# Comparative Study of Two Central Corneal Thickness Measurements in Glaucoma Patients

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***Background:*** *Goldmann applanation tonometry (GAT) has been the gold standard for IOP measurements in glaucoma patients. The accuracy of GAT measurements is dependent on many factors, particularly the central corneal thickness (CCT) has been shown to have effect on IOP measurements.*
***Objective:*** *To compare of two central corneal thickness measurements in glaucoma patients.*
***Material and Method:*** *Forty-five right eyes of 45 patients were enrolled. All patients underwent a complete ophthalmologic examination. CCT measurements were performed with an ultrasound pachymeter on two different visits. Patients presenting Diabetes Mellitus (DM), previous history of intraocular surgery and laser were excluded. Antiglaucoma medications were allowed to use during the study. For statistical analysis, paired t-test was used.*
***Results:*** *In the present study, the mean age of patients was 59.18 years. (range 40-91 years). Twenty-one patients (46.7%) were male and twenty-four patiens (53.3%) were female. The interval between two measurement periods was 8.42 weeks (range 2-24 weeks). The mean CCT values were not significantly different between the two visit (521.29 micron SD 32.52 micron and 518.76 micron SD 33.26 micron; p = 0.15).*
***Conclusion:*** *In the present study which excluded patients with DM, previous history of intraocular surgery and laser treatment was shown that there was no statistically significant difference in CCT measurements on different occasions.*

***Keywords:*** *Central corneal thickness, Glaucoma*

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Glaucoma is the leading cause of irreversible blindness worldwide and second most common cause of blindness overall[1]. Increased intraocular pressure (IOP) is a major risk factor for glaucoma[1]. Goldmann applanation tonometry (GAT) has been the gold standard for IOP measurements in glaucoma patients[2]. The accuracy of GAT measurements is dependent on many factors such as corneal thickness, corneal curvature and axial lenght[3]. Particularly the central corneal thickness (CCT) has been shown to have effect on IOP measurements. Because the calculation GAT is based on average central corneal thickness of 520 microns[4], intraocular pressure measured by GAT may be overestimated or underestimated in thick or thin corneas, Respectively[5]. One study points that one measurement of CCT should not be considerd sufficient in glaucoma clinics[6]. On the other hand, one study reports that no clinically significant difference in CCT measurement was found on different occasions[7]. As a result, the objective of the present study is to compare two CCT measurements in glaucoma patients.

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## Material and Method

In a prospective single-center study, forty-five right eyes of 45 patients were enrolled consecutively from HRH Princess Maha Chakri Sirindhorn Medical Center, Department of Ophthalmology, Faculty of medicine, Srinakharinwirot University, Nakhornnayok, Thailand. All patients underwent a complete ophthalmic examination, including best-corrected visual acuity evaluation, slit-lamp examination, gonioscopy and fun-dus examination with a 90-diopter lens. For each patient, we recorded age, sex, race, underlying disease and

antiglaucoma medication. The CCT measurements were performed with an ultrasound pachymetry (Bio and Pachymeter AL-3000, Tomey) on two different visits. All of the measurements were performed by the same examiner. Each patient was received topical anesthesia (0.5% Tetracain hydrochloride) and allowed to blink before CCT measurement to avoid any bias because of cornea drying. The pachymeter probe was placed on the center of the cornea and the average of 5 CCT reading was recorded for each eye. The exclusion criteria included Diabetes Mellitus (DM), history of intraocular surgery, previous treatment of laser and corneal disease. Antiglaucoma medications were allowed to use during the study.

Statistical analysis was performed with the SPSS statistical software (version 13.0; SPSS Inc., Chicago, IL). The statistical significance was determined by paired t-test.

**Results**

In the present study, forty-five right eye of 45 patients were enrolled. The study included 9 eyes with primary open-angle glaucoma (POAG), 7 eyes with normal-tension glaucoma (NTG), 19 eyes with suspected glaucoma and 10 eyes with clinically normal. Descriptive statistics for demographic data are presented in Table 1. The mean age of patients was 59.18 years (range 40-91 years). Twenty-one patients (46.7%) were male and twenty-four patients (53.3%) were female. The interval between two measurement periods was 8.42 weeks (range 2-24 weeks). The values of CCT and IOP in each group are given in Table 2. In the whole study group, the mean CCT at the first visit was 521.29 micron SD 32.52 micron (range 432-580 micron). The second visit, the mean CCT of total group was 518.76 micron SD 33.26 micron (range 453-594 micron). The mean CCT values were not significantly different be-

**Table 1.** Demographic data.

| | Total | POAG | NTG | Suspected glaucoma | Normal |
|---|---|---|---|---|---|
| Age (years) | | | | | |
| Mean | 59.18 ± 12.17 | 58.33 ± 12.09 | 58.57 ± 11.43 | 53.11 ± 11.84 | 62.90 ± 7.55 |
| Range | 40-91 | 49-91 | 49-82 | 40-74 | 52-74 |
| Sex | | | | | |
| Male | 21 | 7 | 4 | 8 | 2 |
| Female | 24 | 2 | 3 | 11 | 8 |
| Antiglaucoma drugs | | | | | |
| Beta-blocker | 5 | 3 | 2 | 0 | 0 |
| Prostaglandin | 11 | 6 | 5 | 0 | 0 |
| None | 29 | 0 | 0 | 19 | 10 |

POAG indicates Primary open-angle glaucoma; NTG: Normal-tension glaucoma

**Table 2.** Values for central corneal thickness and intraocular pressure on two different visit.

| | Total | POAG | NTG | Suspected glaucoma | Normal |
|---|---|---|---|---|---|
| CCT (1st time) | 521.29 ± 32.52 | 523.22 ± 17.41 | 509.00 ± 37.10 | 524.16 ± 36.81 | 522.70 ± 33.71 |
| CCT (2 nd time) | 518.76 ± 33.26 | 522.67 ± 21.91 | 505.86 ± 39.24 | 522.63 ± 37.06 | 516.90 ± 32.05 |
| Dif. Of CCT | 2.53 | 0.56 | 3.14 | 1.53 | 5.80 |
| p-value | 0.15 | 0.85 | 0.27 | 0.64 | 0.18 |
| IOP (1st time) | 14.87 ± 4.24 | 18.67 ± 5.75 | 12.57 ± 4.20 | 14.58 ± 2.99 | 13.60 ± 2.91 |
| IOP (2nd time) | 13.58 ± 2.78 | 14.22 ± 2.11 | 11.14 ± 3.39 | 14.47 ± 2.78 | 13.00 ± 1.94 |
| Dif. Of IOP | 1.29 | 4.44 | 1.43 | 0.11 | 0.60 |
| p-value | 0.01 | 0.04 | 0.14 | 0.81 | 0.42 |

POAG indicates Primary open-angle glaucoma; NTG: Normal-tension glaucoma; CCT: central corneal thickness; IOP: intraocular pressure, Dif.: difference.

tween the two visits (p = 0.15 ). In subgroup analysis (POAG group, NTG group, suspected glaucoma group and normal group) were shown no significant difference between two visits of CCT measurements (p = 0.56, 0.27, 0.64 and 0.18 respectively).

**Discussion**

The Goldmann applanation tonometry is the most widely used method of measuring the IOP[2], but the accuracy of GAT measurements were affected by many factors, especially corneal thickness[3]. Goldmann and Schmidt calibrated the tonometer for an average CCT of 520 microns[4]. If the CCT measurements were different from that value, the GAT may be inaccurate.

Several methods are available to obtain reliable and reproducible measurements of corneal thickness. Ultrasound pachymetry is an efficient and accurate way to measure corneal thickness. Its accuracy is dependent on the perpendicularity of the probe's application to the cornea and reproducibility relies on precise probe placement on the cornea center. It may be difficult to accurately locate the same point of measurement in serial examinations. The previous study had been shown that the mean CCT values were significantly different between the two occasions[6] . On the other hand, the present study has been performed that all groups of patients were not significantly different between the two times of CCT measurement.

Central corneal thickness are influenced by many factors. Increasing age was caused decreased central corneal thickness[8]. Many studys were reported that the increased CCT was significantly correlated with diabetic patients and diabetic duration[9-11]. Few reports have been performed that CCT has increased significantly in postoperative period[12,13]. Glaucoma treatment with prostaglandin analogs were associated with CCT thinning[14,15].

In the present study, multiple factors such as DM, previous history of intraocular surgery, previous history of laser treatment and corneal disease that affected CCT measurements were excluded. The short interval between two measurement periods was exclude to avoid increasing age bias. Patients were allowed to use antiglaucoma medications included prostaglandin analogs that may be affected CCT measurements, but in prostaglandin analogs subgroup analysis has been performed no significant difference between two visits of CCT measurements (515.82 micron SD 32.60 micron and 515.55 micron SD 35.82 micron, respectively p = 0.91).

In the total group and POAG group were found significantly decreased IOP in the second visit because of antiglaucoma medications. But both groups were not significant difference between two occasions of CCT measurements. One study has been published that there was no significant change in the CCT value even though the IOP was elevated[16].

In conclusion, the present study has been performed that the CCT measurements by ultrasound pachymetry were no significant difference on two visits when excluded patients with DM, previous history of intraocular surgery, previous history of laser treatment and corneal disease. The present study points that one measurement of CCT may be sufficient in selected patients.

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## *การศึกษาเปรียบเทียบการวัดความหนาของกระจกตาส่วนกลางสองครั้งในผู้ป่วยโรคต้อหิน*

***สุมาลี บุญยะลีพรรณ***

***ภูมิหลัง****: การวัดความดันตาแบบแอพพลาเนชั่น ยังคงเป็นวิธีมาตรฐานในการตรวจโรคต้อหิน ความถูกต้องของการวัดความดันตาแบบแอพพลาเนชั่นขึ้นอยู่กับหลายปัจจัย และปัจจัยที่สำคัญคือ ความหนาของกระจกตาส่วนกลาง ซึ่งถ้าได้ค่าที่ไม่แม่นยำ อาจมีผลต่อการแปลผลความดันตาได้*

***วัตถุประสงค์****: เพื่อที่จะศึกษาเปรียบเทียบการวัดความหนาของกระจกตาส่วนกลางสองครั้งในผู้ป่วยโรคต้อหิน*

***วัสดุและวิธีการ****: ศึกษาข้อมูลจำนวน 45 ตาขวา ของผู้ป่วย 45 คน โดยผู้ป่วยทุกรายจะได้รับการตรวจตาอย่างละเอียด และได้รับการตรวจหาค่าความหนาของกระจกตาส่วนกลางทั้งสองข้าง และนัดตรวจซ้ำในครั้งต่อไป โดยยังคงให้ผู้ป่วยโรคต้อหินสามารถหยอดยาลดความดันตาได้ตลอดการศึกษา ส่วนผู้ป่วยที่เป็นเบาหวานเคยได้รับการผ่าตัดในลูกตา หรือเคยได้รับการยิงแสงเลเซอร์มาก่อน จะถูกคัดออกจากการศึกษาในการศึกษานี้ใช้ pairs t-test ในการคำนวณค่าทางสถิติ*

***ผลการศึกษา****: จากการศึกษาพบว่าอายุเฉลี่ยของผู้ป่วยคือ 58.18 ปี (ค่าระหว่าง 40-91 ปี) เป็นผู้ชาย 21 คน ผู้หญิง 24 คน ระยะเวลาที่ทำการวัดค่าความหนาของกระจกตาส่วนกลางซ้ำเฉลี่ย 8.42 สัปดาห์ (ค่าระหว่าง 2-24 สัปดาห์) ผลการศึกษาพบว่าค่าเฉลี่ยความหนาของกระจกตาส่วนกลางครั้งแรก คือ 521.29 ไมครอน ค่าความแปรปรวน 32.52 ไมครอน และค่าเฉลี่ยความหนาของกระจกตาส่วนกลางครั้งที่สองคือ 518.76 ไมครอน ค่าความแปรปรวน 33.26 ไมครอน ซึ่งไม่มีความแตกต่างกันอย่างมีนัยสำคัญทางสถิติ*

***สรุป****: จากการศึกษาในครั้งนี้พบว่า ไม่มีความแตกต่างกันอย่างมีนัยสำคัญทางสถิติในการวัดค่าความหนาของกระจกตาส่วนกลางสองครั้งในการวัดต่างวันกัน*