



Correlation between Central Corneal thickness and Intraocular Pressure measured with Goldmann Applanation Tonometer (GAT) in healthy individuals

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Abstract

Introduction: 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). It has been stated that thinner corneas leads to false low IOP interpretations while thicker corneas leads to false high IOP interpretations, thus causing apparent normal tension glaucoma (NTG) and ocular hypertension (OHT) respectively

Objective: To evaluate the effect of CCT on IOP readings by Goldmann Applanation Tonometry in healthy individuals

Methodology: This prospective study included 200 eyes of 100 patients attending the outpatient department of ophthalmology, from January 2018 to June 2018, in MMIMSR, Mullana. The patients included were devoid of any corneal disorder, history of antiglaucoma medications, keratitis, keratoconus, corneal scar, corneal dystrophy and degeneration. A total number of 200 eyes were investigated using the Ultrasonic topography system and Goldmann Applanation Tonometry. The minimum CCT was 415 μ m, maximum CCT was 648 μ m with mean CCT being 528.5 μ m with SD \pm 29.48 μ m. The minimum IOP recorded was 9 mmHg, maximum IOP was 22 mmHg and mean IOP was 14.92 mmHg with SD \pm 2.98 mmHg

Conclusion: In our study, we found that Central corneal thickness was correlated with intraocular pressure significantly in both men and women. Athick cornea leads to an overestimation of IOP while thin cornea leads to an underestimation of IOP.

Keywords: Central corneal thickness, Intraocular pressure, Goldmann Applanation Tonometer, pachymetry, Glaucoma.

Introduction

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} The GAT is based on Imbert-Fick law which states that an external force against a sphere equals the pressure in the sphere times the area flattened by the external force. However, the

rationality of this law needs that the sphere is exactly spherical and flexible, dry and extremely thin. But the cornea fails to gratify any of these requirements as it is aspherical and wet and neither flexible nor markedly thin. The moisture generates surface tension, while the lack of flexibility needs force that is not dependent of the internal pressure to mold the cornea. These forces balance each other for the GAT (applanation diameter of 3.06 mm) when the CCT is 520 μm , providing a “reference” value where the applanating pressure does equal the IOP³ Goldmann based his notion of tonometry on a modification of this law and found that ocular rigidity does not significantly influence the measurement of IOP. However, corneal variables, contact duration, semicircles of Goldmann tonometry, and calibration may influence the results. A thicker cornea needs greater force to applanate and on the other hand, a thinner cornea gets easily flattened. Athin cornea is a important risk factor for the development of glaucoma⁴. Various studies have been done to correlate the relationship between IOP measured by GAT and CCT^{4,5} however it was Ehlers et al¹ and Whitacre et al² who measured IOP by manometer. It has been stated that thinner corneas leads to false low IOP interpretations while thicker corneas leads to false high IOP interpretations, thus causing apparent normaltension glaucoma (NTG) and ocular hypertension (OHT) respectively⁶. With the advent of PRK (photorefractive keratectomy) in myopia, there is underestimation of IOP as PRK causes thinning of central cornea^{7,8}. Ultrasonic pachymetry is the most frequently used method for measuring CCT however various sophisticated methods have been recently used one of them being non-contact Scanning Slitbased (Orbscan) pachymetry. In this study we evaluated the effect of CCT on IOP readings by GAT in healthy individuals.

Methodology

This prospective study included 200 eyes of 100 patients attending the outpatient department of ophthalmology, from January 2018 to June 2018, in MMIMSR, Mullana. The patients included were devoid of any corneal disorder, history of antiglaucoma medications, keratitis, keratoconus, corneal scar, corneal dystrophy and degeneration. Out of 100 patients, 54 were females and 46 were males.

The age range of patients was 14 years- 60 years with mean age was 29.32 years with standard deviation (SD) \pm 7.45 years. A total number of 200 eyes were investigated using the Ultrasonic topography system and Goldmann Applanation Tonometry. The minimum CCT was 415 μm , maximum CCT was 648 μm with mean CCT being 528.5 μm with SD \pm 29.48 μm . The minimum IOP recorded was 9 mmHg, maximum IOP was 22 mmHg and mean IOP was 14.92 mmHg with SD \pm 2.98 mmHg. In this study 46 patients (92eyes) were males. The minimum CCT in male patients was 421 μm , maximum CCT was 632 μm and mean CCT was 527.02 μm SD \pm 28.19 μm . The minimum IOP was 9 mmHg, maximum IOP was 20 mmHg and mean IOP was 14.96 mmHg SD \pm 2.89 mmHg. Out of 100 patients, 54 were females. The minimum CCT of female patients was 415 μm , maximum CCT was 648 μm and mean CCT was 532.15 μm SD \pm 34.21 μm . The minimum IOP was 10 mmHg, maximum IOP was 21 mmHg and mean IOP was 15.43 mmHg SD \pm 2.98 mmHg. The patients were divided into various groups according to CCT and IOP and are depicted in Table no.1

Table No.1 CCT and IOP in different age groups

GROUPS	CENTRAL CORNEAL THICKNESS		INTRAOCULAR PRESSURE BY GAT(mm Hg)	
	NO. of eyes(n)	Mean	No.of eyes(n)	Mean
410-439 μm	05	432.95 μm	05	10.43
440-469 μm	06	459.73 μm	06	11.65
470-499 μm	28	492.78 μm	28	12.52
500-529 μm	80	522.65 μm	80	14.63
530-569 μm	68	556.45 μm	68	15.54
570-599 μm	08	580.29 μm	08	16.64
600-629 μm	03	610.34 μm	03	19.23
630-669 μm	02	649.00 μm	02	21.00

Discussion

There are numerous studies on the relationship between CCT and IOP⁹⁻¹². Some studies done showed significant relationship between CCT and IOP as reported by Wolfs et al and Herndon et al. However, in a study conducted by Lam and Douthwaite on Chinese subjects in the age group 19-23 years showed no significant relationship between CCT and IOP. This study of ours reported a statistically significant positive correlation between CCT and IOP. The IOP is an vital functional parameter for the diagnosis and management of glaucoma. Goldmann applanation tonometry is one of the most frequent method used for calculating IOP, however numerous aspects such as tear film, shape of the anterior cornea, corneal thickness or scleral rigidity can effect its precision in healthy individuals. It has been proposed that CCT is a main source of error in applanation tonometry^{13,14}, a thick cornea causing an overestimation of IOP and a thin cornea causing an underestimation^{1,15,16}.

Numerous studies endorses a correlation between central corneal thickness and false IOP readings. In a study conducted by Johnson and coauthors¹⁷ in a 17-year-old girl with an IOP of 30 to 40 mm Hg with standard visual fields and optic nerve heads in both eyes and failed medical management reported the central corneal thickness of was 900 μm in both eyes without corneal edema. On Manometry of left eye, IOP recorded was 11 mm Hg; while the IOP measured with Perkins and Schiötz tonometers was 35 and 34 mm Hg, respectively. In our study, the mean IOP for both sexes combined to be 14.92 mmHg. However, the mean IOP was 15.8 mmHg in Icelandic population survey which used Schiötz tonometry¹⁸ and to the 15.2 mmHg in a study done by Klein et al., who surveyed using Goldmann applanation tonometry¹⁹. The mean IOP in females and males in our study was 15.43 mmHg and 14.96 mmHg respectively. This result was comparable to the several large population samples surveyed using Goldmann applanation tonometry²⁰. Mean CCT we found

was 528.5 μm for both males and females. In a study done on Japanese population showed mean CCT of 517.5 μm .

Conclusion

In our study, we found that Central corneal thickness was correlated with intraocular pressure significantly in both men and women. A thick cornea leads to an overestimation of IOP while thin one leads to an underestimation of IOP. There was no significant difference in central corneal thickness and intraocular pressure between the right and left eyes or between male and female subjects.

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