

Diurnal Variation Of Intraocular Pressure And Central Corneal Thickness In Pseudoexfoliation Eyes: A Prospective Observational Study

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Abstract

Purpose: To evaluate the diurnal variation in intraocular pressure (IOP) and central corneal thickness (CCT) in pseudoexfoliation syndrome (PXS) eyes and assess their interrelationship.

Methods: This prospective observational study was conducted on 51 eyes diagnosed with PXS. IOP and CCT were measured at 8 AM, 11 AM, 2 PM, and 5 PM using Goldmann Applanation Tonometry and ultrasound pachymetry. Statistical analysis involved Friedman's test and Spearman's correlation.

Results: The mean age of patients was 68.96 ± 9.08 years. Mean IOP showed a decreasing trend: 17.75 mmHg at 8 AM to 16.82 mmHg at 5 PM. Mean CCT declined significantly from $524.22 \mu\text{m}$ to $515.51 \mu\text{m}$ ($p < 0.001$). A statistically significant negative correlation was found between CCT and IOP at all time points ($\rho = -0.555$ to -0.738 , $p < 0.001$).

Conclusion: PXS eyes show significant diurnal reduction in CCT and an inverse relationship between IOP and CCT. These findings underscore the need to consider corneal thickness and time-of-day in IOP assessment for optimal glaucoma care.

Keywords: Pseudoexfoliation syndrome, central corneal thickness, intraocular pressure, diurnal variation, glaucoma

INTRODUCTION

Pseudoexfoliation syndrome (PXS) is an age-associated systemic disorder characterized by deposition of abnormal fibrillar extracellular material on ocular structures such as the anterior lens capsule, iris, zonules, and trabecular meshwork [1,2]. It is the most common identifiable cause of secondary open-angle glaucoma globally [3]. Pseudoexfoliation glaucoma (PXFG) tends to have more aggressive progression, higher IOP fluctuations, and poorer prognosis compared to primary open-angle glaucoma (POAG) [4,5]. One of the hallmark features of PXS is fluctuating intraocular pressure (IOP). IOP is known to follow a diurnal pattern, with highest values typically in the morning [6]. However, this variation is often exaggerated in eyes with PXS, increasing the risk of glaucomatous optic nerve damage [7]. Single-time IOP assessments may miss peak values, especially in asymptomatic patients, thus underestimating disease severity [8].

Central corneal thickness (CCT) is another factor critical to the interpretation of IOP. Goldmann applanation tonometry (GAT), the most commonly used method of IOP measurement, is sensitive to corneal thickness; thinner corneas lead to underestimation of actual IOP [9]. Multiple studies have shown that PXS eyes tend to have thinner corneas compared to normal eyes, which may contribute to diagnostic delay [10,11].

Furthermore, PXS is associated with genetic alterations in the LOXL1 gene, which affects extracellular matrix remodeling and is linked to structural changes in ocular tissues, including the cornea [12]. Understanding the interplay between IOP and CCT over time in PXS eyes is essential for early identification of those at high risk for glaucoma.

This study aims to evaluate the diurnal variation in IOP and CCT in PXS eyes and determine the correlation between these parameters at various times of the day.

METHODS

Study Design and Setting

This prospective observational study was conducted in the Department of Ophthalmology, Sri Devaraj Urs Medical College, after obtaining approval from the institutional ethics committee.

Inclusion Criteria

- Age > 40 years
- Clinically diagnosed pseudoexfoliation syndrome (PXM on anterior lens capsule, iris, or angle)

Exclusion Criteria

- History of glaucoma or ocular hypertension
- Prior ocular surgery or trauma
- Use of IOP-lowering medications
- Corneal pathology or opacity interfering with pachymetry

Procedure

All patients underwent a comprehensive ocular examination. IOP was measured using Goldmann Applanation Tonometry and CCT was recorded using ultrasound pachymetry. Measurements were taken at 8 AM, 11 AM, 2 PM, and 5 PM by the same examiner to avoid inter-observer variation.

Statistical

Data were analyzed using SPSS version 22. Descriptive statistics were used for demographics. The Friedman test assessed diurnal changes in IOP and CCT. Spearman’s correlation examined the relationship between IOP and CCT. A p-value < 0.05 was considered statistically significant.

Analysis

RESULTS

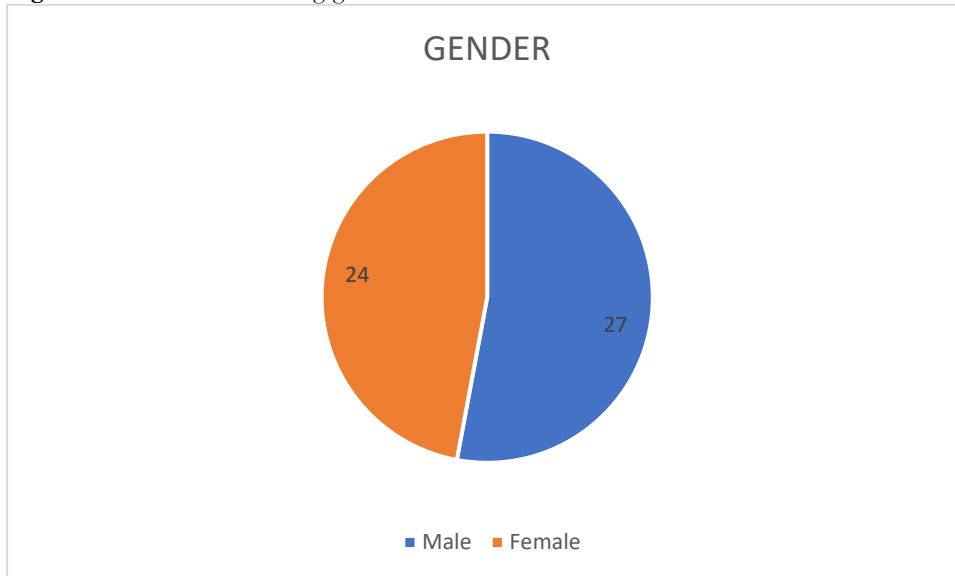
Demographics

The study included 51 eyes of 51 patients. The mean age was 68.96 ± 9.08 years (median 69; IQR 62–75). Males comprised 52.9% of participants.

Table 1: Gender Distribution

Gender	Frequency	Percentage
Male	27	52.9%
Female	24	47.1%

Figure 1: Pie chart showing gender distribution



IOP and CCT Trends

Table 2: IOP and CCT at Different Time Points

Time	IOP (mmHg) ± SD	CCT (µm) ± SD
8 AM	17.75 ± 3.76	524.22 ± 21.47
11 AM	17.55 ± 3.84	521.10 ± 20.73
2 PM	17.29 ± 4.14	520.37 ± 20.74
5 PM	16.82 ± 4.38	515.51 ± 17.51

Figure 2: Line graph showing IOP variation

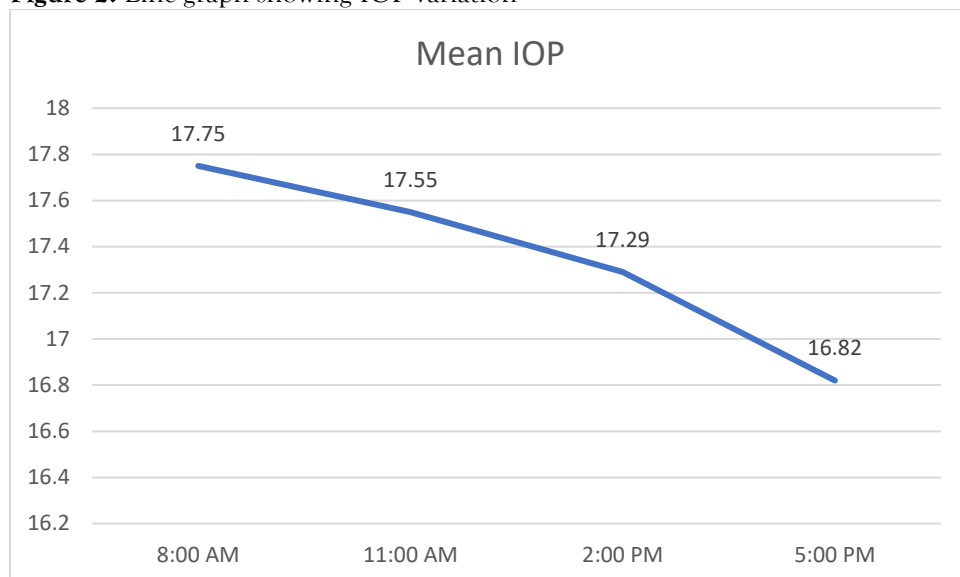
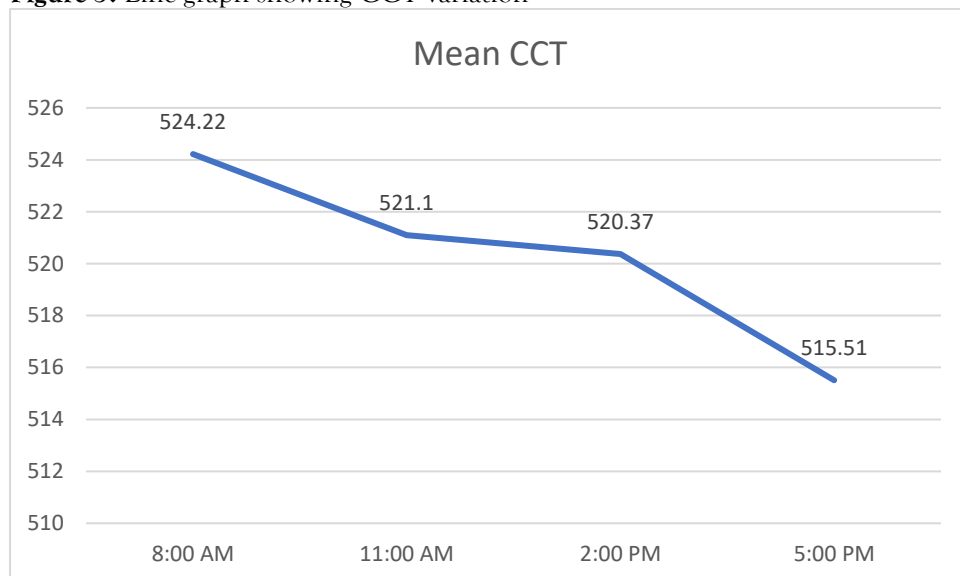


Figure 3: Line graph showing CCT variation



Statistical Analysis

Table 3: Friedman Test - CCT Variation

Time	Mean Rank	p-value
8 AM	3.10	
11 AM	2.62	
2 PM	2.55	
5 PM	1.74	<0.001

Table 4: Friedman Test - IOP Variation

Time	Mean Rank	p-value
8 AM	2.83	
11 AM	2.40	
2 PM	2.49	
5 PM	2.27	0.110

CCT and IOP Correlation

Table 5: Spearman's Correlation

Time	ρ (Spearman's rho)	p-value
8 AM	-0.598	<0.001
11 AM	-0.738	<0.001
2 PM	-0.562	<0.001
5 PM	-0.555	<0.001

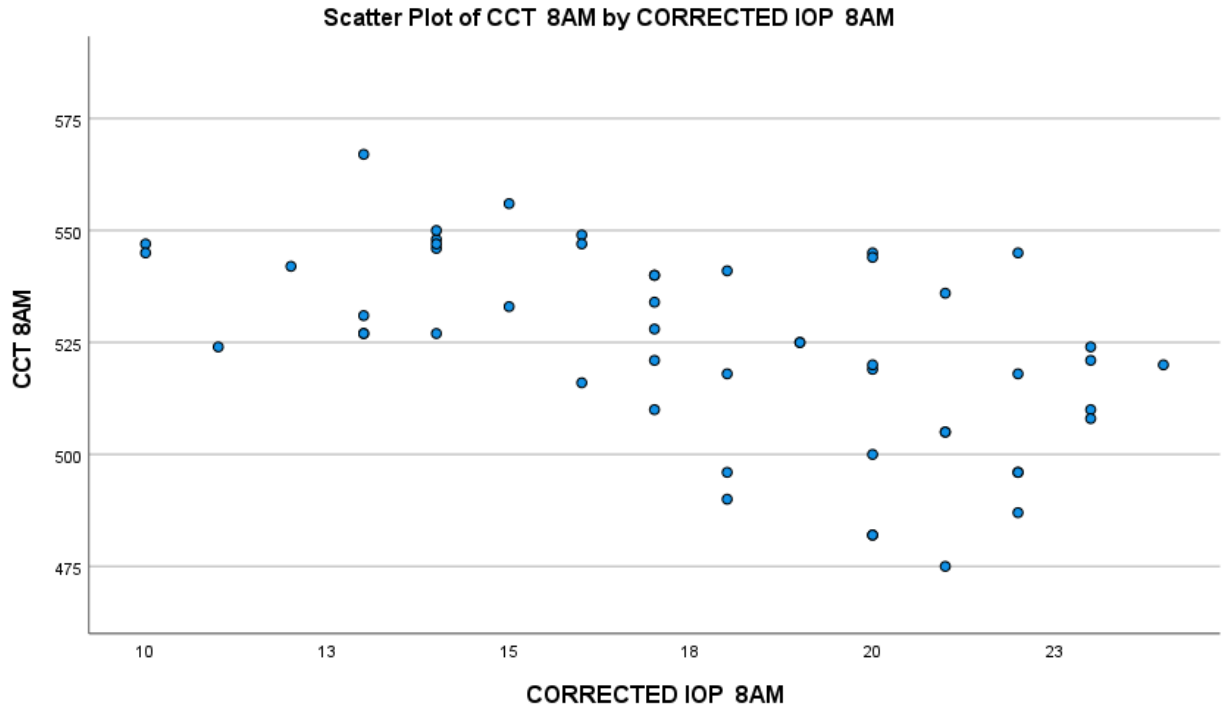


Figure 4: Scatter plot of CCT against corrected IOP at 8 AM

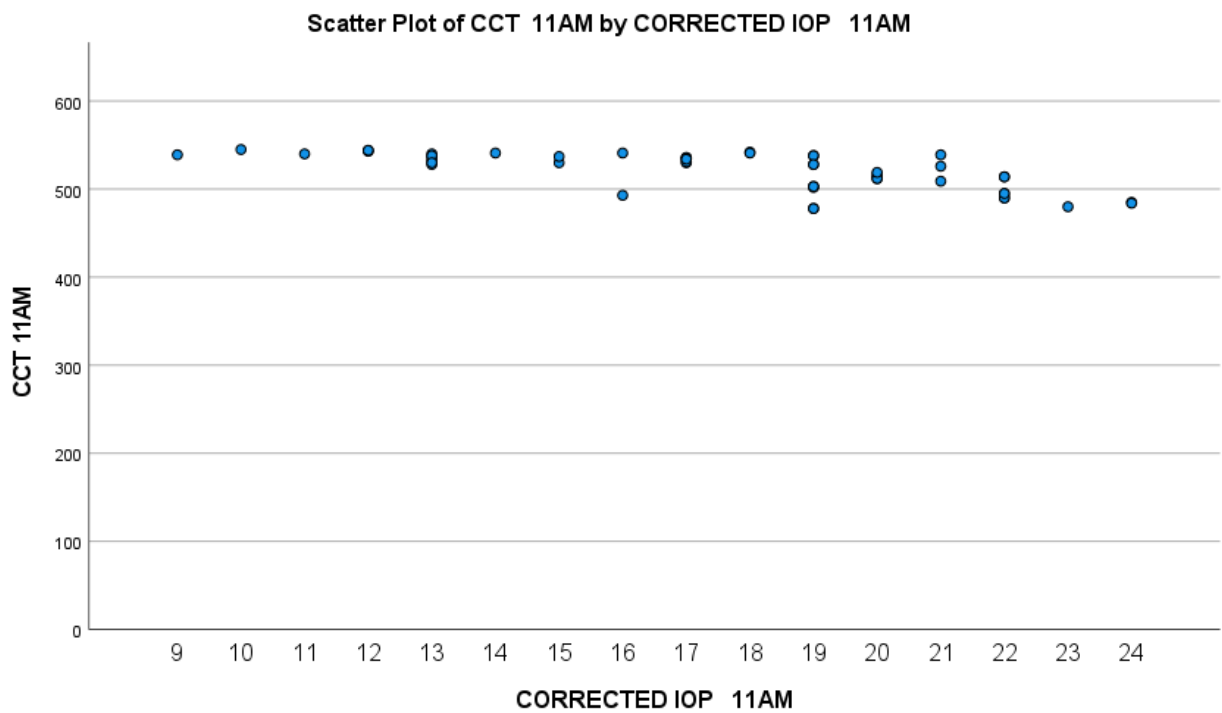


Figure 5: Scatter plot of CCT against corrected IOP at 11 AM

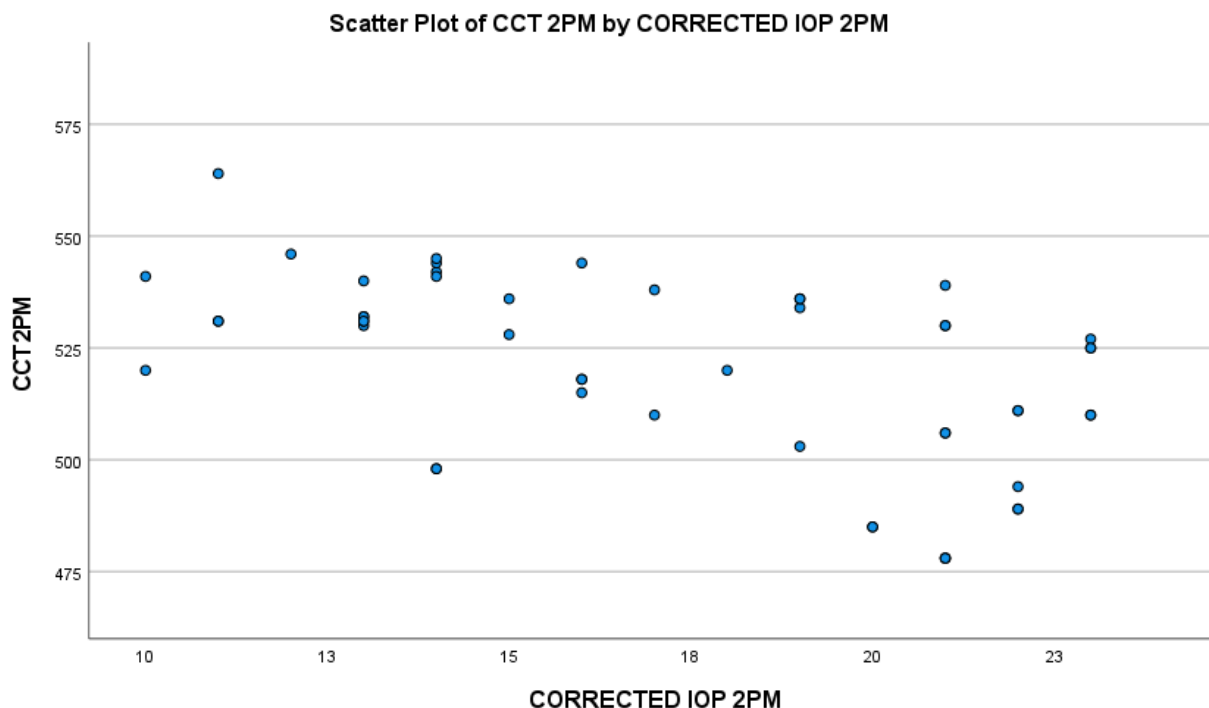


Figure 6: Scatter plot of CCT against corrected IOP at 2 PM

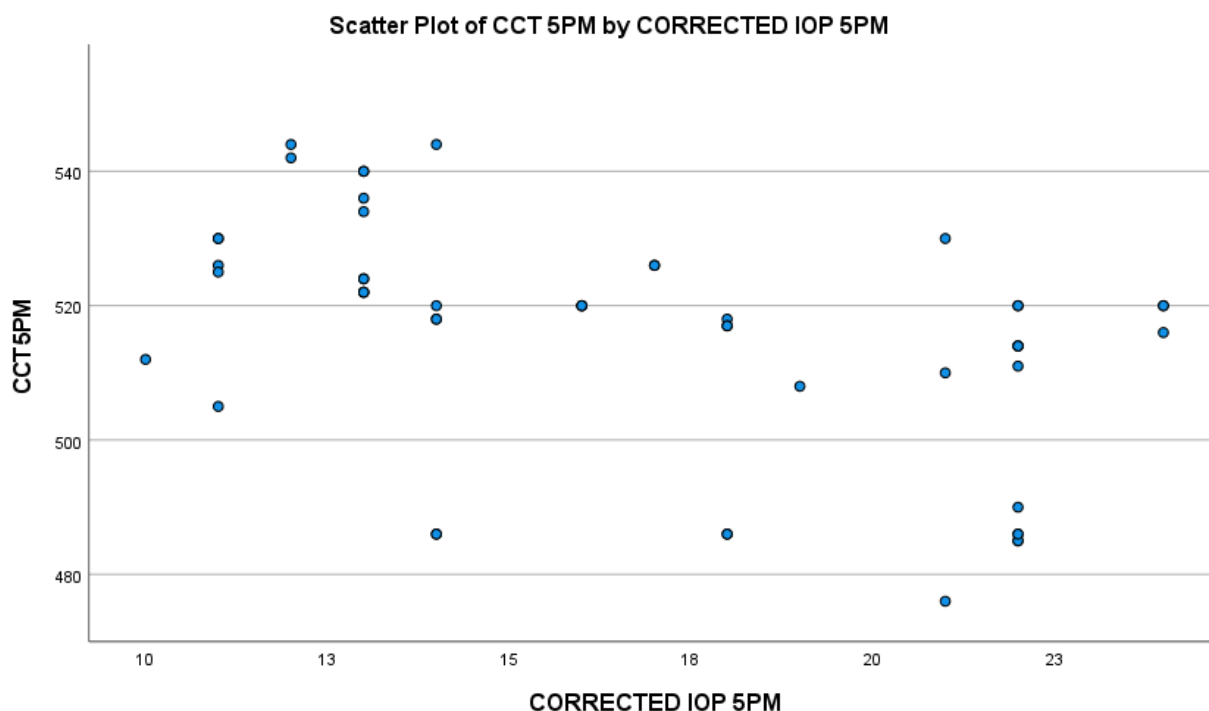


Figure 7: Scatter plot of CCT against corrected IOP at 5 PM

DISCUSSION

This study demonstrated a significant diurnal reduction in CCT and a non-significant but downward trend in IOP among patients with pseudoexfoliation syndrome. A strong negative correlation between CCT and IOP at all time points was also established.

Our findings align with previous studies showing diurnal fluctuation in ocular parameters. Altintas et al. reported large diurnal variations in IOP among PXS patients, often exceeding 5 mmHg, which may go unnoticed in single-time assessments [4]. Inoue et al. found significantly thinner corneas in PXFG eyes compared to normals, contributing to IOP underestimation [10].

The observed inverse correlation highlights the interplay between CCT and IOP readings. Goldmann Applanation Tonometry tends to underestimate IOP in thinner corneas, a situation common in PXS eyes due to altered extracellular matrix remodeling [9,12].

Genetic studies, particularly those involving LOXL1 polymorphisms, support the notion that pseudoexfoliative material affects both trabecular and corneal tissues, contributing to biomechanical instability [12]. In our study, the consistent correlation between declining CCT and IOP throughout the day suggests that clinicians must consider these dynamics when assessing PXS patients.

Compared to Konstas et al., who used six time points for diurnal IOP analysis, our study used four, aligning with practical clinical workflow while still capturing meaningful variation [13]. The decline in IOP, though statistically non-significant, followed the known circadian pattern due to decreasing aqueous production over the day [14].

Given these results, we recommend time-adjusted and CCT-corrected IOP evaluation in all PXS patients. Diurnal CCT variation also suggests a role for repeated pachymetry during glaucoma risk assessment.

CONCLUSION

This study shows that PXS eyes exhibit significant diurnal reduction in CCT and a moderate-to-strong inverse correlation with IOP. Relying on single-time IOP measurements can lead to misdiagnosis or under-treatment. A comprehensive approach accounting for time-of-day and corneal thickness is essential for managing PXS patients at risk of glaucoma.

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