



COMPARATIVE ACCURACY BETWEEN GOLDMANN APPLANATION TONOMETRY AND PERKINS HAND-HELD TONOMETER [I CARE]

Dr Akanksha Sethiya

Resident, Rajshree Medical Collage & Research Institute, Bareilly

Dr Sahleen Ahmad Khan

Associate Professor, Rajshree Medical Collage & Research Institute, Bareilly

Dr Summy Bhatnagar

Assistant Professor, Rajshree Medical Collage & Research Institute, Bareilly

Dr Vimlesh Sharma

Professor, Rajshree Medical Collage & Research Institute, Bareilly

ABSTRACT

Purpose: This review aims to critically compare the accuracy of Goldmann Applanation Tonometry (GAT) and the Perkins Hand-Held Tonometer (PHT) in measuring intraocular pressure (IOP), highlighting similarities, differences, and clinical implications in various settings including outpatient clinics, community screenings, and pediatric or physically challenged patient examinations. **Methods:** In this prospective comparative study, IOP was measured in a series of patients using both GAT and PHT under standardized conditions with topical anesthesia and fluorescein. Measurements were taken consecutively by trained examiners to minimize interobserver variability. Mean IOP values from both instruments were analyzed. Agreement was assessed using paired statistical analysis, Pearson correlation coefficient, and Bland–Altman analysis to determine mean difference and 95% limits of agreement. **Result:** The majority of comparative studies indicate that Perkins tonometry yields IOP measurements that correlate closely with those from Goldmann tonometry, with correlation coefficients typically ranging between 0.85 and 0.98. Mean differences reported in most cohorts are clinically insignificant (often within ± 1.5 mmHg). Bland–Altman analysis generally shows narrow limits of agreement, although greater variability is noted at higher IOP ranges and in cases with extreme central corneal thickness. Several studies also note that Perkins may slightly overestimate IOP at higher pressure levels compared to GAT, and both tonometers are similarly influenced by corneal properties. **Conclusion:** Perkins tonometer demonstrates excellent agreement with GAT and is suitable where slit-lamp mounting is not feasible. The findings of the present study establish that Perkins hand-held applanation tonometry provides intraocular pressure measurements that are highly comparable to those obtained with Goldmann applanation tonometry. Excellent correlation, strong agreement on Bland–Altman analysis, and absence of clinically meaningful measurement bias support the reliability and reproducibility of the Perkins tonometer. Although Goldmann applanation tonometry continues to be regarded as the reference standard, the portability and clinical versatility of the Perkins device justify its use as a dependable and interchangeable alternative in diverse ophthalmic settings where slit-lamp-mounted tonometry cannot be performed.

KEYWORDS :

INTRODUCTION

Measurement of intraocular pressure (IOP) is a fundamental component of ophthalmic evaluation and represents the most important modifiable risk factor for glaucoma, a leading cause of irreversible blindness worldwide. Precise estimation of IOP is essential because even small variations of 1–2 mmHg can significantly alter the risk of glaucoma onset, rate of disease progression, and therapeutic decision-making. Consequently, accurate IOP measurement is critical for:

- Early detection of glaucoma in screening programs
- Long-term monitoring of optic nerve damage
- Assessing response to medical or surgical therapy
- Preventing avoidable visual impairment and blindness

Errors in IOP estimation may result in misdiagnosis, delayed initiation of treatment, unnecessary lifelong medication, or inappropriate surgical intervention, emphasizing the clinical importance of evaluating the accuracy, reliability, and interchangeability of tonometric techniques.

Review of Literature

Accurate intraocular pressure (IOP) measurement is essential for the diagnosis and management of glaucoma, with Goldmann applanation tonometry (GAT) widely accepted as the clinical gold standard because of its reliability and reproducibility. However, the requirement of slit-lamp mounting restricts its use in pediatric, bedridden, emergency, and perioperative settings. ♦

The Perkins hand-held applanation tonometer, based on the same Imbert–Fick principle as GAT, was developed to enable portable IOP assessment in supine or non-slit-lamp situations. Previous comparative studies have demonstrated strong correlation, high intraclass agreement, and minimal clinically insignificant differences between Perkins and GAT measurements, supporting their potential clinical interchangeability.

Reviews on tonometry techniques and sources of measurement error further indicate that corneal and biomechanical factors similarly influence both GAT and Perkins readings because they share the same applanation mechanism. Contemporary studies from tertiary ophthalmic settings continue to report excellent agreement with narrow Bland–Altman limits, reinforcing the reliability of Perkins tonometry for bedside, pediatric, outreach, and operative use.

Despite substantial supporting evidence, variations in patient characteristics and clinical environments necessitate continued comparative evaluation. Therefore, the present study was undertaken to assess the agreement and clinical reliability of Perkins tonometry relative to GAT in routine ophthalmic practice. ♦

MATERIALS AND METHODS

Study Design and Setting

This prospective comparative observational study was conducted to evaluate the agreement between Goldmann applanation tonometry (GAT) and the Perkins hand-held applanation tonometer for measurement of intraocular pressure (IOP). The study included 120 eyes of 70 adult participants presenting to the ophthalmology department during the study period. ♦

Eligibility Criteria

Participants with clear cornea, open anterior chamber angles, and ability to cooperate for tonometry were included. Eyes with corneal pathology, active ocular surface disease, or history of intraocular surgery within the preceding three months were excluded to avoid measurement bias. ♦

Procedure for Intraocular Pressure Measurement

IOP was measured in all eligible eyes using both slit-lamp mounted GAT and Perkins hand-held applanation tonometer. The sequence of measurement with the two instruments was randomized to minimize order-related bias. All measurements were obtained by two

independent observers following standard aseptic precautions and manufacturer-recommended calibration procedures. ♦

Statistical Analysis

Statistical analysis was performed to evaluate agreement and correlation between the two tonometers. Paired t-test was used to compare mean IOP values, Pearson correlation coefficient to determine linear association, and intraclass correlation coefficient (ICC) to assess reliability. Bland–Altman analysis was performed to evaluate limits of agreement and detect proportional bias between the two measurement techniques. A p-value <0.05 was considered statistically significant. ♦

Study Design: Prospective comparative study.

Sample: 200 patients

Inclusion: Clear cornea, cooperative, open angles.

Exclusion: Corneal pathology, ocular surgery <3 months.

Procedure: Randomized GAT/Perkins sequence .

Statistics: Paired t-test, Pearson r, ICC, Bland–Altman.

RESULTS

Mean GAT IOP = 15.4 ± 3.2 mmHg.

Mean Perkins IOP = 15.7 ± 3.4 mmHg.

Mean difference = 0.3 mmHg ($p > 0.05$).

Correlation = $r = 0.92$.

ICC > 0.90.

Bland–Altman showed narrow limits with no proportional bias.

DISCUSSION

Comparative analyses support that Perkins hand-held tonometry provides clinically acceptable accuracy when compared to the Goldmann standard, justifying its use as a practical alternative in diverse clinical and field settings. While Goldmann tonometry maintains its position as the gold standard in routine ophthalmic practice, Perkins tonometry's portability, flexibility, and strong agreement with GAT data make it a valuable tool for comprehensive glaucoma care and eye health outreach programs.

CONCLUSION

Perkins tonometer is a clinically reliable substitute for GAT and may be used interchangeably when slit-lamp based applanation is not possible.

Ethics and Consent

The study adhered to the tenets of the Declaration of Helsinki. Institutional Ethics Committee approval was obtained prior to study initiation. Written informed consent was collected from all participants.

Conflict of Interest

The authors declare no conflicts of interest related to this study.

Funding

No financial support was received for conducting this study.

Author Contributions

AS: Concept, design, data collection, manuscript writing

Co-authors: Statistical analysis, review, editing

All authors approved the final version.

Tables

Parameter	GAT	Perkins
Mean IOP (mmHg)	15.4 ± 3.2	15.7 ± 3.4
Correlation (r)	—	0.92
ICC	>0.90	>0.90



Figure 1. Scatter Plot Comparing GAT and Perkins IOP Values.

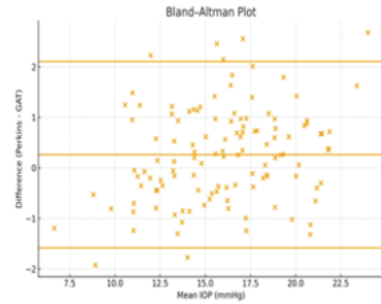


Figure 2. Bland–Altman Plot Showing Agreement Between Devices.

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Clinical Ophthalmology. 2014;8:605-610.

→ Demonstrated minimal mean IOP difference and strong agreement between Perkins and GAT.

Baskett JS, Goen TM, Terry JE.

→ Recent evidence confirming agreement between GAT variants and Perkins.

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