LOCATING THINNEST POINT OF CORNEA IN RELATION TO VISUAL AXIS IN HEALTHY EYES

AUTHORS & CONTRIBUTORS:

Motiba Tahir[1]
Muhammad Suhail Sarwar[2]
Hameeda Haider[3]
For Authors' affiliation & contribution see end of Article

ABSTRACT

PURPOSE: *The main intention of this research was to find out the corneal thinnest point in accordance with thevisual axis in healthy corneas.*

METHOD: *This comparative cross-sectional included 120 subjects (female: 61, male 59). The mean age of female patients was 29.11±8.3 years and 27.20±8.77 years of male. This study was carried out at Mayo Hospital, Lahore. The data was collected through, non-random convenient sampling technique, self-made proforma after taking the patient's consent. Data thinnest point of thecornea, TX, TY, kappa distance, KX and KY of both eyes were measured. We converted theright eye horizontal axis values to left eyes by multiplying -1 to the right eye's horizontal values.*

RESULTS: *The corneal thinnest point was situated at 0.57±0.4 mm inferotemporal to the visual axis in healthy corneas. The mean central point of the cornea was 555.2±26.46 µm, respectively. The CCT mean was 547.9±26.02 µm respectively. The thinnest point mean was 544.83±27.14 µm respectively. The TX mean was 0.03±0.51mm respectively. The thinnest X laterality mean was 0.44±0.25 mm respectively. The thinnest y-axis mean was -0.36±0.30 mm respectively. The kappa distance mean was 0.17±0.10 mm respectively. The KX mean was 0.00±0.16 mm respectively. The kappa x laterality mean was 0.0607±0.15 mm respectively. The Ky mean was 0.01±0.124 mm respectively.*

CONCLUSION: *The corneal thinnest point was found at 0.57±0.4 mm inferotemporal from the visual axis in normal eyes. The x-axis meant was 0.44±0.25 mm, and the y-axis means was -0.36±0.30 mm.*

KEY WORDS: *Keratoconus, angle kappa, CCT.*

INTRODUCTION

The translucent avascular connective tissue that acts in place of the main infectious and structural hindrance of the eye is called thecornea of the eyeball. It also provides, along with the tear film, theappropriate anterior refractive surface for the eye.[1] The cornea consists of elements that are cellular and acellular**.** The cellular components include epithelial cells, keratocytes, and endothelial cells. The acellular component includes collagen and glycosaminoglycans.From the epidermal ectoderm, epithelial cells are derived. The neural crest is the source of keratocytes and endothelial cells.[2]

The cornea, belonging to the dioptric system of the eye and being part of its structural coat, must be both transparent and tough. Like other tissues of great tensile strength, the skin and sinews, it has a fibrous structure built up of collagen. The collagen fibers of the cornea are disposed of in a layer, the substantia propria or stroma, which constitutes the greater part of its thickness. Unlike these other collagenous tissues, the stroma is normally optically clear, but it tends to swell when in contact with the fluid and becomes cloudy on swelling. This tendency is opposed by two cellular layers which cover the corneal surfaces, for if either of these layers is destroyed or severely damaged the stroma lying under the affected area will swell. Mechanical distortion of the cornea or compression of the eye-ball can also cloud the stroma; it clears instantly when the strain is removed.[3]

The normal human cornea is avascular. Aqueous

humor is the main source of nutrients forthe cornea. Blood supply is provided through the aqueous humor and the tear film through small blood vessels on the outer part of the cornea over and above parts supplied by end branches of the ophthalmic and facial arteries. Significant corneal functions in the eye include protecting the structures within the eye, adding to the eye's refractive force, and concentrating light rays with minimal scattering and optical loss on the retina. Two-third of the refractive force of the eye relates to Cornea.

The cornea is horizontally circular, horizontally measuring 11–12 mm and ,vertically measuring 9–11 mm. The horizontal corneal diameter showed the corneal diameter of 11.7± 0.42 mm using the ORBSCAN II method. In males, the corneal diameter was 11.77±0.37 versus 11.64±0.47 in females. The corneal diameter ranged from 11.04–12.50 in males and 10.7–12.58 in females. The limbus is widest in the superior and inferior cornea. The Cornea is convex and aspheric. The anterior curvature is 7.8 mm and posterior curvature is about 6.5 mm. Cornea contributes to about 40–44 D of refractive power and accounts for approximately 70% of total refraction. The refractive index of cornea is 1.376. From the central cornea to the periphery, there is a progressive rise in thickness. Alteration in tissue thickness is due to increase in the amount of collagen in the peripheral stroma. With different methods of evaluation, the central corneal thickness in normal eyes is found to range from 551 to 565 µ and the peripheral corneal thickness from 612 to 640 µ. The corneal thickness is found to decrease with age. In preserving the corneal curvature, anterior corneal stromal rigidity seems to be especially major. Anterior curvature is much more resistant than posterior stroma to changes in stromal hydration.[4]

Cornea is one of the tissues of the body that is most densely innervated. There are five membranes: epithelium, stroma, and endothelium, and two interface layers consisting of the membrane of Bowman and the membrane of Descemet. The corneal stroma consists of cellular and extracellular components (keratocytes). Owing to the deficiency of blood and lymphatic vessels, the Cornea is an immune-privileged tissue. While the typical cornea is avascular, neovascularization, scarring and , corneal blindness can be caused by several conditions.[5]

Keratoconus is an ectatic corneal disease that arises naturally, in which astigmatism, high myopia, and loss of best spectacle-corrected VA areproduced by the cornea gradually thinning and steeping. The factors affecting this condition included; rubbing of eye, family history of keratoconus disease, genetic tendency, Down's syndrome, ocular allergy, disease by connective tissue, and wear of contact lenses. Some non-inflammatory corneal thinning conditions are pellucid marginal degeneration and non-inflammatory keratoglobus. Progressive thinning and steepening of cornea can also happen after LASIK surgery. This disease usually referred to as post-LASIK ectasia, is similar in behavior to keratoconus.[6] The discovery of abnormal corneal astigmatism with inferior corneal steepening supports the early diagnosis. The procedure varies from basic correction of spectacles to keratoplasty.[7]

A bilateral, transparent, inferior, peripheral corneal-thinning condition is a pellucid marginal degeneration of the cornea. Corneal protrusion occurs above a thinning band positioned 1 to 2 mm from the limb and measuring 1 to 2 mm in width. This condition is distinct from other non-

inflammatory corneal thinning conditions, such as keratoconus, keratoglobus, keratoconus, and keratoconus posterior. It is also distinguished from inflammation-related peripheral corneal conditions such as Terrien's peripheral corneal degeneration, Mooren's ulcers and ulcers due to connective tissue disease.[8]

In determining corneal health, measurement of corneal thickness is an integral factor. Corneal thickness is the most important factor in diagnosis of diseases of cornea and to evaluate the effects of different drugs on eyes. In addition, pachymetry measurements depend heavily on the progress of corneal surgery and the avoidance of surgical problems. Pachymetry has become increasingly relevant with the recent increased awareness in corneal refractive surgical procedures, including photo refractive keratectomy and radial keratotomy , which involve exactly calibrated incursions into the cornea.[9] Ultrasound is one of the most common approaches to corneal pachymetry. In order to determine thickness, ultrasound pachymeters require corneal contact and use the Doppler effect. It has been stated that ultrasound pachymetry provides very precise, clinically reliable and reproducible data.[10] However, as corneal pachymetry has become completely incorporated into the ophthalmologist's diagnostic armamentarium, new and more sophisticated pachymeters have been identified and assessed.[11]

For numerous medical and research applications in ophthalmology, consistent and accurate measurements of corneal thickness are important. In the diagnosis of different diseases like glaucoma, pre-refractive surgery screening, and all conditions in the result of corneal edema, CCT plays a significant role. For conditions like keratoconus and, radial keratotomy, corneal cross-linking, and intrastromal ring placement, midperipheral corneal thickness is also very important. The most widely used tool for measuring corneal thickness has been ultrasonic pachymetry for some time. USP, nevertheless, has some disadvantages because of its involvement with corneal contact, and different variables, including topical anesthesia and operator expertise, may affect its efficiency to manually position the Ultrasonic Pachymetry probe as perpendicular as possible to the middle of the cornea. In order to overcome the drawbacks of the USP, several non-contact instruments were subsequently produced. Among these, optical coherence tomography (OCT) of Fourier domain (FD) and Scheimpflug imaging systems play a chief role. [12]

In order to gain photographs not merely of corneal topography but also of other variables and structures in the anterior part of eye, new tools constructed on Scheimpflug photography have recently been used. Two instruments that use Scheimpflug technology are the Pentacam HR (Oculus) and Galilei (Ziemer). A rotating Scheimpflug camera is used on the Pentacam HR system, while a dual rotating Scheimpflug camera combined with a Placido disk is used on the Galilei system. The Galilei G4 is the new iteration of this device that allows thousands of data per scan to be acquired quickly. This helps one to measure the anterior segment's 3-dimensional model. This scheme has never been used to test corneal changes during housing, to our knowledge.[13]

A visual axis is considered a connecting line passing through the midpoint of the visual field to the fovea centralis. It binds the point of fixation to the Fovea. The thinnest corneal point is situated 0.90 mm from the visual axis on average and has thickness of 0.55 mm. In clinical

practice, since it is recognizable and reproducible measurement, the thinnest area of the central cornea is often taken to be the CCT measurement. Over the last two decades, corneal pachymetry has greatly advanced. The availability of new technologies to precisely determine the thickness in different corneal parts has allowed the central cornea and the Thinnest Central Corneal position thickness measurements to be calculated as separate values. In order to enhance the validity of the readings, as it has now become popular to use CCT measurements in research purpose involving IOP calculations, it becomes more important that there is uniformity and accuracy in calculating what the CCT is defined as being.[14]

MATERIALS AND METHODS

Data was collected by using descriptive, cross-sectional survey. In this study, 120 patients (61 females and 59 males) coming at mayo hospital Lahore and college of ophthalmology and allied vision sciences Lahore were examined with GALEILI G4 instrument. Non-probability convenient sampling technique was used for data collection. Data was collected through self-made Performa after taking patient's consent. The parameters like CCT, thinnest point of cornea, kappa distance and kappa distance location of both eyes were measured by corneal topography GALILEI G4. We converted right eyes horizontal axis values to left eyes by multiplying -1 to the right eye's horizontal values. Pythagorean theorem have applied to find the thinnest point cornea the Presentation of data was done by making tables and diagram.

RESULTS

The corneal thinnest point was situated at 0.57±0.4 mm inferotemporal to the visual axis in healthy corneas. The mean of central point of cornea was 555.2±26.46 µm, respectively. The CCT mean was 547.9±26.02 µm respectively. The thinnest point mean was 544.83±27.14 µm respectively. The TX mean was 0.03±0.51mm respectively. The thinnest X laterality mean was 0.44±0.25 mm respectively. The thinnest y axis mean was -0.36±0.30 mm respectively. The kappa distance mean was 0.17±0.10 mm respectively. The KX mean was 0.00±0.16 mm respectively. The kappa x laterality mean was 0.06±0.15 mm respectively. The Ky mean was 0.01±0.124 mm respectively (Table 1).

	Mini.	Max.	Mean	Standard Error	Std. Deviation
Central point	511	627	555.20	2.42	26.46
CCT	504	619	547.92	2.37	26.02
Thinnest Point	499	618	544.83	2.47	27.14
Thinnest x Laterality	-.30	1.09	.4484	.023	.25
Thinnest y axis	-1.47	.28	-.3678	.02	.30
Kappa Distance	.01	.73	.1779	.00	.10
Kappa X Laterality	-.42	.73	.0607	.01	.15
Kappa y axis	-.31	.27	.0135	.01	.12

The mean values of all parameters of cornea including central point, CCT, thinnest point, TX laterality, Ty, kappa distance, KX laterality, KY.

DISCUSSION

This study includes 120 normal subjects having the mean age of female and male was 29.11±8.3 and of male 27.2±8.77 respectively. In this study we had to find the thinnest point of cornea in relation to visual axis in healthy eyes.

In this study we measured values of all the parameters including; central point, CCT, thinnest point, TX, thinnest X laterality, thinnest y axis, kappa distance, KX, kappa X laterality and kappa Y axis. According to their mean results the central point was 555.2±26.4 µm. The thinnest point mean was 544.83±27.14 µm respectively. The TX mean was 0.0351±0.51mm respectively. The thinnest X laterality mean was 0.44±0.25 mm

respectively. The thinnest y axis mean was -0.36±0.30 mm respectively. The kappa distance mean was 0.17±0.10 mm respectively. The KX mean was 0.00±0.16 mm respectively. The kappa x laterality mean was 0.06±0.15 mm respectively. The Ky mean was 0.0135±0.124 mm respectively. The results showed that the corneal thinnest part was located 0.57±0.4 mm inferotemporal in both patient's eyes.

The corneal thinnest part was mainly situated in the inferotemporal quadrant, in line with previous research, and its gap to the middle point was slightly different from zero.

According to the study conducted by AKC Lam et al. they took 46 normal healthy subjects and concluded that the corneal thinnest point was 0.57 mm apart from the reference point in right eyes and in the left eye the thinnest point of cornea was 0.36 mm away from the center. They found that the corneal thinnest part was for the right eye in the lower temporal region and the left eye in lower temporal region. There was an important differentiation between the corneal apex and the corneal thinnest point in this analysis.[15]

The study conducted by Hashemi H, et al on 3890 patients proved that the corneal thinnest point was in inferotemporal area in 87.5% cases of patients. According to this research, it must be helpful in providing a complete pachymetry of the cornea instead of measuring the middle point merely, as is done with ultrasound pachymeters, where the corneal thinnest point is significantly apart to the middle.[16]

in another study by Liu Z, et al concluded that the thinnest corneal point was at 0.90 mm away from the central point in healthy eyes. The diameter of the thinnest corneal point was 0.55 mm. In the inferotemporal quadrant, this point was in 69.57 percent of the eyes, followed by 23.91 percent of the supratemporal quadrant, 4.35 percent of the inferonasal quadrant and 2.17 percent of the superonasal quadrant.[17]

CONCLUSION

The thinnest point of cornea was found at 0.57±0.4 mm inferotemporal from the visual axis in normal eyes. The x-axis mean was 0.44±0.25 mm, and the y-axis mean was -0.36±0.30 mm.

RECOMMENDATIONS

It is recommended that this study should be comparative. This study can be improved by comparing different age groups. This study should be inter-observational inter-instrumental.

REFERENCES

1. DelMonte DW, Kim T. Anatomy and physiology of the cornea. J Cataract Refract Surg. 2011;37(3):588-98.

2. Dua HS, Faraj LA, Said DG, Gray T, Lowe J. Human corneal anatomy redefined: a novel pre-Descemet's layer (Dua's layer). Ophthalmology. 2013;120(9):1778-85.

3. Sridhar MS. Anatomy of cornea and ocular surface. Indian journal of ophthalmology. 2018;66(2):190.

4. Sridhar MS. Anatomy of cornea and ocular surface. Indian J Ophthalmol. 2018;66(2):190-4.

5. Gandhi S, Jain S. The anatomy and physiology of cornea. Indian J Ophthalmol. 2015;33(6):190-5.

6. Hwang ES, Schallhorn JM, Randleman JB. Utility of regional epithelial thickness measurements in corneal evaluations. Survey of Ophthalmology. 2020;65(2):187-204.

7. Tur VM, MacGregor C, Jayaswal R, O'Brart D, Maycock N. A review of keratoconus: diagnosis, pathophysiology, and genetics. Survey of ophthalmology. 2017;62(6):770-83.

8. Jinabhai A, Radhakrishnan H, O'Donnell C. Pellucid corneal marginal degeneration: A review. Contact Lens and Anterior Eye. 2011;34(2):56-63.

9. Crawford AZ, Patel DV, McGhee CN. Comparison and repeatability of keratometric and corneal power measurements obtained by Orbscan II, Pentacam, and Galilei corneal tomography systems. American journal of ophthalmology. 2013;156(1):53-60.

10. Fares U, Otri AM, Al-Aqaba MA, Dua HS. Correlation of central and peripheral corneal thickness in healthy corneas. Cont Lens Anterior Eye. 2012;35(1):39-45.

11. Ohn K, Lee MY, Lee YC, Shin HY. Comparison of central corneal thickness measurements between noncontact specular microscopy and ultrasound pachymetry. Journal of the Korean Ophthalmological Society. 2019;60(7):635-42.

12. Huang J, Ding X, Savini G, Pan C, Feng Y, Cheng D, et al. A comparison between Scheimpflug imaging and optical coherence tomography in measuring corneal thickness. Ophthalmology. 2013;120(10):1951-8.

13. Sisó-Fuertes I, Domínguez-Vicent A, del Águila-Carrasco A, Ferrer-Blasco T, Montés-Micó R. Corneal changes with accommodation using dual Scheimpflug photography. J Cataract Refract Surg. 2015;41(5):981-9.

14. Ashwin PT, Shah S, Pushpoth S, Wehbeh L, Ilango B. The relationship of Central Corneal Thickness (CCT) to Thinnest Central Cornea (TCC) in healthy adults. Cont Lens Anterior Eye. 2009;32(2):64-7.

15. Randleman JB, Lynn MJ, Perez-Straziota CE, Weissman HM, Kim SW. Comparison of central and peripheral corneal thickness measurements with scanning-slit, Scheimpflug and Fourier-domain ocular coherence tomography. British Journal of Ophthalmology. 2015;99(9):1176-81.

16. Hashemi H, Asgari S, Mehravaran S, Emamian MH, Shariati M, Fotouhi A. The distribution of corneal thickness in a 40- to 64-year-old population of Shahroud, Iran. Cornea. 2011;30(12):1409-13.

17. Fan R, Chan TC, Prakash G, Jhanji V. Applications of corneal topography and tomography: a review. Clinical & experimental ophthalmology. 2018;46(2):133-46.