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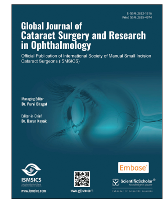

Original Article

Comparative accuracy of Barrett true-K and Haigis-L formulas for intraocular lens power calculation in post-laser-assisted *in situ* keratomileusis cataract surgery

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ABSTRACT

Objectives: The objective of the study is to compare the refractive accuracy of the Barrett true-K total keratometry (TK) and Haigis-L intraocular lens (IOLs) power calculation formulas in post-laser-assisted *in situ* keratomileusis (LASIK) eyes undergoing cataract surgery.

Materials and Methods: This retrospective comparative study included 60 eyes of 40 patients with a history of LASIK who underwent uneventful phacoemulsification with monofocal IOL implantation at a tertiary eye care centre in Gujarat, India (2024–2025). IOL power was calculated using Barrett True-K TK in 30 eyes (Group 1) and Haigis-L in 30 eyes (Group 2). The cohort comprised 44 myopic LASIK eyes (73.3%) and 16 hyperopic LASIK eyes (26.7%). Outcome measures included post-operative uncorrected distance visual acuity (UDVA), best-corrected visual acuity (BCVA), spherical equivalent (SE), mean absolute error (MAE), prediction error (PE) and residual astigmatism. PE was defined as achieved minus predicted post-operative SE. Statistical analysis included paired and independent *t*-tests or non-parametric equivalents, Chi-square tests for categorical variables and age-adjusted analysis of covariance with generalised estimating equations to account for baseline age differences and inter-eye correlation.

Results: Both formulas produced significant post-operative improvement in UDVA and BCVA (all $P < 0.001$). At 1 month, UDVA was significantly better with Barrett true-K TK (0.04 ± 0.08 logMAR) compared with Haigis-L (0.12 ± 0.19 logMAR; $P = 0.021$), while BCVA was comparable between groups (0.01 ± 0.03 logMAR; $P = 0.82$). Mean post-operative SE was closer to emmetropia with Barrett true-K TK (−0.29 ± 0.34 D) than with Haigis-L (−0.44 ± 0.54 D). Barrett True-K TK demonstrated significantly lower MAE (0.34 ± 0.12 D) compared with Haigis-L (0.54 ± 0.21 D; $P = 0.038$) and a higher proportion of eyes within ±0.50 D of target refraction (80% vs. 63%). Subgroup analysis showed consistently lower MAE with Barrett true-K TK across axial length categories and LASIK types, with greater variability observed in post-hyperopic LASIK eyes.

Conclusion: Both formulas yielded satisfactory outcomes in post-LASIK cataract patients; however, Barrett true-K TK demonstrated superior refractive predictability and accuracy. Its independence from historical refractive data supports its use as the preferred IOL calculation formula in post-refractive eyes.

Keywords: Barrett true-K total keratometry, Cataract surgery, Haigis-L; Refractive accuracy, Intraocular lens power calculation, Laser-assisted *in situ* keratomileusis

INTRODUCTION

Laser-assisted *in situ* keratomileusis (LASIK) is one of the most widely performed refractive procedures, with over 40 million cases reported globally.[1] In India, the uptake of LASIK has grown rapidly due to advances in refractive surgery and increasing demand for spectacle independence among young adults.[2,3] As these individuals age, many are now presenting with age-related cataract, the leading cause of visual impairment and blindness worldwide, affecting nearly 95 million people.[4] The intersection of these two common conditions has created a unique and expanding subgroup: Patients requiring cataract surgery after LASIK.

Accurate intraocular lens (IOL) power calculation is essential for optimal cataract surgery outcomes, yet it remains particularly challenging in post-LASIK eyes. Conventional formulas such as Sanders-Retzlaff-Kraff/T, Holladay I and Hoffer Q assume stable correlations between anterior and posterior corneal curvature and effective

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lens position (ELP).[5,6] LASIK permanently alters anterior corneal curvature and disrupts these assumptions, leading to significant refractive prediction errors (PEs).[7-9] The difficulty is further magnified in India and other developing regions where pre-LASIK data are rarely available, increasing the risk of residual ametropia and patient dissatisfaction.[10-12]

To address these challenges, specialised formulas have been developed. The Haigis-L formula uses empirically derived corrections to keratometry, while the Barrett true-K formula applies theoretical corneal modelling and does not require historical data. Multiple international studies suggest that Barrett true-K achieves superior refractive accuracy compared with Haigis-L, but evidence in Indian populations remains limited.[7,10,13]

Given the growing number of post-LASIK cataract patients and their heightened expectations for spectacle-free outcomes, optimising IOL power calculation in this group is of considerable clinical relevance. This study was therefore designed to evaluate and compare the visual outcomes and refractive predictability of Barrett true-K and Haigis-L formulas in post-LASIK cataract patients treated at a tertiary eye care centre in western India. By addressing this evidence gap, the findings aim to guide clinical practice and improve refractive outcomes in this demanding patient population.

MATERIALS AND METHODS

Study design and ethical considerations

This study was a retrospective, comparative, observational clinical study conducted at a tertiary eye care centre in South Gujarat, India, between October 2024 and May 2025. The centre functions as a regional referral facility for cataract and refractive surgery and is equipped with advanced diagnostic and surgical infrastructure. The study adhered to the principles of the Declaration of Helsinki and was approved by the Institutional Ethics Committee of Shree Bharatimaiya College of Optometry and Physiotherapy. Written informed consent had been obtained from all patients at the time of surgery for the use of anonymised clinical data for research purposes.

Study population

Clinical records of patients with a documented history of LASIK who subsequently underwent phacoemulsification with posterior chamber monofocal IOL implantation were reviewed. Eligible patients were ≥45 years of age, had undergone myopic or hyperopic LASIK at least 1 year before cataract surgery and presented with a visually significant age-related cataract and a normal posterior segment examination. A minimum post-operative follow-up of 1 month was required.

Eyes were included only if regular corneal astigmatism was ≤2.0 dioptres. Exclusion criteria comprised prior corneal refractive procedures other than LASIK (photorefractive keratectomy (PRK), small incision lenticule extraction, radial keratotomy, phototherapeutic keratectomy), previous intraocular surgery (vitrectomy, trabeculectomy and keratoplasty), corneal ectasia, central corneal scarring, irregular or decentred ablation patterns, ocular comorbidities affecting visual outcome (glaucoma, diabetic retinopathy, age-related macular degeneration), significant systemic disease influencing vision and implantation of toric or multifocal IOLs.

A total of 60 eyes from 40 patients met the eligibility criteria and were included. When both eyes of a patient were eligible, both were analysed and statistical adjustment for inter-eye correlation was performed.

Group allocation and IOL power calculation

Eyes were divided into two groups based on the IOL power calculation formula used. Group 1 comprised 30 eyes calculated using the Barrett true-K total keratometry (TK) formula, incorporating TK (anterior and posterior corneal power) available on the IOLMaster 700. Group 2 comprised 30 eyes calculated using the Haigis-L formula. Allocation was based on consecutive case availability during the study period and was not randomised.

Pre-operative evaluation

All patients underwent a standardised pre-operative assessment that included measurement of uncorrected and best-corrected distance visual acuity using Snellen charts with conversion to logMAR, manifest refraction and optical biometry using the IOLMaster 700 (Carl Zeiss Meditec, Germany) to obtain axial length, keratometry, anterior chamber depth and lens thickness.

Detailed corneal assessment was performed using Scheimpflug–Placido tomography (Sirius system) to evaluate anterior and posterior corneal curvature, pachymetry and ablation centration. Eyes demonstrating significant irregularity or decentred ablation were excluded. Slit-lamp biomicroscopy, intraocular pressure measurement using rebound tonometry (iCare TA01i, Finland) and dilated fundus evaluation with optical coherence tomography when indicated were performed in all cases.

The intended post-operative target refraction for all eyes was emmetropia (0.00 dioptres), and the same target was applied irrespective of corneal curvature profile.

Surgical technique

All procedures were performed by a single experienced surgeon under topical anaesthesia using a standardised phacoemulsification technique. A 2.8-mm clear corneal incision was created, followed by continuous curvilinear capsulorhexis, nucleus emulsification, cortical aspiration and implantation of a foldable hydrophobic acrylic aspheric non-toric monofocal IOLs (AcrySof IQ, Alcon, USA) into the capsular bag. Post-operative treatment consisted of topical antibiotics and corticosteroids tapered over 4 weeks.

Post-operative care and follow-up

Post-operative examinations were conducted on day 1, day 10 and at 1 month. At each visit, uncorrected and best-corrected distance visual acuity, manifest refraction, spherical equivalent (SE) and residual refractive astigmatism were recorded. Vector analysis of astigmatism was performed using the Alpins method. Intraocular pressure, wound integrity, IOL centration and anterior segment status were also assessed.

Outcome measures

The primary outcome measure was refractive PE, defined as the achieved post-operative SE minus the predicted SE. Positive values indicated hyperopic error and negative values indicated myopic error. Secondary outcome measures included mean absolute error (MAE), the proportion of eyes within ±0.25, ±0.50 and ±1.00 dioptres of the intended refraction, post-operative uncorrected and best-corrected visual acuity (BCVA) and residual astigmatism parameters derived from vector analysis.

Statistical analysis

Data were analysed using the Statistical Package for the Social Sciences version 26.0 (IBM Corp., Armonk, NY, USA). Distribution normality was assessed using the Shapiro–Wilk test. Continuous variables were compared using paired or independent *t*-tests for normally distributed data and Wilcoxon signed-rank or Mann–Whitney U tests for nonparametric data. Categorical variables were analysed using the Chi-square or Fisher's exact test.

To account for inter-eye correlation and baseline differences, generalised estimating equations (GEE) and analysis of covariance (ANCOVA) were applied. Results are presented as mean ± standard deviation or median with interquartile range, along with 95% confidence intervals (CI). A $P < 0.05$ was considered statistically significant.

RESULTS

Study population and surgical subgroups

A total of 60 eyes from 40 patients were included in this retrospective comparative analysis. Thirty eyes were evaluated using the Barrett true-K TK formula (Group 1) and thirty eyes using the Haigis-L formula (Group 2). All eyes had a documented history of corneal refractive surgery and underwent uneventful phacoemulsification with posterior chamber IOLs implantation.

With respect to the type of prior refractive surgery, 44 eyes (73.3%) had undergone myopic LASIK, while 16 eyes (26.7%) had undergone hyperopic LASIK. The distribution of myopic versus hyperopic LASIK eyes was comparable between the two formula groups ($\chi^2 = 0.18$, $P = 0.67$), indicating the absence of selection bias related to refractive surgery type.

Baseline demographic and biometric characteristics

Baseline demographic and biometric parameters are summarised in Table 1. The two groups were statistically comparable in terms of axial length, mean keratometry, anterior chamber depth, baseline corneal astigmatism and pre-operative SE (all $P > 0.05$), confirming appropriate baseline equivalence.

The only statistically significant baseline difference was age, with the Barrett true-K TK group being younger than the Haigis-L group (54.9 ± 9.6 years vs. 61.3 ± 6.5 years; mean difference 6.4 years, 95% CI 2.2–10.6; $P = 0.003$). Given the potential influence of age on ELP prediction, all primary refractive outcome analyses were adjusted for age using ANCOVA. For patients contributing bilateral eyes, GEE with an exchangeable correlation structure was applied. Adjustment did not materially alter the magnitude or direction of inter-formula differences, confirming that outcome differences were primarily formula-dependent [Figure 1].

Visual acuity outcomes

Within-group outcomes

Both formulas demonstrated highly significant improvement in uncorrected distance visual acuity (UDVA) and BCVA

Table 1: Baseline demographic and biometric characteristics.

Parameter	Barrett true-K TK (*n*=30)	Haigis-L (*n*=30)	*P*-value
Age (years)	54.9±9.6	61.3±6.5	0.003
Female/male	21/9	21/9	1.00
Axial length (mm)	24.86±1.48	25.02±1.35	0.54
Mean keratometry (D)	43.2±1.4	43.4±1.6	0.62
Anterior chamber depth (mm)	3.28±0.32	3.31±0.29	0.74
Corneal astigmatism (D)	0.78±0.32	0.81±0.35	0.69
Pre-operative SE (D)	−0.65±2.16	−0.74±2.31	0.68

TK: Total keratometry, SE: Spherical equivalent, *P* value of <0.05 was considered statistically significant

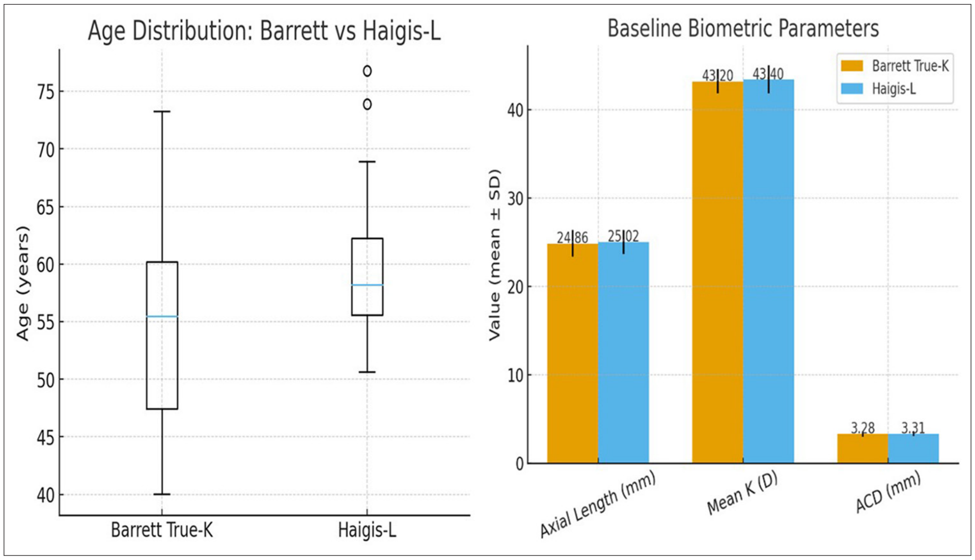

Figure 1: Baseline demographic and biometric comparability between Barrett true-K total keratometry and Haigis-L groups, demonstrating similarity across key parameters except age. SD: Standard deviation, ACD: Anterior chamber depth.

from pre-operative to post-operative assessment (paired *t*-test, all $P < 0.001$).

Between-group comparison

At 1 month postoperatively, mean UDVA was significantly superior in the Barrett true-K TK group (0.04 ± 0.08 logMAR) compared with the Haigis-L group (0.12 ± 0.19 logMAR; mean difference −0.08 logMAR, 95% CI −0.14 to −0.02; $P = 0.021$). The calculated effect size (Cohen's d = 0.55) indicates a moderate and clinically meaningful advantage favouring Barrett true-K TK.

Post-operative BCVA was excellent and comparable between groups (0.01 ± 0.03 logMAR in both; $P = 0.82$), confirming that both formulas achieved similar best-corrected visual potential and that observed differences were predominantly refractive rather than optical-quality related.

Categorical analysis demonstrated a higher proportion of eyes achieving UDVA ≥20/20 (73% vs. 60%) and UDVA ≥20/40 (93% vs. 87%) in the Barrett group, although these differences did not reach statistical significance [Table 2 and Figure 2].

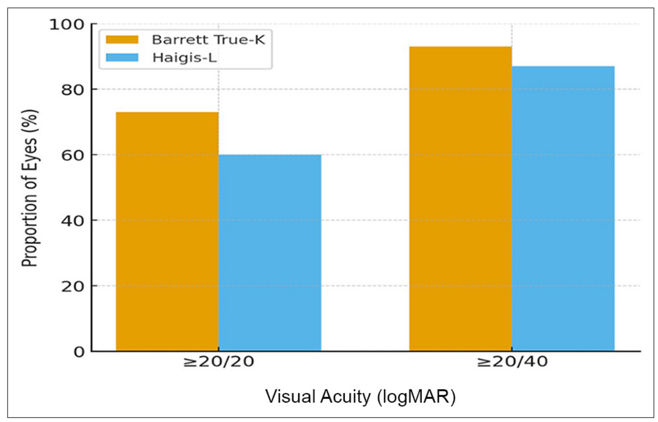

Figure 2: Comparison of post-operative uncorrected distance visual acuity between formulas, showing superior uncorrected visual outcomes with Barrett true-K total keratometry.

Table 2: Post-operative visual acuity outcomes.

Outcome	Barrett true-K TK	Haigis-L	*P*-value
UDVA (logMAR)	0.04±0.08	0.12±0.19	0.021
BCVA (logMAR)	0.01±0.03	0.01±0.03	0.82
UDVA ≥20/20 (%)	73	60	0.27
UDVA ≥20/40 (%)	93	87	0.44

UDVA: Uncorrected distance visual acuity, BCVA: Best-corrected visual acuity, TK: Total keratometry. A *P* value of <0.05 was considered statistically significant.

Refractive accuracy and PE

PE was defined as the achieved post-operative SE minus the predicted SE, with negative values indicating a myopic outcome.

The MAE was significantly lower with Barrett true-K TK (0.34 ± 0.12 D) compared to Haigis-L (0.54 ± 0.21 D; mean difference −0.20 D, 95% CI −0.33 to −0.07; $P = 0.038$). The large effect size (Cohen's d = 1.09) reflects a substantial improvement in refractive precision with Barrett true-K TK.

Both formulas demonstrated a mild myopic bias; however, the magnitude of bias was greater with Haigis-L (−0.29 ± 0.41 D) than with Barrett true-K TK (−0.18 ± 0.27 D), suggesting a higher tendency toward IOL under-powering with Haigis-L in post-LASIK eyes.

The proportion of eyes achieving refractive outcomes within ±0.50 D of target was 80% (95% CI 63–91%) in the Barrett group compared with 63% (95% CI 44–79%) in the Haigis-L group. Corresponding proportions within ±1.00 D were 97% and 90%, respectively. The cumulative distribution curve [Figure 3] demonstrated a steeper slope for Barrett true-K TK, indicating tighter clustering and reduced variability of refractive outcomes [Table 3].

Residual astigmatism and vector analysis

Mean residual refractive astigmatism was slightly lower in the Barrett group (0.32 ± 0.21 D) compared with the Haigis-L group (0.39 ± 0.25 D), although this difference did not reach statistical significance ($P = 0.21$).

Vector analysis revealed smaller centroid displacement and reduced scatter of J0 and J45 components in the Barrett true-K TK group. While intergroup differences were not statistically significant, this pattern suggests greater directional stability of astigmatic outcomes, which is clinically relevant in post-LASIK corneas where even small vector misalignments may adversely affect uncorrected visual quality [Table 4; Figures 4 and 5].

Subgroup analysis: Axial length and LASIK type

Across all axial length categories, Barrett True-K TK consistently demonstrated lower MAE compared with Haigis-L. This advantage was preserved in short, medium and long eyes [Table 5].

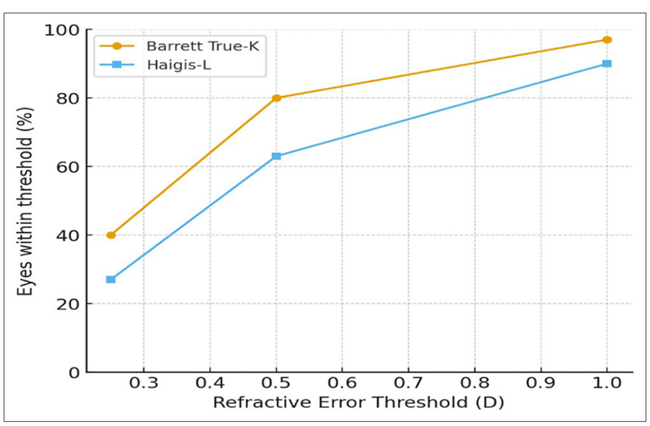

Figure 3: Cumulative distribution of refractive prediction error, illustrating tighter clustering and reduced variability with Barrett true-K total keratometry.

In myopic LASIK eyes, MAE was 0.33 ± 0.11 D with Barrett true-K TK versus 0.53 ± 0.20 D with Haigis-L, representing the subgroup with the greatest relative benefit. In contrast, hyperopic LASIK eyes exhibited higher variability with both formulas (0.36 ± 0.12 D vs. 0.56 ± 0.23 D), indicating reduced predictability regardless of calculation method [Figure 6].

Outliers and safety analysis

Large refractive outliers (>1.00 D PE) occurred in one eye (3%) in the Barrett group and three eyes (10%) in the Haigis-L group, reinforcing the greater clinical reliability of Barrett true-K TK. No intraoperative or post-operative complications were observed in either group [Table 6].

Table 3: Refractive accuracy and prediction error.

Parameter	Barrett true-K TK	Haigis-L	*P*-value
Mean SE (D)	−0.29±0.34	−0.44±0.54	0.038
Mean absolute error (D)	0.34±0.12	0.54±0.21	0.038
Mean prediction error (D)	−0.18±0.27	−0.29±0.41	—
Within±0.50 D (%)	80	63	—
Within±1.00 D (%)	97	90	—

TK: Total keratometry, SE: Spherical equivalent, A *P* value of <0.05 was considered statistically significant.

Table 4: Residual astigmatism and vector components.

Parameter	Barrett true-K TK	Haigis-L
Residual astigmatism (D)	0.32±0.21	0.39±0.25
J0 (D)	−0.02±0.11	−0.05±0.13
J45 (D)	0.01±0.09	−0.02±0.11

TK: Total keratometry

Table 5: Subgroup mean absolute error by axial length and LASIK type.

Subgroup	Barrett true-K TK	Haigis-L
Axial length <24 mm	0.31±0.10	0.48±0.19
Axial length 24–26 mm	0.34±0.11	0.52±0.22
Axial length >26 mm	0.37±0.14	0.57±0.25
Myopic LASIK	0.33±0.11	0.53±0.20
Hyperopic LASIK	0.36±0.12	0.56±0.23

TK: Total keratometry, LASIK: Laser-assisted *in situ* keratomileusis

Table 6: Refractive outliers.

Outcome	Barrett true-K TK	Haigis-L
Prediction error >1.00 D (%)	3	10

TK: Total keratometry

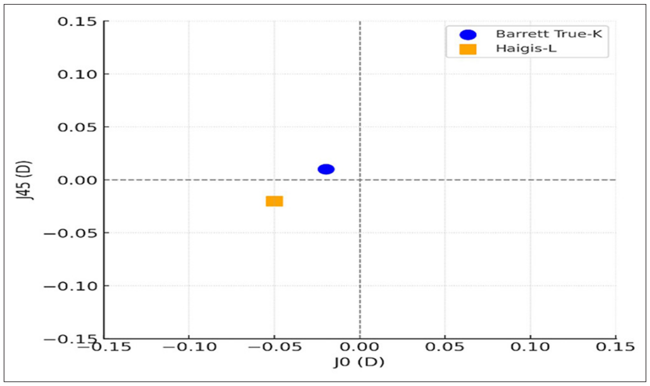

Figure 4: Centroid vector analysis of residual refractive astigmatism. The X-axis represents the horizontal astigmatic component (J0, diopters) and the Y-axis represents the oblique astigmatic component (J45, diopters). The plot illustrates the mean vector (centroid) and distribution of astigmatic components for both Barrett true-K TK and Haigis-L groups, demonstrating smaller vector displacement and tighter clustering in the Barrett true-K TK group.

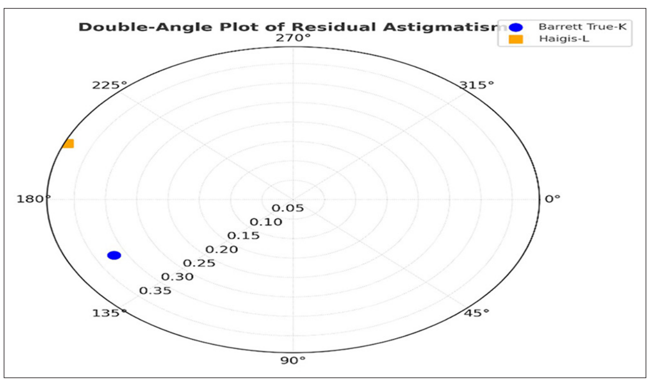

Figure 5: Double-angle vector plot of residual astigmatism highlighting reduced scatter with Barrett true-K total keratometry.

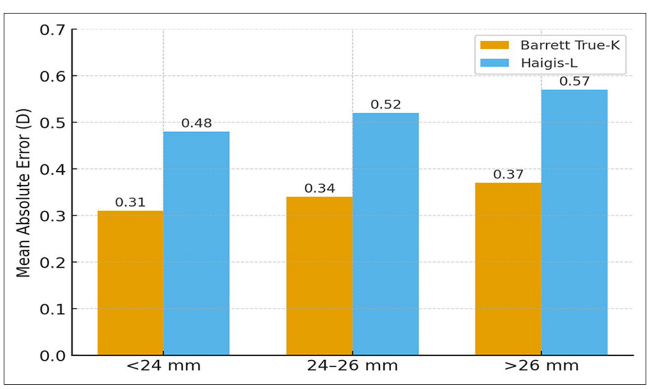

Figure 6: Subgroup comparison of mean absolute error (diopters) (Y-axis) vs subgroups axial length categories and laser-assisted in situ keratomileusis type (X-axis).

Safety outcomes

No intraoperative complications such as posterior capsule rupture or zonular dehiscence were observed. Post-operative recovery was uneventful, with no cases of cystoid macular oedema, corneal oedema or endophthalmitis. All IOLs remained well centred at 1 month. Mild, transient corneal oedema and temporary elevation of intraocular pressure were noted in a few eyes but resolved spontaneously within the 1st post-operative week and did not differ between groups.

DISCUSSION

Accurate IOL power calculation in eyes that have undergone laser *in situ* keratomileusis (LASIK) remains one of the most challenging aspects of modern cataract surgery. Alterations in anterior corneal curvature, disruption of the anterior-posterior corneal relationship and frequent unavailability of historical refractive data compromise the assumptions underlying conventional keratometry-based formulas.[5-7] In this context, the present study evaluated and compared the refractive performance of Barrett true-K, TK and Haigis-L formulas in post-LASIK eyes undergoing cataract surgery.

The principal finding of this study is that Barrett true-K TK demonstrated superior refractive predictability compared with Haigis-L, as evidenced by lower MAE, better post-operative UDVA and fewer large refractive outliers [Tables 2 and 3; Figures 2 and 3]. While both formulas achieved satisfactory outcomes overall, Barrett true-K TK consistently provided more accurate and reliable refractive results across multiple outcome measures.

Interpretation of findings

Refractive accuracy, as reflected by MAE, represents the most clinically meaningful indicator of IOL calculation performance in post-refractive eyes. In the present study, Barrett true-K TK achieved a significantly lower MAE (0.34 ± 0.12 D) compared with Haigis-L (0.54 ± 0.21 D; $P = 0.038$) [Table 3]. This difference translated into a higher proportion of eyes achieving refractive outcomes within ±0.50 D and ±1.00 D of the intended target refraction, as demonstrated by the cumulative distribution curve [Figure 3].

Post-operative UDVA was also significantly better in the Barrett true-K TK group [Table 2 and Figure 2], whereas BCVA was excellent and comparable between groups. This finding indicates that the observed inter-formula differences were primarily attributable to refractive accuracy rather than optical quality or surgical factors, reinforcing the clinical relevance of formula selection in post-LASIK cataract surgery.

Both formulas demonstrated a mild myopic PE; however, the magnitude of bias was greater with Haigis-L [Table 3]. This tendency toward under-powering has been previously reported with Haigis-L and may reflect its reliance on empirically derived regression models that are less capable of fully compensating for altered corneal biomechanics in post-refractive eyes.[5,9]

Algorithmic considerations

The superior performance of Barrett true-K TK can be attributed to its theoretical optics-based design, which incorporates TK and a refined estimation of ELP without requiring historical refractive data.[6,7] In contrast, Haigis-L applies corneal power adjustments derived from population-based regression formulas, which may be less robust in eyes with atypical corneal geometry following refractive surgery.[5,9]

This distinction is clinically significant, particularly in real-world settings where pre-LASIK refractive and keratometric data are often unavailable or unreliable. In such circumstances, formulas that minimise dependence on historical data such as Barrett True-K TK offer a clear practical advantage.

Comparison with previous studies

The findings of this study are consistent with prior reports evaluating IOL calculation formulas in post-refractive eyes. Abulafia *et al*. demonstrated that Barrett True-K produced significantly lower PEs than Haigis-L and Shammas formulas in post-LASIK and post-PRK eyes, particularly when historical data were unavailable.[10] Wang *et al*. similarly reported superior refractive accuracy with Barrett True-K compared with Haigis-L, emphasising its reliability in no-history scenarios.[11]

Ferguson *et al*. showed that Barrett true-K performed as well as or better than multi-formula averaging strategies, supporting its use as a standalone formula.[7] More recently, Salama *et al*. and Li *et al*. reported MAE values for Barrett true-K in the range of 0.30–0.40 D in post-myopic LASIK eyes, closely matching the outcomes observed in the present study.[8, 12] Conversely, the higher MAE observed with Haigis-L in our cohort aligns with findings reported by Menon *et al*. in Indian eyes, where Haigis-L demonstrated reduced accuracy compared with newer-generation formulas.[13]

Subgroup analysis: Axial length and LASIK type

Subgroup analysis revealed that Barrett true-K TK maintained superior refractive accuracy across all axial length categories, including short, medium and long eyes [Table 5 and Figure 6]. This finding is clinically important, as long axial length eyes are known to pose additional challenges for IOL power prediction due to altered ELP and increased sensitivity to biometric measurement errors.[14]

With respect to LASIK type, the greatest relative benefit of Barrett true-K TK was observed in post-myopic LASIK eyes, where refractive predictability was highest [Table 5]. In contrast, post-hyperopic LASIK eyes demonstrated greater variability with both formulas, reflecting the inherent difficulty of IOL calculation in this subgroup due to steeper peripheral corneal profiles and altered corneal biomechanics.[15] These results support a cautious interpretation of refractive outcomes in post-hyperopic LASIK eyes, even when advanced formulas are used.

Astigmatism outcomes and vector analysis

Although mean residual refractive astigmatism did not differ significantly between formulas [Table 4], vector analysis demonstrated smaller centroid displacement and reduced scatter of J0 and J45 components in the Barrett true-K TK group [Figures 4 and 5]. While these differences did not reach statistical significance, they suggest improved directional stability of astigmatic outcomes, which is clinically relevant in post-LASIK corneas where even small vector misalignments may adversely affect uncorrected visual quality.

These findings are consistent with previous studies highlighting the importance of incorporating posterior corneal power and total corneal astigmatism into IOL calculations.[13,16] The integration of TK within the Barrett true-K TK algorithm likely contributes to this observed stability.

Clinical implications

From a clinical perspective, the results of this study underscore the importance of formula selection in post-refractive cataract surgery. Barrett true-K TK not only achieved superior refractive accuracy but was also associated with fewer large refractive outliers [Table 6], which are particularly impactful in highly demanding post-LASIK patients. The higher proportion of eyes achieving UDVA ≥20/20 further emphasises its value in meeting contemporary expectations for spectacle independence [Table 2; Figure 2].

In regions such as India, where pre-LASIK records are frequently unavailable and patient expectations for refractive precision are high, the robustness and independence of Barrett true-K TK from historical data make it especially advantageous.[12]

Strengths and limitations

The strengths of this study include a direct head-to-head comparison of two widely used formulas, uniform surgical technique performed by a single experienced surgeon and comprehensive evaluation of refractive accuracy, visual outcomes and astigmatic vector behaviour. Adjustment for age-related differences using ANCOVA and GEEs further strengthened the validity of the findings [Table 1 and Figure 1].

Limitations include the retrospective design, relatively small sample size and short follow-up period of 1 month, which may not fully capture long-term refractive stability. In addition, only two formulas were evaluated; newer-generation formulas and artificial intelligence-based calculators were not included, limiting the breadth of comparison.

Future directions

Future studies should be prospective, multicentric and adequately powered to include a broader range of modern formulas, longer follow-up and patient-reported outcome measures such as visual quality, glare and satisfaction. Such data would complement refractive accuracy metrics and provide a more comprehensive understanding of functional outcomes.

CONCLUSION

Accurate IOL power calculation in post-LASIK eyes remains a critical challenge in cataract surgery. In this comparative analysis, both Barrett true-K TK and Haigis-L formulas achieved satisfactory visual outcomes; however, Barrett true-K TK demonstrated consistently superior refractive predictability. It was associated with a significantly lower MAE, improved UDVA, a higher proportion of eyes achieving emmetropic targets and fewer large refractive outliers.

The superiority of Barrett true-K TK was maintained across axial length categories and was most pronounced in post-myopic LASIK eyes, while greater variability was observed in post-hyperopic LASIK eyes with both formulas, underscoring the inherent complexity of this subgroup. In addition, vector analysis suggested greater directional stability of residual astigmatism with Barrett true-K TK, further supporting its clinical reliability.

Given its independence from historical refractive data and robust performance across biometric subgroups, Barrett true-K TK should be considered the preferred formula for IOLs power calculation in post-refractive cataract patients, particularly in routine clinical settings where pre-LASIK records are unavailable. Larger prospective studies with longer follow-up and inclusion of newer-generation formulas are warranted to further validate and extend these findings.

Ethical approval: The research/study was approved by the Institutional Review Board at Shree Bharatimaiya College of Optometry, Physiotherapy, Surat, number IEC/BMCOP/22/2025, dated August 08, 2024.

Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patients have given their consent for their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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