Correlation between Retinal Nerve Fiber Layer Thickness and Central Corneal Thickness in Healthy Subjects

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Objective: *To evaluate the correlation between retinal nerve fiber layer (RNFL) thickness obtained by optical coherence tomography (Spectralis OCT, Heidelberg Engineering, Heidelberg, Germany) and central corneal thickness (CCT) in healthy subjects.*

Material and Method: *This was a retrospective cross-sectional study. Two hundred twenty nine healthy subjects were included in the present study. All subjects received a standard ocular examination, including RNFL thickness measurement by optical coherence tomography. CCT measurement was performed by ultrasonic pachymeter. The Pearson's correlation test was used to determine the relationship between CCT and RNFL thickness.*

Results: *The significantly positive relationship was found between CCT and RNFL thickness in overall average and inferior sector. There was no statistically significant relationship found between CCT and the other sectors of RNFL thickness.*

Conclusion: *CCT was statistically significant related to RNFL thickness in overall average and inferior sector in healthy subjects.*

Keywords: *Central corneal thickness, Retinal nerve fiber layer thickness*

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Glaucoma is the second leading cause of blindness worldwide[1]. It affects 60.5 million people worldwide in 2010 and will increase to 79.6 million by 2020, and of these, 74% will have open angle glaucoma[2]. The risk factors for development of open-angle glaucoma have been determined by some studies such as the ocular hypertension study (OHTS) and European glaucoma prevention study (EGPS)[3,4]. One of the strong risk factors that have been shown to be related to glaucomatous development is central corneal thickness (CCT)[3,4]. The Ocular Hypertension Treatment Study (OHTS)[3] demonstrated that a decreased CCT predicts the development of primary open angle glaucoma. People with CCT ≤555 µm had three times the risk of progressing to glaucoma than those with a CCT >588 µm. The mechanism of this relationship has not been well understood. It has been hypothesized to be related to the correlation between central corneal thickness and the other structure of the eye, which may involve susceptibility to glaucoma. Many studies have been conducted and found the relationship between CCT and glaucomatous development in eyes with ocular hypertension[3,5-7]. Central corneal thickness was also found to correlate with the rate of progression in glaucomatous patients[8,9]. However, limited information is known about the relationship between retinal nerve fiber layer (RNFL) thickness and CCT in healthy subjects. Study of this relationship might provide some benefit to understand about the mechanism of the relationship between CCT and glaucomatous development.

The purpose of the present study was to determine the correlation between CCT and RNFL thickness in healthy subjects. The authors also evaluated the relationship between CCT and different sectors of RNFL thickness. The overall average and sector RNFL thickness of each eye were analyzed for their relationships to CCT.

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Material and Method

This was a retrospective study performed at Mettapracharak Hospital, Thailand. We collected the data from the annual ocular check-up for healthcare workers in Mettapracharak Hospital in 2011. All participants received a comprehensive ocular examination, including medical history, uncorrected visual acuity, best-corrected visual acuity, intraocular pressure measurement by non-contact tonometer, fundus photography, CCT measurement, and RNFL imaging with optical coherence tomography (OCT).

CCT measurement was performed by ultrasound pachymetry (OcuScan RxP; Alcon, USA), and OCT scans were performed on both eyes by spectral domain OCT using Spectralis OCT (Heidelberg Engineering, Heidelberg, Germany) without pupil dilation. Three hundred and sixty degree circular scan with a diameter of 3.4 mm, centered on the optic disc, was performed using the fast RNFL thickness protocol. The minimal scan quality of more than or equal to 20 dB was accepted for inclusion to the study.

Inclusion criteria were best corrected visual acuity greater than or equal to 20/40, Intraocular pressure (IOP) less than 21 mmHg, normal appearing optic nerve head (ONH) and normal RNFL imaging. Subjects with a history of ocular surgery were excluded.

The present study was approved by the Institutional Ethical Committee of the Mettapracharak Hospital.

Statistical analysis

Correlations between RNFL thickness and CCT were analyzed by using the Pearson's correlation test.

Results

Two hundred fifty two subjects received annual ocular check-up at Mettapracharak Hospital in 2011. Of the 252 subjects examined, 229 subjects (458 eyes) met the inclusion criteria and were included in the study. Forty-four subjects were male and 185 subjects were female. The average age of subjects was 37.0±8.6 years (range: 20-61). Mean corneal thickness was 534.6±31.2 µm (range: 441-621). Fig. 1 showed the distribution of CCT across all studied population. Mean average and sector RNFL thickness measurements were shown in Table 1 with their correlations to CCT.

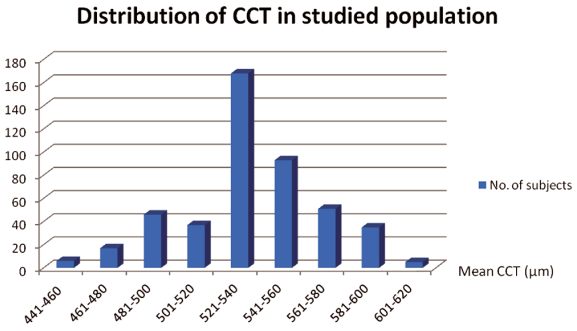

Fig. 1 Distribution of CCT across all studied population.

Pearson's correlation statistical analysis

Average RNFL thickness and inferior RNFL thickness were found to have statistically significant positive relationship with CCT (p = 0.048 and 0.025 respectively). Temporal and superior RNFL thickness had some correlation with CCT but not statistically significant (p = 0.072 and 0.243 respectively). No statistical significant relationship was found between CCT and the all other parameters (IOP, age, and testing side).

Discussion

An interesting factor that has been demonstrated as a major risk factor for glaucoma development is CCT[3-9]. It has also been recognized as a significant risk factor for progression of ocular hypertensive patients to primary open angle glaucoma (POAG)[3]. Lower CCT was significantly associated with increasing risk for POAG development in ocular hypertensive patients. The mechanism of such reverse relationship is not well understood. Some researchers have proposed about the possibility of the relationship between CCT and the other tissue of the eye. It is possible that a thinner cornea may be related to a thinner or more susceptible retinal nerve fiber layer at the back of the eye that make the patient more

Table 1. Retinal nerve fiber layer (RNFL) thickness measurement and their relationship with central corneal thickness (CCT)

Parameters	Mean ± SD (micron)	Pearson's correlation coefficient	*p*-value
Average RNFL thickness	105.9±8.6	0.092	0.048
Superior RNFL thickness	137.3±14.9	0.055	0.243
Inferior RNFL thickness	137.7±14.5	0.104	0.025
Nasal RNFL thickness	73.3±11.4	0.000	0.998
Temporal RNFL thickness	74.5±9.6	0.084	0.072

susceptible to glaucoma. Some studies suggested that there might be an anatomical correlation between CCT and optic nerve susceptibility to glaucoma[10,11]. It has been found that thinner cornea appears to be related with larger and deeper optic disc cups in glaucoma patients. Henderson et al[7] had reported that ocular hypertension patients with thinner cornea had thinner retinal nerve fiber layer than ocular hypertensive patients with thicker cornea and healthy control subjects.

Limited data have been provided about CCT and its relationship to RNFL thickness in healthy subjects. The present study aimed to evaluate such relationship; we found the significant relationship between CCT and average RNFL thickness and inferior RNFL thickness in normal subjects. Mumcuoglu et al[12] studied the relationship between CCT and average RNFL thickness in 218 eyes of 109 subjects using scanning laser polarimetry (GDx-VCC), confocal scanning laser ophthalmoscopy (HRT II) and optical coherence tomography (Stratus OCT). They reported no significant relationship between CCT and average RNFL thickness. In the present study, we studied in some more details of RNFL thickness. The author evaluated the relationship between CCT and each sector including overall average of RNFL thickness. The statistically significant positive relationships were found between CCT and RNFL thickness in overall average and inferior sector. The slightly positive relationships were also found between CCT and RNFL thickness in superior and temporal sector but not statistically significant. No relationship was found between CCT and nasal RNFL thickness. As the inferior RNFL thickness is the area that usually affected in glaucoma. This finding in the study might be the interesting information for further investigation to evaluate the possible mechanism of the role of CCT as a risk factor for glaucoma development. However, findings in the present study were the opposite of the study by Mumcuoglu et al[12], which studied the relationship between CCT and average RNFL thickness measurement in healthy subjects by using three different methods of RNFL thickness measurement. In the present study we used only one machine (Spectralis OCT) for RNFL thickness measurement but studied in different sectors and overall average thickness of RNFL. The different machines and methods used in the studies might be the reasons for the different results found between both studies.

There is no gold standard method for true RNFL thickness measurement. Many imaging technologies are available for RNFL thickness measurement including scanning laser polarimetry, confocal scanning laser ophthalmoscopy, and OCT. Each method uses light in different ways to determine RNFL thickness. Some studies have been conducted to compare the various technologies for RNFL measurement. There was no single imaging device that outperformed the others in terms of distinguishing glaucoma from normal[13,14]. In the present study the author chose to use OCT to measure the RNFL thickness because it was easy to perform and comparable with the other technologies.

Thinning of RNFL in glaucoma is not equal in all sectors. The most common sectors of RNFL affected in glaucoma are the inferotemporal followed by the superotemporal[15]. Studying in different sectors of RNFL thickness should be able to provide more information than overall average of RNFL thickness in order to find the correlation of RNFL thickness and CCT, which might lead to the possibility to explain the relationship of CCT and risk of glaucoma development. The present study found the relationship between the CCT and the inferior RNFL thickness which is the most common sector affected in glaucoma. However, further studies are required for better understanding of such relationship.

In conclusion, CCT had positive correlation with overall average and inferior sector of RNFL thickness in healthy subjects.

What is already known on this topic?

There is the strong relationship between thin CCT and the development of glaucoma. The OHTS[3] demonstrated that a decreased CCT predicts the development of primary open angle glaucoma. However, the mechanism of such relationship is not well understood.

One of the diagnostic features of glaucoma is thinning of the RNFL thickness. Some researchers suggested that there might be an anatomical correlation between CCT and RNFL, which might be able to explain the mechanism of thin CCT as a strong risk factor for glaucoma. However, limited data about CCT and its relationship to RNFL thickness in healthy subjects has been reported.

What this study adds?

This study reported some information about the correlation between CCT and RNFL thickness in healthy subjects.

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Potential conflicts of interest

None.

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การศึกษาหาความสัมพันธ์ระหว่างความหนาของชั้นเส้นใยประสาทที่จอตากับความหนาของกระจกตาในคนปกติ

ดวงดาว ทัศณรงค์

วัตถุประสงค์: เพื่อศึกษาหาความสัมพันธ์ระหว่างความหนาของชั้นเส้นใยประสาทตาและความหนาของกระจกตาในคนปกติ
วัสดุและวิธีการ: เป็นการศึกษาแบบการวิจัยย้อนหลัง โดยมีผู้เข้าร่วมการศึกษาทั้งหมด 229 ราย ผู้เข้าร่วมการศึกษาทุกรายได้รับการตรวจตาตามมาตรฐานรวมทั้งการวัดความหนากระจกตาด้วยเครื่อง ultrasonic pachymeter และความหนาของชั้นเส้นใยประสาทตาด้วยเครื่อง optical coherence tomography สถิติที่ใช้ในการศึกษาหาความสัมพันธ์ของข้อมูลคือ Pearson's correlation test
ผลการศึกษา: ความหนาของกระจกตามีความสัมพันธ์ไปในทางเดียวกันกับความหนาของชั้นเส้นใยประสาทตาโดยเฉลี่ยทั้งหมดและความหนาของเส้นใยประสาทตาเฉพาะส่วนล่างของจอตาอย่างมีนัยสำคัญทางสถิติ และไม่พบความสัมพันธ์อย่างมีนัยสำคัญทางสถิติระหว่างความหนาของกระจกตากับความหนาของชั้นเส้นใยประสาทตาในส่วนอื่น ๆ ของจอตา
สรุป: ความหนาของกระจกตามีความสัมพันธ์ไปในทางเดียวกันกับความหนาของชั้นเส้นใยประสาทตาโดยเฉลี่ยทั้งหมดและโดยเฉพาะส่วนล่างของจอตาอย่างมีนัยสำคัญทางสถิติในคนปกติ