ASSESMENT OF CENTRAL CORNEAL THICKNESS IN MYOPIC EYES

By

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ABSTRACT

BACKGROUND

Central corneal thickness (CCT) is an important indicator of corneal health status. The measurement of CCT has gained importance in recent years, partly due to the growing interest in the continued use of contact lenses, refractive surgery, and the early identification of those who are at a higher risk of developing primary open angle glaucoma. Corneal thickness is a limiting factor, especially for LASIK, because the residual stromal bed must have enough biomechanical stability to prevent corneal ectasia. Previous studies investigating the correlation between Central Corneal thickness and myopia have shown conflicting results.

AIMS

The aim of the study is to determine association of central corneal thickness with myopia

MATERIALS AND METHODS

This is a cross-sectional and time-bound study in which the patients with a diagnosis of myopia, between 20 to 50 years of age attending the Ophthalmic outpatient department are included in the study. Details of the patient including history, clinical examination, investigations done will be recorded after obtaining consent from the patient. Clinical examination includes Visual Acuity (by Snellen's Chart), Slit Lamp Examination, Dry and Cycloplegic (if required) retinoscopy with streak retinoscope, subjective correction, Pachymetry(Ultrasound), A-Scan, B-Scan (if required), intraocular pressure.

RESULTS

A total of 500 eyes of 250 patients were included in the study. The mean Central Corneal thickness was 526.2 μm and was thinner in eye with longer axial length (Pearson correlation -0.395, p-value- <0.001), higher spherical error(Pearson correlation -0.278, p-value- <0.001). Association between central corneal thickness and age, gender, laterality and intraocular pressure were not statistically significant. Myopic fundus changes were present in eyes with lower central corneal thickness.

CONCLUSION

Central Corneal thickness in Indian population is lower as compared to other population. Central Corneal thickness is involved in process of myopic progression.

Keywords: Central Corneal thickness, Myopia, Axial length, Spherical error, refractive surgery.

LIST OF ABBREVATIONS

AL	Axial length
AS-OCT	Anterior segment Optical Coherence Tomography
C-LASIK	Customized Laser in - situ keratomileusis
CCT	Central Corneal thickness
D	Dioptre
E-LASIK	Epi Laser in - situ keratomileusis
Fig.	Figure
ICR	Intracorneal ring
IOL	Intraocular Lens
IOP	Intraocular Pressure
IQ	Intelligence quotient
LASIK	Laser in - situ keratomileusis
LRI	Limbal relaxing incision
PCT	Peripheral Corneal thickness
PRK	Photorefractive keratectomy
RK	Raidal Keratotomy
SE	Spherical equivalent of refractive error
US	Ultrasound Pachymetry
µm	Micron

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INTRODUCTION

Myopia is a type of refractive error in which parallel rays of light coming from infinity are focused in front of the retina when accommodation is at rest.[1] Although the true etiology of myopia is still unknown, the cornea is responsible for approximately two-thirds of optical refraction and its role in myopia has consequently been studied intensely over the years.[2]

Myopic changes of the eyes include elongated axial length, deeper anterior chamber and vitreous depth, thinner retina with lattice change and higher prevalence of retinal detachment, decreased choroid circulation, as well as decreased scleral thickness and elasticity.[3]According to a study conducted in Andhra Pradesh, prevalence of myopia in subjects aged above 15 years, was 19.39%.[4]

Corneal pachymetry is the process of measuring the thickness of the cornea and can be done using contact methods such as ultrasound and confocal microscopy or non-contact methods such as optical biometry with a single Scheimpflug camera (such as the Oculus Pentacam or Sirius), Dual Scheimpflug (e.g., Galilei), coherence tomography (Visante, iVue, or others), optical coherence pachymetry (with Orbscan).[5]

Central corneal thickness (CCT) is an important indicator of corneal health status. It is an essential tool in assessment and management of corneal diseases and helps to estimate the corneal barrier and endothelial pump function.[6] The measurement of CCT has gained importance in recent years, partly due to the growing interest in the continued use of contact lenses, refractive surgery, and the early identification of those who are at a higher risk of developing primary open angle glaucoma.[7]

Modern excimer laser treatment has changed the scenario of elective surgery to eliminate refractive error. The excitement in this field has led to millions of patients worldwide having laser-assisted in situ keratomileusis (LASIK), photorefractive keratectomy (PRK), or other refractive surgeries. In general, the results of these surgeries have been excellent. CCT values are of great importance during the pre-operative evaluation of the patients undergoing refractive surgery. Corneal thickness is a limiting factor, especially for LASIK, because the residual stromal bed must have enough biomechanical stability to prevent corneal ectasia. A residual stromal thickness of 250 μm is a customary target as they influence the decision whether or not to perform surgery, the type of recommended procedure, and rate of postoperative complications.[8]

Factors influencing the corneal pachymetry include the time of day, patient age, the use of contact lens, or any corneal degeneration.[9] The influence of the refractive error on corneal thickness has not yet been clearly established. Some found that myopic subjects have a thicker CCT, other a thinner CCT, while yet others found no correlation between CCT and myopia,[2] so further evaluation of the association of Central corneal thickness with myopia is necessary.

AIM AND OBJECTIVE OF THE STUDY

The aim of the study is to determine the association of central corneal thickness with myopia.

Objective: To investigate the variation of Central corneal thickness with myopia using Ultrasound pachymetry.

REVIEW OF LITERATURE

Cornea

Structure and function

The cornea consists of transparent avascular tissue that acts as the primary infectious and structural barrier of the eye. The average adult cornea is 0.52 mm thick in the centre and about 0.65 mm thick at the periphery. The horizontal diameter of the cornea is 11.5 to 12 mm, and it is approximately 1 mm larger than the vertical diameter.[10,11] From anterior to posterior, the human cornea has long been believed to consist of five distinct layers (Figure 1); however, a sixth layer (Dua´s layer) has recently been proposed.[12]

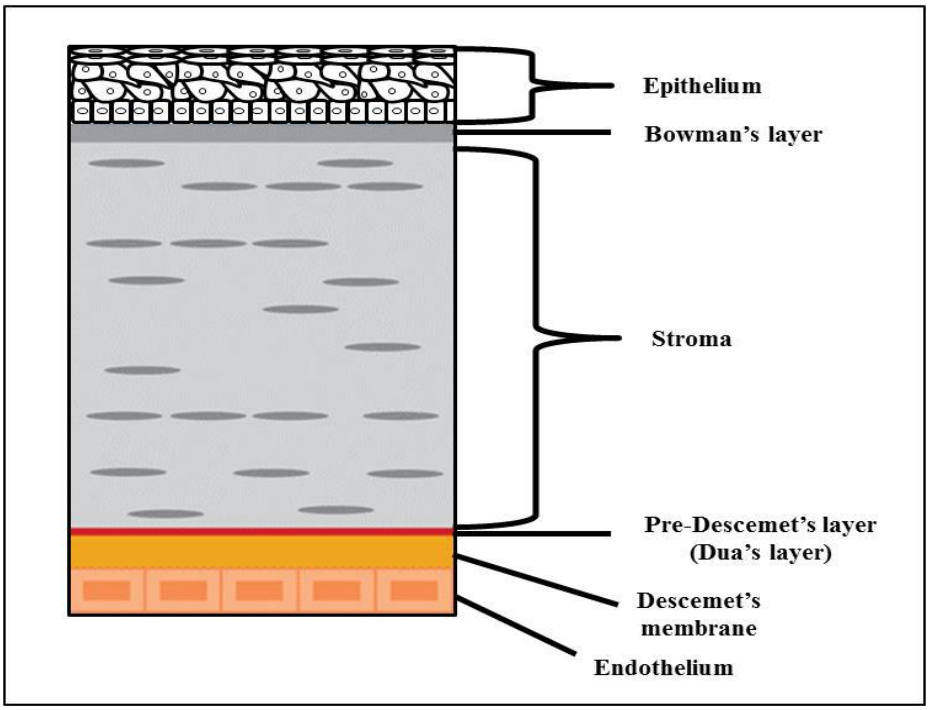


Figure 1: Five distinct layers of the cornea. A sixth layer (Dua`s layer) has recently been proposed.

The epithelium

The corneal epithelium is a non-keratinized, stratified squamous epithelium of four to six cells layers and represents approximately 10% of the corneal thickness.[13] The mean epithelial thickness at the corneal vertex is 53.4±4.6 μm, and it is thicker inferiorly than superiorly and thicker nasally than temporally.[14] It is continuous with the conjunctival epithelium at the corneoscleral limbus.[15] The corneal epithelium is composed of a basal layer of column-shaped cells, a suprabasal layer of cuboid wing cells, and a superficial layer (1–3 layers) of flat squamous cells.[16] There is general agreement that the stem cells of the corneal epithelium in humans are located in the periphery of the cornea, although other locations recently have been suggested.[17-19] The limbal stem cells give rise to basal corneal epithelial cells that migrate centrally. These basal cells generate suprabasal cells,[42] which in turn give rise to differentiated squamous cells with numerous finger-like projections or microvilli on their surface.[20] The microvilli increase the cell surface area, allowing close association with the tear film that traps tear fluid, thus preventing desiccation of the ocular surface.[21] Moreover, there are tight junctions between the cells that form the corneal barrier,[22] which prohibit tears, toxins, and microbes from entering deeper corneal layers. Individual epithelial cells are connected to each other and to the basement membrane by desmosomes and hemidesmosomes, respectively. These structures are important in mediating cell migration in response to epithelial injury.[23] Under normal conditions, the corneal epithelium is renewed every 9–12 months.[24] This contrasts with the human epidermis, where the replacement takes place approximately once a month.[25]

Bowman´s membrane

Bowman´s membrane is a clear acellular layer consisting of collagen fibrils with a diameter of 20-25 nm and proteoglycans. These fibrils are not ordered in bundles; individual fibrils run in various directions to form a thick, dense, felt-like sheet that is about 8-12 μm thick. The collagen fibrils in the posterior layer of the Bowman´s sheet are gradually assembled in bundles and merge into the collagen lamellae of the stroma.[26] The Bowman´s membrane is more resistant to damage than the corneal epithelium. However, unlike the corneal epithelium, it cannot regenerate after injury. Instead, fibrous scar tissue is formed, resulting in opacity. Bowman´s membrane is not necessary for the formation of normal epithelium, and its physiological role remains somewhat unclear.[21]

The stroma

The stroma accounts for about 90% of the total corneal thickness.[16] The parallel arrangement of lamellae formed from heterodimeric complexes of type I and type V collagen fibrils maintains the transparency of the cornea.15 The collagen fibrils have a diameter of 25-35 nm, and are packed in parallel-arranged layers or *lamellae*.[27] Adjacent lamellae lie at different angles, between 0 and 90°.[28] The human corneal stroma consists of over 300-stacked lamellae through its central thickness. As the cornea thickens away from the vertex, the number of lamellae increases, reaching about 500 throughout the stromal thickness at the limbus.[29] The collagen lamellae are thin (about 0.2-1.2 μm) and narrow (about 0.5-30 μm) in the anterior third of the stroma, run mostly obliquely to the corneal surface, and are more irregularly interwoven. Furthermore, parts of the anterior lamellae are inserted into Bowman's layer.[30-32] In the posterior stroma, collagen lamellae become thicker (0.2-2.5 μm) and

wider (100-200 μm) and tend to be arranged parallel to the corneal surface, preferentially oriented along the superior-inferior and nasal-temporal corneal meridians.[26,33,34,35] It is envisaged that these properties of the anterior lamellae contribute to balance the intraocular pressure, maintain corneal curvature, make stronger transverse shear properties and increase tensile strength compared to the posterior stroma; while the preferentially aligned fibrils in the posterior stroma take up the additional tensile stress along the superior-inferior and nasal-temporal meridians exerted by the rectus muscles and the orbicularis.[36-40] The collagen lamellar arrangement has also been reported to be different between the central and limbal area of the cornea in the posterior third of the cornea. The central cornea maintained the preferred superior-inferior and nasal-temporal orientation of collagen to within about 1 mm from the limbus, where a circular or tangential disposition of fibrils interlaced with significant numbers of mature elastic fibres occur.[35,41] The circumferential reinforcement of fibrils is thought to help to withstand the increased tension in that region brought about by the differing curvatures of the cornea and sclera. Furthermore, while the mean fibril diameter remains constant across all corneas, the mean fibril spacing across the central cornea measured 5-7% lower than in the peripheral cornea.[42]

Keratocytes, which represent the main cell type in the stroma and mostly reside in the anterior stroma, are involved in maintaining the extracellular matrix environment. They are able to synthesize collagen molecules and glycosaminoglycans, as well as matrix metalloproteases — all of which are crucial in maintaining stromal homeostasis. Keratocytes also produce crystalline proteins that maintain corneal transparency.[43]

Dua´s layer

A recently described corneal layer was named after Professor Harminder S. Dua, who discovered it. It is a 15 microns thick, well-defined, acellular layer in the pre-Descemet's cornea. The membrane is sufficiently strong to withstand a pressure of approximately 700- 950 mm Hg. Its recognition may have considerable impact on posterior corneal surgery and understanding of corneal biomechanics and posterior corneal pathology.[12]

Descemet's membrane

Endothelial cells continuously "secrete" Descemet's membrane. It is about 3μm thick at birth but increases in thickness throughout life, reaching 10-12 μm in adulthood. It functions as a protective barrier against infections and eye injuries.

The endothelium

The intact human endothelium is a monolayer, a honeycomb-like appearing mosaic when viewed from the posterior side. It is responsible for maintaining the stroma in a relatively dehydrated state. Human endothelial cell density is approximately 3500 cells/mm^2 at birth and decreases at an average rate of 0.6% per year throughout life.[44] The number of endothelial cells also decreases with trauma, inflammation, and other pathological processes. Endothelial cells have no mitotic capability *in vivo*; however, when the cell density decreases the remaining cells have the ability to "stretch" and take over the space of the degenerated endothelial cells.

Pachymetry

Pachymetry is the measurement of corneal thickness. Refractive surgeons invariably use central corneal thickness (CCT) in planning surgery,[45] as adequate thickness is key in reducing the risk of developing post-refractive ectasia. Corneal thickness influences intraocular pressure (IOP) and glaucoma specialists have demonstrated that corneal thinning is an independent risk factor for the development of glaucomatous optic neuropathy.[46] Therefore, pachymetry is performed as a standard in glaucoma consultation. While corneal thickness is an indirect measurement of the endothelial pump function, it is also affected to a lesser degree by IOP. Pachymetry is an important indicator of corneal health but varies widely in "normal" patients.

The thinnest part of the cornea is usually located about 1.5 mm temporal to the centre of the cornea.11 Rapuano et al.[48] measured 303 normal corneas and found a range of 410 to 625 μm, with a mean thickness of 515 μm in the central cornea. In the paracentral region, thickness varied from 522 μm inferiorly to 574 μm superiorly. In the peripheral zone, the thickness was 633 μm inferiorly and 673 μm superiorly. No significant differences were noted in readings between right or left eyes, males or females, month of year, or systemic medication use.[48] Paracentral and peripheral, but not central, measurements tended to become thinner with age, but this trend was not statistically significant.[47] Since the absolute central value can vary significantly and still be "normal," the relationship of central, midperipheral, and peripheral corneal thickness is important and should remain constant.

The central area (within a 4 mm optical zone) is typically thinner than the mid-peripheral cornea (4–9 mm optical zone), which is thinner than the peripheral cornea (outside a 9 mm optical zone). Therefore, a cornea with a central thickness greater

than the mid-peripheral thickness should be considered suspicious for endothelial dysfunction or midperipheral corneal thinning, regardless of absolute values.

Corneal pachymetry is useful in determining the health of a cornea transplant. Corneal pachymetry is also useful in determining and monitoring abnormalities in the corneal structure and/or function, including disorders characterized by corneal thinning such as keratoconus and pellucid marginal corneal degeneration, and by corneal thickening including endothelial dysfunction due to Fuchs endothelial corneal dystrophy and herpetic disciform keratitis.[49]

In contact lens wear, corneal edema and hypoxia can develop in daily wear, extended wear, and therapeutic lens patients. Corneal swelling averages 4% during eye closure, 9–10% with extended wear lenses, 11–14% during sleep, and up to 18% with contact lens wear. Corneal striae become visible at 4–8%, folds are seen at 11–12% swelling, and loss of transparency can occur at greater than 20% swelling.[50] High altitude causes a significant increase in CCT in healthy volunteers with normal corneas.[51]

Techniques for measuring CCT include

- Optical pachymetry,
- Ultrasound pachymetry,
- Confocal microscopy,
- Ultrasound biomicroscopy,
- Optical ray path analysis or scanning slit corneal topography,
- Optical coherence tomography.[52]

Optical methods of pachymetry were first described in 1951 by Maurice and Giardini.[53] Donaldson[54] and Mishima[55] also described manual slit lamp techniques to

view the tear film or anterior corneal surface and the endothelial surface of the cornea. The Mishima −Hedbys fixation device for the Haag-Streit slit lamp reduced alignment problems. Various equations were used to calculate corneal thickness. Variables in these equations were the cornea's refractive index and the anterior radius of curvature. These variables, along with the subjective nature of optical pachymetry readings, led to imprecise measurements and further investigation.[48] Because of its subjective endpoints, the accuracy of optical pachymetry is partly dependent on the skill of the examiner. Advantages, however, include relatively low cost and noncontact technique.[56]

Some specular microscopes designed to evaluate the corneal endothelial cell count also measure corneal thickness using electromechanical devices. These were designed to measure central and apical readings only. The measurement derived is based on the distance from the posterior surface of the tear film to the posterior surface of the Descemet membrane, thus inducing an error of as much as 20 or 30 μm. In the contact mode, corneal touch is involved and compression may be another source of error.[56]

Another optical method of measuring corneal thickness utilizes rotating Scheimpflug cameras to obtain corneal tomography images, available on devices such as the Pentacam (Oculus, Wetzlar, Germany) and Galilei (Ziemer, Port, Switzerland). Scheimpflug CCT measurements are highly reproducible and highly correlated with other measures of central corneal thickness but may not always be interchangeable with ultrasound pachymetry.[57,58] An advantage of Scheimpflug imaging is the display of pachymetric values in a map that facilitates evaluation of regional changes in corneal thickness.

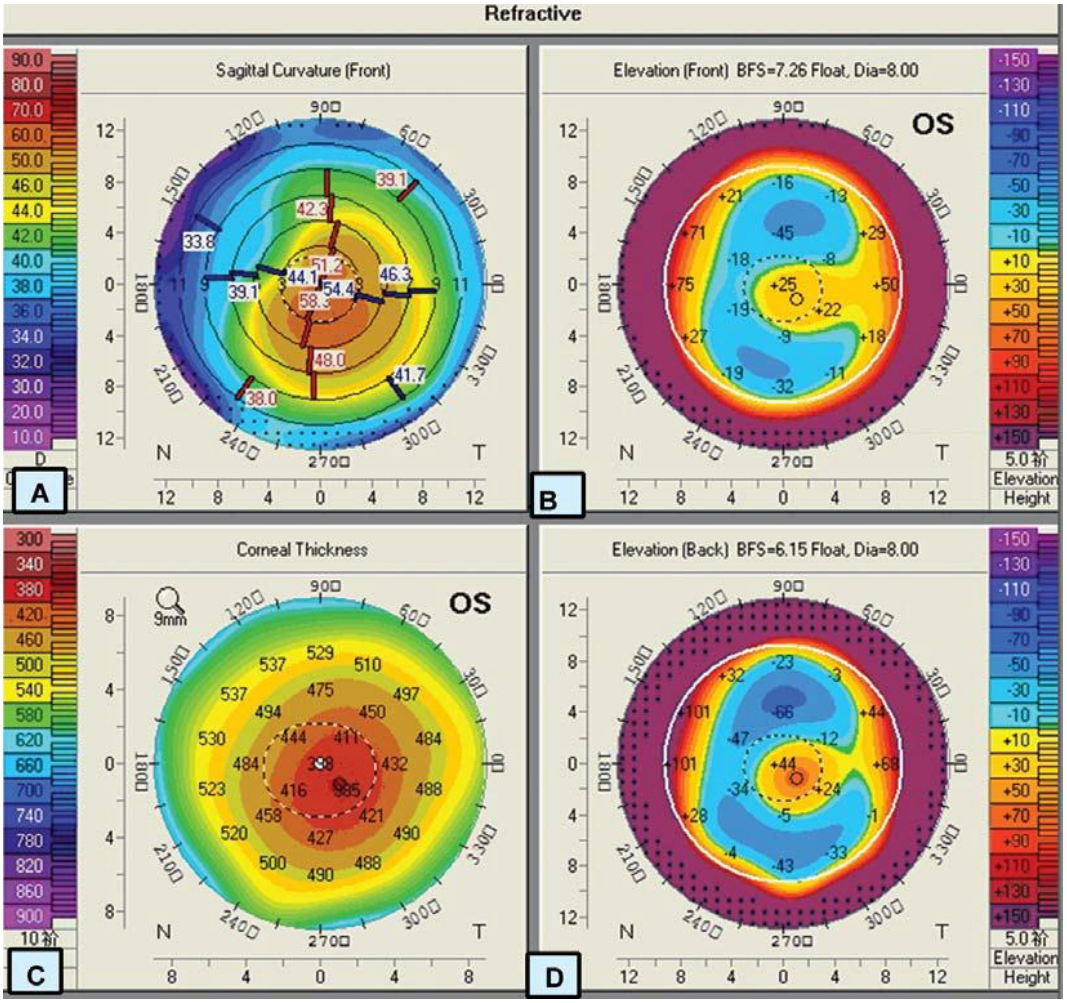


Fig 2: Four map topography display by Pentacam

Since its introduction in 1980, ultrasound technology has improved tremendously. Early units were more expensive, difficult to use, variable, and subject to alignment errors. Salz et al.[59] compared optical pachymetry with three ultrasonic pachymeters and concluded that optical pachymetry had more intersession variation, significant intraobserver variation, and significant right-left thickness differences. Ultrasound pachymetry is not without disadvantages. Topical anesthesia is necessary due to direct contact with the cornea. Contact may be undesirable in the early postoperative period. The handheld nature of the ultrasound probe limits measurement accuracy.[60] Sources of error in pachymetry may be "systematic" or inherent in the methods used in the procedure. Stucchi et al.[25] studied several factors including

repeated measurements, drying of the cornea, patient positioning, and marking. Repeated measurements of the same corneal point showed small variability (<1.5%) and were lower with blinking after each measurement (<1%). After lying down for 3 hours, thickness increased by 2.21%. Pachymetry performed after marking the cornea underestimated thickness in the marked area by an average of .7%.[61] Additionally, modern ultrasound pachymeters are far superior to their predecessors. Significant engineering improvements include the solid-tipped probe, defining the speed of sound in human cornea, continuous-read measurement, automatic gain and angle sensitivity within 5 degrees of axis, advanced electronics and microprocessor control, battery-powered operation, memory storage capability, and 50 MHz high-frequency transducer. Modern ultrasound pachymeters are as light as 3.6 ounces, have a reported accuracy of ±5 microns and resolution of 1 micron, and have an IOP correction factor available.

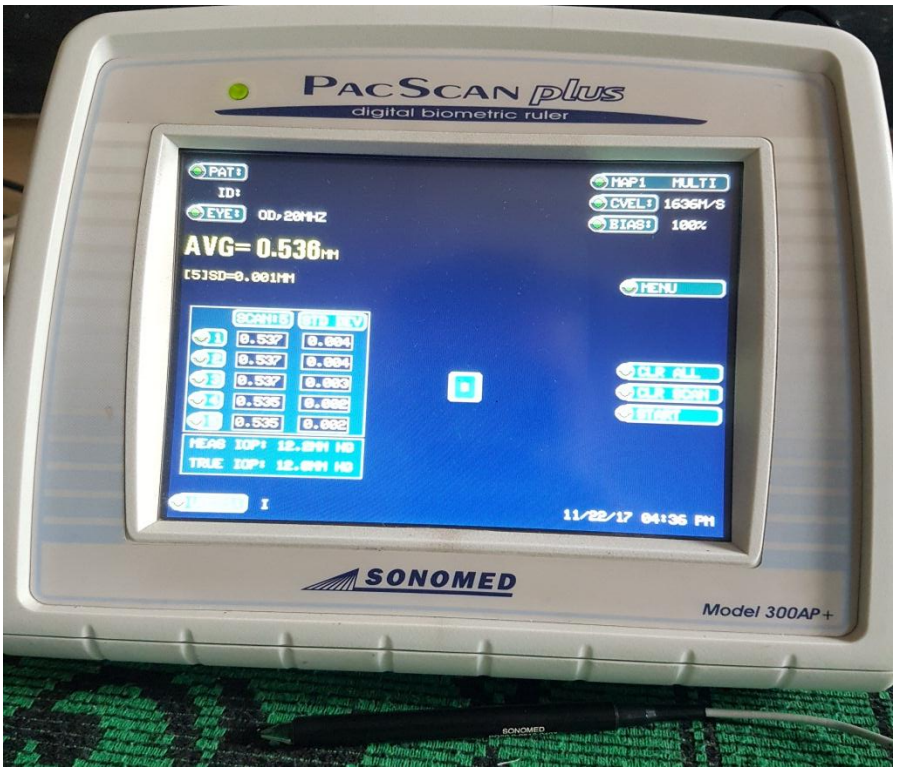


Fig 3 : Measurement of Central Corneal thickness by Ultrasound Pachymetry

The evolution and growth of laser refractive surgery and the importance of preoperative knowledge of corneal thickness have supported refinements in pachymetry. While anterior segment optical coherence tomography (AS-OCT) may not always be used interchangeably with ultrasound pachymetry to measure CCT, it is easy to perform and comfortable for patients, eliminates complications due to corneal contact, and allows quantification of specific structures including the corneal epithelium.[62–65]

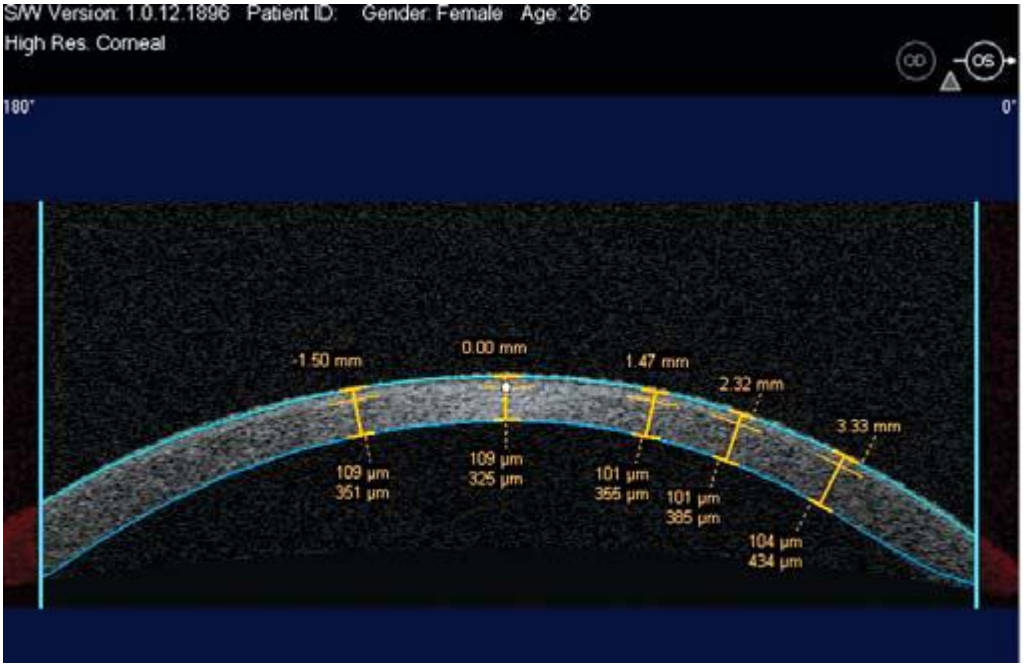


Fig.4: Measurement of thickness of cornea by Optical Coherence Tomography

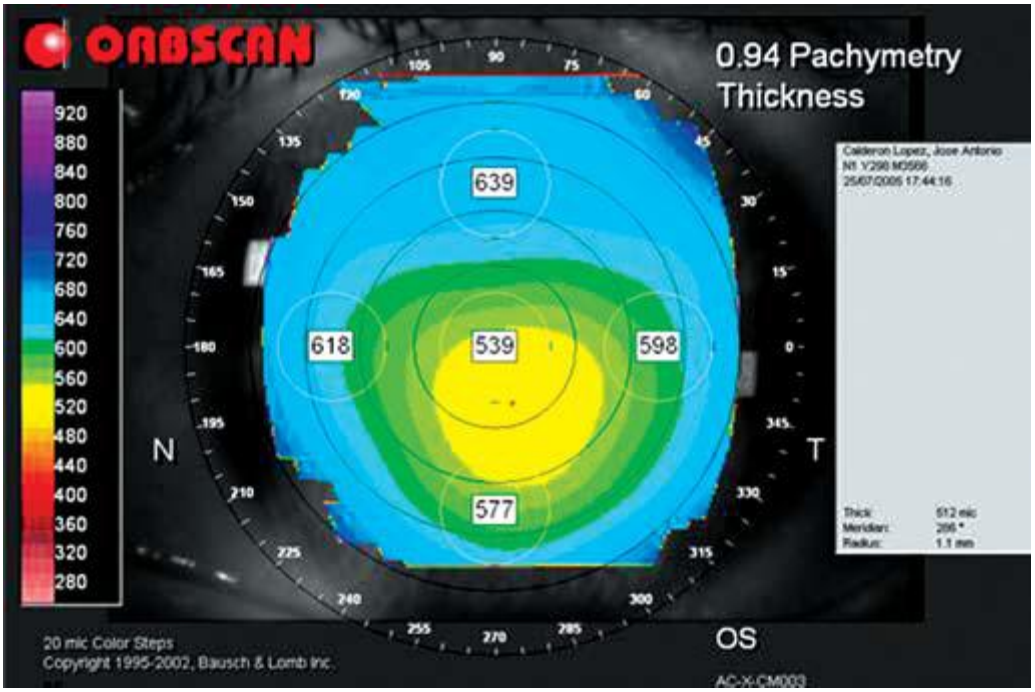


Fig.5: Relation of Central reading with peripheral reading of Corneal thickness by Orbscan

Method	Traditional Ultrasound	Ultrasound Biomicroscopy and Very-High-Frequency Ultrasound	Optical Slit-Lamp Pachymetry	Specular Microscopy Based: Contact and Noncontact	Scanning-Slit Based: Orbscan	Optical Coherence Tomography	Optical Low-Coherence Reflectometry	Confocal Microscopy Through-Focusing	Laser Doppler Interferometry
Operating principle	10- to 20-MHz frequency sound waves	50-MHz (ultrasound biomicroscopy) and 70-MHz sound waves	Image doubling, manual	Measures focus through front-back cornea	Scanning-slit: front-back corneal reflections	Infrared interferometry	Infrared interferometry (like OCT)	Focuses through planes with a confocal microscope	Dual-beam laser Doppler
Contact/ noncontact	Contact	Contact with water bath	Noncontact	Both contact and noncontact	Noncontact	Noncontact	Noncontact	Contact	Noncontact
Resolution	No sublayer pachymetry	Sublayer pachymetry	No sublayer pachymetry	No sublayer pachymetry	No sublayer pachymetry	Sublayer pachymetry	Potential for sublayer pachymetry	High resolution with sublayer pachymetry and cellular details	No sublayer details
Dimensional sections (2D/3D)	Low resolution, NA	High-resolution 3D views possible	No	No	2D display of data	2D display of data	Not available, potential possible	3D views	No
Peripheral pachymetry	Not reliable	Easy to obtain, difficult to standardize	Not reliable	Not reliable	Standard	Easy to obtain, relatively easy to standardize	Not available, potential possible	Requires repositioning	Not reliable
Special applications	Most common method used clinically	Postrefractive surgery: lamellar thickness	Slit-lamp mounted	Simultaneous measurement of cell counts	Postrefractive surgery	Postrefractive surgery	Intraoperative measurement during laser ablations	Cellular morphology/ detail; detects microbes	Can measure axial length
Advantages	Fast, simple, dry technique	Sublayer detail	Simple	Measure cell counts concurrently	Concurrent topography/ elevation data	Measures through opacity, high resolution	Intraoperative measurements possible	High resolution, can quantify haze/light scatter	Purportedly good precision
Disadvantages	Not accurate in edematous corneas, difficult to reposition/ standardize location with precision	Requires water bath, risk of corneal abrasion, complicated technique, difficult location standardization	Manual: observer-dependent precision	Contact method: risk for abrasion of corneas	May be less accurate post–laser *in situ* keratomileusis or in corneas with haze	Interinstrument variability, preliminary clinical experience to date	Currently not able to acquire 2D or 3D images, same as for OCT	Slow data acquisition, poor penetration of corneal opacity, contact method, minimal clinical experience	Minimal clinical experience reported to date

Table 1: Comparison of Pachymetry methods.(Courtesy: Smolin and thoft's The Cornea Scientific Foundations and Clinical Practice 4th edition)

Myopia

The word myopia is derived from the Greek language by Galen. In Greek - from the words myein means to close and ops means the eye (Borish 1970).

The word myopia describes the ancient observation that affected individuals habitually approximated their eyelids to form a stenopaeic slit to improve the image quality. Myopia is also known as near sight because myopia persons have good uncorrected visual acuity at near within an arm's length.

Definition:

Myopia or short sight is that form of refractive error wherein parallel rays of light come to a focus in front of the retina when the eye is at rest.[66]

History of Myopia:

Aristotle (384-322 BC) was the first to describe short sight while it was only Galen (130-200AD) who attempted to put the problem of myopia within the physiological concepts of his days, the theory of humours. The optics of myopia was first elucidated by Johannes Kepler (1604) in his initial clarification of ophthalmic dioptrics when he correctly assumed that the incident light was brought to focus in front of the retina. Von–Graefe (1954) was the first to correlate the ophthalmoscopic and degenerative changes of pathological myopia.[67] Hirschberg (1982) attributed the first discussion of myopia and presbyopia to Aristotle. The relevant discussions were entitled in Aristotle's book ,Problemata and similar to this was Plato's book which constituted the oldest citations explaining the concept of myopia.[68] The first satisfactory definition of the condition was stated by Kepler in 1611, and Plempius (1632) first examined the myopic eye

anatomically and attributed the condition to a lengthening of its posterior part. Donders (1866) established its pathological basis and detailed its clinical manifestations.[66]

Epidemiology:

Myopia is an increasingly important global public eye health problem. In the past two decades, the prevalence among young adolescents has increased from 5-10% to 10-25% in industrialized societies in Europe and North America, and by over 25% to 60-80% in East Asia.[69] In some parts of Asia, myopia is very common. Singapore is believed to have the highest prevalence of myopia in the world; up to 80% of people there have myopia, but the accurate figure is unknown.[70] China's myopia rate is 31%. However, some research suggests the prevalence of myopia in India in the general population is only 6.9%.[71]

Rakhi D et al., in 1996 studied 1,722 subjects > 15 years of age in Hyderabad city, India. Prevalence of Myopia in subjects > 15 years of age was 19.39% & found that there was no significant interaction between education and socioeconomic status and no significant association of myopia with gender, socioeconomic status, religion, or self-reported diabetes.[4]

OPTICS OF MYOPIA

At birth, the eyeball is relatively short having +2 to +3 Dioptre hypermetropia. This is gradually reduced until by the age of 5-7 years the eye is emmetropic and remains so until the age of about 50 years. After 50 years, there is a tendency to develop hypermetropia again which gradually increases until at the extreme of life and by 80 years, the eye has the same +2 to +3 Dioptre with which it started.[1]

The dioptric power of a myopic eye is too powerful for its axial length or the eye is too long for its dioptric power, so that parallel rays of light come to a focus in front of the retina (Fig. 5A). And hence the image of the distant object on the retina is made up of the circles of diffusion formed by the divergent beam.

Far point (punctum remotum) in the myopic eye is a finite point in front of the eye and higher the myopia shorter the distance therefore, a near object situated at the far point is focused without an effort of accommodation (Fig. 5B).

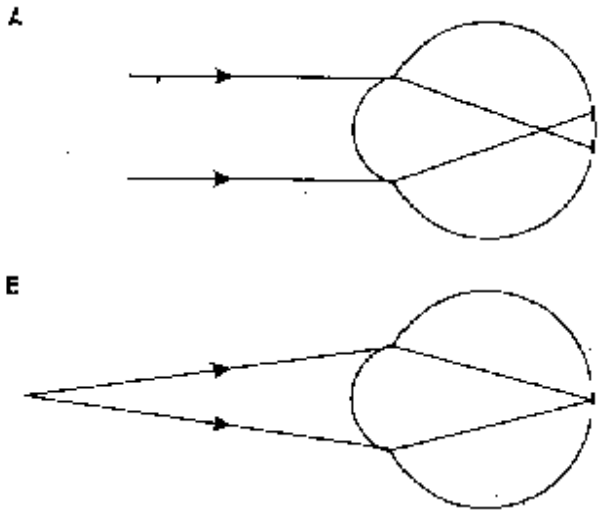


FIG.6: OPTICS OF MYOPIA.

a) Parallel rays are focused in front of retina;

b) Divergent rays from and object at the far point of the eye are focused at the retina.

Nodal point in a myopic eye is farther away from the retina. Therefore, the image formed will be appreciably larger than it would be in the emmetropic eye. With correcting spectacles, however, the opposite holds good and the image appear smaller and brighter (Fig. 6 A & B). To some small extent, this compensates for the poor visual acuity. Angle Kappa of the eye may be negative resulting in an apparent convergent squint.[1]

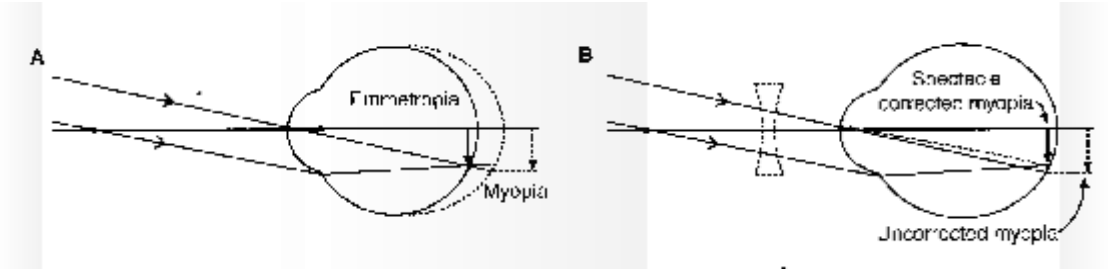


FIG. 7: IMAGE FORMED IN AN UNCORRECTED MYOPIA IS LARGER THAN THAT FORMED BY AN EMMETROPIC EYE (A) AND SPECTACLE CORRECTED MYOPIA (B)

The visual acuity in myopia:

Visual acuity beyond the far point is seriously affected in uncorrected myopia, being reduced by about the same ratio as occurs in absolute hypermetropia (Eggers 1945).[72] It is impossible to predict accurately in any individual case what the uncorrected vision and refractive error in Dioptre should be, but it has been found that the visual acuity and the error, in general, are closely correlated.

TABLE 2: VISUAL ACUITY AND MYOPIA.

Myopia in D	-0.5	-1.0	-1.5	-2.0	-3.0	-4.0	-5.0	-6.0
VA	20/25	20/65	20/110	20/165	20/285	20/420	20/565	20/675

Aetiology and Risk factors of Myopia:

Age: Myopia is common in premature infant, not so common is new-born infant, and rare by age 6 months. Premature and low birth weight infants have higher risk of developing myopia later in life, there is a sharp rise in incidence of myopia from ages 5-20 years and then gradually there is a decline in the incidence throughout middle and advancing age. The refraction of the infant eye

averages +2.00 to +3.0 D. The prevalence of myopia is greatest in adolescence, reaching approximately 25% and reflecting the tendency of hyperopia to decrease and myopia to increase.

Heredity: Heredity is an unarguably the most significant factor in causation and progression of myopia. Linkage studies have identified 18 genetic loci on 15 different chromosomes that are associated with myopia. That means no single gene(s) are responsible for the disease.

There is a greater prevalence of myopia in children of myopic parents than in children of nonmyopic parents.[73] Siblings and offspring of a myopic person has, on an average, a three to five times greater chance of being myopic than people without such a myopic relative.[74]

Nutrition Like so many dietary deficiencies or dietary anomalies linked with certain diseases, myopia also finds a place in this list. Poor diet lacking especially in proteins has been implicated in myopia. Hyperinsulinemia, insulin resistance, insulin-like growth factor, carbohydrate metabolism disturbances, all have hypothetical attributions in myopia.

Environmental Factors: The evolution of eyes has been going on for millions of years. Human eye, as many authorities suggest, was not programmed for so much of near work. The environment to which the human body was adapted over millions of years does not match our present environment. Its function was to view landscapes, mountains and meadows. The stress of constant near work, compounded by the use of computers and other gadgets, has increased the prevalence of myopia. Lopsided reading habits, artificial lighting, reversal of biological clock, all have contributed to the increase in myopia. There is evidence that lack of normal stimuli causes improper

development of the eyeball. The ‘normal stimuli’ refers to the environment. Modern humans, who spend most of their time indoor in dimly lighted or fluorescent lighted rooms, are not giving their eyes the appropriate visual stimuli and may be contributing to myopia. Certain races in Africa and Arctic regions who mostly lead a life of hunting and wandering outdoors, have the lowest rate of myopia. Intelligence and Myopia A large number of studies have reported a relationship between myopia and high IQ. Explanations to this effect point to intensive near reading by studious children. Another study shows that certain ‘pleiotropic’ gene(s) affect the development of both the brain and the eye simultaneously. Some reports suggest that high IQ and myopia co-exist, independent of excessive reading or near work.

Near Work Hypothesis: Lot of thought has gone into the relationship of near work with the development of myopia. This hypothesis is also referred as the ‘useabuse’ theory, which correlates the progression of myopia with excessive use of our eyes for near work. This produces excessive stress on our accommodation-convergence mechanism. There are two main points to support this hypothesis. Firstly, continuous near work causes constant convergence, which in turn creates constant stress on the extraocular muscles, increases their tone and puts pressure on the globe. Secondly, the continuous accommodative stress on the ciliary muscles, under constant phase of contraction slowly builds pressure in the eye, and the eyes of children which are still developing, may overgrow in size.[75]

CLASSIFICATION OF MYOPIA:

1. CLASSIFICATION BY THE ANATOMICAL FEATURES OF MYOPIA[76]
    - Axial myopia
    - Refractive myopia
    - Index myopia
        - Congenital
        - Acquired
    - Curvature myopia
2. **CLASSIFICATION BASED ON THE DEGREE OF MYOPIA**
    - Mild myopia < -3.0
    - Moderate myopia - 3.0 to 6.0 D
    - High myopia > -6.0 D
3. **CLASSIFICATION BASED ON THE AGE OF ONSET**
    - Congenital myopia
    - Youth onset myopia
    - Early adult onset myopia
    - Late adult onset myopia
4. **Duke-elder classification**
    - Simple myopia
    - Pathological myopia
5. **Clinical classification[75]**
    - Simple myopia
    - Nocturnal myopia
    - Pseudomyopia
    - Degenerative myopia
    - Induced myopia

Classification based on the age of Onset:

Grosvenor (1987) classified myopia into the following categories.[77,78]

Congenital myopia: Myopia is present at birth and persists through infancy. But it is usually diagnosed by the age of 2-3 yrs.[1] It is seen more frequently in prematurely born children or with various birth defects, such as marfan's syndrome and homocystinuria. Most of the time myopia is unilateral. It is usually associated with an increase in axial length and overall globe size. It may be associated with congenital convergent squint. Usually the error is of about 8-10 Dioptres, which mostly remains constant. It may be associated with other congenital anomalies such as cataract microphthalmos, aniridia, megalocornea and congenital separation of retina. The child will have difficulty in seeing the distant objects and will hold the things very close for viewing. Unilateral congenital myopia is frequently discovered either by routine screening examination or after a strabismus develops because of the associated amblyopia. Early correction of congenital myopia is desirable to help the child to develop normal distant vision, and perception of the world. The full cycloplegic refractive error including any astigmatic correction should be prescribed. Achieving 6/6 vision is very difficult. The prognosis for good vision and normal binocularity is poor in unilateral cases if the anisometropia and myopia are severe. The prevalence of this form of myopia, which is usually of sufficient amount to persist throughout life, is about 2%.

Youth onset myopia: The onset of myopia occurs between 6 years of age and the early teens. During this period, the prevalence of myopia (of 0.50 D or more) increases from about 2% ate 6 to about 20% at age 20. A large percentage of youth-onset myopes have a relatively small amount of myopia, and many of them will

become emmetropic or even hyperopic in later years, with result that the prevalence of this form of myopia would be expected to decrease during adult years.

Early adult onset myopia: Onset of myopia occurs between 20 and 40 years of age and brings the prevalence of myopia to about 30% during this period of life. Many of those will have only a small amount of myopia and will become emmetropic or even hyperopic in their later years.

Late adult onset myopia: Myopia onset occurs after 40 years of age, with the prevalence gradually increasing in the later years of life. The major cause of this form of myopia is incipient nuclear cataracts.

Duke-Elder classification:

Simple Myopia:

Simple or developmental myopia is the commonest variety. It is considered as the physiological error not associated with any disease of the eye. Its prevalence increases from 2% at 5 years to 14% at 15 years of age. Since the sharpest rise occurs at school going age that is between 8 years to 12 years, so it is also called as school myopia.[66, 1]

Etiology: It results from normal biological variation in the development of eye which may or may not be genetically determined. Some factors associated with simple myopia are as follows.

- Axial type: May signify just a physiological variation in the length of the eyeball.
- Curvatural type
- Role of diet: In early childhood has also been reported.[48]

- Role of genetics - Genetics plays some role in the biological variation of the development of eye, as prevalence of myopia is more in children with both parents myopic (20%) than the children with one parent myopic (10%) and children with no parent myopic (5%).[1]
- Theory of excessive near work in childhood was also put forward

Clinical picture:

Symptoms:

Poor vision for distance (Short-Sightedness) is the main symptom of myopia.

- Asthenopic symptoms-with small degree of myopia like eye strain, headache, early fatigue
- Half shutting of the eyes may be complained by parents of the child.
- Holding books near while reading
- Squint, photophobia,
- Rubbing of eyes.
- Repeated attacks of Hordeolum externum, Hordeolum internum and Chalazion.
- Floaters occasionally.
- Night blindness
- Contraction of visual fields.
- Scotoma.

Signs:

- Prominent eyeballs, large cornea,
- Deep anterior chamber
- Pupils – large and a bit sluggishly reacting to light.
- Fundus is normal, rarely temporal myopic crescent may be seen.
- Magnitude of error: usually does not exceed 6-8 D.

Pathological myopia:

Degenerative / Progressive myopia, as the name indicates, is a rapidly progressive error which starts in childhood at 5-10 years of age and results in high myopia during early adult life, which is usually associated with degenerative changes in the eye.

Etiology: It results from a rapid axial growth of the eye ball which is outside the normal biological variations of development. It is linked with hereditary and general growth process.

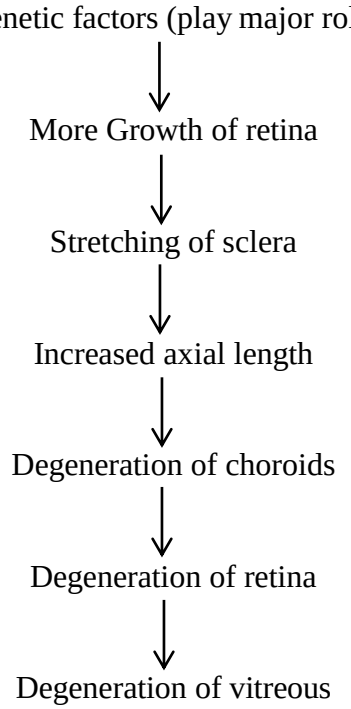
Role of heredity: Genetic factors play a major role in the etiology as the progressive myopia is

- Familial
- More common in certain races like Chinese, Japanese, Arabs and Jews, and
- Uncommon among Negroes, Nubians and Sudanese.

It is presumed that heredity-linked growth of retina is the determinant in the development of myopia. The sclera, due to its distensibility follows the retinal growth, but the choroid undergoes degeneration due to stretching, which in turn causes degeneration of retina.

Role of general growth process: Lengthening of the posterior segment of the globe commences only during the period of active growth, and ends with the termination of the active growth. Therefore, the factors (such as nutritional deficiency, debilitating diseases, endocrinal disturbances and indifferent general health), which affect the general growth process will also influence the progression of myopia.

The etiological hypothesis for pathological myopia is summarized below.



Clinical features:

Symptoms: [72, 79]

- Defective vision for distance and uncorrectable loss of vision may occur due to progressive degenerative changes.
- Muscae volitantes that is floating black opacities in front of the eyes are also complained of by many patients. These occur due to degenerated liquefied vitreous.
- Night blindness-Complained by very high myopes having marked degenerative changes.
- Repeated attacks of Hordeolum externum, Hordeolum internum & Chalazion.
- Contraction of visual fields.
- Scotoma
- Rubbing of the eyes.
- Asthenopic symptoms, early fatigue, headache and watering.
- Reduced contrast sensitivity.[52,53]

Signs:

- Prominent eyeballs: Elongation of the eyeball mainly affects the posterior pole and the surrounding area; the part of the eye anterior to the equator may be normal Cornea is large and curvature will be more.
- Refractive index of the lens may be increased and it may be moved anteriorly.
- Anterior chamber is deep.
- Pupils are slightly large and react sluggishly to light
- Axial length is increased
- Angle Kappa: Angle Kappa is the angle between visual axis and pupillary axis. In emmetropic eyes it is positive and negative in high myopia.
- Fundus examination:
    - Optic disc appears large and pale and at its temporal edge, a characteristic myopic crescent is present. Peripapillary crescent encircling the disc due to distraction of choroid and retina away from the disc margin may be present.
    - Degenerative changes in retina and choroid:
        - Tigroid appearance of fundus because of visible prominent large choroidal vessels following atrophy of retinal pigment epithelium and choriocappilaries.
        - Total disappearance of choroidal tissue, characterized by white atrophic patches due to visible sclera with a little heaping of pigment around them in latter stages.
        - Foster-Fuch's spot: dark red circular patch due to subretinal neovascularization and choroidal haemorrhage.
        - Cystoid degeneration

        - Total chorioretinal atrophy in advanced cases
        - Lattice degeneration and/or snail track lesion.
    - Posterior staphyloma due to ectasia of sclera at posterior pole may be apparent as an excavation, with vessels bending backward over its margin.
    - Degenerative changes in vitreous: like liquefaction, vitreous opacities and posterior vitreous detachment, appearing as weiss' reflex.
- Visual fields show contraction and in some cases ring scotoma.
- Electroretinography reveals subnormal electroretinogram due to chorioretinal atrophy.

Complication

- Retinal tears and retinal detachment
- Complicated cataract
- Vitreous haemorrhage
- Choroidal haemorrhage and thrombosis
- Primary open angle glaucoma, actually not a complication but an association.[1]

MANAGEMENT OF MYOPIA

Optical treatment of myopia constitutes prescription of appropriate concave lenses, so that clear image is formed on the retina. Apart from the elimination of any pathological changes in the fundus, the eyes should be examined at frequent intervals to assess the significance of any progress, particularly when a hereditary tendency to myopia is shown.

1) VISUAL REHABILITATION

a) Optical correction by

- Spectacle lenses
- Contact lenses
- Low visual aids

b) Surgical correction by[1]

- Radial keratotomy
- Photorefractive keratectomy
- Laser in-situ keratomileusis
- Clear lens extraction
- Phakic IOL
- Intracorneal ring implantation
- Orthokeratology
- Epikeratophakia

2) PREVENTION OF MYOPIC PROGRESSION

a) General supportive measures

b) Modification of ocular use

c) Contact lens

3) PROPHYLAXIS

MANAGEMENT OF MYOPIA

The aim of management of simple myopia is visual rehabilitation and prevention of myopic progression. Myopic eyes should be thoroughly examined. Ocular motility, IOP measurement and fundus examination is mandatory, to have a baseline observation. Retinoscopy should be done under cycloplegia, and for the patients under the age of 6 years, atropine ointment is preferred.

The prescription of spectacles for young myopic subjects is psychologically important, with their optical defect uncorrected, they develop in a limited world wherein they are at a considerable disadvantage in comparison with others, a handicap which may entail a seeming limitation of intelligence and a curtailment of interests which are frequently ascribed to stupidity and backwardness, or to naughtiness, while they are really due to the physical defect; avoiding outdoor sports and prone to introspection, debarred from free mixing with their fellows and unable to enjoy a full appreciation of life; they frequently tend to grow up with introverted mental habits and peculiarities.

Poor vision and inability to read the material on the blackboard can have a serious impact on a child's participation and learning in class and this can adversely affect the child's education, occupation and socio-economic status for life.

The problem of poor vision due to myopia is so prevalent that it does not only interfere with the children's ability to attend classes and study, but also creates grave social consequences. Teachers who do not realize the plight of the problem, for example, accuse them persistently. Unsympathetic classmates also pester them and laugh at them in the classrooms as well as in the playgrounds. Even their parents and siblings undermine and discourage this unfortunate children.[80]

Lower contrast sensitivity as observed with myopes is associated with impaired perception of "real world targets,"[81] poorer flight performance in aircraft simulators[82] and deficits in visual spatial attention.[83]

1) VISUAL REHABILITATION:

a) Optical correction:

Spectacle lenses: The optical correction of myopia is accomplished by interposing a concave lens between cornea and the far point of the eye. Myopia should never be overcorrected. This can be done with duochrome test, which gives an extremely precise end point when the red objects are seen slightly more clearly than the green.

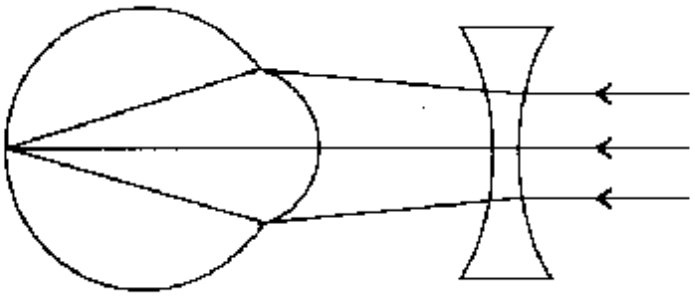


Fig. 8 : Refraction in a myopic eye corrected with concave lens.

But motility disorders can vary the final prescriptions to some extent. A young symptomatic myopia with moderate esophoria may function better with some degree of under correction. Adolescent may not accept full correction for near work, because they are accustomed to read without exercising accommodation, he may indeed be more comfortable without spectacles or with weaker lenses. It should be

impressed upon him that in the matter of near work, they are not intended to improve his vision but to allow him to use his eyes in their normal relationship.

In adults, on the other hand, in whom visual habits have become stabilized, such a care is unnecessary and the constant use of spectacles need not be insisted upon; moreover, in the absence of previous correction it will frequently be found that the ciliary muscle is not equal to the unaccustomed task of accommodating efficiently, so that a lens of slightly lower power may be prescribed with comfort for reading.

In the lower degrees of myopia, the necessary for regular supervision once the condition is static is questionable; in general low myopes change little after the end of adolescent and they may be confidently advised to return for further examination only if their spectacle frames or lenses become physically damaged or if they notice any deterioration in their corrected vision. They should be reassured that the latter event is unlikely in any event before the age of 40 years. Above the age of 40 years, when accommodation fails physiologically, weaker lenses for near work are advisable or the spectacles can be removed.

In the higher degree of myopia, full correction can rarely be tolerated largely because the images formed by strong concave lenses are diminished and very bright and clear, and the patient, accustomed to interpret hazy diffusion circles, is intolerant of them. A compromise must therefore be adopted, and while an attempt is made to reduce the correction as little as is compatible with comfort for binocular vision, lenses are prescribed with which greatest visual acuity is obtained without distress. The amount which has to be deducted usually varies from 1 to 3D, but in the highest grades spectacles even weaker than these will be found necessary. In these cases

contact lenses may be of value if they are easily tolerated. Optical correction of pathological myopia is the same as that of simple myopia. In higher degree of myopia, full correction is less tolerated. Vertex distance of new lenses should always be noted on the prescription. Small frames can be preferred to reduce the weight. Thick edge can be camouflaged by coloring the edges of the lens as that of the frame. Plastic lenses are better. In cases where in degenerative changes have taken place in the macular area telescopic spectacles are of value.

If the spectacles are not worn constantly, especially in high myopia, the requisite amount of convergence for near work may be impossible. The effort to converge is thus abandoned so that reading and other near work may become uniocular and the disused eye may become divergent.[79,60]

Contact lenses:

These offer both optical and cosmetic advantages over spectacles. Both hard and soft contact lenses can be used in myopic patients. Rigid contact lenses require less care and produce better results and can correct substantial degree of astigmatism. Soft contact lenses are easy to wear and have better patient compliance. But they require more care and maintenance. Low myopia being perhaps the most widespread indication for their use. They offer dramatically improved appearance and enhance the visual acuity in high myopes.

ADVANTAGES OF CONTACT LENSES OVER SPECTACLES: OPTICAL:

- Near normal image size.
- Wider field of vision
- Elimination of distortions and aberrations associated with spectacles
- Minimal prismatic experience.
- Better adaptation in anisometropics.

COSMETIC:

- Spectacles can be avoided
- Appearance of small eye behind the spectacles is overcome.
- Large and attractive globe is seen.

Disadvantages of contact lenses:

Greater effort of accommodation and convergence is required; this may be of no consequences in young myopes, but is important for presbyopic patients in whom difficulties in near vision may be precipitated.

Moderate degrees of myopia are ideally corrected by corneal lenses, and a variety of fitting techniques and designs are available. The choice of which depends upon the personal fancy and experience of the individual practitioner.

In the higher degree, the optical advantage of the corneal contact lenses are correspondingly increased, but problems arise in their fitting i.e. lenses are heavy and every effort is made to fashion them to be as thin as possible; a central thickness of 0.1 mm or slightly less is about the minimum that can be produced consistent with mechanical stability.

Low vision aids:

In case of high myopia, the most useful low vision aid for distance is the telescopic lens. The disadvantages of these are their weight and restriction of peripheral field. New models feature a small telescopic lens inserted eccentrically to the normal visual axis, and can be brought into play only when patient needs to discern greater details. These lenses give advantages of telescopic magnification without the restriction of visual field.[84]

a) SURGICAL CORRECTION OF MYOPIA:

The earliest report of surgery to change refractive error dates back to 1885, when Schiotz[85] used a limbal relaxing incision (LRI). In 1894, Bates[86] noticed flattening in the axis of traumatic peripheral corneal scars. In 1898, Lans[87] also described methods to reduce astigmatism. In 1939, Sato[88] was the first to describe posterior corneal incisions for the treatment of astigmatic error in keratoconus. Sato's technique led to corneal decompensation and was modified to anterior incisions by Yanaliev.[89] He published his results of 426 incisional refractive cases between 1969 and 1977.[90] Fyodorov and Durnev[91–93] continued to refine keratotomy and popularized the technique. In 1978, Bores, Myers, and Cowden were the first in the United States to perform radial keratotomy and report their results.[94,95] Lamellar methods for refractive surgery were evolving simultaneously. Jose Barraquer was the first to correct refractive error through lamellar surgery.[96-100] More recently, in addition to incisional and lamellar surgery, the field of refractive surgery has expanded to include intracorneal and intraocular implants. Today, the field of refractive surgery has evolved to include many modalities for the treatment of different refractive errors.

Surgery to correct myopia has become very popular and it should be performed after the error has stabilized preferably after 20 years of age.[1,101] Refractive surgery is now the second most common procedure in Singapore after cataract surgery.[102] Various techniques in use are described below:

1. RADIAL KERATOTOMY: (RK)

It refers to making deep (90% of corneal thickness) radial incisions in the peripheral part of cornea leaving the central 4mm optical zone (Fig. 8A &B). These incisions on healing; flatten the central cornea thereby reducing its refractive power. This gives very good correction in low to moderate myopia (2-6D).

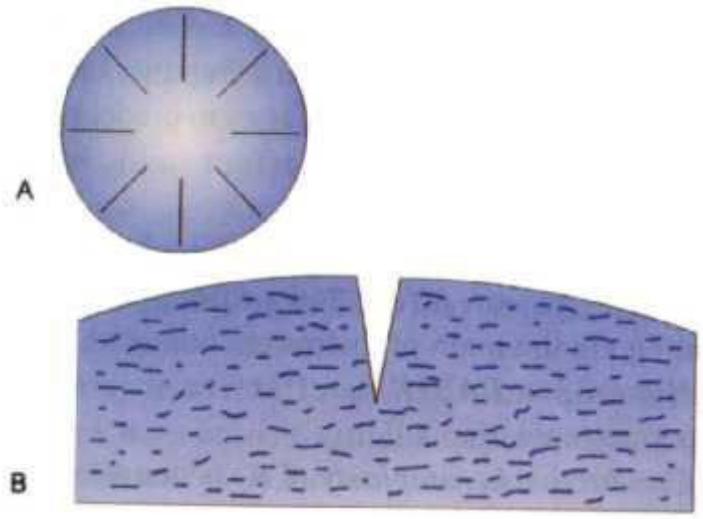


FIG. 9 : RADIAL KERATOTOMY

A) Configurations of radial incisions B) Depth of incision.

Disadvantages Cornea is weakened, so chances of globe rupture following trauma are more after RK than after PRK. This point is particularly important for patients who are at high risk of blunt trauma e.g. sports persons, athletes and military personnel.

- Rarely uneven healing may lead to irregular astigmatism.
- Patients may feel glare at night.
- Perforation and infection.

Because of its disadvantages. RK is not recommended presently.

2. PHOTOREFRACTIVE KERATECTOMY (PRK):

In this technique, to correct myopia a central optical zone of anterior corneal stroma is photoablated using excimer laser (Fig. 9 A & B). Like RK, the PRK also gives very good correction for -2 to -6D of myopia.

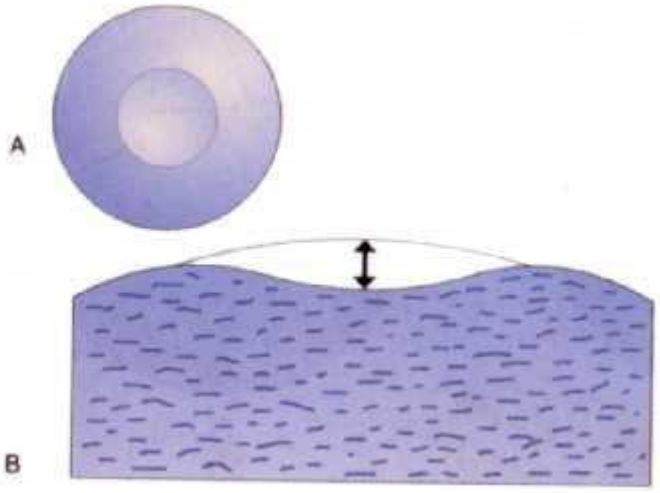


FIG 10 : PRK FOR MYOPIA AS SEEN A) FROM FRONT B) IN CROSS SECTION

DISADVANTAGES:

- Postoperative recovery is slow; healing of the epithelial defect may delay return of good vision and patient may experience pain or discomfort for several weeks.
- There might be some residual corneal haze in the center affecting vision.
- PRK is more expensive than RK.
- Loss of contrast sensitivity.

Because of these disadvantages, PRK is not recommended presently.

3. LASER IN-SITU KERATOMILEUSIS (LASIK):

In this technique, first a flap of 130-160 micron thickness of anterior corneal tissue is raised. After creating a corneal flap, midstromal tissue is ablated directly with an excimer laser beam, ultimately flattening the cornea (Fig. 10 A, B & C). Currently this procedure is being considered the refractive surgery of choice for myopia of upto-12D.[101,103]

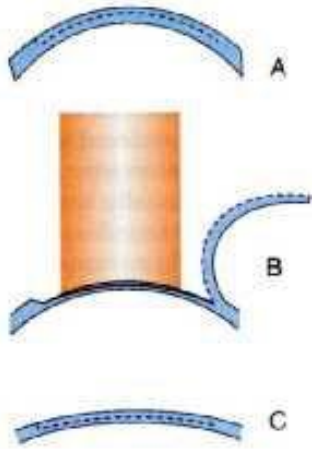


FIG. 11 : LASIK A) MICROKERATOME CUT, B) LASER PHOTOABLATION WITH FLAP LIFTED, C) FLAP REPOSITED. THINNER, FLATTER CORNEA.

PATIENT SELECTION CRITERIA ARE:

- Patients above 18 years of age,
- Stable refraction for 12 months (A change of refraction within ± 0.5 over one year is considered stable).
- Motivated patient.
- Absence of corneal pathology, presence of ectasia or any other corneal pathology and a corneal thickness less than 450 microns is an absolute contraindication for LASIK.

ADVANCES IN LASIK:

Recently many advances have been made in LASIK surgery.

A. CUSTOMIZED (C) LASIK:

C-LASIK is based on wave front technology. This technique, in addition to spherical and cylindrical correction, also corrects the aberrations present in the eye and gives vision beyond 6/6 i.e. 6/5 or 6/4.

B. EPI-(E) LASIK:

In this technique, instead of corneal stromal flap only the epithelial sheet is separated mechanically with the use of customized device (Epiedge Epikeratome). Being an advanced surface ablation procedure, it is devoid of complications related to corneal stromal flap.

ADVANTAGES OF LASIK:

- Minimal or no postoperative pain.
- Recovery of vision is very early as compared to PRK.
- No risk of perforation during surgery and later rupture of globe due to trauma unlike RK.
- No residual haze unlike PRK where sub epithelial scarring may occur
- LASIK is effective in correcting myopia of -12D.

DISADVANTAGES OF LASIK:

- LASIK is more expensive.
- It requires greater surgical skill than RK and PRK.
- Flap related complications like
    - Intra-operative flap amputation.
    - Wrinkling of the flap on repositioning.
    - Postoperative flap dislocation/subluxation.
    - Epithelization of flap-bed interface.
    - Irregular astigmatism.

4. CLEAR LENS EXTRACTION (FUCALA,S OPERATION):

This has been advocated for myopia of -16 to -18D, especially in unilateral cases. Recently clear lens extraction with intraocular lens implantation of appropriate power is being recommended as the refractive surgery for myopia of more than 12D.

Disadvantages:

- Retinal detachment
- Endophthalmitis.

5. PHAKIC IOL (INTRAOCULAR CONTACT LENS IMPLANTATION):

Is considered for correction of myopia of >12D. In this technique, a special type of intraocular lens is implanted in the anterior chamber or posterior chamber anterior to the natural crystalline lens.

COMPLICATIONS:

- Endophthalmitis.
- Cataract.

6. INTRACORNEAL RING (ICR) IMPLANTATION OR INTACS:

ICR implantation into the peripheral cornea at approximately 2/3rd stromal depth is being considered. It results in a vaulting effect that flattens the central cornea, decreasing myopia. The ICR procedure has the advantage of being reversible. It corrects myopia upto-6.0 Dioptres.

Disadvantages being unpredictable results and keratitis.

7. ORTHOKERATOLOGY:

A nonsurgical reversible method of molding the cornea with overnight wear unique rigid gas permeable contact lenses is also being considered for correction of myopia up to -5D. It can be used even in patients below 18 years of age.

8. EPIKERATOPHAKIA:

This technique was first developed by Kaufman in 1979. This technique involves removing the recipient epithelium after making a little peripheral trephine mark of defect in bowman's membrane. A freezed or lyophilized piece of stroma is placed on the surface of the recipient cornea and sutured into stroma. The epithelium grows over the Bowman's membrane to cover the new surface and in effect, a living contact lens has been applied.

2) PREVENTION OF MYOPIC PROGRESSION:

a) General supportive measures: Like balanced diet, with abundant amount of proteins, vitamins especially vitamin C and calcium. Regular exercises and outdoor games are advised.

b) MODIFICATION OF OCULAR USE:

Patients are occupationally rehabilitated to prevent excessive close work, ocular hygienic measures like avoiding close work, reading under well illuminated conditions in proper posture. The clarity of print should be suitably supervised and undue ocular fatigue should be avoided. The amount of work should be adjusted to the general physical and mental development of the child rather than to the degree of myopia, and only if the child appears strained under the forced or competitive stress of school life which is sometimes considerable should be withdrawn from school or his study cut down.

c) CONTACT LENSES:

Rigid contact lenses have been used in several clinical trials, as it is postulated that these lenses retard myopia progression by causing corneal flattening.[78]

EFFECT OF CONTACT LENSES OVER THE ARREST OF PROGRESSION OF MYOPIA:

There is a difference of opinion as regards to it. Some says it arrests the progression of myopia and some says myopia may progress to its destiny in spite of wearing and still some other are of the opinion that myopia may increase when the use of contact lenses have been discontinued.

As per as the management of simple myopia is concerned whether the patient be an adult or child, the extent to which spectacles are worn, the amount of near work done, peculiarities of diet or the administration of drugs are of small moment provided that hygienic conditions are good, over strain is avoided and the general standards of health and development are maintained.

MYOPIA CONTROL:

Attempts to slow the progression of myopia are considered as myopic control. There are presently a number of options for myopia prevention and control. That Thatinclude[78,104-109]:

- Bifocals.
- Rigid contact lens
- Topical eye drops like atropine
- Agents that lower intraocular pressure.
- Optical lenses
- Biofeedback methods.

However the effectiveness of some of these methods is questionable, and there is inadequate scientific evidence for implementation in a population setting.

Many clinical trials lacked randomization, had high dropout rates or failed to account for confounding. On the other hand it is difficult to prescribe interventions to reduce exposure to either intermediate or distal factors like education, near work and living conditions.

3) PROPHYLAXIS:

Prophylactic eugenic measures should be adopted. There need be no restraint on marriage and procreation among simple myopes; but a parent with degenerative myopia should be warned that any offspring will be liable to the same disability according to the laws of Mandelian inheritance. Two highly myopic parents with degenerative changes should never-from the medical point of view-have children. The children of such parents should be closely supervised from their earliest years and if an increase in refractivity appears to evolve more rapidly than would normally be expected, they should be treated as if they were myopes.[72,79]

In 2001, Shu-Wen Chang, I-Lun Tsai, Fung-Rong Hu, Luke Long-Kuang Lin, Yung-Feng Shih concluded that changes in the anterior segments as the eyeball elongates in myopia progression included flatter corneal curvature, decreased corneal thickness, as well as decreased endothelial density. The corneas had a mean corneal thickness of 533(SD29) μm and were thinner in more myopic eyes ($r = 0.16$, $p = 0.021$). The corneas tended to be thinner in eyes with longer axial length.[3]

In 2002 SRIV ANNABOON S studied on relation between Corneal Thickness and Level of Myopia in 533 eyes, concluded that there was no clinical correlation between corneal thickness and level of myopia and also between corneal thickness and corneal curvature.[110]

In 2003 J.A. Sanchis-Gimeno, J. Casanova, L. Alonso, S.M. Rahhal, A. Ruiz Torner and F. Martínez Soriano assessed the central corneal thickness in extreme myopic patients and concluded that in extreme myopic eyes there is a slight tendency for central corneal thickness to increase in the presence of higher degrees of myopia. Nevertheless, central corneal thickness in extreme myopic patients is similar to that noted in non-extreme myopic patients.[111]

In 2003 Kunert, Kathleen S,Bhartiya, Prashant,Tandon, Radhika, Dada, Tanuj, studied Central Corneal Thickness in Indian patients undergoing LASIK for Myopia concluded after evaluating 1214 eyes of 615 patients that mean corneal thickness of 518.23 to 520 µm in Indian patient is lower as compared to that reported in literature of other studies.[112]

In 2005 Lene Pedersen, Jesper Hjortdal and Niels Ehlers concluded that CCT is not systematically altered in myopia. The process by which the myopia progresses does not to a measurable degree influence the central cornea.[2]

In 2009 Hani S. Al-Mezaine, Saleh Al-Obeidan, Dustan Kangave, Abdulkareem Sadaawy, Taher A. Wehaib, Saleh A. Al-Amro after doing a prospective study on 982 myopic eye 158 emmetropic eye concluded that there is no difference in CCT between emmetropic and myopic eyes. CCT did not

correlate with the degree of myopia. It seems that the central cornea is not significantly involved in the process of myopic progression.[113]

In 2014 Sara Ortiz, Laura Mena, Ana Rio-San Cristobal, Raul Martin after analyse the relationship between the central corneal thickness (CCT) and mid-peripheral corneal thickness (PCT) with the degree of myopia [axial length (AL) and spherical equivalent refractive error (SE) concluded that There are no significant differences among low, moderate and extremely myopic eyes related to the CCT and PCT. Corneal thickness is very similar in myopic eyes with small differences that are not clinically relevant to myopic patient management.[114]

MATERIALS AND METHODS

This was a cross sectional and time bound study in which the patients attending the outpatient department of Ophthalmology, B.L.D.E.U's Shri B.M Patil Medical College, Hospital and Research Centre Bijapur, who have been diagnosed as myopia, between the age of 20-50 years were chosen.

The patient were explained about the study and patient's willful consent were taken. Then details of patient including history, clinical examination, investigations were recorded. Clinical examination includes Visual Acuity (by Snellen's Chart), Slit Lamp Examination, Dry and Cycloplegic (if required) retinoscopy with streak retinoscope, subjective correction, Pachymetry, A-Scan, B-Scan (if required), intraocular pressure were recorded.

Central Corneal thickness was measured using a handheld ultrasonic Pachymetry (PAC Scan plus, Model: 300AP+, Sonomed). The cornea was anesthetized with topical anesthetic eye drops 0.5% proparacaine and recordings were taken after 90 seconds of instillation. The patient was seated and asked to fixate at a target in front of him. The pachymetry probe was brought in light contact with the cornea centrally and perpendicularly and five readings were taken. CCT was recorded as average of those five readings.

SAMPLE SIZE

With the prevalence rate of myopia 19%, at 95% confidence interval and at ±5 margin of error the sample size is 236

$n = [(1.96)^2 \times p \times q]/d^2$

Where

n = Sample size

p = Prevalence of positive character i.e. Myopia

q = 100-p
d = margin of error

Statistical analysis of the data will be done by:

- DIAGRAMS
- MEAN ±SD
- CHI SQUARE TEST
- CORRELATION

INCLUSION CRITERIA

- Patients having clinical diagnosis of myopia (>= -1.00 D).
- Age: between 20-50 years

EXCLUSION CRITERIA

History of contact lens use in past 2 weeks

Visual impairment due to:

- Astigmatism > -1.00D.
- Corneal opacities Lens opacities.
- Diseases affecting Central Corneal Thickness like keratoconus, keratitis, uncontrolled diabetes, dry eye.
- Any ocular surgery.

RESULTS

Total No of cases: 500 Eyes of 250 Patients

Table 3: Distribution of cases according to Sex

Sex	N	%
Male	109	43.6
Female	141	56.4
Total	250	100

In our study of 500 eyes of 250 patients, there were 109 male patients (43.6%) and 141 female patients (56.4%)

Graph 1: Distribution of cases according to Sex

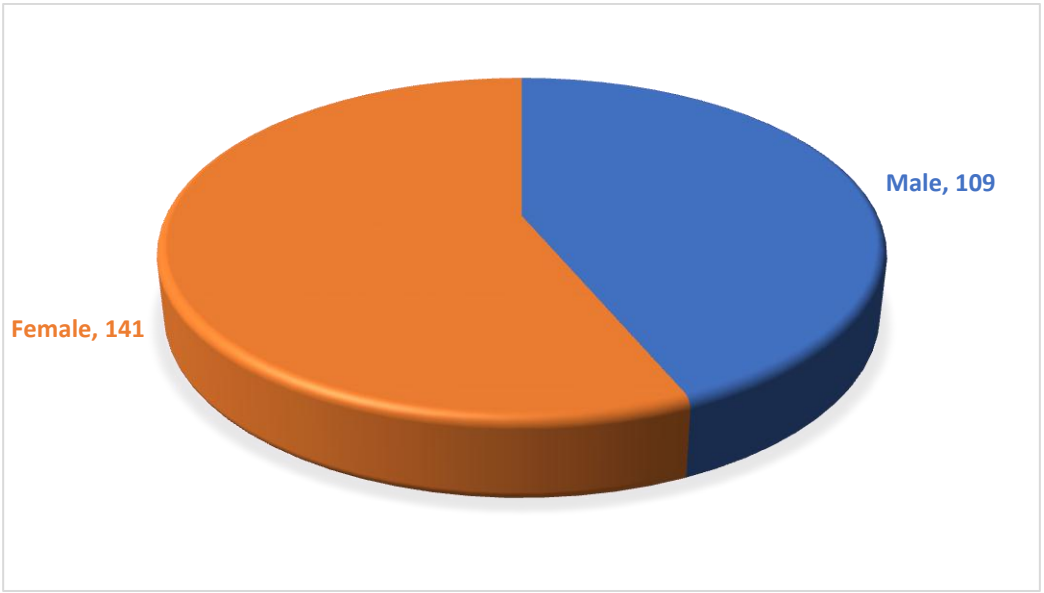
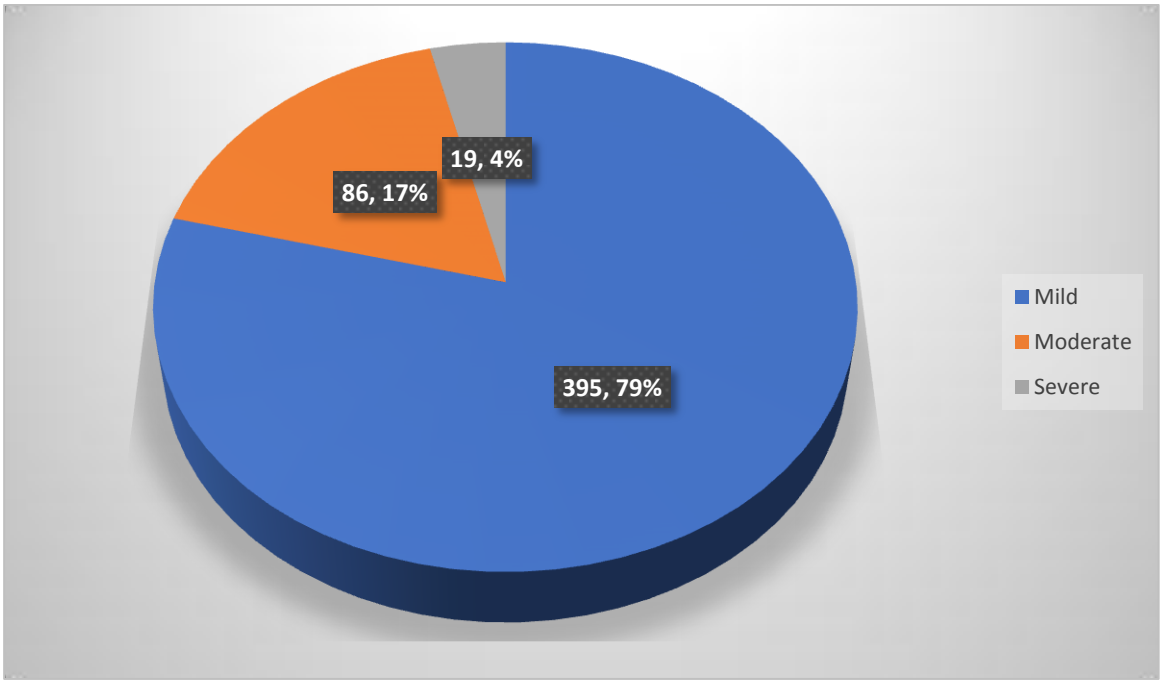


Table 4: Distribution of cases according to Myopia

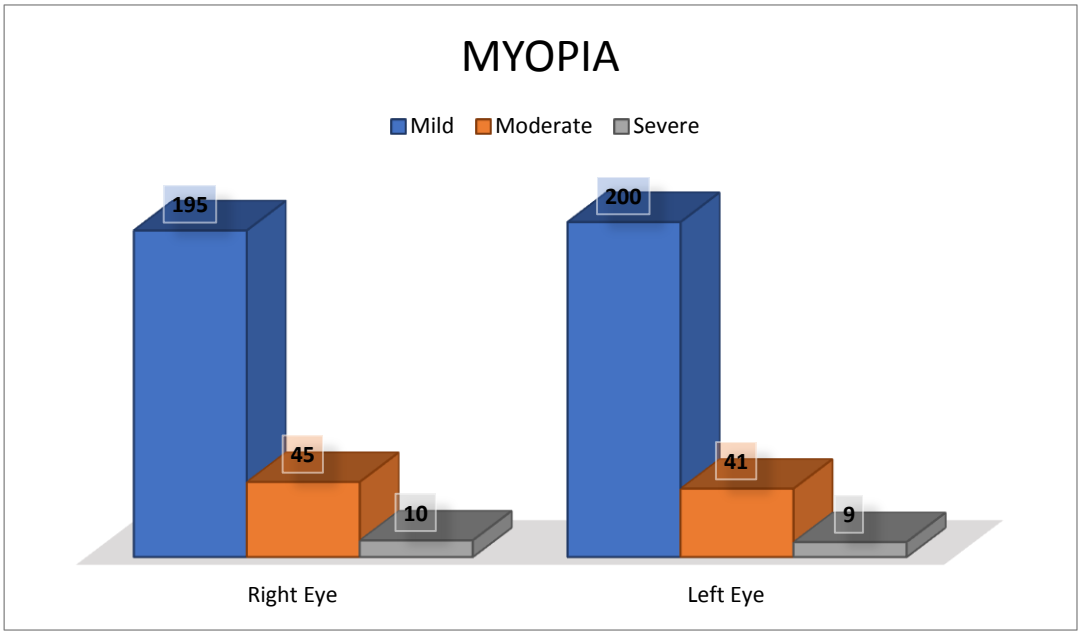
Myopia	Left Eye		Right Eye		Total	
	N	%	N	%	N	%
Mild	200	80	195	78	395	79
Moderate	41	16.4	45	18	86	17.2
Severe	9	3.6	10	4	19	3.8
Total	250	100	250	100	500	100

In total of 500 eyes, 395(79%) eyes had a refractive error of less than -3.0 Dioptre, 86(17.2%) eyes were between -3.0 to -6.0 Dioptre and 9(3.8%) eyes were more than -6.0 Dioptre.

Graph 2: Distribution of cases according to degree of Myopia



Graph 3: Distribution of cases in each eye according to Myopia



Out of 250 right eyes of 250 patients, 195(78%) had refractive error of less than -3.0 Dioptre, 45(18%) were between -3.0 to -6.0 Dioptre and 10(4.0%) were more than -6.0 Dioptre.

Out of 250 Left eyes of 250 patients, 200(80%) had refractive error of less than -3.0 Dioptre, 41(16.4%) were between -3.0 to -6.0 Dioptre and 9(3.6%) were more than -6.0 Dioptre.

Table 5: Intra group Comparison of mean CCT & SE according to Myopia

Parameter	CCT	
	Mean(µm)	SD
Mild Myopia(<3)	527.8	17.5
Moderate Myopia(3-6)	528.4	30.0
Severe Myopia(>6)	484.2	15.6
Total	526.2	21.8

In our study, Mean Central Corneal Thickness of 500 eyes was 526.2 µm with standard deviation 21.8 µm. Mean central corneal thickness in Mild, Moderate & Severe Myopia was 527.8 µm, 528.4 µm, 484.2 µm with standard deviation 17.5 µm, 30 µm, 15.6 µm, respectively.

Graph 4: Comparison of mean CCT according to Myopia

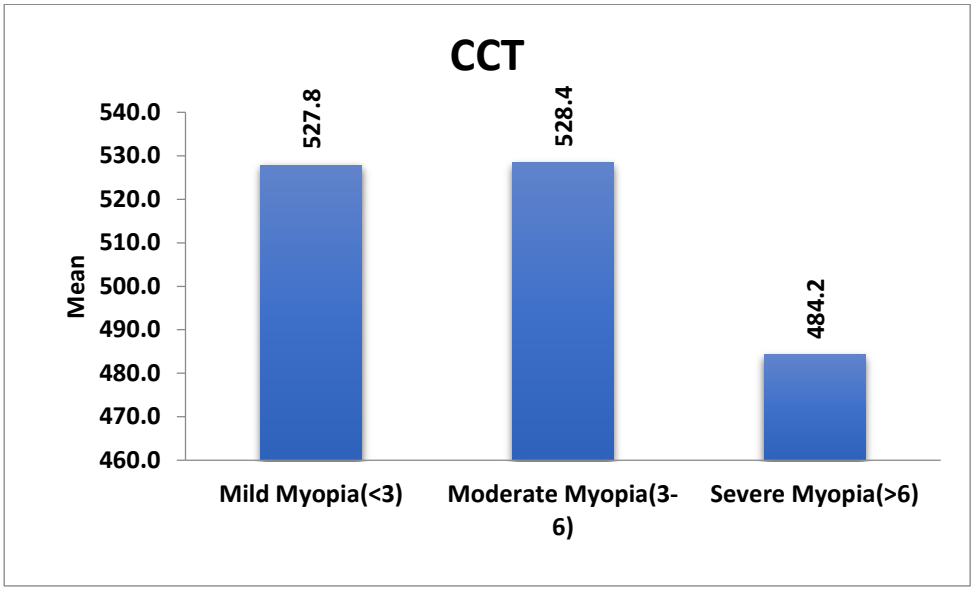


Table 6: Mean CCT according to grade of Myopia

Variables		Mild Myopia(<3)		Moderate Myopia(3-6)		Severe Myopia(>6)		Total	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
Right Eye	Pachymetry (µm)	526.9	17.1	529.3	29.1	482.3	17.5	525.5	21.6
Left eye		528.4	17.9	530.4	27.9	482.4	17.9	526.9	22.0

Table No. (6) shows that mean Central Corneal thickness for Right eye in Mild Myopia, Moderate Myopia and severe Myopia were 526.9 µm, 529.3 µm, 482.3 µm with standard deviation of 17.1 µm, 29.1 µm, and 17.5 µm respectively. Table No. (6) shows that mean Central Corneal thickness for Left eye in Mild Myopia, Moderate Myopia and severe Myopia were 528.4 µm, 530.4 µm, 482.4 µm with standard deviation of 17.9 µm, 27.9 µm, and 17.9 µm respectively.

Graph 5: Mean Pachymetry according to grades of Myopia

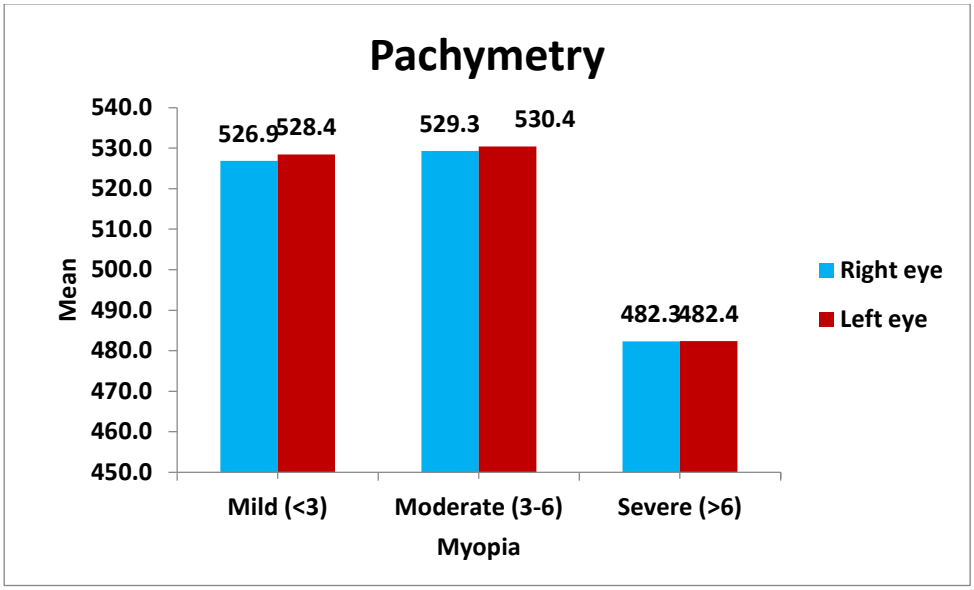


Table 7: Mean CCT and Spherical Error

Parameter	Total	
	Mean	SD
SE(Dioptre)	-2.5	1.7
CCT(µm)	526.2	21.8

Graph 6: SCATTERED PLOT BETWEEN CCT AND SE

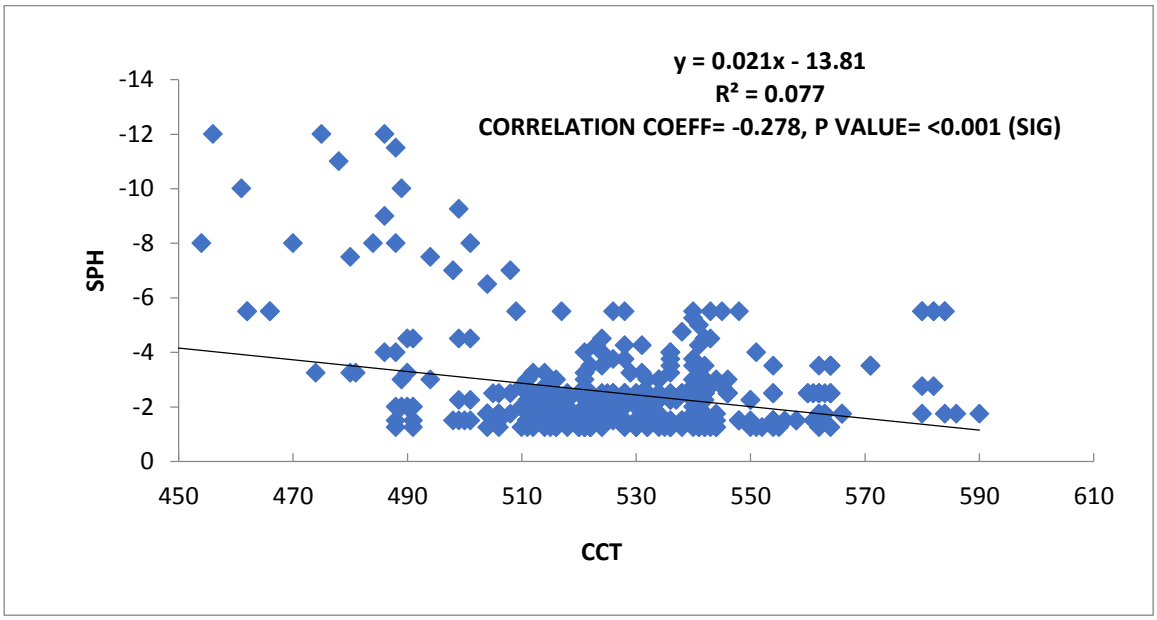


Table 8: Correlation coefficient between CCT & SE

Pearson Correlation	p value
-0.278	<0.001

The mean Spherical error and Central Corneal thickness of 500 eyes was -2.5 Dioptre with standard deviation of 1.7 dioptre and 526.2 µm with standard deviation of 21.8 µm. Highest and lowest Central Corneal thickness in 500 eyes was 590 µm and 454 µm as shown in graph (6) spherical error and Central Corneal thickness show a significant negative correlation.

Table 9: Comparison of mean CCT according to SEX

PARAMETERS		Mean CCT(μm)	SD	P VALUE
SEX	MALE	525.0	20.9	0.277
	FEMALE	527.2	22.4	

Note: * significant at 5% level of significance ($p<0.05$)

The Mean Central Corneal thickness in male patients was 525 μm with SD of 20.9 μm, and among female was 527.2 μm with SD of 22.4 μm with a p value of 0.277, sowed that there was no significant difference between Central Corneal thickness between male and female subjects.

Graph 7: Comparison of mean CCT according to SEX

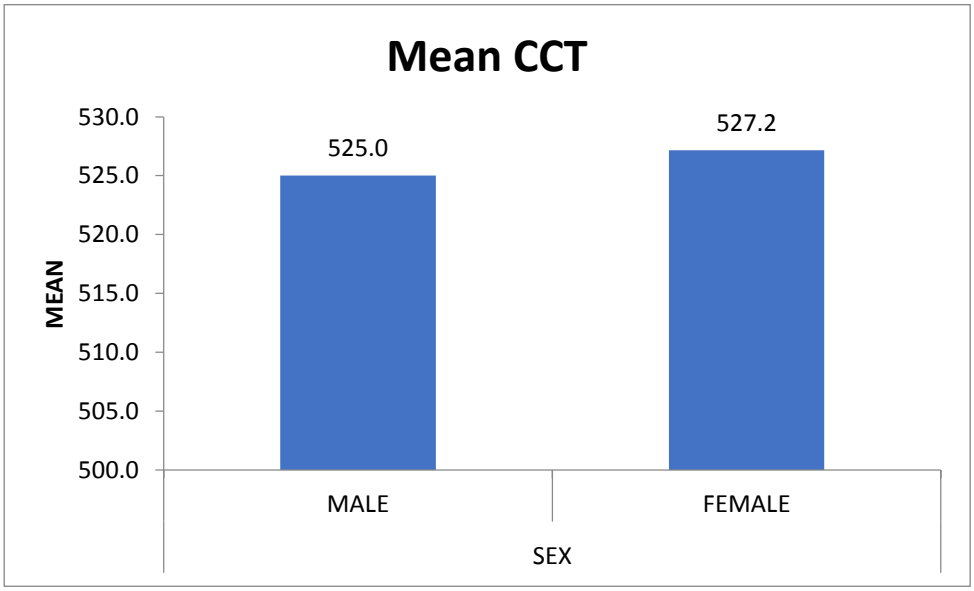
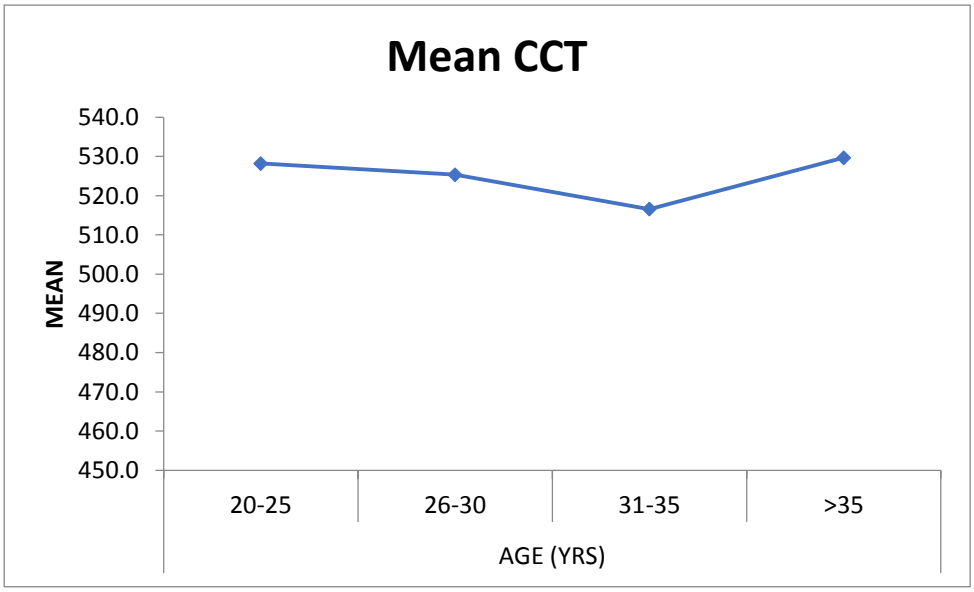


Table 10: Comparison of mean CCT according to AGE

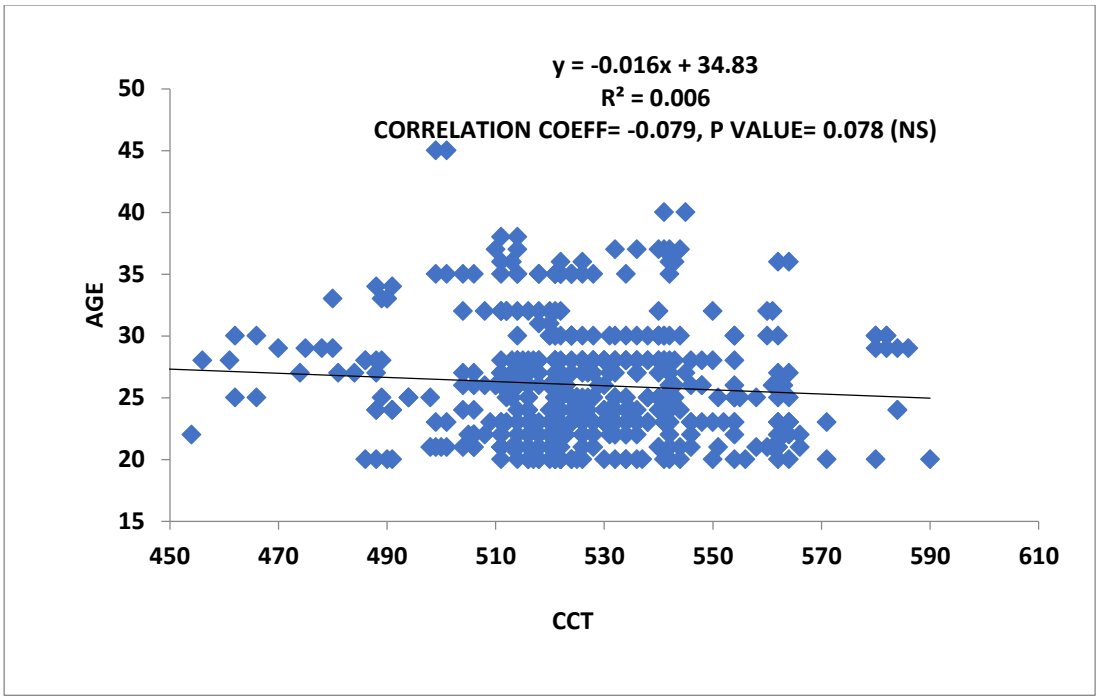
PARAMETERS		Mean CCT(μm)	SD
AGE (YRS)	20-25	528.2	21.1
	26-30	525.3	23.6
	31-35	516.6	17.2
	>35	529.7	18.6

The mean Central Corneal thickness in age group of 20-25 years, 26-30 years, 31-35 years were 528.2 μm, 525.3 μm, 516.6 μm, 529.7 μm with standard deviation of 21.2 μm, 23.6 μm, 17.2 μm, 18.6 μm.

Graph 8: Comparison of mean CCT according to AGE



Graph 9: SCATTERED PLOT BETWEEN CCT AND AGE



The mean age of subjects was 26.04 years with standard deviation of 4.5 years. As shown in graph (9), Central Corneal thickness was negatively correlated with age but it was not statistically significant (p value: 0.078)

Table 11: Comparison of mean CCT according to EYE

PARAMETERS		Mean CCT(μm)	SD	P VALUE
EYE	RE	525.5	21.6	0.46
	LE	526.9	22	

Note: * significant at 5% level of significance (p<0.05)

In our study, Mean central corneal thickness of Right eye was 525.5 μm with SD 21.6 μm and in Left eye was 526.9 μm with SD 22 μm with a p value of 0.46, showed that there was no significant difference between Central Corneal thickness in both eyes.

Graph 10: Comparison of mean CCT according to EYE

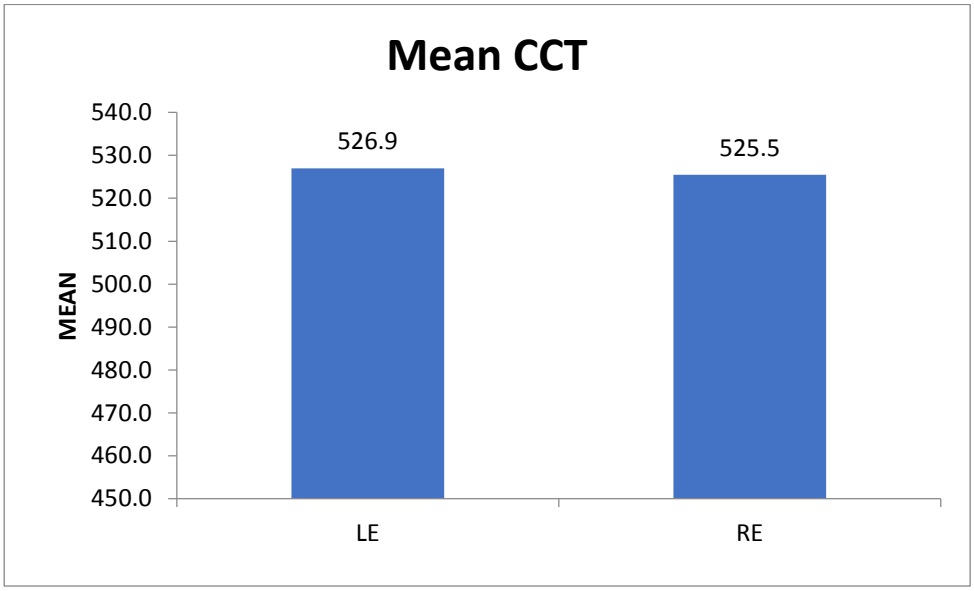
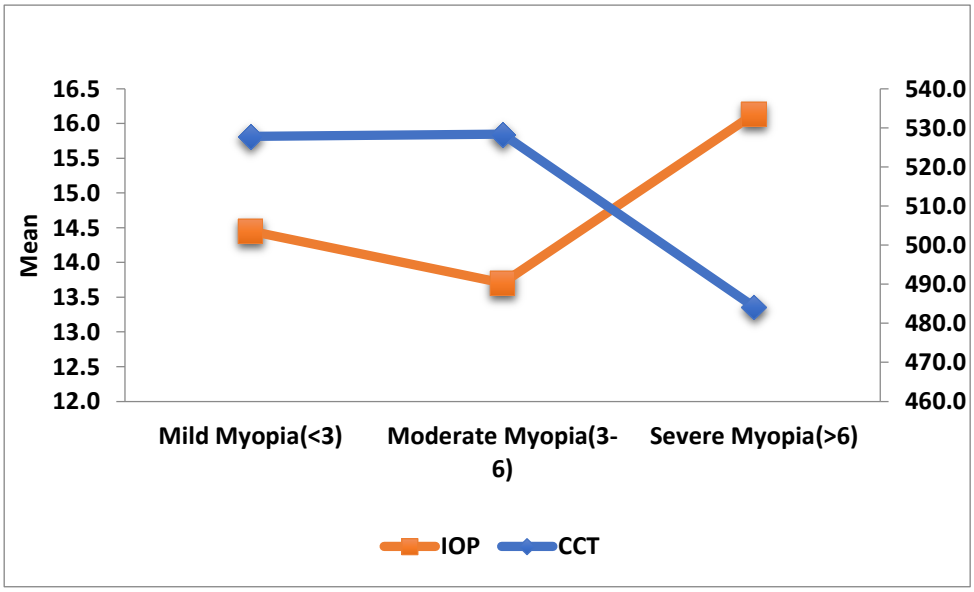


Table 12: Intra group Comparison of mean CCT & IOP according to Myopia

Parameter	CCT(µm)		IOP(mm Hg)	
	Mean	SD	Mean	SD
Mild Myopia(<3)	527.8	17.5	14.5	1.7
Moderate Myopia(3-6)	528.4	30.0	13.7	2.1
Severe Myopia(>6)	484.2	15.6	16.1	2.9

In present study mean Central Corneal thickness and Intraocular Pressure in Mild Myopia, Moderate Myopia and Severe Myopia were 527.8 µm, 528.4 µm, 484.2 µm and 14.5mm Hg, 13.7mm Hg, 16.1mm Hg.

Graph 11: Intra group Comparison of mean CCT & IOP according to Myopia



Graph 12: SCATTERED PLOT BETWEEN CCT AND IOP

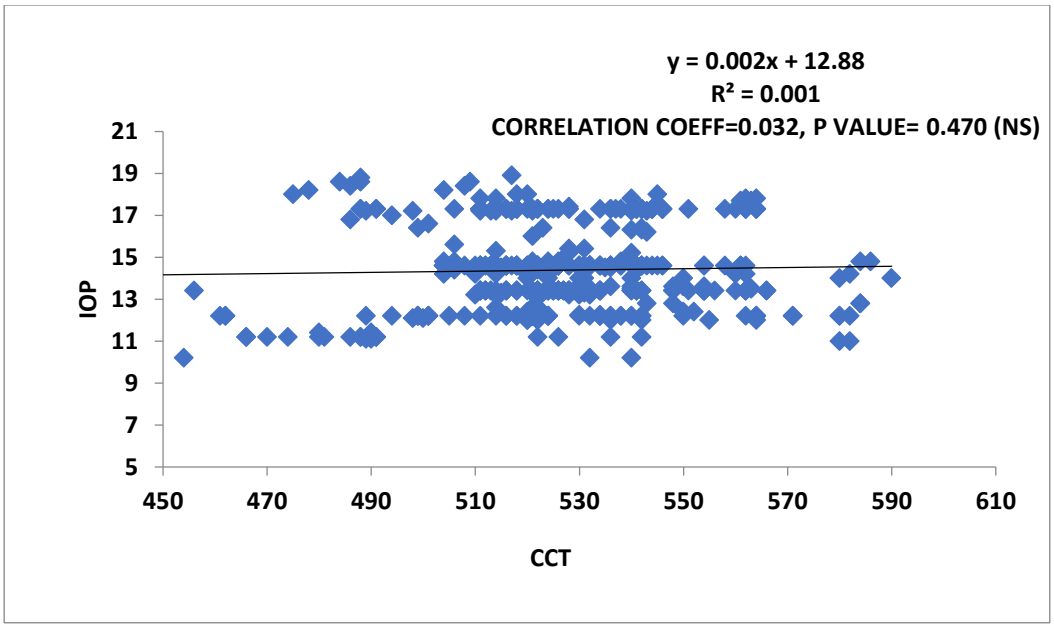


Table 13: Mean CCT and IOP

Parameter	Total	
	Mean	SD
IOP(mm Hg)	14.4	1.9
CCT(μm)	526.2	21.8

Pearson Correlation: 0.032, pvalue: 0.471

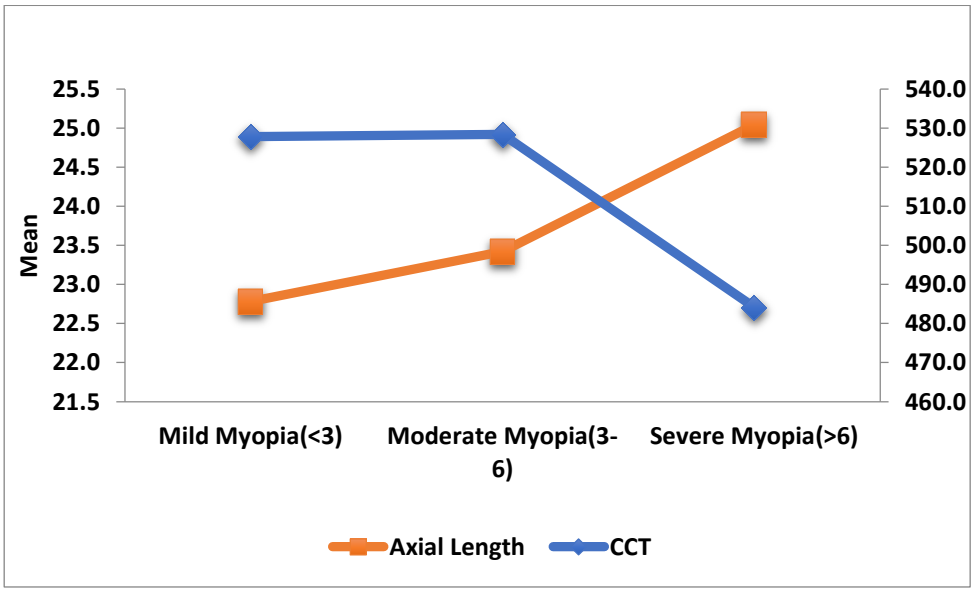
The mean Intraocular pressure of 500 eyes was 14.4 mm Hg with standard deviation of 1.9 mm Hg. As shown in graph (12) and table (13) intraocular pressure increases with increase in Central Corneal thickness but was not statistically significant (p value: 0.471)

Table 14: Intra group Comparison of mean CCT & Axial Length according to Myopia

Parameter	CCT(μm)		Axial Length(mm)	
	Mean	SD	Mean	SD
Mild Myopia(<3)	527.8	17.5	22.8	0.6
Moderate Myopia(3-6)	528.4	30.0	23.4	1.1
Severe Myopia(>6)	484.2	15.6	25.0	0.3

In present study mean Central Corneal thickness and Axial length in Mild Myopia, Moderate Myopia and Severe Myopia were 527.8 μm, 528.4 μm, 484.2 μm and 22.8 mm, 23.4 mm, 15.6 mm.

Graph 13: Intra group Comparison of mean CCT & Axial Length according to Myopia



Graph 14: SCATTERED PLOT BETWEEN CCT AND AXIAL LENGTH

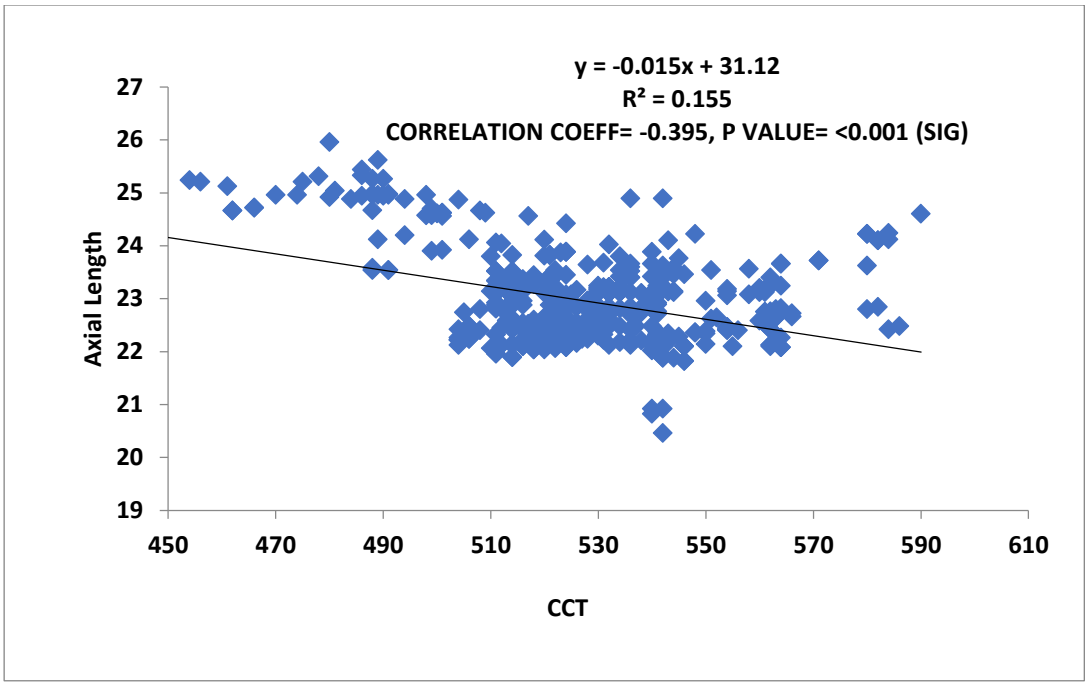


Table 15: Mean CCT and Axial length

Parameter	Total	
	Mean	SD
AXL(mm)	23	0.9
CCT(µm)	526.2	21.8

Pearson Correlation: -0.395, pvalue: <0.001

Note: * significant at 5% level of significance (p<0.05)

The mean Axial length of 500 eyes was 23 mm with standard deviation of 0.9mm. As shown in graph (14) and table (15) Central Corneal thickness is negatively correlated with axial length with a p value <0.001*.

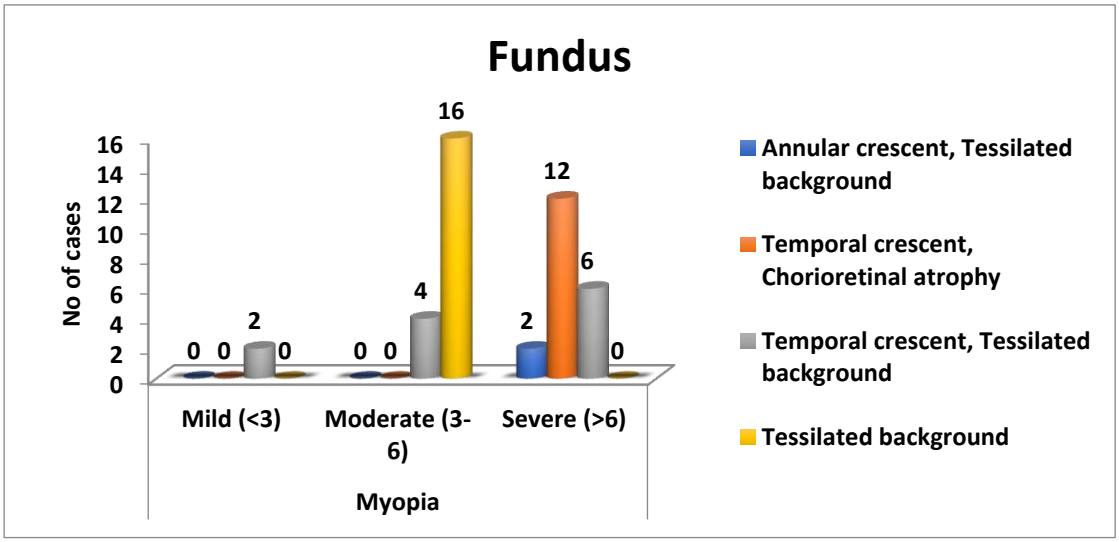
Table 16: Distribution of Fundus according to grades of Myopia

Fundus	Myopia			Total
	Mild (<3)	Moderate (3-6)	Severe (>6)	
Annular crescent, Tessilated background	0	0	2	2
Temporal crescent, Chorioretinal atrophy	0	0	12	12
Temporal crescent, Tessilated background	2	4	6	12
Tessilated background	0	16	0	16
Total	390	90	20	500

In our study of 500 eyes, 42 eyes showed myopic fundus changes.

Out of 390 eyes with Mild Myopia, 2 eyes had Temporal crescent + Tessilated background. Out of 90 eyes with moderate myopia 4 eyes had Temporal crescent + Tessilated background, and 16 eyes had Tessilated background. Out of 20 eyes with severe myopia, 2 eyes had Annular crescent+ Tessilated background, 12 eyes had Temporal crescent + Chorioretinal atrophy, 6 eyes had Temporal crescent + Tessilated background.

Graph 15: Distribution of Fundus according to grades of Myopia



DISCUSSION

Myopia is the commonest cause of visual impairment, and though this is known for more than a century we are far from understanding or preventing it. Prevalence of Myopia is increasing almost everywhere in the world—East Asia, Europe, America, and the Indian subcontinent.

Though there is no permanent cure for myopia, we can treat myopia with rehabilitative aids or refractive surgery.[115] Myopia mostly affects the posterior segment of the eye such as posterior staphyloma, choroidal atrophy, and thinned retina and sclera, inducing more chances of retinal detachment.[1] Changes in the anterior segment associated with myopia are still under controversies. With increasing rates of myopia, refractive surgery such as the laser in situ keratomileusis (LASIK) has become popular in Asia.

Measurement of central corneal thickness is performed for both diagnostic and therapeutic purposes. CCT allows determination of the amount of stromal ablation to minimize the risk of iatrogenic keratectasia in Laser Assisted In situ Keratomileusis (LASIK) surgery. Analysis of corneal thickness in contact lens wearers is essential for monitoring any changes in the cornea. Knowledge of CCT is also necessary for accurate determination of intraocular pressure, because tonometer readings are dependent on corneal thickness to a certain degree. This has important implications in the management of glaucoma.[116]

Studies that have attempted to investigate the effect of refractive errors on CCT have reported conflicting results. Some of them have found the cornea to be thinner in more myopic eyes.

Mean CCT

In the present study, the mean Central Corneal Thickness of 500 eyes of 250 patients was 526.2 μm with SD of 21.8 μm.

Table 17: Overview of previously published papers with information on myopia and central corneal thickness

			No. of Eyes		
Author and Year	Country	Method	Total	Myopic	CCT(μm)
Mimouni, M et al. 2017[117]	Israel	US	30245	30245	533.5
Ortiz, S. et al 2014[114]	Spain	Orbscan II	175	175	544
Al-Mezaine, H.S. et al. 2008[113]	Saudi Arabia	US	982	982	543.8
Fam et al. 2006[118]	USA	Orbscan	714	714	534.5
Kunert et al. 2003[112]	India	US/Orbscan	615	615	519.92
Chang et al. 2001[3]	Taiwan	US	216	Unknown	533
Present Study	India	US	250	250	526.2

When compared with Central Corneal thickness in other countries as shown in table (17), Central Corneal thickness in Indian population is lower. Previous studies done in Indian population shows that Central Corneal thickness in Indian population is lower than other countries, which is similar to the present study.[112,119]

Such difference in Central Corneal thickness can be due many factors like race, genetics, environment etc. Interracial difference have been noted in many studies (In comparison to black people white people have thicker corneas. Data from Asia

suggests that Mongolians, Japanese, and Burmese have thinner corneas. Lower Central Corneal thickness can be a limitation for refractive surgery or full correction of myopia.[119]

Type of Myopia

In total of 500 eyes, 395(79%) eyes had Mild Myopia (< -3.0 D), 86(17.2%) eyes had Moderate Myopia (-3.0 D to -6.0 D) and 9(3.8%) eyes had Severe Myopia (> -6.0 D). Overall Mild Myopia cases were found to be more than Moderate and severe Myopia cases in our study.

Mean CCT according to degree of Myopia

As shown in table (5) In our study Mean central corneal thickness has statically significant negative correlation with degree of Myopia.

A study conducted by Chang et al. on 216 subjects found that cornea were thinner in more myopic eyes.[3] Wei et al. in a study of 982 eyes from Northern China found that high myopes (6–9 D) had a slightly thinner CCT than mild myopes (< 3 D).[120] Similarly, Pedersen et al. found that higher myopes (> 6 D) had thinner CCT than emmetropes in a study in Denmark.[2]

Many studies found no correlation between Central Corneal thickness and degree of myopia.[114,117,118] Dissimilar findings between these studies may perhaps be explained by differences in the study populations examined in the different studies.

Correlation of Mean CCT to Sex

In our study Mean Central Corneal Thickness in female(527.2μm) was higher than in male (525 μm) but was not statistically significant. A Study conducted on 30245 Israeli subjects by Mimouni, M et al showed no significant difference in Central Corneal thickness between Male and Female, which is similar to result found in the present study.[114]

Correlation of CCT to Age

In present study, mean Central Corneal thickness in 20-25 year age group was 528.2μm and it decreased with age as shown in table (10). The Singapore Malay Eye Study there was a 5-micron thinning for every decade, a report based on data from the OHTS study demonstrated that older age was associated with thinner CCT (r = - 0.15, p\0.001) with a thinning of approximately 6 microns per decade.[121] Similarly, Foster et al.[122] reported a 10-micron decrease in CCT per decade and Nangia et al.[123] reported that in 4711 subjects from India there was a significant correlation (r = 0.14, p\0.001).

Correlation of CCT to Eye

As shown in table (11) mean Central Corneal Thickness in Left eye (526.9 μm) was more than in Right Eye (525.5 μm) but was not statistically significant. Chen Y et al, in 2013 stated that there was no difference between CCT of Right eye and Left eye,[124] which is comparable to present study.

Correlation of CCT and IOP

In present study Intraocular Pressure was positively correlated with Central Corneal thickness but was not statistically significant.

In a study conducted by Vijaya et al on 6754 subjects, they found that in the rural population, a 100 μm increase in CCT was associated with a 1.96-mmHg increase in IOP. In the urban population, it was a 2.45-mmHg increase for every 100 μm difference.[119] Many studies show a positive correlation between Intraocular pressure and Central Corneal thickness. Because of less no of cases with moderate myopia and severe myopia, a statistically significant relation was not found.

Correlation of CCT and Axial Length

In our study the mean Central Corneal Thickness was lowest in eye with longer axial length as shown in table (14). As per study conducted by Chang et al., they found that cornea tend to be thinner in cases of longer axial length, which is comparable to present study.[3] Solu T et al also found that patients with more axial length had thinner cornea.[125] Bueno- Gimeno *et al*. also found similar results[126]

Limitation of study

- Central Corneal thickness of patients were measured irrespective of the time.
- Number of cases of different degree of myopia was not same.
- Scleral Thickness was not measured
- Nutritional and environmental data of patient was not taken into consideration.

CONCLUSION

In conclusion we found

- That Central Corneal thickness in Indian population is lower as compared to other countries.
- The Central Corneal thickness is lower in high myopes and in those with higher axial length and can pose difficulty for refractive surgeon and these patients also need to be educated about the risk of glaucoma associated with thin cornea.
- Gender, age and Intraocular pressure did not show any statistically significant relationship with Central Corneal thickness.
- There is no significant difference in Central Corneal thickness in right eye vs left eye.
- Central Corneal thickness is involved in process of myopic progression.

SUMMARY

A cross sectional, time bound study was done on patients with diagnosis of myopia, aged between 20 to 50 years, attending outpatient department of the hospital to determine association between Central Corneal thickness and myopia.

A total of 500 eyes of 250 patients, fulfilling the inclusion criteria were included in the study. Their parameters including: central corneal thickness, axial length, spherical error, intraocular pressure, fundus changes and demographic data were noted and studied in detail.

In the present study, mean Central Corneal thickness was 526.2μm with standard deviation of 21.8μm. Mean age, axial length, spherical error, intraocular pressure were 26.04 years, 23mm, -2.5 dioptre, 14.4mm Hg with standard deviation of 4.5 years, 0.9mm, 1.7 dioptre, 1.9mm Hg.

Number of cases of mild myopia were much more than moderate and severe myopia. Central Corneal thickness was lowest 484.2 μm in high myopia group (pearson correlation: -0.278, pvalue <0.001). No statistically significant difference was found in Central Corneal thickness of right eye and left eye and gender of the patient.

Central corneal thickness was found to be decreasing with age but it was not statistically significant (Pearson correlation: -0.079, pvalue: 0.078). Intraocular pressure showed a weak correlation central corneal thickness (pearson correlation: 0.032, pvalue:0.471).

With increase in axial length, there was decrease in central corneal thickness (pearson correlation: -0.395, pvalue: <0.001). Eye with higher degree of myopia had more myopic fundus changes.

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ANNEXURES

ETHICAL CLEARANCE CERTIFICATES

B.L.D.E.UNIVERSITY'S
SHRI.B.M.PATIL MEDICAL COLLEGE, BIJAPUR – 586103
INSTITUTIONAL ETHICAL COMMITTEE

NO/588/2015
20/11/15

INSTITUTIONAL ETHICAL CLEARANCE CERTIFICATE

The Ethical Committee of this college met on 17-11-2015 *at* 03pm *scrutinize the Synopsis of Postgraduate Students of this college from Ethical Clearance point of view. After scrutiny the following original/corrected and revised version synopsis of the Thesis has accorded Ethical Clearance.*

Title "Assesment of central corneal thickness in myopic eyes"

Name of P.G. Student : Dr. Vinit Satish Shah
Dept of Ophthalmology

Name of Guide/Co-investigator : Dr. Sunil. G. Biradar
professor of Ophthalmology

DR.TEJASWINI VALLABHA
CHAIRMAN

CHAIRMAN
Institutional Ethical Committee
BLDEU's Shri B.M. Patil
Medical College,BIJAPUR-586103.

Following documents were placed before E.C. for Scrutinization
1)Copy of Synopsis/Research Project
2)Copy of informed consent form.
3)Any other relevant documents.

SAMPLE INFORMED CONSENT FORM

TITLE OF THE PROJECT	:	ASSESMENT OF CENTRAL CORNEAL THICKNESS IN MYOPIC EYES
PG GUIDE	:	**DR. SUNIL G BIRADAR** M.S. (OPHTHALMOLOGY) PROFESSOR OF OPHTHALMOLOGY DEPARTMENT OF OPHTHALMOLOGY
PRINCIPAL INVESTIGATOR	:	**DR. VINIT S SHAH**

PURPOSE OF RESEARCH:

I have been informed that this study is conducted to assess the central corneal thickness in myopic eyes.

PROCEDURE:

I will be subjected to detailed history and systemic and ocular examination. In ocular examination visual acuity testing, slit lamp examination, Dry & cycloplegic (if required) refraction and give correction for refractive error, pachymetry, A-Scan will be performed.

RISK AND DISCOMFORTS:

I understand that I have to undergo a complete ocular and systemic examination as required. I may have blurring of vision for a few hours as a result of pharmacological pupil dilatation for detailed fundus evaluation and retinoscopy. I may have to undergo the various tests required and to expect a time delay for all the various test reports to come.

BENEFITS:

I understand that my participation in the study will help in assessment of Central Corneal Thickness in Myopic eyes.

CONFIDENTIALITY:

I understand that the medical information produced by this study will become a part of hospital records and will be subject to the confidentiality. Information of sensitive personal nature will not be part of the medical record, but will be stored in the investigations research file.

If the data are used for publication in the medical literature or for teaching purpose, no name will be used and other identifiers such as photographs will be used only with special written permission. I understand that I may see the photograph before giving the permission.

REQUEST FOR MORE INFORMATION:

I understand that I may ask more questions about the study to **Dr. VINIT SATISH SHAH** in the Department of Ophthalmology who will be available to answer my questions or concerns. I understand that I will be informed of any significant new findings discovered during the course of the study, which might influence my continued participation. A copy of this consent form will be given to me to keep for careful reading.

REFUSAL FOR WITHDRAWAL OF PARTICIPATION:

I understand that my participation is voluntary and that I may refuse to participate or may withdraw consent and discontinue participation in the study at any time without prejudice. I also understand that **Dr. VINIT SATISH SHAH** may terminate my participation in the study after he has explained the reasons for doing so.

INJURY STATEMENT:

I understand that in the unlikely event of injury to me resulting directly from my participation in this study, if such injury were reported promptly, the appropriate treatment would be available to me. But, no further compensation would be provided by the hospital. I understand that by my agreements to participate in this study and not waiving any of my legal rights.

I have explained to _____the purpose of the research, the procedures required and the possible risks to the best of my ability.

_____ _____

Dr. VINIT SATISH SHAH Date
(Investigator)

STUDY SUBJECT CONSENT STATEMENT:

I confirm that Dr. VINIT SATISH SHAH has explained to me the purpose of research, the study procedure, that I will undergo and the possible discomforts as well as benefits that I may experience in my own language. I have been explained all the above in detail in my own language and I understand the same. Therefore I agree to give consent to participate as a subject in this research project.

_____ _____

(Participant) Date

_____ _____

(Witness to signature) Date

PROFORMA

NAME OF THE PATIENT:	
OP/IP. No:	
Age/ Sex:	
Address:	
Occupation:	

1) CHIEF COMPLAINTS :

2) HISTORY OF PRESENTING ILLNESS : PATIENT WAS APPARENTLY ALRIGHT _____EARLIER THEN

H/O DIMINUTION OF VISION YES/ NO

H/O PROGRESSIVE DIMINUTION OF VISION YES/NO

H/O DIPLOPIA YES/ NO

H/O HEADACHE YES/NO

H/O EYESTRAIN YES/NO

H/O WATERING YES/NO

H/O ITCHING YES/NO

3) PAST HISTORY : H/O CHEMICAL BURNS/CORNEAL ULCERS/ TRAUMA/WEARING CONTACT LENS/ OCULAR SURGERY.

4) PERSONAL HISTORY :

5) FAMILY HISTORY :

6) GENERAL PHYSICAL EXAMINATION:

PULSE	
BLOOD PRESSURE	
RESPIRATORY RATE	

7) SYSTEMIC EXAMINATION :

8) OCULAR EXAMINATION

	RIGHT EYE	LEFT EYE
• HEAD POSTURE		
• FACIAL SYMMETRY		
• VISUAL AXIS		
• EXTRA-OCULAR MOVEMENTS		
• VISUAL ACUITY		
UNAIDED		
PINHOLE		
NEAR VISION		
• ADNEXA		

• CONJUNCTIVA		
• CORNEA		
SIZE		
SHAPE		
SURFACE		
TRANSPARENCY		
CORNEAL SENSATION		
• ANTERIOR CHAMBER		
• IRIS		
• PUPIL		
• LENS		
• FUNDUS		
DISC		
BACKGROUND		
BLOOD VESSEL		
MACULA		
• IOP		
• A-SCAN		
• PACHYMETRY		
• RETINOSCOPY (STREAK RETINOSCOPE)		

SUBJECTIVE READING :

	PRISM	SPH	CYL	AXIS
6/				
N				

	PRISM	SPH	CYL	AXIS
6/				
N				

9) Diagnosis :

Measuring CCT by Ultrasound Pachymetry

Detail examination of eye by Slit-lamp

Retinoscopy by Streak retinoscope

Fundus Examination

KEY TO MASTER CHART

Sl.No – Serial Number

OP No. – Outpatient department number

RE – Right Eye

LE – Left Eye

Dist. – Distant Vision

Nv – Near vision

Ph – pin-hole

M1 – Vertical Meridian

M2 – Horizontal Meridian

SPH – Spherical

Cyl – Cylindrical

Deg – Degree

Cr VA – Corrected Visual Acuity

Ant. Segment – Anterior segment

IOP – Intraocular pressure

M – Male

F – Female

NA – Not applicable

D – Deep anterior chamber

S – Shallow anterior chamber

SR – Sluggishly reactive pupil

TC – Temporal Crescent

AC – Annular Crescent

TB – Tessellated Background

CRA – Chorioretinal Atrophy

N – Normal