitation of Haigis formula is that the three A constants must be derived by regression analysis based on surgeon-specific data of a large number of cases (n>50) containing a wide range of axial lengths. Haigis-L formula is included as part of IOL Master standard software package.[158]

The Holladay 2 formula, available since 1998, is the most accurate theoretical formulas that are currently available. The formula is easy to optimize and works well across a wide range of axial lengths; however, it requires input of seven variables to guess the effective lens position, including the AL, average K, LT, horizontal white to- white corneal diameter, ACD, preoperative refraction and age of patient. [159]

A study was done by Yasin Çinar, Abdullah et al to compare the measurements of optical versus ultrasonic biometry devices in keratoconus patients. The study showed that Lenstar measured CCT , LT and AL thinner than US biometer, whereas it measured ACD deeper than Ultrasound biometer in keratoconic eyes.[160]

In a study done by Mana Tehrani, Frank Krummenauer, Rajiv Kumar, et al to compare and contrast AL measurements assessed by ultrasound biometry and optical biometry among 360 eyes, optical biometry resulted in a median difference of 0.14 mm ,a statistically significant longer AL measurement than with ultrasound . Study showed that optical biometry and ultrasound applanation biometry give statistically significant differences in AL measurement in patients with cataract and even in normal lens.[161]

Gursoy, Afsun Sahin, et al compared the CCT, AL, ACD and LT measured with Lenstar with those obtained with ultrasound pachymetry and A-scan contact ultrasound among 565 children. Mean difference between pachymetry and Lenstar was 13.20 + 13.13 µm. Mean difference between A-scan and Lenstar was - 0.72 + 0.35 mm for AL, - 0.27 + 0.32 mm , for ACD, and 0.24 + 0.28 mm for LT. They concluded that axial length and AC depth were found to be greater with Lenstar, whereas CCT and LT measures were smaller.[162]

In a study done by HM Hussin, PGD Spry, MA Majid and P Gouws to assess the repeatability and validity of PCI (IOL Master) and A-scan ultrasound measurement of AL in children. The mean test–retest difference for A-scan was considerably larger than IOL Master at 0.042 and 0.004mm, respectively. They concluded that IOL Master was more accurate and reproducible than the contact ultrasonographic technique when used in children. Such results indicate that IOL Master may be a useful tool in studies like growth of an eye and refractive development in Children.[163]

MATERIAL & METHODS

MATERIALS AND METHODS

SOURCE OF DATA:

Patients visiting Ophthalmology outpatient department at R.L. JALAPPA HOSPITAL AND RESEARCH CENTRE,TAMAKA, KOLAR attached to SRI DEVARAJ URS MEDICAL COLLEGE for routine check-up or refraction.

STUDY DURATION: 18 Months (December 2019 to May 2021)

SAMPLE SIZE: 192 eyes (96 in Group A -Males and 96 in Group B- Females)

STUDY DESIGN: Cross sectional comparative study

INCLUSION CRITERIA:

All individuals aged more than 18 years who visited Ophthalmology OPD for routine eye check-up or refraction.

EXCLUSION CRITERIA:

1. Patients with ocular abnormalities like corneal diseases, uveitis, cataract, glaucoma, high refractive error will be excluded after examination.
2. Previous history of ocular trauma or ocular surgery
3. Patients with Diabetes mellitus.
4. Patients on long standing oral or topical medication for any systemic or ocular disease.
5. Patients not willing to participate.

METHODOLOGY

This study included 192 eyes grouped into two based on the gender (96 in each group: Group A-males & group B- females). After obtaining the approval from Institutional ethics committee, a written informed consent (ANNEXURE III) was obtained from all the participants fulfilling the inclusion criteria.

The demographic details were noted & then patients were subjected to detailed ophthalmic examination as follows: (ANNEXURE I)

- ✔ Distant Visual Acuity by Snellen's.
- ✔ Near vision
- ✔ Anterior segment examination by Slit Lamp Biomicroscopy
- ✔ Estimation of axial length, anterior chamber depth, lens thickness by A-scan biometry using hand held contact technique (mean value of the three best readings was taken).
- ✔ Assessment of intraocular pressure using Goldmann Applanation tonometer
- ✔ Gonioscopy – whenever indicated
- ✔ Fundus examination by indirect Ophthalmoscopy

SAMPLE SIZE ESTIMATION

Formula used:

$$n_1 = \frac{(\sigma_1^2 + \sigma_2^2 / \kappa)(z_{1-\alpha/2} + z_{1-\beta})^2}{\Delta^2}$$

$$n_2 = \frac{(\kappa * \sigma_1^2 + \sigma_2^2)(z_{1-\alpha/2} + z_{1-\beta})^2}{\Delta^2}$$

The notation for the formulae are:

η_1 = Sample size of group A

η_2 = Sample size of group A

σ_1 = Standard deviation of group A

σ_2 = Standard deviation of group B

Δ = Difference in group means

κ= ratio = $\eta_{2/}\ \eta_1$

$Z_{1-\alpha/2}$ = Two sided Z value (eg. Z=1.96 for 95% Confidence interval)

$Z_{1-\beta}$ = Power

Sample size is calculated by open epi application using mean values and standard deviation of axial length from a study on sex related differences in axial length , anterior chamber depth and lens thickness in young healthy eyes by Takehiro Yamashita et al.[23]

SAMPLE SIZE FOR COMPARING TWO MEANS			
Input Data			
Confidence interval (2 -sided)			95%
Power			80%
Ratio of sample size (Group 2/Group 1)			1
	Group 1	**Group 2**	**Difference**
Mean	25.11	25.7	-0.59
Standard deviation	1.48	1.38	
Variance	2.1904	1.9044	
Sample size of group A			96
Sample size of group B			96
Total sample size			192
*Difference between the means			

STATISTICAL METHODS USED FOR STUDY

Data was coded and entered into excel sheet. All quantitative measures was presented by mean and SD. Qualitative or categorical data is represented by frequency and percentage. Difference in proportions was compared by Chi Square (Bar- Fischer Exact Test). Mean comparison between values of ocular parameters was done by using t-test or Mann Whitney U test. A P-value =/< 0.05 was considered as statistically significant.

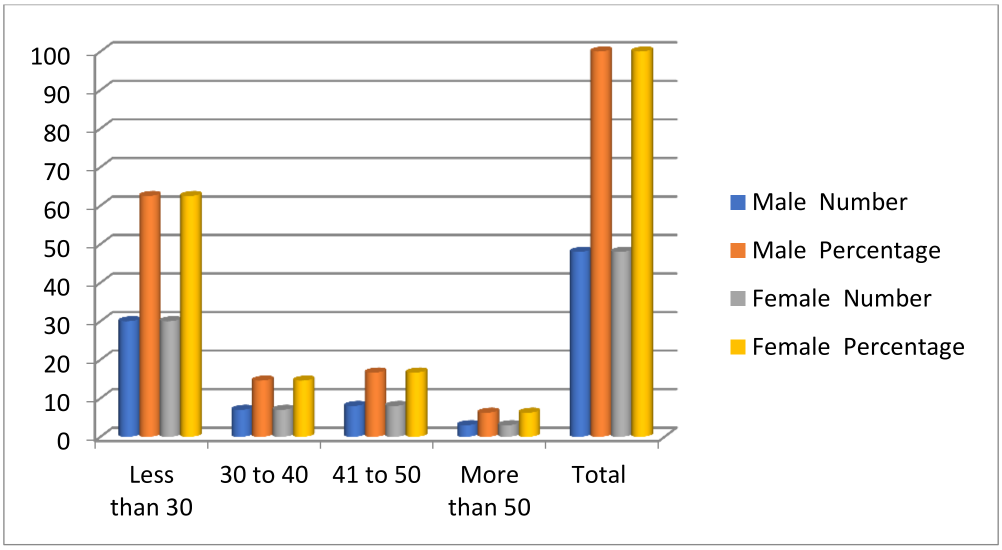
RESULTS

RESULTS

The present study was undertaken for documenting gender differences in lens thickness, axial length and anterior chamber depth among age matched adults. A total of 192 eyes of 48 males and 48 females were enrolled. Following results were obtained:

Table 3: Age-wise distribution of patients

Age group (years)	Male		Female	
	Number	Percentage	Number	Percentage
Less than 30	30	62.50	30	62.50
30 to 40	7	14.58	7	14.58
41 to 50	8	16.67	8	16.67
More than 50	3	6.25	3	6.25
Total	48	100	48	100
Mean ± SD	**31.48 ± 9.67**		**31.95 ± 9.62**	



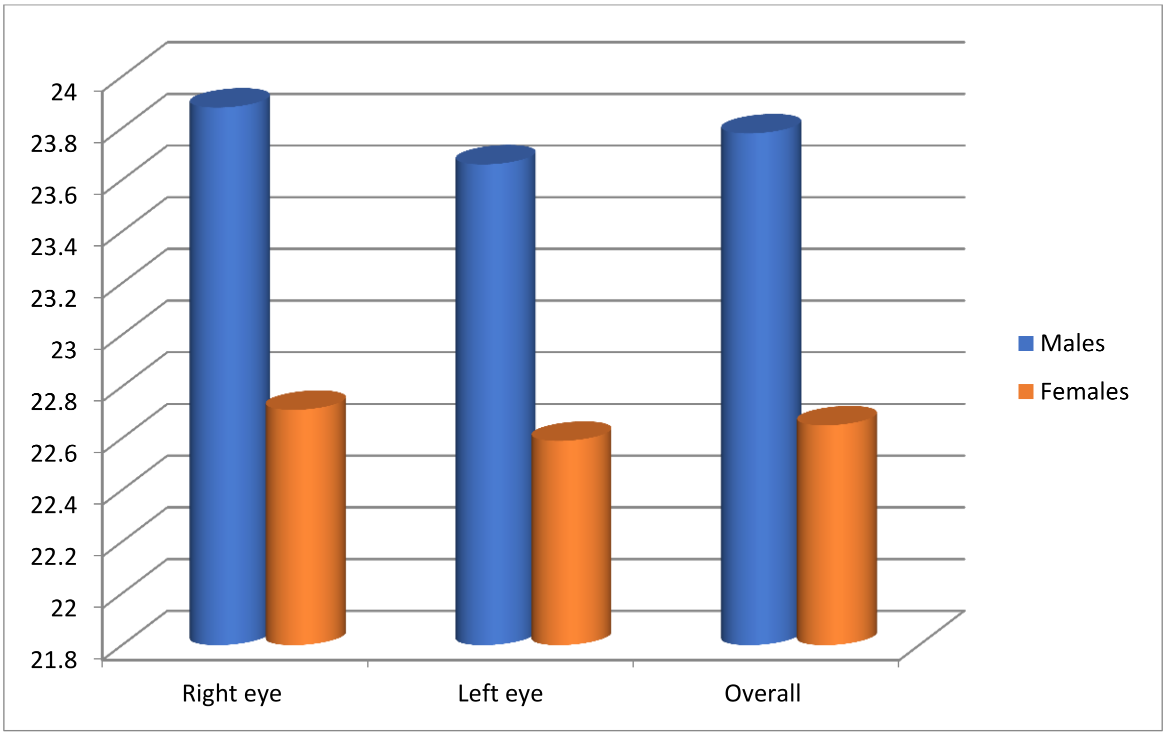
Graph 1: Age-wise distribution of patients

Out of 48 males, 62.50 percent of the subjects belonged to the age group of less than 30 years while 16.67 percent and 14.58 percent of the subjects belonged to the age group of 41 to 50 years and 30 to 40 years respectively. Out of 48 females, 62.50 percent of the subjects belonged to the age group of less than 30 years while 16.67 percent and 14.58 percent of the subjects belonged to the age group of 41 to 50 years and 30 to 40 years respectively. Mean age of the male and female subjects was 31.48 years and 31.95 years respectively.

Table 4: Comparison of axial length among males and females

Axial length (mm)		Males	Females	p-value
Right eye	Mean	23.88	22.71	P < 0.0001*
	SD	0.84	0.98	
Left eye	Mean	23.66	22.59	P < 0.0001*
	SD	0.78	0.93	
Overall	Mean	23.78	22.65	P < 0.0001*
	SD	0.84	0.95	

*: Significant



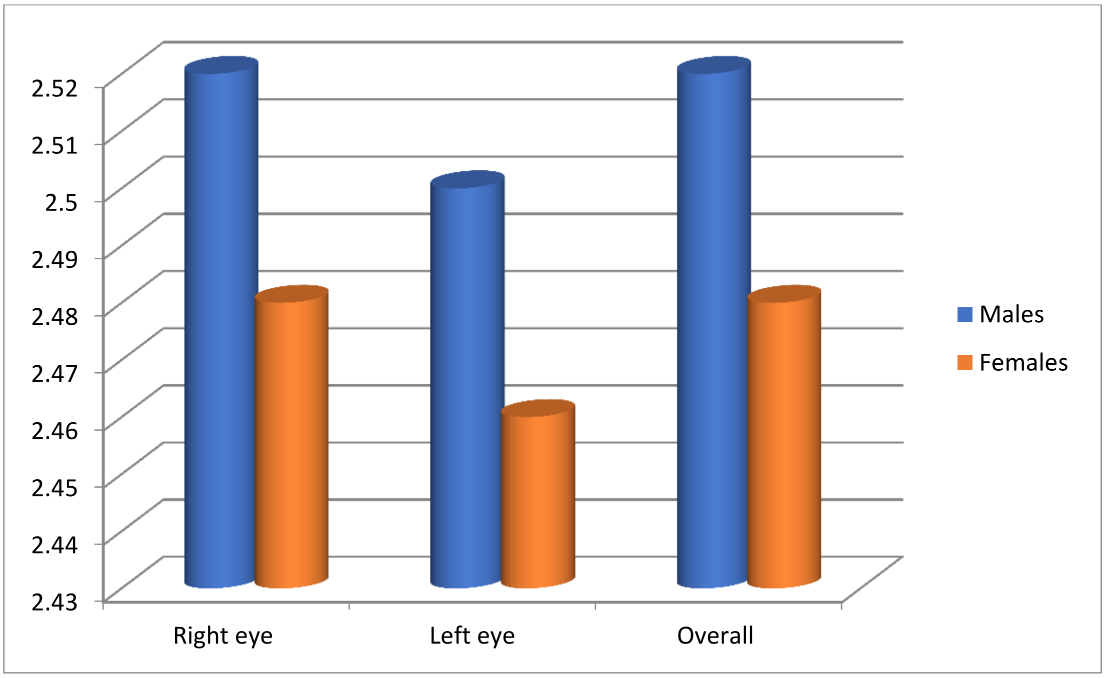
Graph 2: Comparison of axial length among males and females

Among males, mean axial length of right eye and left eye was 23.88 mm and 23.66 mm respectively, while among females mean axial length of right eye and left eye was 22.71 mm and 22.59 mm respectively. Overall, mean axial length among males and females was 23.78 mm and 22.65 mm respectively. Mean axial length among males was significantly higher in comparison to females.

Table 5: Comparison of anterior chamber depth among males and females

Anterior chamber depth (mm)		Males	Females	p-value
Right eye	Mean	2.52	2.48	P = 0.182
	SD	0.16	0.13	
Left eye	Mean	2.50	2.46	P = 0.094
	SD	0.13	0.10	
Overall	Mean	2.52	2.48	P= 0.1524
	SD	0.15	0.12	

*: Significant



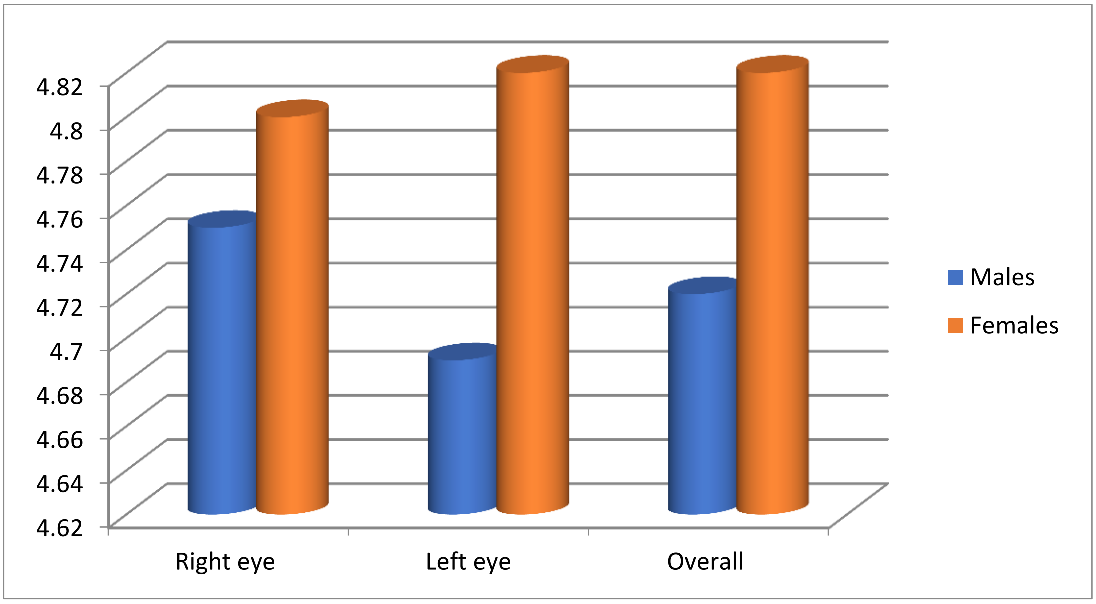
Graph 3: Comparison of anterior chamber depth among males and females

Among males, mean anterior chamber depth of right eye and left eye was 2.52 mm and 2.5 mm respectively, while among females mean anterior chamber depth of right eye and left eye was 2.48 mm and 2.46 mm respectively. Overall, mean anterior chamber depth among males and females was 2.52 mm and 2.48 mm respectively. Non-significant results were obtained while comparing the mean anterior chamber depth among males and females.

Table 6: Comparison of lens thickness among males and females

Lens thickness (mm)		Males	Females	p-value
Right eye	Mean	4.75	4.80	P = 0.481
	SD	0.38	0.31	
Left eye	Mean	4.69	4.82	P = 0.173
	SD	0.38	0.32	
Overall	Mean	4.72	4.82	P = 0.161
	SD	0.38	0.31	

*: Significant



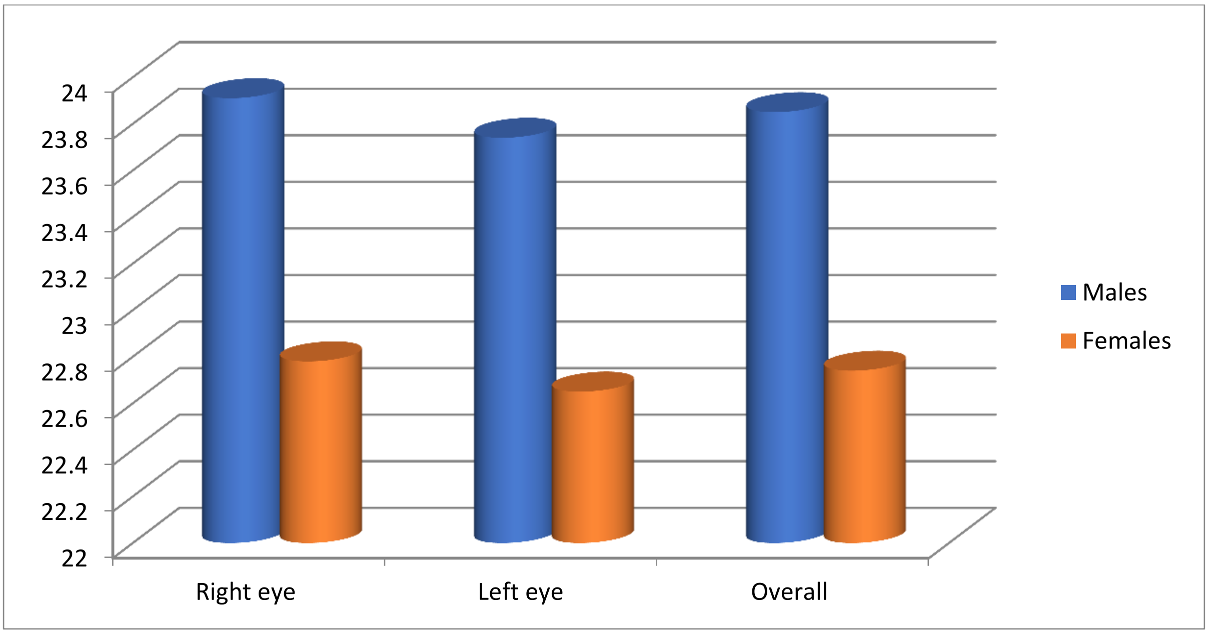
Graph 4: Comparison of lens thickness among males and females

Among males, mean lens thickness of right eye and left eye was 4.75 and 4.8 respectively, while among females mean lens thickness of right eye and left eye was 4.69 mm and 4.82 mm respectively. Overall, mean lens thickness among males and females was 4.72 mm and 4.82 mm respectively. Non-significant results were obtained while comparing the mean lens thickness among males and females. (Table 6, Graph 4)

Table 7: Comparison of axial length among males and females of age group of 20 to 30 years (n=30)

Axial length (mm)		Males	Females	p-value
Right eye	Mean	23.91	22.78	P < 0001*
	SD	0.85	0.92	
Left eye	Mean	23.74	22.65	P < 0001*
	SD	0.78	0.88	
Overall	Mean	23.85	22.74	P < 0001*
	SD	0.82	0.90	

*: Significant



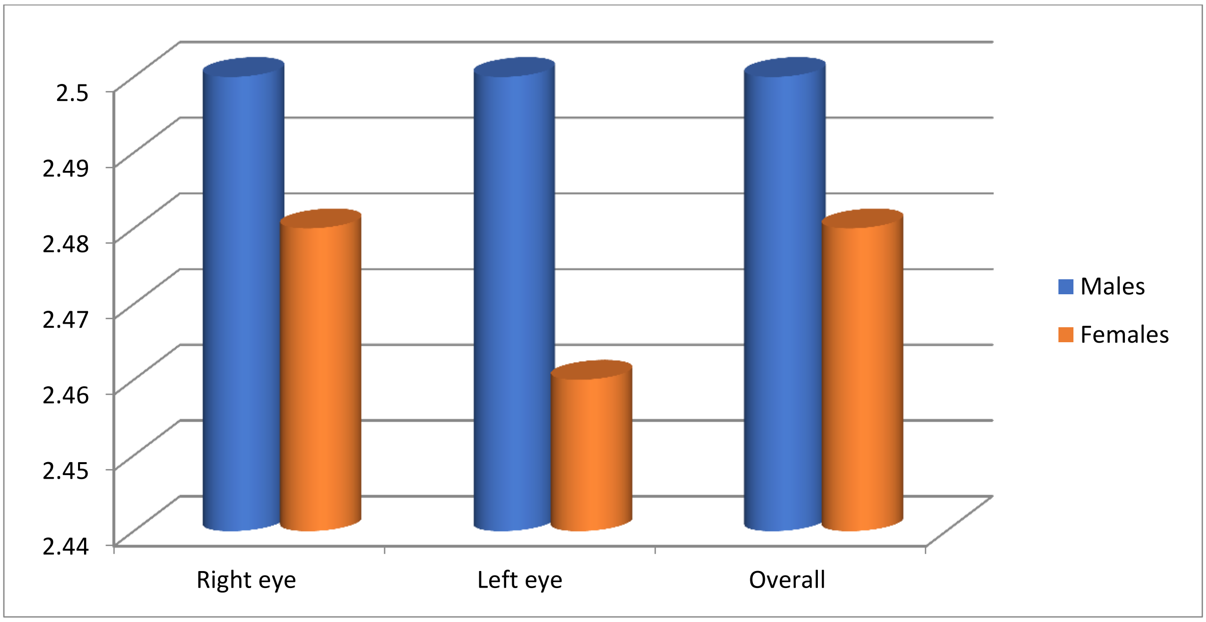
Graph 5: Comparison of axial length among males and females of age group of 20 to 30 years (n=30)

Among males of age group of 20 to 30 years, mean axial length of right eye and left eye was 23.88 mm and 23.66 mm respectively, while among females of age group of 20 to 30 years mean axial length of right eye and left eye was 22.71 mm and 22.59 mm respectively. Overall, mean axial length among males and females of age group of 20 to 30 years was 23.78 mm and 22.65 mm respectively. Mean axial length among males of age group of 20 to 30 years was significantly higher in comparison to females of age group of 20 to 30 years.

Table 8: Comparison of anterior chamber depth among males and females of age group of 20 to 30 years (n=30)

Anterior chamber depth (mm)		Males	Females	p-value
Right eye	Mean	2.50	2.48	P = 0.608
	SD	0.14	0.16	
Left eye	Mean	2.50	2.46	P = 0.201
	SD	0.12	0.12	
Overall	Mean	2.50	2.48	P =0.315
	SD	0.14	0.14	

*: Significant



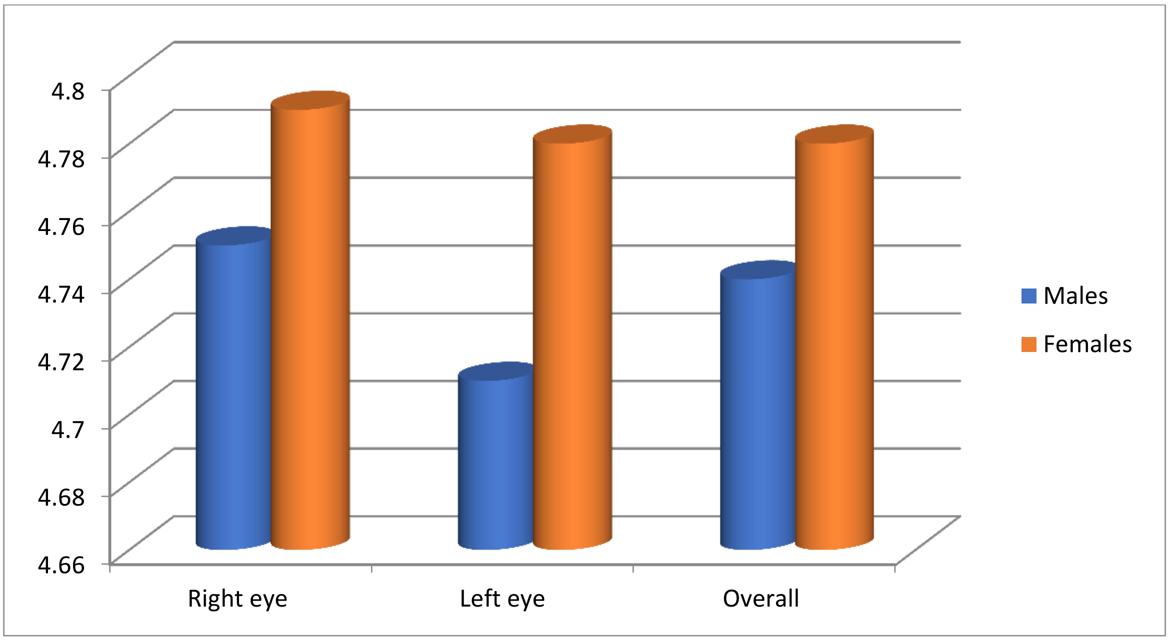
Graph 6: Comparison of Anterior chamber depth among males and females of age group of 20 to 30 years (n=30)

Among males of age group of 20 to 30 years, mean Anterior chamber depth of right eye and left eye was 23.88 mm and 23.66 mm respectively, while among females of age group of 20 to 30 years mean Anterior chamber depth of right eye and left eye was 22.71 mm and 22.59 mm respectively. Overall, mean anterior chamber depth among males and females of age group of 20 to 30 years was 23.78 mm and 22.65 mm respectively. Non-significant results were obtained while comparing the Mean Anterior chamber depth among males and females of age group of 20 to 30 years.

Table 9: Comparison of lens thickness among males and females of age group of 20 to 30 years (n=30)

Lens thickness (mm)		Males	Females	p-value
Right eye	Mean	4.75	4.79	P = 0.665
	SD	0.39	0.32	
Left eye	Mean	4.71	4.78	P = 0.435
	SD	0.35	0.34	
Overall	Mean	4.74	4.78	P = 0.669
	SD	0.38	0.34	

*: Significant



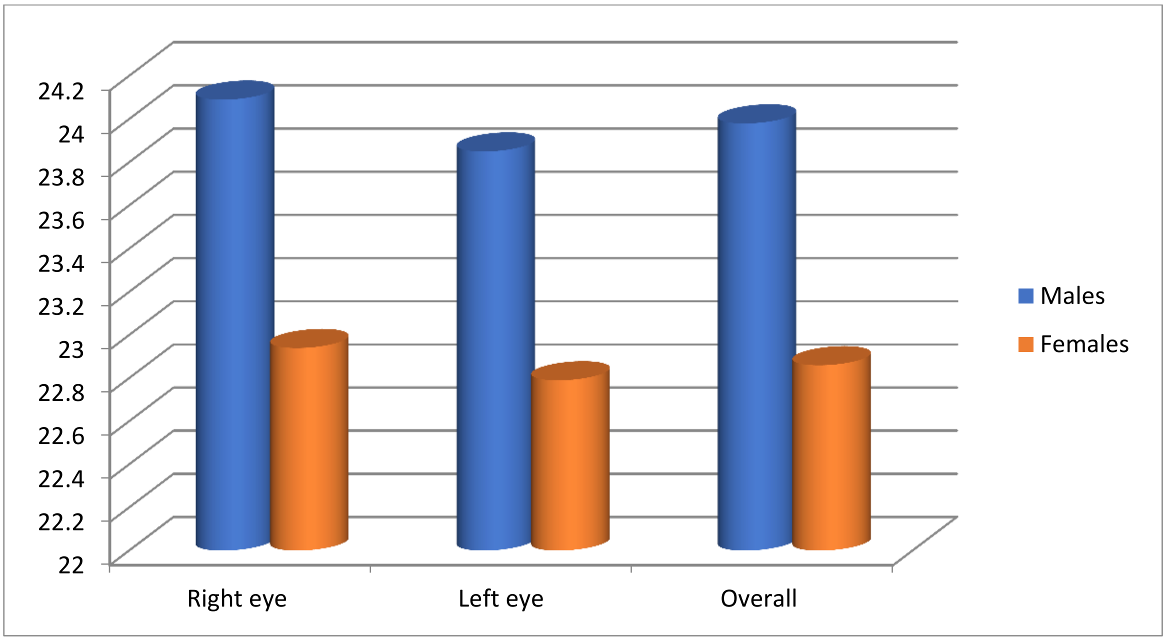
Graph 7: Comparison of lens thickness among males and females of age group of 20 to 30 years (n=30)

Among males of 20 to 30 years, mean lens thickness of right eye and left eye was 4.75 mm and 4.71 mm respectively, while among females of 20 to 30 years, mean lens thickness of right eye and left eye was 4.79 mm and 4.78 mm respectively. Overall, mean lens thickness among males and females of 20 to 30 years was 4.74 mm and 4.78 mm respectively. Non-significant results were obtained while comparing the mean lens thickness among males and females of 20 to 30 years.

Table 10: Comparison of axial length among males and females of age group of 31 to 40 years (n=7)

Axial length (mm)		Males	Females	p-value
Right eye	Mean	24.09	22.94	P = 0.039*
	SD	0.80	1.01	
Left eye	Mean	23.85	22.79	P = 0.057
	SD	1.07	0.80	
Overall	Mean	23.98	22.86	P = 0.058
	SD	01.02	0.98	

*: Significant



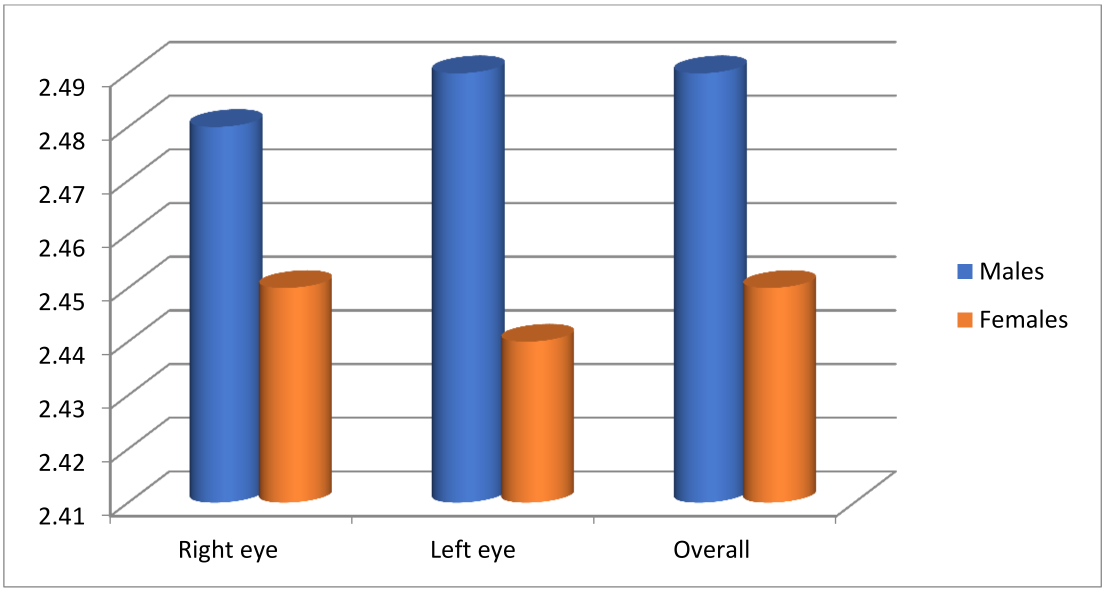
Graph 8: Comparison of axial length among males and females of age group of 31 to 40 years (n=7)

Among males of age group of 31 to 40 years, mean axial length of right eye and left eye was 24.09 mm and 23.85 mm respectively, while among females of age group of 31 to 40 years mean axial length of right eye and left eye was 22.94 mm and 22.79 mm respectively. Overall, mean axial length among males and females of age group of 31 to 40 years was 23.98 mm and 22.86 mm respectively. Mean axial length of right eye among males of age group of 31 to 40 years was significantly higher in comparison to females of age group of 20 to 30 years.

Table 11: Comparison of Anterior chamber depth among males and females of age group of 31 to 40 years (n=7)

Anterior chamber depth (mm)		Males	Females	p-value
Right eye	Mean	2.48	2.45	P = 0.398
	SD	0.09	0.01	
Left eye	Mean	2.49	2.44	P = 0.219
	SD	0.10	0.02	
Overall	Mean	2.49	2.45	P = 0.319
	SD	0.10	0.02	

*: Significant



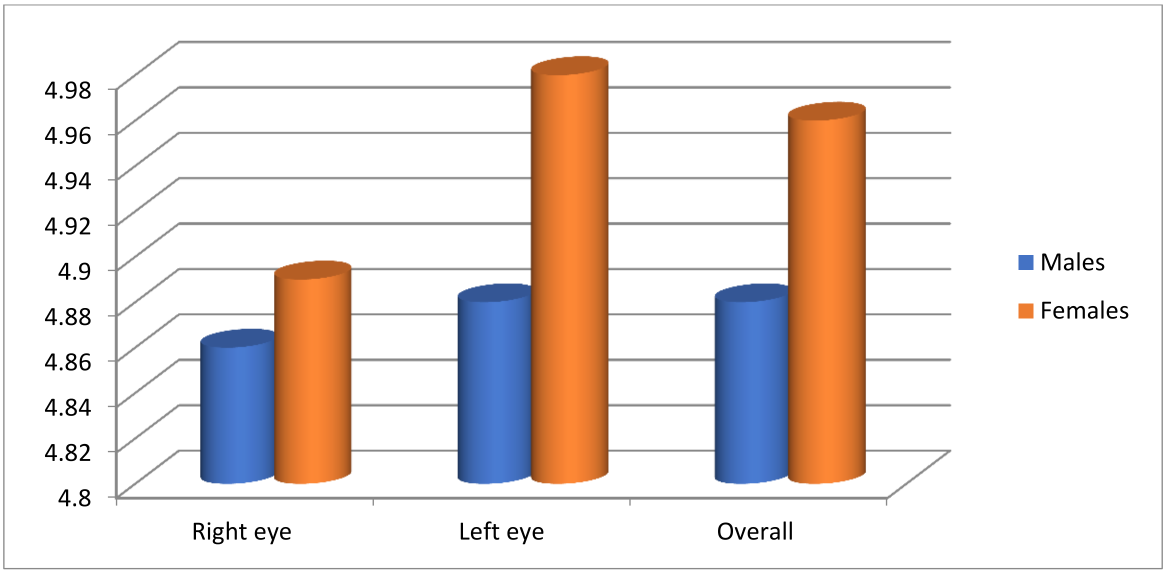
Graph 9: Comparison of Anterior chamber depth among males and females of age group of 31 to 40 years (n=7)

Among males of age group of 31 to 40 years, mean Anterior chamber depth of right eye and left eye was 2.48 mm and 2.49 mm respectively, while among females of age group of 31 to 40 years mean Anterior chamber depth of right eye and left eye was 2.45 mm and 2.44 mm respectively. Overall, mean anterior chamber depth among males and females of age group of 31 to 40 years was 2.49 mm and 2.45 mm respectively. Non-significant results were obtained while comparing the Mean Anterior chamber depth among males and females of age group of 31 to 40 years.

Table 12: Comparison of lens thickness among males and females of age group of 31 to 40 years (n=7)

Lens thickness (mm)		Males	Females	p-value
Right eye	Mean	4.86	4.89	P = 0.876
	SD	0.42	0.27	
Left eye	Mean	4.88	4.98	P = 0.479
	SD	0.34	0.15	
Overall	Mean	4.88	4.96	P = 0.654
	SD	0.38	0.26	

*: Significant



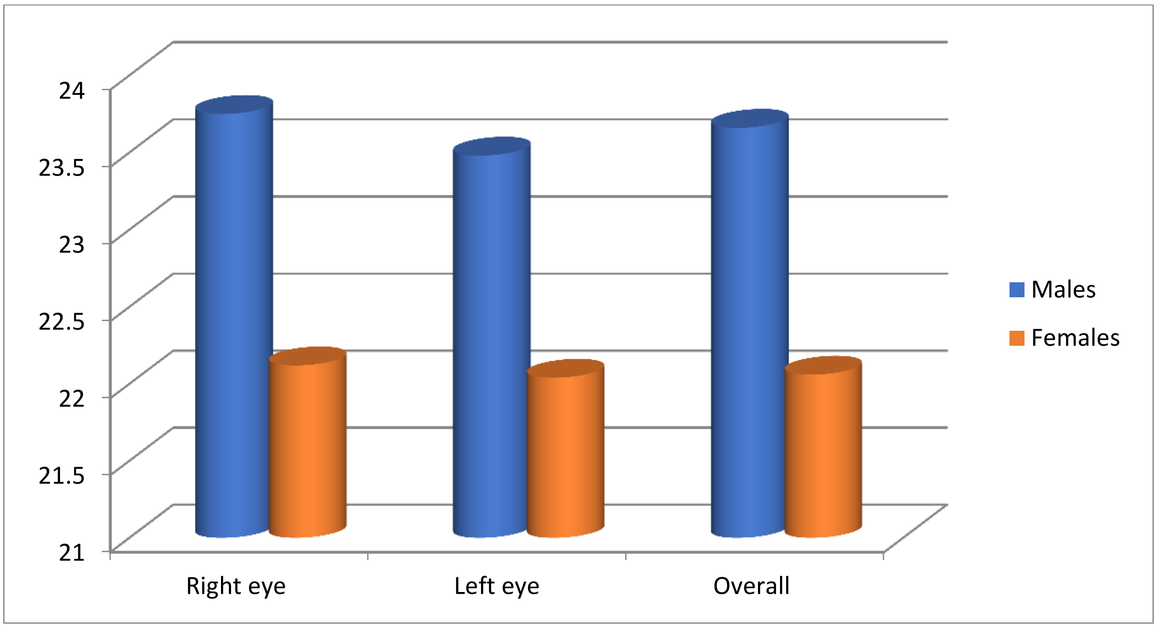
Graph 10: Comparison of lens thickness among males and females of age group of 31 to 40 years (n=7)

Among males of age group of 31 to 40 years, mean lens thickness of right eye and left eye was 4.86 mm and 4.88 mm respectively, while among females of age group of 31 to 40 years mean lens thickness of right eye and left eye was 4.89 mm and 4.98 mm respectively. Overall, mean lens thickness among males and females of age group of 31 to 40 years was 4.88 mm and 4.96 mm respectively. Non-significant results were obtained while comparing the Mean lens thickness among males and females of age group of 31 to 40 years.

Table 13: Comparison of axial length among males and females of age group of 41 to 50 years (n=8)

Axial length (mm)		Males	Females	p-value
Right eye	Mean	23.75	22.12	P = 0.001*
	SD	0.99	0.62	
Left eye	Mean	23.48	22.04	P = 0.0005*
	SD	0.61	0.68	
Overall	Mean	23.66	22.06	P = 0.0007*
	SD	0.82	0.66	

*: Significant



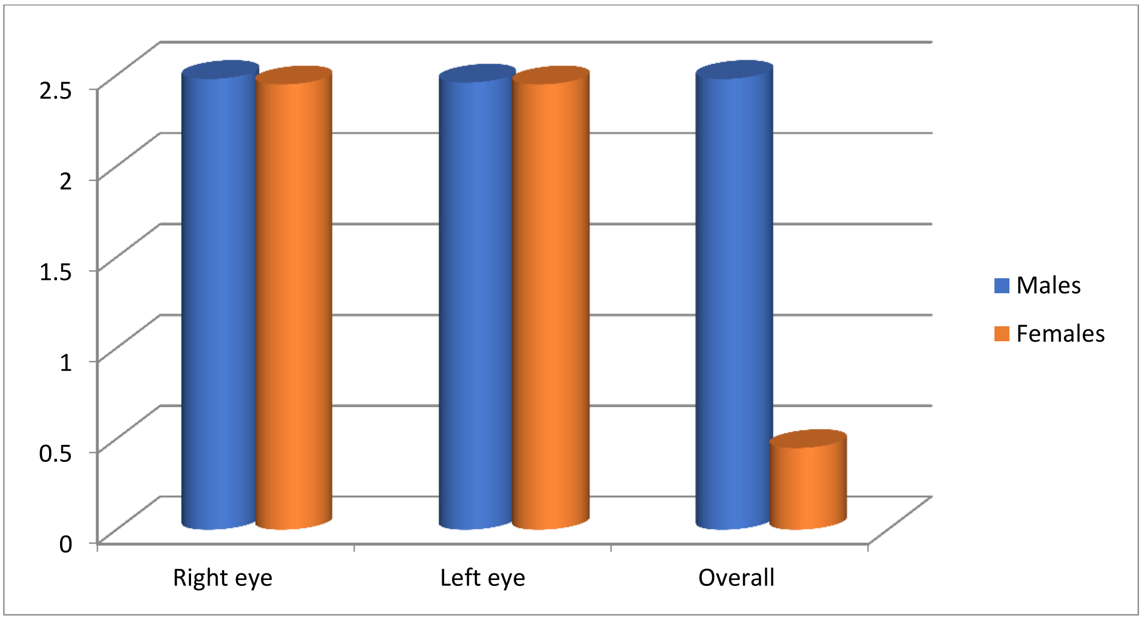
Graph 11: Comparison of axial length among males and females of age group of 41 to 50 years (n=8)

Among males of age group of 41 to 50 years, mean axial length of right eye and left eye was 23.75 mm and 23.48 mm respectively, while among females of age group of 41 to 50 years mean axial length of right eye and left eye was 22.12 mm and 22.04 mm respectively. Overall, mean axial length among males and females of age group of 41 to 50 years was 23.66 mm and 22.06 mm respectively. Non-significant results were obtained while comparing the mean axial length among males and females of age group of 41 to 50 years.

Table 14: Comparison of Anterior chamber depth among males and females of age group of 41 to 50 years (n=8)

Anterior chamber depth (mm)		Males	Females	p-value
Right eye	Mean	2.48	2.45	P = 0.555
	SD	0.14	0.01	
Left eye	Mean	2.46	2.45	P = 0.607
	SD	0.05	0.02	
Overall	Mean	2.48	2.45	P= 0.169
	SD	0.12	0.02	

*: Significant



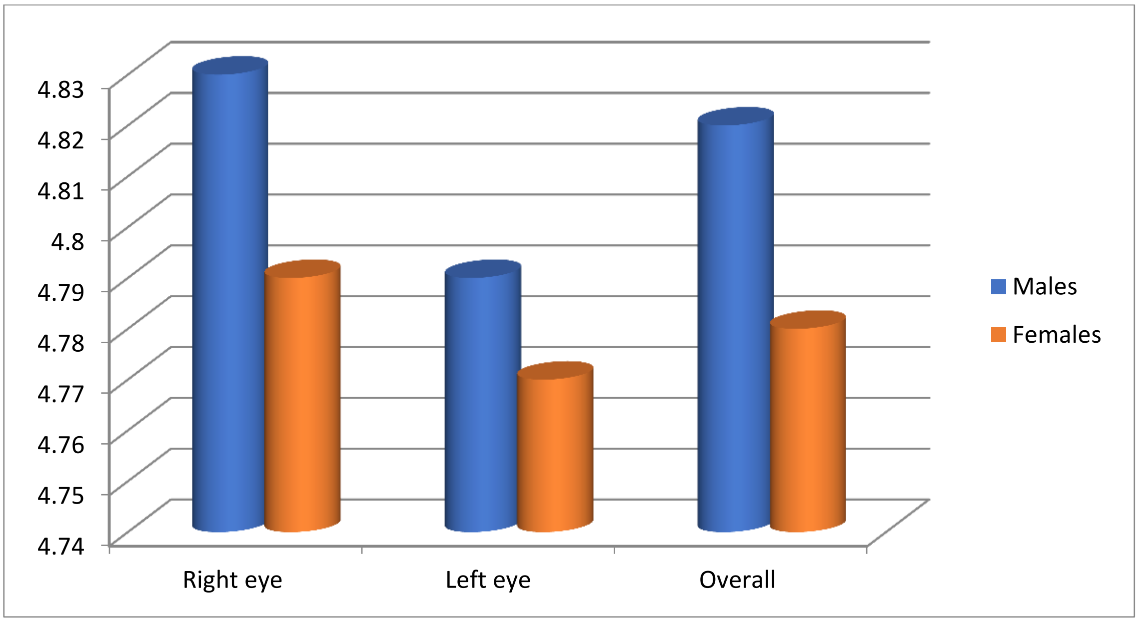
Graph 12: Comparison of Anterior chamber depth among males and females of age group of 41 to 50 years (n=8)

Among males of age group of 41 to 50 years, mean anterior chamber depth of right eye and left eye was 2.48 mm and 2.46 mm respectively, while among females of age group of 41 to 50 years mean anterior chamber depth of right eye and left eye was 2.45 mm. Overall, mean anterior chamber depth among males and females of age group of 41 to 50 years was 2.48 mm and 2.45 mm respectively. Non-significant results were obtained while comparing the mean anterior chamber depth among males and females of age group of 41 to 50 years.

Table 15: Comparison of lens thickness among males and females of age group of 41 to 50 years (n=8)

Lens thickness (mm)		Males	Females	p-value
Right eye	Mean	4.83	4.79	P = 0.744
	SD	0.26	0.22	
Left eye	Mean	4.79	4.77	P = 0.911
	SD	0.27	0.42	
Overall	Mean	4.82	4.78	P = 0.811
	SD	0.27	0.38	

*: Significant



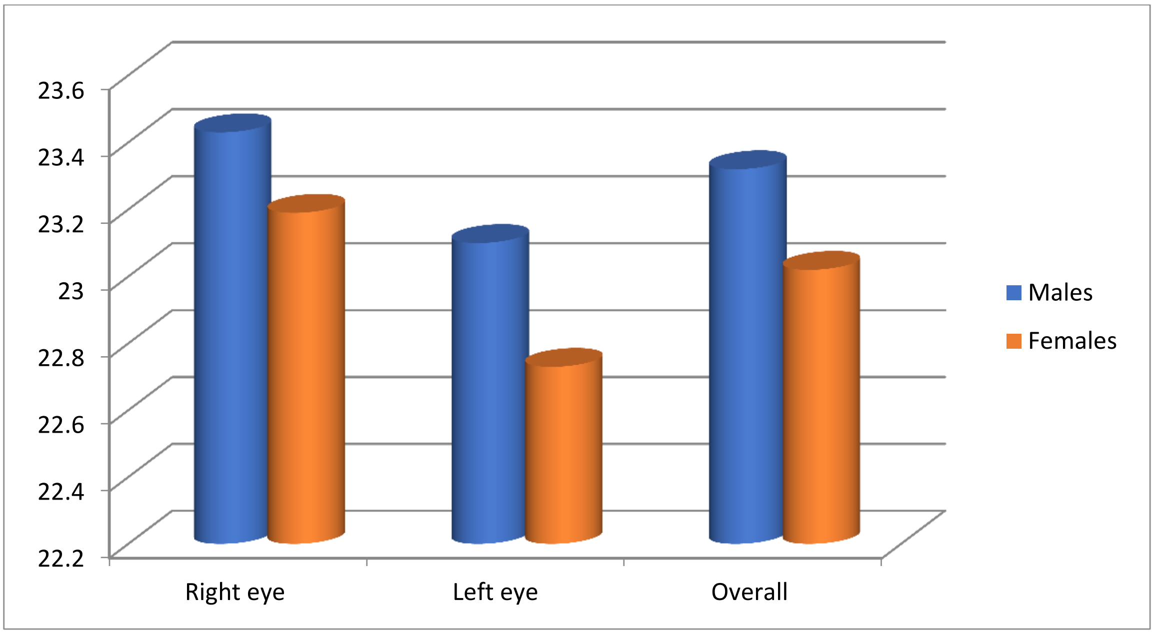
Graph 13: Comparison of lens thickness among males and females of age group of 41 to 50 years (n=8)

Among males of age group of 41 to 50 years, mean lens thickness of right eye and left eye was 4.83 mm and 4.79 mm respectively, while among females of age group of 41 to 50 years mean lens thickness of right eye and left eye was 4.79 mm and 4.77 mm respectively. Overall, mean lens thickness among males and females of age group of 41 to 50 years was 4.82 mm and 4.78 mm respectively. Non-significant results were obtained while comparing the mean lens thickness among males and females of age group of 41 to 50 years.

Table 16: Comparison of axial length among males and females of age group of 51 to 60 years (n=3)

Axial length (mm)		Males	Females	p-value
Right eye	Mean	23.43	23.19	P = 0.821
	SD	0.58	1.63	
Left eye	Mean	23.1	22.73	P = 0.674
	SD	0.72	1.22	
Overall	Mean	23.32	23.02	P = 0.769
	SD	0.66	1.52	

*: Significant



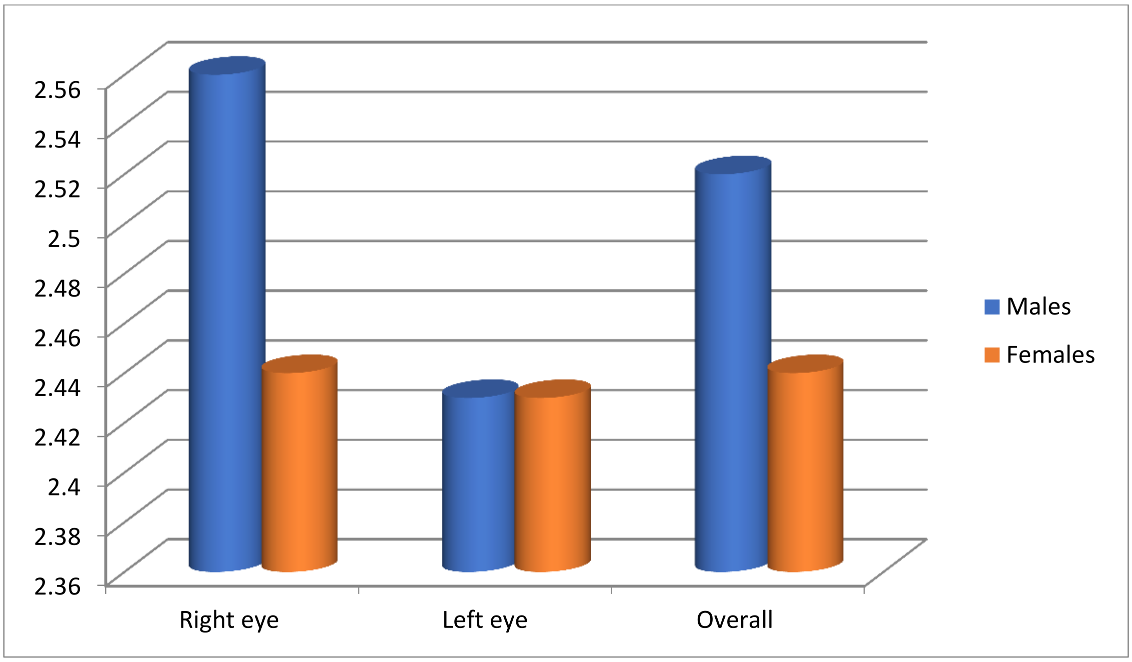
Graph 14: Comparison of axial length among males and females of age group of 51 to 60 years (n=3)

Among males of age group of 51 to 60 years, mean axial length of right eye and left eye was 23.43 mm and 23.1 mm respectively, while among females of age group of 51 to 60 years mean axial length of right eye and left eye was 23.19 mm and 22.73 mm respectively. Overall, mean axial length among males and females of age group of 51 to 60 years was 23.32 mm and 23.02 mm respectively. Non-significant results were obtained while comparing the mean axial length among males and females of age group of 51 to 60 years.

Table 17: Comparison of Anterior chamber depth among males and females of age group of 51 to 60 years (n=3)

Anterior chamber depth (mm)		Males	Females	p-value
Right eye	Mean	2.56	2.44	P = 0.380
	SD	0.21	0.02	
Left eye	Mean	2.43	2.43	P = 1.000
	SD	0.01	0.02	
Overall	Mean	2.52	2.44	P = 0.318
	SD	0.12	0.02	

*: Significant



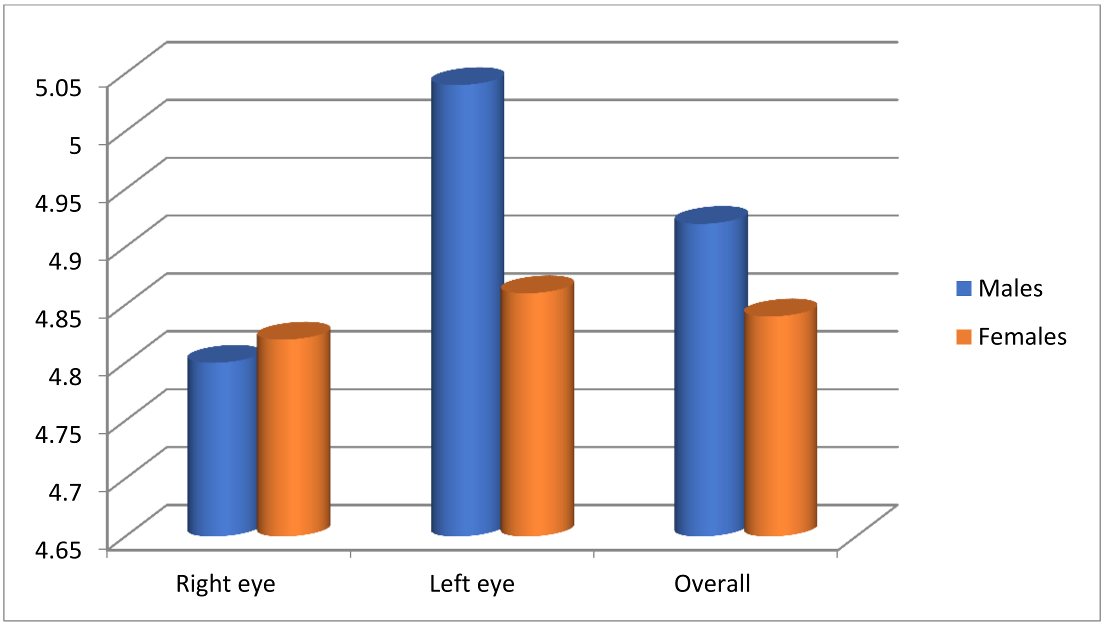
Graph 15: Comparison of Anterior chamber depth among males and females of age group of 51 to 60 years (n=3)

Among males of age group of 51 to 60 years, mean anterior chamber depth of right eye and left eye was 2.56 mm and 2.43 mm respectively, while among females of age group of 51 to 60 years mean anterior chamber depth of right eye and left eye was 2.44 mm and 2.43 mm respectively. Overall, mean anterior chamber depth among males and females of age group of 51 to 60 years was 2.52 mm and 2.44 mm respectively. Non-significant results were obtained while comparing the mean anterior chamber depth among males and females of age group of 51 to 60 years.

Table 18: Comparison of lens thickness among males and females of age group of 51 to 60 years (n=3)

Lens thickness (mm)		Males	Females	p-value
Right eye	Mean	4.80	4.82	P = 0.954
	SD	0.28	0.49	
Left eye	Mean	5.04	4.86	P = 0.201
	SD	0.04	0.20	
Overall	Mean	4.92	4.84	P = 0.748
	SD	0.18	0.36	

*: Significant



Graph 16: Comparison of lens thickness among males and females of age group of 51 to 60 years (n=3)

Among males of age group of 51 to 60 years, mean lens thickness of right eye and left eye was 4.80 mm and 5.04 mm respectively, while among females of age group of 51 to 60 years mean lens thickness of right eye and left eye was 4.82 mm and 4.86 mm respectively. Overall, mean lens thickness among males and females of age group of 51 to 60 years was 4.92 mm and 4.84 mm respectively. Non-significant results were obtained while comparing the mean lens thickness among males and females of age group of 51 to 60 years.

DISCUSSION

DISCUSSION

Worldwide advances in the field of ophthalmology have formed a greater necessity for ocular parameters in various diagnostic and clinical fields. One essential ocular parameter is the Axial length which is commonly required for calculation of IOL power before refractive and cataract operation and benefits ophthalmologists in the diagnosing various ocular pathologies like staphyloma, and risk of retinal detachment.[9]

Calculating ocular biometry, especially the axial length and its components, gives important and valuable information to operating surgeons. Studies regarding the ocular biometry parameter distribution in population-based studies have been reported. Various publications have confirmed the relation between ophthalmic biometrics, mainly axial length and refractive errors. As these biometry indices can be influenced by race, ethnicity, and genetics, their variations among different populations can possibly enlighten differences in refractive errors. This could be helpful to assess the distribution of biometric parameters in each area.[164]

Hence, the present study was undertaken for documenting gender differences in lens thickness, Axial length and Anterior Chamber Depth among age matched adults.

AGE

Out of 48 males (96 eyes), 62.50 % belonged to the age group of less than 30 years while 16.67 % and 14.58 % of the subjects belonged to the age group of 41-50 years & 31-40 years respectively. Out of 48 females, 62.50 % belonged to the age group of less than 30 years while 16.67 % and 14.58 % belonged to the age group of 41 to 50 years and 30 to 40 years respectively. Mean age of the female and male subjects was 31.48 ± 9.67 years & 31.95 ± 9.62 years respectively. In a study conducted by Aprioku et al, mean age for females 44.8+15.8 years. and that for males was 41.6 ±12. [165]

AXIAL LENGTH (AL)

In our study, mean axial length of right eye and left eye among males was 23.88mm and 23.66mm respectively, while among females mean AL of right eye and left eye was 22.71mm and 22.59mm respectively. Overall, mean axial length among males and females was 23.78 mm and 22.65 mm respectively. Mean axial length among males was significantly higher in comparison to females. Mean axial length among males of age group of 20 to 30 years was significantly higher in comparison to females of age group of 20 to 30 years.

Mean AL of right eye among males of age group of 31 to 40 years was significantly higher in comparison to females of age group of 20 to 30 years. Statistically insignificant results were obtained while comparing the mean AL among males and females of age group of 41 to 50 years and 51 to 60 years.

Our results were in concordance with the results obtained by Fotedar R et al, who also reported similar findings. In their study conducted on an older population, mean AL was 23.44 mm and was greater in men (23.76 mm) than in women (23.19 mm) which was statistically significant (p- value < 0.05).[11]

Similar gender variations in the mean AL for men (23.74 mm) and women (23.20 mm) were reported by the Reykjavik Eye Study and in the Los Angeles Latino Eye Study population group (23.65 mm in men and 23.18 mm in women). This was presumed to be due to the slightly flatter corneas observed in men.[166,167] In a study conducted by Chen MJ et al, authors also reported significantly higher AL among males (23.5) and females (23.0).[9]

Therefore, it can be deduced that AL is one of the primary anatomic indices in ophthalmology and a major variable for the optical quality of the image on the retina. However, despite its importance, relatively fewer studies have focused on axial length in population-based studies. These reports were from the study populations of Singapore, South and Central India, Alaska, Mongolia, California, Myanmar, Wisconsin, England, and other regions.[168]

A similar study conducted on 3468 individuals by Yin G et al, showed significantly higher axial length among males in comparison to females where the normative data of ophthalmic AL and its associations were investigated. AL calculations available for 3159 (91.1%) study participants revealed mean AL to be 23.25 mm (range: 18.96–30.88 mm). In multivariate analysis, axial length was significantly related with the systemic indices of higher age (P=0.001), increased body height (P=0.003), increased level of education (P=0.001) and urban region of habitation (P=0.001).

It was also correlated with the ocular indices of thicker central cornea (P=0.001), higher corneal curvature radius (P=0.001), deeper anterior chamber (P=0.001), thicker lens (P=0.001) more myopic refractive error (P=0.001), larger pupil diameter (P = 0.018) and higher best corrected visual acuity (P=0.001). It was additionally and negatively associated with the lens vault (P=0.001). In highly myopic eyes, axial length was significantly associated with lower level of education (P = 0.008), more myopia (P=0.001), and lower best corrected visual acuity (P = 0.034).

The mean axial length was same among the older age group in our study. This is similar to the study done in Greater Beijing on older adult population, where the mean ocular axial length (23.256 mm) was same as the value measured in other urban populations and was higher than in a Central rural Indian population. This relation between axial length and older age may potentially be related to a survival artifact. The association between axial length and body height agrees with the general association between anthropomorphic measures and eye globe size.[21]

Foster JP et al, reported that mean AL of males was 23.8mm while that of females was 23.29mm with significant difference.[16]

The gender difference in AL was identical to that found in the Los Angeles Latino Study (0.47 mm), even though the difference in Anterior Chamber Depth was greater between Angelino men and women (0.12 mm). In a study conducted by Hoffer KJ et al, mean axial length among males and females was 23.75mm and 23.23mm respectively (p- value < 0.05).[44,167]

Aprioku et al, in their study reported that the mean AL of the subjects was 23.2 ± 1.0mm which was same as the values measured by Connell et al, (23.03±1.61mm), Hashemi (23.14mm) and the Beijing et al , (23.25±1.14). It was slightly lesser than that found by Adio et al. (23.57±1.19 mm) & Iyamu et al. (23.5±0.70mm). These variations maybe attributed to the fact that the former was a hospital-based research study and may not have been characteristic of the population.[91,165,169]

However , in a study by Hashemi et al in Iran, Adio et al in Nigeria, “Tanjong Pagar eye study” and in Britain and the Central India eye study, even though females had lower axial lengths than males but they reported a statistically insignificant difference between the AL in females and males. A study on Nigerians by Iyamu et al reported a mean AL in males was lower than that in females. This difference in final results may have been due to smaller sample size with a smaller proportion of female.[12,13,14,170]

ANTERIOR CHAMBER DEPTH AMONG MALES AND FEMALES

In our study , among males, mean anterior chamber depth of right eye and left eye was 2.52mm and 2.5mm respectively, while among females mean anterior chamber depth of right eye and left eye was 2.48mm and 2.46mm respectively. Overall, mean anterior chamber depth among males and females was 2.52mm and 2.48mm respectively. Statistically insignificant results were obtained while comparing the mean anterior chamber depth among males and females. These insignificant results were also observed while comparing anterior chamber depth among males and females in different age groups in our study.

Our results were in concordance with the results obtained by previous authors who also reported similar findings. In a study conducted by Chen MJ et al, authors also reported non-significant difference in terms of ACD among males (3.0mm) and females (2.9mm). Foster JP et al, in their study reported that mean anterior chamber depth of males was 3.15mm while that of females was 3.08mm.[16, 33]

It has been noted that physiological conditions may change the ACD measurement. Mete et al. found that the valsalva maneuvers reduce the ACD by anterior displacement of iridolenticular diaphragm during this exercise. Pregnancy was found to vary ACD in the third trimester versus postpartum period, but these changes were not statistically significant.[171]For many years, the question remained if low birth weight was related to adulthood modifications in anterior chamber geometry.

The Gutenberg Health Study provided with the database power to analyze whether this factor negatively impacted the AL and ACD. Contrary to the expectation, low birth weight had no association with short ACD after adjustment with age and sex.[172,173]

The anterior chamber may reduce its length with central retinal vein occlusions (CRVO), mainly by the vascular congestion of the ciliary body and an increase in posterior pole volume, In extreme conditions this leads to angle closure in shallow ACD (especially if < 2 mm) eyes or reduced AL. This emphasizes the need for performing gonioscopy following CRVO, both for the angle closure and neovascular glaucoma.[174-1 76]

In a study conducted by Hoffer KJ et al, mean ACD among males and females was 3.15mm and 2.99mm respectively (P value > 0.05).[40] Sng CC et al identified the determinants of anterior chamber depth and to ascertain the relative importance of these determinants. A stepwise selection algorithm was used to identify sequentially the contribution of each independent variable. The mean age of participants was 56.9 years and 50.5% were men. The mean ACD was 3.24 mm.[177]

In a study conducted by IN Aprioku et al, the mean distribution of ACD in males (3.2mm) was shown to be more than that in females (3.1mm), although this difference was not statistically significant and in a study by Elabjer et al, where it was found that there was no statistically significant difference of right eye ACD between both genders.[22,165]

LENS THICKNESS AMONG MALES AND FEMALES

Among males, the mean lens thickness of right eye and left eye was 4.75mm and 4.8mm respectively, while among females mean lens thickness of right eye and left eye was 4.69mm and 4.82mm respectively. Overall, mean lens thickness among males and females was 4.72mm and 4.82mm respectively. Statistically insignificant results were obtained while comparing the mean lens thickness among males and females. We also observed insignificant difference while comparing the mean lens thickness among males and females among the other age groups.

Our results were in concordance with the results obtained by previous authors who also reported similar findings. In a study conducted by Hoffer KJ et al, mean lens thickness among males and females was 4.75 each (p value > 0.05).[109]

As there have been worldwide advancement in the field of ophthalmology, there is a greater need for ocular biometry parameters in different clinical and diagnostic fields. One vital ophthalmic parameter is the axial length (AL) which is commonly needed for calculation of intraocular lens power prior cataract and refractive surgeries. This helps ophthalmologists in the diagnosis of several eye conditions such as staphyloma, primary angle closure glaucoma and risk of retinal detachment.[9]

Many publications have referred to the eye's average or normal axial length (AL) and corneal power (K). The former has been customarily accepted as being 23.50mm, the latter as 43.50 D. In 1980, a previous reported publication of a large series of 7500 cataractous eyes, using immersion A-scan ultrasound, reported a mean AL of 23.65 (±1.35) mm, a mean K of 43.81 (±1.60) D and a mean anterior chamber depth (ACD) (corneal epithelium to anterior lens surface) of 3.24 (±0.44)mm.

In a study of 600 cataractous eyes (age 19 to 97 years), again using immersion A-scan ultrasound, reported a mean lens thickness (LT) of 4.63 (±0.68)mm but in the 503 of these eyes over age 60 the mean LT was 4.68 (±0.64)mm. Such average values have been used for various purposes, including schematic eyes used in optics and the development of intraocular lens (IOL) power formulas such as the Holladay 2 formula.[40,109]

LIMITATIONS OF STUDY

In our study Ultrasound Biometry was used to calculate the ocular parameters. However, use of optical biometry will give more accurate results .

Our study population was restricted to a single study centre. A multicentric study including a larger population of various ethnicities better understanding of the normative data.

CONCLUSION

CONCLUSION

This study compared gender differences in axial length, anterior chamber depth and lens thickness in age matched adults.

In our study the mean age among males and females was found to be 31.48 and 31.95 years respectively.

The mean axial length among males was significantly higher in comparison to females. The comparison of mean anterior chamber depth between males and females was found to be statistically insignificant. Comparison of mean lens thickness among males and females for age matched adults was also found to be statistically insignificant .

Thus, through this study, we can conclude that the normative data obtained can help in accurate assessment of ocular biometry and different pathological conditions of the eye .

However, a larger multicentric study can help in better extrapolation of results for definitive use.

SUMMARY

SUMMARY

Multiple ocular diseases are significantly correlated with ocular parameters. Gender is well thought-out to be a predictor of the ocular biometrics. Biological parameters like anterior chamber depth (ACD), lens thickness (LT), axial length (AL) are of great significance in calculation of IOL power before cataract surgery, diagnosis and management of angle closure glaucoma, staphyloma, prediction of refractive status and various other conditions. A-scan biometry is most widely used method for measurement of these parameters.

The current cross sectional comparative study was conducted in Department of Ophthalmology in R. L. Jalappa Hospital and Research Centre attached to Sri Devaraj Urs Medical College from December 2019 and May 2021.

A total of 192 eyes of 48 males and 48 females were evaluated. These patients were subjected for detailed ophthalmic examination of both eyes including Axial length, Anterior chamber depth and Lens thickness by A-scan biometry using contact technique.

In the present study it was found that mean age of the male and female subjects was 31.48 years and 31.95 years respectively. The mean axial length among males (23.78mm) was significantly higher in comparison to females (22.65mm). Statistically insignificant results were obtained on comparison of mean anterior chamber depth among males (2.52mm) and females (2.48mm). Insignificant results were also noted in measurement of mean lens thickness among males (4.72mm) and females (4.82mm). The lens thickness increased with age whereas the anterior chamber depth decreased with age.

Thus, through this study, we can conclude that the normative data obtained can help in accurate assessment of ocular biometry and different pathological conditions of the eye .

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ANNEXURE

ANNEXURE- I

CASE PROFORMA

SERIAL NO. :

Name: I.P. No.:

Age: O.P.No. :

Address: Date :

Brief History:

Past History:

Family History:

Personal History:

GENERAL PHYSICAL EXAMINATION:

Pallor: Icterus: Clubbing:

Cyanosis: Oedema: Lymphadenopathy:

Pulse:

Blood Pressure:

SYSTEMIC EXAMINATION

Cardiovascular System:

Respiratory System:

Gastrointestinal System:

Nervous System:

OCULAR EXAMINATION

OD OS

- Head Posture :
- Ocular Posture:
- Facial symmetry:
- Extra Ocular Movements:
- Conjunctiva:
- Cornea:
- Anterior chamber:
- Iris:
- Pupil :-

1.Size

2.Shape

3.Reaction

- Lens:
- Visual Acuity:-
    - Distant
        - Without spectacles :
        - With spectacles :
    - Near

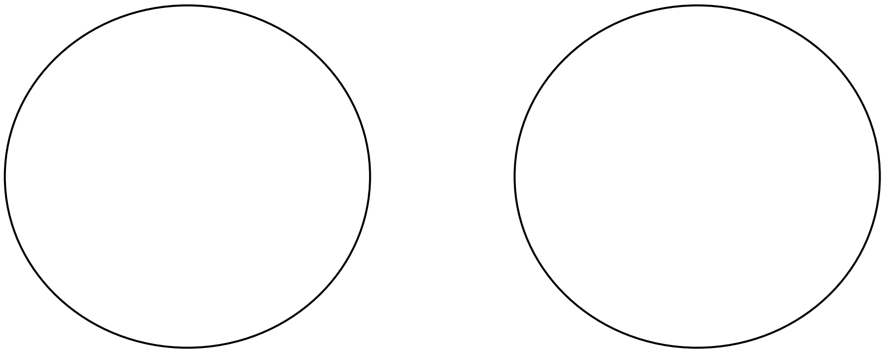
OD 0S

A-Scan:

- Axial length
- Anterior chamber depth
- Lens thickness

OD OS

- IOP
- VH grade of AC angle
- Fundus examination



ANNEXURE- II

SRI DEVARAJ URS ACADEMY OF HIGHER EDUCATION AND RESEARCH, TAMAKA, KOLAR – 563101

PATIENT INFORMATION SHEET

This information is to help you understand the purpose of the study "To compare gender differences in lens thickness, axial length and anterior chamber depth in age matched adults" You are invited to take part voluntarily in this research study, it is important that you read and understand the purpose, procedure, benefits and discomforts of the study.

1. What is the purpose of this study?

   To compare gender differences in lens thickness, axial length and anterior chamber depth in age matched adults.

2. What are the various investigations being used? Are there any associated risks?

   Absolutely no risks are associated with various investigations involved in this study such as Best Corrected Visual Acuity done with Snellen's chart, Slit lamp bio-microscopy and dilated fundus examination, A-scan biometry.

3. What is the benefit for me as a participant?

Participation in this research study may not change the final outcome of your eye condition. However, patients in the future may benefit as a result of knowledge gained from this study. You will not be charged extra for any of the procedures performed during the research study. Your taking part in this study is entirely voluntary. You may refuse to take part in the study or you may stop your participation in the study at any time, without a penalty or loss of any benefits to which you were otherwise entitled before taking part in this study.

CONFIDENTIALITY

Your medical information will be kept confidential by the study doctor and staff and will not be made publicly available. Your original records may be reviewed by your doctor or ethics review board. For further information/ clarification please contact.

Dr. DEEPAK ARORA

Junior Resident

Department of ophthalmology

SRI DEVARAJ URS MEDICAL COLLEGE

TAMAKA, KOLAR

Contact number - -8553481770

ಶ್ರೀ ದೇವರಾಜ್ ಯುಆರ್ಎಸ್ ಅಕಾಡೆಮಿ ಆಫ್ ಹೈಯರ್ ಎಜುಕೇಶನ್ ಅಂಡ್ ರಿಸರ್ಚ್, ತಮಕಾ, ಕೋಲಾರ್ - 563101

ರೋಗಿಯ ಮಾಹಿತಿ ಹಾಳೆ

ಈ ಮಾಹಿತಿಯು ಅಧ್ಯಯನದ ಉದ್ದೇಶವನ್ನು ಅರ್ಥಮಾಡಿಕೊಳ್ಳಲು ನಿಮಗೆ ಸಹಾಯ ಮಾಡುತ್ತದೆ "ಮಸೂರ ದಪ್ಪ, ಅಕ್ಷೀಯ ಉದ್ದ ಮತ್ತು ವಯಸ್ಸಿಗೆ ಹೊಂದಿಕೆಯಾದ ವಯಸ್ಕರಲ್ಲಿ ಮುಂಭಾಗದ ಕೋಣೆಯ ಆಳದಲ್ಲಿನ ಲಿಂಗ ವ್ಯತ್ಯಾಸಗಳನ್ನು ಹೋಲಿಸಲು" .ಈ ಸಂಶೋಧನಾ ಅಧ್ಯಯನದಲ್ಲಿ ಸ್ವಯಂಪ್ರೇರಣೆಯಿಂದ ಭಾಗವಹಿಸಲು ನಿಮ್ಮನ್ನು ಆಹ್ವಾನಿಸಲಾಗಿದೆ, ನೀವು ಮುಖ್ಯ ಅಧ್ಯಯನದ ಉದ್ದೇಶ, ಕಾರ್ಯವಿಧಾನ, ಪ್ರಯೋಜನಗಳು ಮತ್ತು ಅಸ್ವಸ್ಥತೆಗಳನ್ನು ಓದಿ ಮತ್ತು ಅರ್ಥಮಾಡಿಕೊಳ್ಳಿ.

1. ಈ ಅಧ್ಯಯನದ ಉದ್ದೇಶವೇನು?

ವಯಸ್ಸಿಗೆ ಹೊಂದಿಕೆಯಾಗುವ ವಯಸ್ಕರಲ್ಲಿ ಲೆನ್ಸ್ ದಪ್ಪ, ಅಕ್ಷೀಯ ಉದ್ದ ಮತ್ತು ಮುಂಭಾಗದ ಕೋಣೆಯ ಆಳದಲ್ಲಿನ ಲಿಂಗ ವ್ಯತ್ಯಾಸಗಳನ್ನು ಹೋಲಿಕೆ ಮಾಡಲು.

2. ವಿವಿಧ ತನಿಖೆಗಳನ್ನು ಬಳಸಲಾಗುತ್ತಿದೆ? ಯಾವುದೇ ಸಂಬಂಧಿತ ಅಪಾಯಗಳಿವೆಯೇ?

ಸ್ನೆಲೆನ್‌ನ ಚಾರ್ಟ್, ಸ್ಲಿಟ್ ಲ್ಯಾಂಪ್ ಬಯೋ-ಮೈಕ್ರೋಸ್ಕೋಪಿ ಮತ್ತು ಡಿಲೇಟೆಡ್ ಫಂಡಸ್ ಪರೀಕ್ಷೆ, ಎ-ಸ್ಕ್ಯಾನ್ ಬಯೋಮೆಟ್ರಿಯೊಂದಿಗೆ ಮಾಡಿದ ಅತ್ಯುತ್ತಮ ಸರಿಪಡಿಸಿದ ವಿಷುಯಲ್ ಆಕ್ಯುಟಿ ಈ ಅಧ್ಯಯನದಲ್ಲಿ ಒಳಗೊಂಡಿರುವ ವಿವಿಧ ತನಿಖೆಗಳೊಂದಿಗೆ ಯಾವುದೇ ಅಪಾಯಗಳು ಸಂಬಂಧಿಸಿಲ್ಲ.

3. ಭಾಗವಹಿಸುವವನಾಗಿ ನನಗೆ ಏನು ಪ್ರಯೋಜನ?

ಈ ಸಂಶೋಧನಾ ಅಧ್ಯಯನದಲ್ಲಿ ಭಾಗವಹಿಸುವುದರಿಂದ ನಿಮ್ಮ ಕಣ್ಣಿನ ಸ್ಥಿತಿಯ ಅಂತಿಮ ಫಲಿತಾಂಶವು ಬದಲಾಗುವುದಿಲ್ಲ. ಆದಾಗ್ಯೂ, ಈ ಅಧ್ಯಯನದಿಂದ ಪಡೆದ ಜ್ಞಾನದ ಪರಿಣಾಮವಾಗಿ ಭವಿಷ್ಯದಲ್ಲಿ ರೋಗಿಗಳು ಪ್ರಯೋಜನ ಪಡೆಯಬಹುದು. ಸಂಶೋಧನಾ ಅಧ್ಯಯನದ ಸಮಯದಲ್ಲಿ ನಿರ್ವಹಿಸುವ ಯಾವುದೇ ಕಾರ್ಯವಿಧಾನಗಳಿಗೆ ನಿಮಗೆ ಹೆಚ್ಚುವರಿ ಶುಲ್ಕ ವಿಧಿಸಲಾಗುವುದಿಲ್ಲ. ಈ ಅಧ್ಯಯನದಲ್ಲಿ ನೀವು ಭಾಗವಹಿಸುವುದು ಸಂಪೂರ್ಣವಾಗಿ ಸ್ವಯಂಪ್ರೇರಿತವಾಗಿದೆ. ನೀವು ಅಧ್ಯಯನದಲ್ಲಿ ಭಾಗವಹಿಸಲು ನಿರಾಕರಿಸಬಹುದು ಅಥವಾ ಈ ಅಧ್ಯಯನದಲ್ಲಿ ಪಾಲ್ಗೊಳ್ಳುವ ಮೊದಲು ನಿಮಗೆ ಅರ್ಹತೆ

ದೊರೆತ ಯಾವುದೇ ಪ್ರಯೋಜನಗಳ ದಂಡ ಅಥವಾ ನಷ್ಟವಿಲ್ಲದೆ ನೀವು ಯಾವುದೇ ಸಮಯದಲ್ಲಿ ಅಧ್ಯಯನದಲ್ಲಿ ಭಾಗವಹಿಸುವುದನ್ನು ನಿಲ್ಲಿಸಬಹುದು.

ಗೌಪ್ಯತೆ

ನಿಮ್ಮ ವೈದ್ಯಕೀಯ ಮಾಹಿತಿಯನ್ನು ಅಧ್ಯಯನ ವೈದ್ಯರು ಮತ್ತು ಸಿಬ್ಬಂದಿ ಗೌಪ್ಯವಾಗಿಡುತ್ತಾರೆ ಮತ್ತು ಸಾರ್ವಜನಿಕವಾಗಿ ಲಭ್ಯವಾಗುವುದಿಲ್ಲ. ನಿಮ್ಮ ಮೂಲ ದಾಖಲೆಗಳನ್ನು ನಿಮ್ಮ ವೈದ್ಯರು ಅಥವಾ ನೈತಿಕ ಪರಿಶೀಲನಾ ಮಂಡಳಿಯು ಪರಿಶೀಲಿಸಬಹುದು. ಹೆಚ್ಚಿನ ಮಾಹಿತಿಗಾಗಿ / ಸ್ಪಷ್ಟೀಕರಣಕ್ಕಾಗಿ ದಯವಿಟ್ಟು ಸಂಪರ್ಕಿಸಿ

ಡಾ.ದೀಪಕ್ ಅರೋರಾ

ಸ್ನಾತಕೋತ್ತರ ವಿದ್ಯಾರ್ಥಿ

ನೇತ್ರಶಾಸ್ತ್ರ ವಿಭಾಗ

ಶ್ರೀ ದೇವರಾಜ್ ಯುಆರ್ಸ್ ಮೆಡಿಕಲ್ ಅಕಾಡೆಮಿ

ತಮಾಕಾ ಕೋಲಾರ

ಸಂಪರ್ಕ ಸಂಖ್ಯೆ: 8553481770

ANNEXURE- III

SRI DEVARAJ URS ACADEMY OF HIGHER EDUCATION AND RESEARCH, TAMAKA, KOLAR - 563101.

INFORMED CONSENT FORM

Case no: **IP no:**

TITLE: COMPARATIVE STUDY OF GENDER VARIATIONS IN OCULAR PARAMETERS BY A-SCAN IN AGE MATCHED ADULTS.

I, the undersigned, agree to participate in this study and authorize the collection and disclosure of personal information as outlined in this consent form.

I understand the purpose of this study, the risks and benefits of the technique and the confidential nature of the information that will be collected and disclosed during the study. The information collected will be used only for research.

I have had the opportunity to ask questions regarding the various aspects of this study and my questions have been answered to my satisfaction.

I understand that I remain free to withdraw the participation from this study at any time and this will not change the future care.

Participation in this study does not involve any extra cost to me.

Name	Signature	Date	Time
Patient:			
Witness:			
Primary Investigator/ Doctor:			

ಶ್ರೀ ದೇವರಾಜ್ ಯುಆರ್ಎಸ್ ಅಕಾಡೆಮಿ ಆಫ್ ಹೈಯರ್ ಎಜುಕೇಶನ್ ಅಂಡ್ ರಿಸರ್ಚ್, ತಮಕಾ, ಕೋಲಾರ್ - 563101.

ಮಾಹಿತಿ ಕಾನ್ಸೆಂಟ್ ಫಾರ್ಮ್

ಪ್ರಕರಣ ಸಂಖ್ಯೆ: ಐಪಿ ಸಂಖ್ಯೆ:

ಶೀರ್ಷಿಕೆ : ವಯಸ್ಸಾದ ವಯಸ್ಕರಲ್ಲಿ ಎ-ಸ್ಕ್ಯಾನ್ ಮೂಲಕ ಸಂಪೂರ್ಣ ಪ್ಯಾರಾಮೀಟರ್‌ಗಳಲ್ಲಿ ಲಿಂಗ ವ್ಯತ್ಯಾಸಗಳ ತುಲನಾತ್ಮಕ ಅಧ್ಯಯನ

ನಾನು, ಸಹಿ ಮಾಡದವರು, ಈ ಅಧ್ಯಯನದಲ್ಲಿ ಭಾಗವಹಿಸಲು ಒಪ್ಪುತ್ತೇನೆ ಮತ್ತು ಈ ಒಪ್ಪಿಗೆಯ ರೂಪದಲ್ಲಿ ವಿವರಿಸಿರುವಂತೆ ವೈಯಕ್ತಿಕ ಮಾಹಿತಿಯ ಸಂಗ್ರಹಣೆ ಮತ್ತು ಬಹಿರಂಗಪಡಿಸುವಿಕೆಯನ್ನು ಅಧಿಕೃತಗೊಳಿಸುತ್ತೇನೆ.

ಈ ಅಧ್ಯಯನದ ಉದ್ದೇಶ, ತಂತ್ರದ ಅಪಾಯಗಳು ಮತ್ತು ಪ್ರಯೋಜನಗಳು ಮತ್ತು ಅಧ್ಯಯನದ ಸಮಯದಲ್ಲಿ ಸಂಗ್ರಹಿಸಿ ಬಹಿರಂಗಪಡಿಸುವ ಮಾಹಿತಿಯ ಗೌಪ್ಯ ಸ್ವರೂಪವನ್ನು ನಾನು ಅರ್ಥಮಾಡಿಕೊಂಡಿದ್ದೇನೆ. ಸಂಗ್ರಹಿಸಿದ ಮಾಹಿತಿಯನ್ನು ಸಂಶೋಧನೆಗೆ ಮಾತ್ರ ಬಳಸಲಾಗುತ್ತದೆ.

ಈ ಅಧ್ಯಯನದ ವಿವಿಧ ಅಂಶಗಳಿಗೆ ಸಂಬಂಧಿಸಿದಂತೆ ಪ್ರಶ್ನೆಗಳನ್ನು ಕೇಳುವ ಅವಕಾಶ ನನಗೆ ಸಿಕ್ಕಿದೆ ಮತ್ತು ನನ್ನ ಪ್ರಶ್ನೆಗಳಿಗೆ ನನ್ನ ತೃಪ್ತಿಗೆ ಉತ್ತರಿಸಲಾಗಿದೆ.

ಈ ಅಧ್ಯಯನದಿಂದ ಭಾಗವಹಿಸುವಿಕೆಯನ್ನು ಯಾವುದೇ ಸಮಯದಲ್ಲಿ ಹಿಂತೆಗೆದುಕೊಳ್ಳಲು ನಾನು ಮುಕ್ತನಾಗಿರುತ್ತೇನೆ ಮತ್ತು ಇದು ಭವಿಷ್ಯದ ಆರೈಕೆಯನ್ನು ಬದಲಾಯಿಸುವುದಿಲ್ಲ ಎಂದು ನಾನು ಅರ್ಥಮಾಡಿಕೊಂಡಿದ್ದೇನೆ.

ಈ ಅಧ್ಯಯನದಲ್ಲಿ ಭಾಗವಹಿಸುವಿಕೆಯು ನನಗೆ ಯಾವುದೇ ಹೆಚ್ಚುವರಿ ವೆಚ್ಚವನ್ನು ಒಳಗೊಂಡಿರುವುದಿಲ್ಲ.

ಹೆಸರು	ಸಹಿ	ದಿನಾಂಕ	ಸಮಯ
ರೋಗಿ:			
ಸಾಕ್ಷಿ:			
ಪ್ರಾಥಮಿಕ ತನಿಖಾಧಿಕಾರಿ / ವೈದ್ಯರು:			

<u>**ANNEXURE- IV**</u>

PHOTOGRAPHS

PHOTOGRAPH 1 – SLIT LAMP EXAMINATION

PHOTOGRAPH 2- A-SCAN BIOMETRY MACHINE

PHOTOGRAPH 3 – PERFORMING A-SCAN BIOMETRY

MASTER CHART

ANNEXURE-V

KEY TO MASTER CHART

AL – Axial length

ACD – Anterior chamber depth

LT - Lens thickness

	MALE								FEMALE						
UHID	AGE	Right Eye			Left Eye				UHID	AGE	Right Eye			Left Eye		
		AL	ACD	LT	AL	ACD	LT				AL	ACD	LT	AL	ACD	LT
902804	24	23.43	2.45	4.96	23.05	2.45	4.64		800912	27	23.74	2.45	4.72	23.38	2.43	4.54
902791	53	23.87	2.46	4.26	23.78	2.45	3.98		943652	51	21.86	2.45	4.86	21.87	2.44	4.87
800997	36	22.74	2.46	3.51	22.67	2.45	3.5		811212	35	25.02	3.33	3.79	24.97	3.09	4.01
902550	29	22.94	2.76	5.01	23.2	2.74	4.66		902550	29	21.9	2.45	4.72	21.56	2.45	4.11
796662	25	23.09	3	3.58	23.05	2.95	3.82		811296	25	21.63	2.45	4.92	21.77	2.47	5.04
814732	27	22.66	2.4	4.68	23.01	2.57	4.8		812782	26	23.17	2.45	4.98	23.3	2.44	5.11
810219	21	24.07	2.43	4.88	24.28	2.45	4.47		810219	21	23.05	2.45	4.9	22.96	2.43	4.99
831297	22	24.39	2.45	4.45	24.21	2.46	4.94		813864	27	21.76	2.45	4.92	21.83	2.47	5.01
846219	27	24.87	2.51	4.79	24.53	2.53	4.62		839610	27	23.37	2.45	5.01	23.33	2.44	5.12
832489	23	24.41	2.44	4.49	24.27	2.39	4.4		938764	23	22.98	2.45	3.7	22.17	2.45	4.07
838612	22	24.32	2.45	4.92	24.12	2.38	4.68		838612	21	21.92	2.49	4.82	21.66	2.45	4.31
829614	31	24.67	2.49	4.52	24.54	2.52	4.45		840130	33	23.07	2.43	4.86	22.98	2.42	4.67
819266	25	23.76	2.42	4.6	23.71	2.4	4.42		796666	25	22.92	2.43	4.76	22.98	2.41	4.82
821578	22	24.39	2.43	4.42	24.21	2.46	4.99		798219	29	23.11	2.49	4.88	22.98	2.45	4.9
921234	35	24.27	2.41	4.96	23.75	2.45	4.5		903534	35	23.47	2.48	4.89	23.41	2.45	4.94
811214	22	24.41	2.41	4.9	23.65	2.45	4.67		903567	25	22.59	2.45	4.88	22.52	2.45	4.76
708596	45	23.98	2.81	4.94	23.83	2.44	5.09		792318	45	21.95	2.41	4.31	21.62	2.43	4.74
902571	46	22.82	2.45	4.47	23.09	2.42	5.04		792345	47	25.04	2.45	5.29	24.05	2.41	5.1
806751	35	21.65	2.45	4.87	22.18	2.58	4.39		806783	35	22.66	2.45	4.85	22.76	2.44	5.07
799986	24	24.09	2.45	5.2	23.49	2.45	5.01		792319	29	21.48	2.45	4.8	21.14	2.41	4.68
808396	29	23.49	2.43	4.99	22.38	2.43	5.01		831235	29	21.9	2.45	4.72	21.56	2.45	4.11
904583	36	24.81	2.45	5.3	25.43	2.45	5.11		831112	37	21.63	2.45	4.92	21.77	2.47	5.04
895679	25	25.11	2.43	5.13	24.82	2.45	5.13		949051	25	23.17	2.45	4.98	23.3	2.44	5.11
949332	41	23.34	2.72	4.18	23.17	2.74	4.23		792616	43	23.05	2.45	4.9	22.96	2.43	4.99
953812	42	22.82	2.46	5.21	22.76	2.47	5.13		953812	42	21.76	2.45	4.92	21.83	2.47	5.01
902387	27	24.67	2.49	4.52	24.54	2.52	4.45		902645	29	23.37	2.45	5.01	23.33	2.44	5.12
845932	28	24.39	2.43	4.42	24.21	2.46	4.99		845654	28	22.59	2.45	4.88	22.52	2.45	4.76
949311	27	24.27	2.41	4.96	23.75	2.45	4.5		949423	27	21.95	2.41	4.31	21.62	2.43	4.74
949295	28	24.41	2.41	4.9	23.65	2.45	4.67		949765	24	25.04	2.45	5.29	24.05	2.41	5.1
903457	38	23.98	2.81	4.94	23.83	2.44	5.09		903452	37	22.66	2.45	4.85	22.76	2.44	5.07
901267	29	22.82	2.45	4.47	23.09	2.42	5.04		786354	29	21.48	2.45	4.8	21.14	2.41	4.68
919033	45	23.49	2.43	4.99	22.38	2.43	5.01		857463	46	21.9	2.45	4.72	21.56	2.45	4.11
919598	26	21.65	2.45	4.87	22.18	2.58	4.39		657493	26	21.63	2.45	4.92	21.77	2.47	5.04
949297	29	24.09	2.45	5.2	23.49	2.45	5.01		436284	26	23.17	2.45	4.98	23.3	2.44	5.11
934765	23	23.49	2.43	4.99	22.38	2.43	5.01		847463	23	21.9	2.45	4.72	21.56	2.45	4.11
901292	22	25.11	2.43	5.13	24.82	2.45	5.13		657485	22	21.63	2.45	4.92	21.77	2.47	5.04
902925	21	23.34	2.72	4.18	23.17	2.74	4.23		758476	20	23.17	2.45	4.98	23.3	2.44	5.11
953902	54	22.82	2.46	5.21	22.76	2.47	5.13		758665	56	23.05	2.45	4.9	22.96	2.43	4.99
895978	26	23.76	2.42	4.6	23.71	2.4	4.42		958564	29	21.76	2.45	4.92	21.83	2.47	5.01
902789	24	24.67	2.49	4.52	24.54	2.52	4.45		768576	24	21.95	2.41	4.31	21.62	2.43	4.74
899045	44	23.76	2.42	4.6	23.71	2.4	4.42		987548	41	22.59	2.45	4.88	22.52	2.45	4.76

	MALE								FEMALE							
UHID	**AGE**	**Right Eye**			**Left Eye**				**UHID**	**AGE**	**Right Eye**			**Left Eye**		
900226	56	24.39	2.43	4.42	24.21	2.46	4.99		657485	57	21.95	2.41	4.31	21.62	2.43	4.74
901890	42	24.27	2.41	4.96	23.75	2.45	4.5		878765	42	25.04	2.45	5.29	24.05	2.41	5.1
902398	33	24.41	2.41	4.9	23.65	2.45	4.67		857453	33	22.66	2.45	4.85	22.76	2.44	5.07
901258	23	23.98	2.81	4.94	23.83	2.44	5.09		757856	25	**22.61**	**2.47**	**4.98**	**22.71**	**2.52**	**4.99**
878903	26	25.23	2.91	4.78	24.89	2.78	4.81		765864	28	23.71	2.58	4.9	23.9	2.59	4.96
901386	47	23.76	3.01	4.99	23.32	3	4.67		868609	49	24.12	2.65	4.7	24.42	2.68	4.9
941890	26	25.11	2.43	5.13	24.82	2.45	5.13		986759	22	22.12	2.62	4.71	22.89	2.61	4.77