



## CORRELATION BETWEEN CENTRAL CORNEAL THICKNESS AND INTRAOCULAR PRESSURE IN MALES AND FEMALES OF AGE 30 YEARS OR ABOVE IN NORMAL POPULATION.

### Physiology

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### ABSTRACT

**Objective:** To find out the correlation between Central Corneal thickness and Intraocular pressure in males and females of age 30 years or above in normal population.

**Methods:** 80 healthy participants were selected that were attending the Outdoor or admitted in the Indoor ward of Regional Institute of Ophthalmology (RIO). Informed consent was taken. All the participants were aged in the range between 30 – 70 years. The Central corneal thickness was measured in all subjects using an optical pachymeter mounted on the slit lamp. Measurements of IOP were using Goldmann applanation tonometer mounted on a slit lamp. The IOP was measured three times in each eye and the pressure taken as the median of these three readings.

**Results:** Central corneal thickness in the study showed no significant change with age. There was also no significant difference between right and left eyes or between men and women. But linear regression analysis of IOP on CCT (adjusted for age and gender) suggests that in normal population, a change in corneal thickness by 10  $\mu$ m would alter the measured IOP by 0.19 mm of Hg (95% CI, 0.10-0.27),  $P=0.0001$  in the right eyes. The identical regression analysis of the left eyes suggests that a 10  $\mu$ m change in corneal thickness would alter the measured IOP by 0.26 mm Hg (95% CI, 0.18-0.34),  $P=0.0001$ .

### KEYWORDS

Male, Female, Central corneal thickness, Intraocular pressure.

### INTRODUCTION

The measurement of the central corneal thickness is an important factor in the assessment of the cornea and measurement of intraocular pressure by applanation tonometry is affected by central corneal thickness.

It has been shown by many investigators that central corneal thickness may exert a large influence on Goldmann applanation tonometry (1).

Intraocular pressure (IOP) measurement is one of the vital and most commonly performed examination in ophthalmology. Goldmann applanation tonometer (GAT) has been labelled as gold standard for measurement of Intraocular pressure. IOP measurement is known to be affected by Central corneal thickness (CCT) (1,2).

Intraocular pressure is used for diagnosis and management of many eye diseases, including several types of glaucoma. Goldmann applanation tonometry is the gold standard of measurement but provides only an estimate intraocular pressure. The accuracy of this estimate depends on many factors 2. To a large extent, errors caused by other factors, notably central corneal thickness, which influences the rigidity of the cornea, cannot be avoided (3).

Applanation tonometry measures the force that is required to flatten a standard area of the corneal surface. Corneas of identical central thicknesses and profiles may have differing resistances to indentation, depending on differing tissue resistance between individual eyes (4).

CCT is a clinically relevant variable, and therefore, pachymetry should be included in the assessment of all patients with presumed ocular hypertension.

The classification and management of patients with elevation of IOP assume a reasonably accurate determination of IOP. There is a wide variation in corneal thickness in the general population.

Corneal pachymetry is clinically helpful in estimating IOP, determining the risk of visual loss, and establishing a target pressure (5).

Relation of Central Corneal Thickness with Intraocular Pressure as measured by Applanation Tonometry

Leon W. Herndon in 1997 observed the relation between central

corneal thickness and applanation intraocular pressure in normal, glaucomatous and ocular hypertensive eyes. There was no significant difference in CCT between normal and glaucomatous eyes.

The Rotterdam study by Roger C. W. Wolfs in 1997, measured Central Corneal Thickness and Intraocular pressure in 395 subjects- 352 control subjects. There was no differences between sexes and no significant association with age.

Wu L, Suzuki Y in 2000 investigated the relationship between CCT and IOP in patients with OHT, NTG, POAG and normal subjects and the importance of CCT in the diagnosis of glaucoma. They observed CCT of OH subjects (582 $\pm$ 32) micron was significantly thicker than that of other groups, while no difference were seen in CCT among normal, NTG and POAG groups. In normal subjects, the CCT was positively correlated with the IOP (6).

Brusini P, Miani F in 2000 measured CCT by pachometry in 49 patients with POAG, 14 with OHT, 14 with NTG and 48 normal subjects. The mean corneal thickness of the OHT patients was significantly greater than that of the normal control group. The NTG patients, on the other hand, had a cornea on average thinner than the normal (7).

### MATERIALS AND METHODS

#### Study population

The present study was carried out in Regional Institute of Ophthalmology, Guwahati during a period from 1 November 2017 to 31 October 2018 consisting of 80 participants attending the outdoor or admitted in the indoor ward of RIO. Informed consent was taken. All the participants were aged in the range between 30 – 70 years.

#### Inclusion Criteria

1. Patients with no ocular disease.
2. Patients with no Myopia or Hypermetropia
3. Patients with no contact lenses.
4. Patients with no ocular surgery.
5. Patients with no corneal disease or clinical corneal changes.
6. Patients willing to give consent.

#### Exclusion Criteria

The exclusion criteria of the patients were:

1. Patients with ocular disease.
2. Patients with Myopia or Hypermetropia of more than 3 diopters (D).
3. Corneal astigmatism > 2D.

- 4. Patients wearing contact lenses.
- 5. Patients who had undergone any ocular surgery.

**Clinical Assessment Of The Patients**

All the patients were subjected to detailed clinical examination and the findings documented. In all the cases, general and systemic examination was done and patients with any abnormalities were excluded from the study.

Ocular examination was done in diffuse light. Visual acuity using Snellen's chart was noted for distant vision.

Slit lamp biomicroscopy, direct and indirect ophthalmoscopy was done. Each case underwent syringing to rule out Nasolacrimal duct obstruction. Indirect gonioscopy was carried out in all the patients using Goldmann three mirror lens.

The Central corneal thickness was measured in all subjects using an optical pachymeter mounted on the slit lamp.

Measurements of IOP were using Goldmann applanation tonometer mounted on a slit lamp. The IOP was measured three times in each eye and the pressure taken as the median of these three readings.

Both the eyes per person were used in the study.

**Methods Adopted For Calculating Different Values**

Different statistical values like range, median and standard deviation were calculated and for comparing means between groups Linear regression analysis was done.

**RESULTS AND OBSERVATIONS**

The present study on correlation between Central Corneal thickness and Intraocular pressure in people aged 30 years or above in our study population includes 160 eyes of 80 normal patients. It was conducted in the Regional Institute of Ophthalmology, Gauhati Medical College, Guwahati and the duration of study was from 1 November 2017 to 31 October 2018.

**Table. (A) Various Population Included In This Study**

Normal Population	
No. of Participants	80
No. of eyes	160
Age group	30-70
Male	50 (63%)
Female	30 (37 %)

**I. Age specific CCT Distribution In Normal Patients**

The age of the normal patients included ranged from 30-70 yrs. The maximum number of patients were in the 30-40 years range. Total number of patients were 80.

**Table 1. Age Specific Mean Corneal Thickness:**

Mean ± Standard Deviation		
Age (yrs)	Range (um)	Mean± SD
30-40	478- 530 (36)	504±24
41-50	470- 532 (26)	502±30
51-60	458- 522 (13)	490±31
61-70	444- 526 (5)	485±34

Values in parenthesis are number of subjects.

**II. Sex Specific CCT In Normal Patients**

Amongst 80 patients studied, 50 were male and 30 were female. Maximum number of both male and female patients were in the age group of 30-40 years.

**Table 2 Sex Specific Mean Corneal Thickness:**

Mean ± Standard Deviation				
Age (yrs)	Male Range (um)	Female Range (um)	Male Mean ± SD	Female Mean±SD
30-40	478-522 (24)	478-530 (14)	500 ± 22	504 ± 26
41-50	472-532 (18)	470-530 (9)	502 ± 30	500 ± 30
51-60	462-522 (6)	458- 522 (5)	492 ± 30	490 ± 32
61-70	444-526 (2)	462- 518 (2)	485 ± 41	490 ± 28

**III. Age Specific IOP Variation In Normal Population**

The age group and number of normal patients were same as for CCT

distribution i.e. age ranged from 30- 70 years and 80 normal patients included.

**Table 3: Age Specific Intraocular Pressure: Mean ± SD**

Age (yrs)	Range (mm of Hg)	Mean ± SD
30-40	9.9- 15.6 (37)	12.8 ± 2.7
41-50	9.4- 17.2 (27)	12.8 ± 3.3
51-60	9.1- 15.5 (11)	12.3 ± 3.2
61-70	8.5 – 16.8 (5)	12.0 ± 3.4

**IV. Sex Specific IOP Variation In Normal Population**

The age group and number of normal patients are same as in Table 3.

**Table 4: Sex Specific Intraocular Pressure: Mean ± SD**

Age (yrs)	Male Range (mm of Hg)	Female Range (mm of Hg)	Male	Female
			Mean ± SD	Mean ± SD
30-40	9.9-15.4 (24)	10.4- 15.6 (14)	12.7 ± 2.6	13 ± 2.6
41-50	9.4- 17.2 (18)	9.7 – 15.1 (9)	13.3 ± 3.3	12.4 ± 3.1
51-60	9.1- 15.5 (6)	9.3 – 15.5 (5)	12.3 ± 3.2	12.4 ± 3.5
61-70	8.5- 16.8 (2)	8.5-14.1(2)	12.6 ± 3.4	11.3 ± 2.9

**V. CCT Distribution Between Males And Females In Normal Population (Age And Sex Specific)**

Mean CCT for male was 488 µm and for females, mean CCT was 495 µm. The difference in CCT measurements between right and left eyes was not significant in both genders.

**Table 5: Age And Sex Specific Mean Corneal Thickness Between Right And Left Eyes: Mean ± SD**

Age (yrs)	Male (Mean ± SD) µm		Female (Mean ± SD) µm	
	Right eye	Left eye	Right eye	Left eye
30-40	501 ± 22	502 ± 20	503 ± 26	503 ± 24
41-50	502 ± 30	500 ± 30	501 ± 30	498 ± 28
51-60	501 ± 30	496 ± 26	492 ± 32	494 ± 28
61-70	485 ± 41	490 ± 36	490 ± 28	492 ± 24

V a. Central Corneal Thickness: Both Eyes

**Table 5a: Central Corneal Thickness: Both Eyes (Mean ± SD)**

Age Group (yrs.)	Right Eye (µm)	Left Eye (µm)
30-70	488 ± 30	492 ± 28

V b. Central corneal thickness: Sex specific

**Table 5b: Central Corneal Thickness: Sex Specific (Mean ± SD)**

Age Group (yrs.)	Male (µm)	Female (µm)
30-70	488±30 (50)	495 ± 28 (30)

**VI. IOP Distribution Between Right And Left Eyes In Normal Population**

Mean IOP for right eyes is found to be 12.5 ± 3.2 mm of Hg and for left eyes is 12.3 ± 2.8 mm of Hg. For males, mean IOP was 12.6 ± 3.2 mm of Hg and for females, mean IOP was 12.1 ± 2.6 mm of Hg. All findings are in people aged 30 years or older.

**Table 6: Age And Sex Specific IOP Distribution Between Right And Left Eyes: Mean ± SD**

Age (yrs.)	Male (Mean ± SD) mm of Hg		Female (Mean ± SD) mm of Hg	
	Right eye	Left eye	Right eye	Left eye
30-40	12.6 ± 2.7	12.6 ± 2.8	12.8 ± 2.6	12.6 ± 2.2
41-50	13.3 ± 3.9	13.1 ± 3.4	12.4 ± 2.7	12.2 ± 2.5
51-60	12.3 ± 3.2	11.9 ± 2.3	12.4 ± 3.1	12.6 ± 2.9
61-70	12.7 ± 4.1	12.8 ± 3.8	11.1 ± 2.8	10.9 ± 2.4

**VI a. Sex Specific IOP Distribution**

**Table 6a: Sex Specific IOP Distribution: Mean ± SD (mm of Hg)**

Age Group (yrs.)	Male (mm of Hg)	Female (mm of Hg)
30-70	12.6 ± 3.2	12.1 ± 2.6

**VI b. Intraocular Pressure Distribution In Right And Left Eyes**

**Table 6b. Intraocular Pressure Distribution In Right And Left Eyes:**

Mean ± SD (mm of Hg)		
Age group (yrs.)	Right Eye (mm of Hg)	Left Eye (mm of Hg)
30-70	12.5 ± 3.2	12.3 ± 2.8

## RESULT

Central corneal thickness in our study showed no significant change with age and with sex. There was also no significant difference between right and left eyes of males and females.

But linear regression analysis of IOP on CCT (adjusted for age and gender) suggests that in normal population, a change in corneal thickness by 10  $\mu\text{m}$  would alter the measured IOP by 0.19 mm of Hg (95% CI, 0.10-0.27),  $P= 0.0001$  in the right eyes. The identical regression analysis of the left eyes suggests that a 10  $\mu\text{m}$  change in corneal thickness would alter the measured IOP by 0.26 mm Hg (95% CI, 0.18-0.34),  $P=0.0001$ .

## DISCUSSION

Applanation tonometry estimates IOP by measuring the force required to flatten an area of cornea 3.06mm in diameter. It has been assumed that for an applanation area of 3- 3.5 mm in diameter, the capillary attraction of the tear film on the tonometer head equals the force with which the cornea resists flattening. The exact diameter of the applanation area (3.07 mm) was chosen because at that applanation area, a force of 0.1 gm corresponds to an IOP of 1 mm Hg.

The thickness of the cornea and the mechanical properties of its constituent tissues clearly will affect the force required to flatten its center. This was recognized when the modern Applanation Tonometer was designed.

When interpreting the readings of an Applanation Tonometer, it is important first to be aware of this potential for error and second to be able to estimate its magnitude.

From these results, it was inferred that a thinner cornea offers less resistance to applanation and hence leads to an erroneous underestimation of the true IOP. This theory was supported by the finding that "Ocular hypertension" patients had significantly thicker corneas than both patients with glaucoma and "normal" subjects.

## REFERENCES

1. Leon W. Herndon, A. Choudhry, Terry Cox: Central corneal thickness in Normal, Glaucomatous, and Ocular hypertensive eyes. *Arch Ophthalmol.* 1997; 115: 1137- 1141.
2. Whitacre MM, Stein R: Sources of error with use of Goldmann- type tonometers. *Surv Ophthalmol.* 1993; 38: 1-30.
3. Roger CW, Wolfs: Distribution of central corneal thickness and its association with intraocular pressure: The Rotterdam study. *Amer J. Ophthalmol.* 1997; 123: 762-772.
4. Simon G, Small RH, Ren Q, Parel JM: Effect of corneal hydration on Goldmann applanation tonometry and corneal topography. *Refractive Corneal Surg.* 1993; 9: 110-117.
5. Argus WA: Ocular hypertension and central corneal thickness. *Ophthalmology.* 1995; 102: 1810-1812.
6. Wu L, Suzuki Y, Araie M. Corneal thickness and intraocular pressure in cases with ocular hypertension and glaucoma. *Zhonghua Yan Ke Za Zhi.* 2000 Nov; 36(6): 438-41.
7. Brusini P, Miami F, Tosoni C. Corneal thickness in glaucoma: An important parameter. *Acta ophthalmol Scand Suppl.* 2000; (232): 41-2.