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RESEARCH ARTICLE

Keratometry changes pre and post applanation tonometry

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Abstract

Purpose: The purpose of this study is to investigate the effect of applanation tonometry on keratometry measurements.

Study Design: Prospective observational study

Methods: 100 patients presenting to the outpatient department of a tertiary care hospital for cataract surgery were enrolled in the study. Keratometry measurements were performed on 200 eyes from 100 patients with IOLMaster 700 before and after performing Goldman applanation tonometry. Paired t-test analyses were used to compare measurements taken prior to and following applanation tonometry. The *p-values* less than 0.05 are considered as statistically significant.

Results: After applanation tonometry, ACD increased to 0.029 ($p < 0.292$). No other statistically significant and no clinically meaningful differences were observed in keratometry and other parameter measurements before versus after applanation tonometry. Age and time gaps do not significantly affect changes, except multivariate analysis shows ACD significantly changes post-tonometry. ACD change is influenced by pre-tonometry ACD ($p < 0.001$) and the time gap between measurements ($p = 0.001$).

Conclusion: Goldman applanation tonometry did not affect the keratometry or other parameters measured by the IOL Master 700, with the exception of ACD measurements. Further studies are needed to explore the underlying mechanisms behind these changes. These findings highlight the importance of considering baseline ACD and timing when interpreting post-tonometry biometry changes.

Key Messages:

Goldmann applanation tonometry does not significantly affect keratometry or most biometry parameters measured by the IOL Master 700, except for ACD. Clinicians should consider baseline ACD and the timing of measurements when interpreting post-tonometry biometry changes, especially in surgical planning and diagnostics.

Key words: Keratometry, Applanation Tonometry, IOL Power, IOL Master, Biometry measurements, Corneal changes.

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Introduction

Keratometry is crucial for diagnosing refractive issues and planning surgeries, including cataract and refractive procedures (Friedman, 2009). Advanced devices like the IOL Master 700 use swept-source OCT (SS-OCT) for high-resolution imaging, enhancing IOL power calculations by detecting corneal irregularities (Song and Rizzuti, 2024; Pathak, Sahu, Kumar, Kaur, Gurnani, 2024). The Goldmann applanation tonometer, the gold standard for measuring intraocular pressure, flattens a small corneal area to assess IOP (Zeppieri and Gurnani, 2024; Brusini, 2021). Accurate keratometry is crucial for IOL power calculation, as even minor errors in curvature or axial length can significantly affect postoperative visual outcomes. However, factors such as applanation tonometry can temporarily distort corneal curvature and disrupt the tear film, leading to inaccurate Keratometric readings. Errors of 0.2 mm in axial length or 0.50 dioptres in corneal curvature can lead to IOL power errors of up to ±1.17 dioptres (McEwan, Massengill and Friedel, 1990). Previous studies have reported varying results on whether temporary corneal distortion from applanation

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tonometry can affect lens selection and visual outcomes. (Nayer *et al*., 2021; George *et al*., 2006; Rabsilber *et al*., 2011; Sambhara *et al*., 2016)

Methods

100 patients (50 male and 50 female) with a mean age of 57.90 ± 7.89 years, presenting to the outpatient department of a tertiary care hospital for cataract surgery, were enrolled in the study. The work was examined by the Hospital Ethics Committee and approved. Patients with a history of surgical intervention, trauma, active ocular inflammation, or any surgery done 6 months back were excluded from the study. Baseline biometry parameters were obtained with the IOL Master 700 from both eyes.

After positioning the patient at the IOL Master 700, instruct the patient to look directly ahead. Keratometry measurements along with the other biometry parameters, such as axial length, anterior chamber depth, and IOL power, were obtained.

For Goldman Applanation tonometry, proparacaine hydrochloride is first used to numb the cornea while the patient is comfortably seated. After that, a fluorescein dye is instilled to make the corneal surface stand out in blue light. The applanation probe is positioned in front of the eye, gently contacting the cornea to flatten a 3.06 mm diameter area. The IOP was computed using the force needed to flatten the cornea, which is measured. Due to logistic concerns, ensuring every patient gets an A-scan within a defined period may not be possible, and hence, we captured the time difference between applanation tonometry and A-scan and later grouped them to analyse.

Repeat corneal biometry parameters were measured from both eyes. A single examiner took all of the keratometry readings. Before measuring the left eye, the right eye was measured in each patient.

Sample size determination: Apart from type-I error and power of the test, the sample size for comparing two population means depends on their respective variance and clinically relevant mean difference. A previous study found standard deviations of min-K, max-K, and diff-K assessed by Javal, Orbscan II, and Pentacam ranging from 0.92 to 2.66, with the majority around 1.5. A 0.50 error in the assessment of K results in a <0.5 diopter error in IOL power calculation (by SRK or SRK-II formula).(Hashemi, Yekta, Ostadi, Norouzirad and Khabazkhoob, 2014) We have calculated the sample size under several assumptions about the standard deviation. We, therefore, assumed that the sample size should be large enough to detect a mean difference of 0.50 between the pre- and post-applanation K values. We planned to have a sample size of around 200 eyes (100 cases) for the study. This will ensure the detection of a mean difference not less than 0.50 with 5% type-I error and 80% power.

We conducted a paired-sample t-test on 200 patients (100 males and 100 females), with a mean age of 57.9 ± 7.89 years, to assess whether there is a significant difference between the pre- and post-applanation values of K1 and K2. The mean difference was reported with its 95% confidence interval based on the actual sample size. We applied multivariate regression analysis to see the effects of pre-tonometry assessments, gender, age, and gender-age interaction on the post-tonometry changes in the ocular biometry.

Data availability statement

The data will be available on request.

Results

The results showed there was no statistically significant difference in keratometry K1 and K2 post-Goldman applanation tonometry in 200 eyes. None of the biometric parameters showed significant changes. The difference between pre- and post-applanation Axial length was 0.007 ± 0.57 (range -0.08–+0.6 mm) (p = 0.856) and CCT was -1.550 ± 11.55 (range +5–+19) (p = 0.059). The difference between pre- and post-ACD was 0.029 ± 0.38 (p = 0.292). The difference between pre- and post-applanation K1 was -0.018 ± 0.473 (range -0.16–+0.26D) (p = 0.594), K2 was 0.010 ± 0.327 (range +0.02–+0.37) (p = 0.661), and the difference between K1 and K2 was 0.129 ± 1.50 (range -1.33–+0.39) (p = 0.226). The mean absolute difference of intraocular lens power was 0.030 ± 0.45 (range 1.50–+1.30 D) (p = 0.347) after applanation tonometry.

Graphical representation of biometry parameters change pre vs post-applanation tonometry, Figure 1

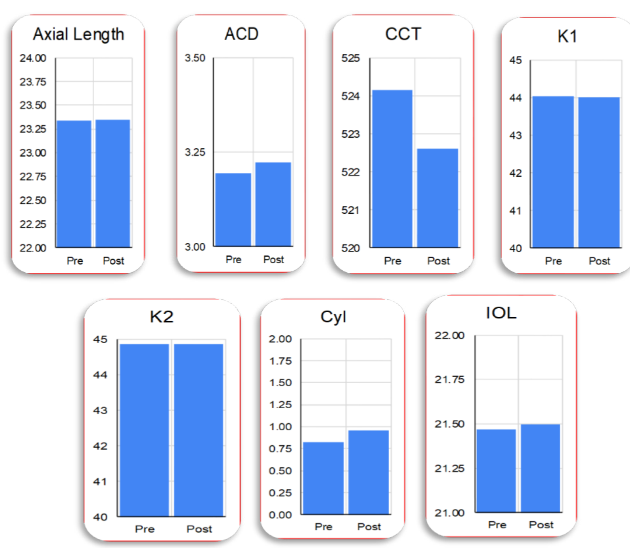

Figure 1: Pre vs post-Goldman applanation tonometry: Change in the biometry parameters

Table 1: effect of gender, age and time-gap on Axial length, ACD and CCT

Post-AXL	*Estimate*	*95% CI LL*	*95% CI UL*	*P-Value*
(Intercept)	0.263			0.785
Pre-tonometry axial length	0.015	-0.059	0.089	0.689
Age	-0.01	-0.024	0.004	0.169
Male (Female=Reference)	-0.219	-1.426	0.987	0.722
Time Gap	0.01	-0.004	0.024	0.166
Age: Male (Interaction)	0	-0.02	0.021	0.970
Post-ACD				
(Intercept)	1.224			< 0.001
Pre-tonometry ACD	-0.317	-0.39	-0.243	< 0.001
Age	-0.005	-0.012	0.003	0.263
Male (Female=Reference)	0.297	-0.368	0.961	0.383
Time Gap	0.014	0.006	0.022	0.001
Age: Male (Interaction)	-0.005	-0.016	0.006	0.39
Post-CCT				
(Intercept)	8.977			0.55
Pre- tonometry CCT	-0.015	-0.061	0.031	0.533
Age	-0.075	-0.355	0.205	0.601
Male(Female=Reference)	-1.406	-25.162	22.35	0.908
Time Gap	-0.071	-0.353	0.211	0.621
Age: Male (Interaction)	0.09	-0.317	0.496	0.666

Table 2: Effect of gender, age and time-gap on Post-applanation tonometry K1, K2 and CYL

K1	***Estimate***	***95% CI LL***	***95% CI UL***	**p-value**
(Intercept)	1.502			0.092
Pre tonometry K1	-0.023	-0.06	0.015	0.237
Age	-0.01	-0.021	0.001	0.089
Male(Female=Reference)	-0.737	-1.72	0.246	0.143
Time Gap	0.007	-0.004	0.019	0.226
Age: Male(Interaction)	0.013	-0.004	0.03	0.123
K2				
(Intercept)	0.267			0.645
Pre-tonometry K2	-0.011	-0.035	0.013	0.361
Age	0.004	-0.004	0.012	0.351
Male(Female=Reference)	-0.077	-0.763	0.61	0.827
Time Gap	0.007	-0.001	0.015	0.076
Age: Male(Interaction)	0.001	-0.011	0.012	0.893
Post-CYL				
(Intercept)	-0.68			0.531
Pre-tonometry CYL	0.041	-0.321	0.403	0.824
Age	0.013	-0.023	0.049	0.484
Male (Female=Reference)	-2.358	-5.432	0.716	0.134
Time Gap	-0.011	-0.047	0.026	0.565
Age: Male (Interaction)	0.044	-0.009	0.096	0.106

We applied multivariate analysis to see the effects of pre-tonometry assessments, gender, age and gender-age interaction on the post-tonometry changes in the ocular biometry. Refer to Tables 1, 2, and 3.

Results showed that the difference between the pre- and post-tonometry axial length and CCT does not depend on any factors like time gap, pre-tonometry values, gender, age, and the gender-age interaction. ACD significantly changed after the tonometry. The change is affected by pre-tonometry assessment of ACD ($p < 0.001$) and the time gap between two measurements ($p = 0.001$) shown in Table 1.

Multivariate analysis showed that the difference between the pre- and post-tonometry K1, K2, and cyl does not depend on any factors like time gap, pre-tonometry values, gender, age, and the gender-age interaction shown in Table 2.

No statistically significant or clinically meaningful differences were observed in IOL power measurements before *versus* after applanation tonometry shown in Table 3. Time gap, pre-tonometry values, gender, age, and the gender-age interaction did not have a significant effect on these changes.

Discussion

Accurate pre-operative biometry measures are currently essential due to current surgical trends, improvements in intraocular lenses and techniques, a patient population with higher expectations, and busy outpatient clinics. Since applanation tonometry measures intraocular pressure accurately, it is often employed as part of the clinic workup. Thus, it is crucial to evaluate how applanation tonometry affects pre-operative cataract assessments to avoid the postoperative outcome errors. Our study found that axial length, K1, K2, and cylinder values do not significantly change after applanation tonometry. The difference between pre- and post-tonometry values was not influenced by factors such as time gap, pre-tonometry values, gender, age, or their interaction. To minimize bias, all measurements were performed by a single examiner, though changes might occur if applanation tonometry measurements were taken by different examiners. T.M. Rabsilber *et al*. reported a mean change in IOL power of 0.31 ± 0.33 D (range: -1.56–+1.12 D) ($p < 0.01$) in 16 patients presented for cataract surgery, whereas our study found a mean difference of 0.030 D ($p = 0.347$), which was not significant statistically.

The study found changes in CCT were not significant at the 5% level, but the p-value is very close to the level ($p = 0.059$). However, the multivariate analysis suggests the change was not significant; neither was it influenced by any factors like gender, age, or time gap. Change in ACD was not significant in univariate analysis. However, the multivariate analysis indicates ACD significantly changed after the tonometry. The change is also affected by pre-tonometry assessment of ACD ($p < 0.001$) and the time gap between two measurements ($p = 0.001$). Zachariya *et al*. also reported a significant increase in the mean anterior chamber depth (ACD), from 3.68 to 3.70 mm ($p < 0.0001$). Our findings suggest that the change in ACD is not simply due to the tonometry itself but is modulated by baseline characteristics of the eye and the timing of subsequent measurements. As noted in our study, eyes with shallower or deeper anterior chamber depths (ACD) at baseline may respond differently to post-applanation tonometry, ACD changes, and also vary depending on the time gap between subsequent measurements. These factors indicate that applanation tonometry-induced changes in ACD are multifactorial and not purely mechanical.

Table 3: Effect of gender, age, and time gap on post-applanation tonometry IOL power

Post-IOL Power	*Estimate*	*95% CI LL*	*95% CI UL*	*p-value*
(Intercept)	-0.37	-1.24	0.5	0.405
Pre-tonometry IOL power	-0.002	-0.026	0.022	0.871
Age	0.009	-0.002	0.02	0.131
Male (Female=Reference)	0.633	-0.318	1.584	0.193
Time Gap	-0.004	-0.015	0.008	0.535
Age: Male	-0.012	-0.028	0.004	0.149

Conclusion

This study aims to address a critical gap in the literature regarding keratometry changes induced by applanation tonometry, a topic that has been underexplored in larger populations.

In conclusion, no other statistically significant differences and no clinically meaningful differences were observed in biometry parameters except in ACD before versus after applanation tonometry. Further studies are needed to explore the underlying mechanisms behind these changes and to determine whether they are temporary or long-lasting. These findings highlight the importance of considering baseline ACD and timing when interpreting post-tonometry biometry changes, with potential implications for clinical practice, particularly in surgical planning and diagnostics.

Given the implications for patient care, it is essential for practitioners to be aware of these potential alterations and to incorporate them into their clinical decision-making processes. Clinicians must take these changes into account since they may affect the precision of tests used to diagnose and treat disorders.

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References

Brusini, P., Salvetat, M. L., & Zeppieri, M. (2021, August 27). How to measure intraocular pressure: An updated review of various tonometers. Journal of Clinical Medicine, 10(17), 3860.

Friedman, N. J. (2009, October 12). Keratometry: Focusing on Astigmatism. Ophthalmology Web.

George, M. K., Kuriakose, T., DeBroff, B. M., & Emerson, J. W. (2006, June 17). The effect of gonioscopy on keratometry and corneal surface topography. BMC Ophthalmology, 6, 26.

Hashemi, H., Yekta, A., Ostadi Moghaddam, H., Norouzirad, R., & Khabazkhoob, M. (2014, May). Comparison of keratometric values using Javal keratometer, Oculus Pentacam, and Orbscan II. Iranian Journal of Ophthalmology. McEwan, J. R., Massengill, R. K., & Friedel, S. D. (1990, January).

Effect of keratometer and axial length measurement errors on primary implant power calculations. Journal of Cataract and refractive surgery, 16

Nayer, Z., Bhat, A., Sohal, P. K., Murdock, B., Watson, S. H., & Belyea, D. A. (2021, June 1). Effect of eyedrops and applanation tonometry on optical biometry. Journal of Cataract and Refractive Surgery, 47(6), 706–712.

Pathak, M., Sahu, V., Kumar, A., Kaur, K., & Gurnani, B. (2024, May 2). Current concepts and recent updates of optical biometry: A comprehensive review. Clinical Ophthalmology, 18, 1191 1206.

Rabsilber, T. M., Bueltmann, S., Holzer, M. P., & Auffarth, G. U. (2011, January). Einfluss der Applanationstonometrie auf die Präzision der Biometrie [Effect of applanation tonometry on precision of biometry measurements]. Der Ophthalmologe, 108(1), 52–56.

Sambhara, D., et al. (2016). Effect of applanation tonometry on keratometry measurements obtained with IOLMaster and Galilei Dual-Scheimpflug Analyzer. Investigative Ophthalmology & Visual Science.

Song, A. L., & Rizzuti, A. (2024, January). Optical Biometry. In StatPearls. StatPearls Publishing.

Zeppieri, M., & Gurnani, B. (2024, January; updated 2023, June 11). *Applanation tonometry*. In StatPearls. StatPearls Publishing