Original Article

Correlation between Central Corneal Thickness and Intraocular Pressure: A Cross Sectional Study

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ABSTRACT

Purpose: To find out correlation between Central Corneal Thickness (CCT) and Intra Ocular Pressure (IOP).

Study Design: Observational Correlational study.

Place and Duration of Study: This study was conducted in Ophthalmology Clinic Primasatya Husada Citra Hospital Surabaya from September 2021 to October 2021.

Methods: One hundred and fifteen subjects were selected through consecutive sampling. Patients of 20 – 60 years age and visiting ophthalmology clinic were included. Patients with history of glaucoma, hypertension, body mass index (BMI) above 30 kg/m^2, under steroid treatment (topical, systemic, peri ocular, inhalation), undergone eye surgery including corneal and refractive surgery, smoker (> 100 cigarettes in his/her life and is still smoking), Alcoholic (> 1 time/month), chronic kidney disease (CKD) and myopia (> 6 diopters) were excluded. Association between CCT and IOP was calculated using Pearson's correlation coefficient.

Results: A total 115 patients were included, 69 (60%) females and 46 (40.0%) males. Mean age was 35.78 ± 11.64 years old. Mean CCT was 550.26 ± 31.66 µm and 551.43 ± 34.92 µm for right and left eye respectively. IOP was 16.06 ± 3.71 mmHg and 15.76 ± 3.52 mmHg in right and left eyes respectively. There was a moderate positive relationship of CCT and IOP. There was a good relationship between right and left "IOP (R = 0.830, p = 0.000) and CCT (R = 0.856, p = 0.000)."

Conclusion: CCT had a moderate positive correlation with IOP (right eyes: R = 0.355, p = 0.000; left eyes: R = 0.381, P = 0.000). There is a positive relationship between CCT and IOP in both eyes (p = 0.000).

Key Words: Central corneal thickness, intraocular pressure, Tonometry,

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INTRODUCTION

Thickness of cornea in its central region affects the readings of intraocular pressure (IOP).[1] This may impact how glaucoma and ocular hypertension patients are screened for the disease, followed, and treated. Given this, one can see why precise IOP measurement is crucial. According to the Ocular Hypertension Study (OHTS) researchers, IOP is underestimated when the central corneal thickness (CCT) is thin and vice versa.[1]

A thin shell hypothesis was developed by Orssengo and Pye, with a statement explaining that there is a combination of factors that have an impact on the Applanation force required for an existing IOP of a certain size. The gap between the Applanation pressure and the actual IOP decreases as the applanation area decreases. It takes more energy to applanate a thicker cornea and less force if the cornea is thinner.[1,2]

Therefore, the notion was that CCT can be a detrimental factor in terms of measuring IOP. CCT has been found to positively correlate with IOP in a number of investigations. As local data is scarce, we planned to assess the strength of link between CCT

and IOP, quantify the impact, and identify any differences in the correlation between the right and left eyes.

METHODS

The correlational study was conducted at in Ophthalmology Clinic Primasatya Husada Citra Hospital Surabaya from September 2021 until October 2021. The study was approved by the Health Research Ethics Commission of Medical Faculty Widya Mandala Catholic University based on "WHO-CIOMS International Ethical Guidelines for Health-related Research Involving Humans". A sample size of 115 was calculated using Leme show formula. This calculation assumed a two-sided test, $\alpha = 0.05$. The inclusion criteria were patients visiting ophthalmology clinic with age 20 – 60 year old. The exclusion criteria were patients with history of glaucoma, hypertension, body mass index (BMI) above 30 kg/m^2, steroid treatment (topical, systemic, periocular, inhalation), previous eye surgery including corneal and refractive surgery, smoker (> 100 cigarettes in his/her life and is still smoking), Alcoholic (> 1 time/month), history of chronic kidney disease (CKD) and myopia (> 6 diopters).

CCT and IOP measurements were carried out with non-Contact Tonometers Canon TX – 20P. To avoid the effect of diurnal variation, the readings were taken during 9-11 am.[3] Age, sex, CCT, and IOP were all collected as primary data from patients. Shapiro-Wilk testwas used to determine whether a variable can match a normal distribution. Because the data obtained did not match, we performed the Kruskal-Wallis test to compare the two groups. The association between CCT and IOP was calculated using Pearson's correlation coefficient. The following criteria were used to determine strength of any observed correlations: Weak or no relationship (0.01), slight/ moderate association (0.025 – 0.49), moderate association (0.50 – 0.74), and strong association (> 0.75).

The impact of CCT on IOP of both eyes was evaluated using simple linear analysis, and the R^2 coefficient of determination was utilized. CCT and IOP measurements were compared between the two eyes using paired-sample t-tests. The analysis was done using SPSS 24.0 program, and the p-value < 0.05 was considered significant in statistical terms.

RESULTS

A total of 115 patients, 69 (60%) females and 46 (40.0%) males were included. Mean age was 35.78 ± 11.64 years. Mean CCT was 550.26 ± 31.66 µm and 551.43 ± 34.92 µm in right and left eyes respectively. Mean IOP was 16.06 ± 3.71 mmHg and 15.76 ± 3.52 mmHg in right and left eye respectively (Table 1).

We found a moderate positive correlation between CCT and IOP of the right eyes (Pearson Correlation Coefficient, R = 0.355, P = 0.000) and left eyes (Pearson Correlation Coefficient, R = 0.381, P = 0.000) (Table 1). Analysis showed that for 100 µm CCT, the measured IOP increased by 0.042 mmHg in right eye ($R^2 = 0.126$, p = 0.000) and by 0.038 mmHg in left eye ($R^2 = 0.145$, p = 0.000) (Figure 1).

We also analyzed inter-eye CCT and IOP. CCT of right and left eye had a strong relationship (R = 0.856, p = 0.000). There was no significant difference in IOP of right and left (R = 1.51, p = 0.132) with IOP of right eye 0.3 higher than IOP of left eye (95% CI [-0.09, 0.69]).

Table 1: Results.

	Right Eye	Left Eye
Number (eyes)	115	115
CCT (Mean ±SD)	550.26 ± 31.66	551.43 ± 34.92
IOP (Mean ±SD)	16.06 ± 3.71	15.76 ± 3.52
R, p value	R =0.355, p=0.000	R=0.381, p=0.000
R^2, p value	R^2=0.126, p=0.000	R^2=0.145, p=0.000
CCT OD-OS	r=0.856, p=0.000	
IOP OD-OS	r=0.830, p=0.000	

DISCUSSION

CCT has been shown to correlate positively with IOP in many studies (Table 2).[4–9] This research found a good relationship between CCT and IOP. According to statistical analysis, the observed IOP rises by 0.042 mmHg ($R^2 = 0.126$, p = 0.000) on the right eye and 0.038 mmHg ($R^2 = 0.145$, p = 0.000) on the left eye for every 100 µm increase in CCT. Furthermore, a good relationship was found between binocular CCT (r = 0.856, p = 0.000) and IOP (r = 0.830, p = 0.000).

Alkhodari et al, confirmed similar findings, a positive connection between CCT and IOP in the right eye "(R = 0.358, P = 0.000) and in the left eye (R = 0.324, P = 0.000). For every 100 µm increase in CCT, observed IOP rises by 0.024 mmHg ($R^2 = 0.138$, P = 0.000) on the right eye and 0.022 mmHg ($R^2 = 0.121$, P = 0.000)"on the left eye.[4]

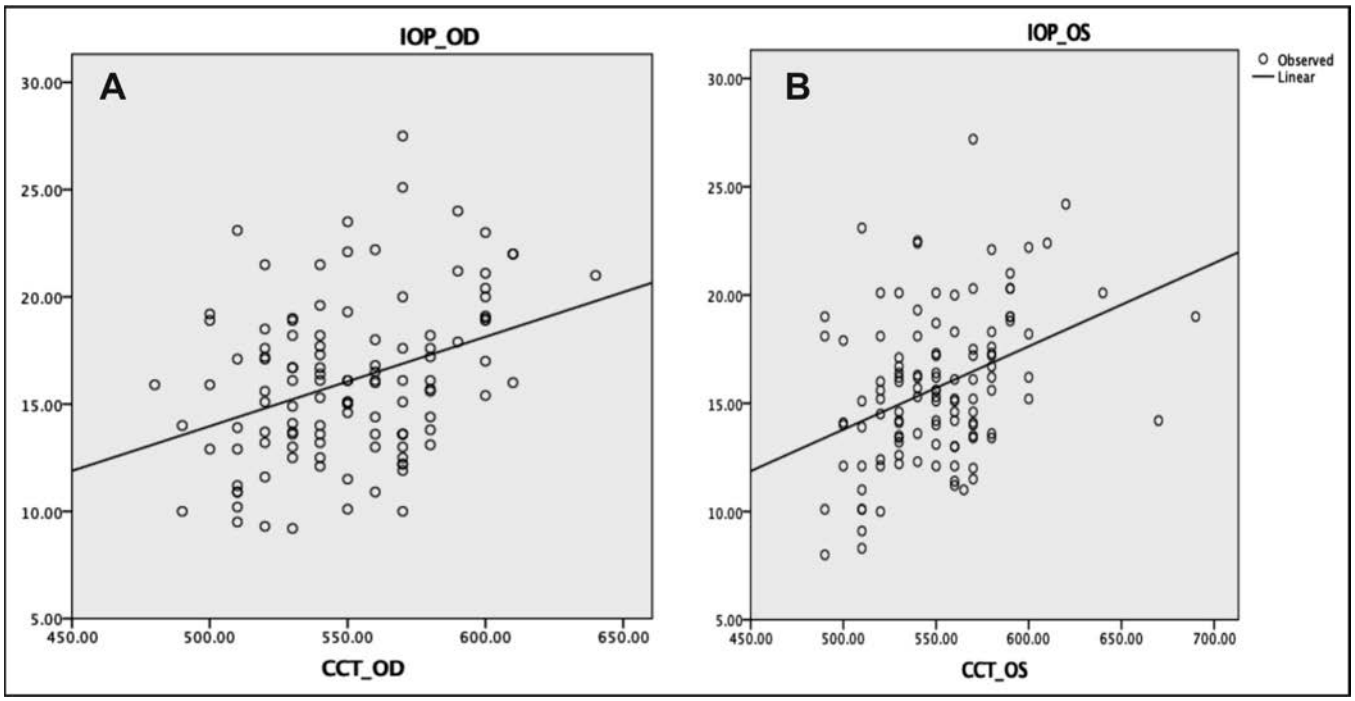

Figure 1: Scatter diagram of CCT and IOP (n = 115) in the right eye (A) and left eye (B). (OD: R^2 = 0.126, p = 0.000; OS: R^2 = 0.145, p = 0.000).

Table 2: Comparison of results of this study with other studies.

	CCT-IOP Relationship		Increase in IOP with Increase in CCT	
	Right Eye	**Left Eye**	**Right Eye**	**Left Eye**
This study	R = 0.355, P = 0.000	R = 0.381, P = 0.000	Every 100 µm: 0.042 mmHg (R^2 = 0.126, p = 0.000)	Every 100 µm: 0.038 mmHg (R^2 = 0.145, p = 0.000)
Al-Khodari et al[4]	R = 0.358, P = 0.000	R=0.324, P=0.000	Every 100 µm: 0.024 mmHg (R2 = 0.138, P = 0.000)	Every 100 µm: 0.022 mmHg (R2 = 0.121, P = 0.000)
Nejabat[5]	R = 0.487, P = 0.000	R = 0.456, P = 0.000	Every 100 µm: 3.3 mmHg	Every 100 µm: 2.9 mmHg
Hoffman et al[6]	N/S	N/S	Every 10 µm: Male: 0.37 mmHg, R^2 = 0.205 Female: 0.35 mmHg, R^2 = 0.235	Every 10 µm: Male: 0.38 mmHg, R^2 = 0.209 Female: 0.45 mmHg, R^2 = 0.229
Ahmed et al[7]	R = 0.54, P = 0.001		N/S	N/S
Lee et al[8]	R = 0.676, P = 0.001		N/S	N/S
Wei et al[9]	R = 0.44, P = 0.05s		N/S	N/S

*N/S: not stated

Using the same method for measuring IOP as the present investigation, Nejabat et al, found a moderate association between CCT and IOP (right eye: R = 0.487, p = 0.000; left eye: R = 0.456, p = 0.000). The right eye saw a more significant rise in IOP (3.3 mmHg) than the left eye (2.9 mmHg) for every 100 µm increase in CCT.[5]

Hoffman et al. found that there was a correlation between IOP rise and CCT: right eye in male 0.37 mmHg, R^2 = 0.205, in female: 0.35 mmHg, R^2 = 0.235; left eye in male: 0.38 mmHg, R^2 = 0.209, in female: 0.45 mmHg, R^2 = 0.229. Furthermore, they demonstrated a significant disparity in mean CCT between the two eyes (p = 0.0001).[6]

Sharma et al, found a moderate positive connection between CCT and IOP, statistically significant for both the right and left eyes (p = 0.001).[10] Positive correlation between CCT and IOP was also found by other researchers.[11-14]

Non-contact tonometry (NCT), which was used in our study is known to have a reasonable correlation

with CCT.[15] The Goldmann Applanation tonometer (GAT) is less vulnerable to CCT than the NCT.[15–19] NCT causes the cornea to flatten in a brief amount of time—roughly 8 ms—making the cornea more rigid than GAT, which measures the response of cornea to steady pressure or compression. Increased measured IOP with increased CCT are consistent across clinical and demographic research alike.[20,21]

The limitations of this study are cross-sectional design for a period of one month. All confounders could not be controlled. Longer period and larger sample size are recommended for further study. In addition, non-Contact Tonometers were used to assess CCT and IOP in this investigation. We highly recommend the use of ultrasound pachymetry as the gold standard for measuring CCT and Goldmann applanation as the gold standard for measuring IOP.

CONCLUSION

CCT had a moderate positive correlation with IOP (right eyes: R = 0.355, p = 0.000; left eyes: R = 0.381, P = 0.000). There is a positive relationship between CCT and IOP in both eyes (p = 0.000). Observed IOP rises by 0.042 mmHg (R2 = 0.126, p = 0.000) in the right eye and 0.038 mmHg (R2 = 0.145, p = 0.000) in the left eye for every 100 micrometer increase in CCT. In addition, CCT was highly positively correlated between right and left eyes (r = 0.856, p = 0.000).

Conflict of Interest

Authors declared no conflict of interest.

Ethical Approval

The study was approved by the Institutional review board/Ethical review board **(214/WM12/KEPK/DOSEN/T/2021).**

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Authors' Designation and Contribution

Ivana Beatrice Alberta; General Practitioner: *Concepts, Design, Literature search, Data acquisition, Data analysis, Statistical analysis, Manuscript preparation, Manuscript editing, Manuscript review.*

Titiek Ernawati; Consultant Ophthalmologist: *Concepts, Design, Literature search, Data acquisition, Data analysis, Statistical analysis, Manuscript preparation, Manuscript editing, Manuscript review.*

Rofiqi Rofiq; Resident: *Concepts, Design, Literature search, Data acquisition, Data analysis, Statistical analysis, Manuscript preparation, Manuscript editing, Manuscript review.*