

Corneal epithelial thickness on the accuracy of intraocular lens calculation formulas

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角膜上皮厚度对人工晶状体计算公式准确度的影响

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摘要

目的:探讨并比较角膜上皮增厚对 Barrett Universal II、Haigis、Holladay 2、Kane、EVO、Hill-RBF 及 SRK/T 等 7 种常用人工晶状体(IOL)计算公式预测准确性的影响。

方法:纳入 2023 年 7 月-2023 年 9 月接受白内障超声乳化联合人工晶状体植入术的患者。术前采用 IOLMaster 700 获取生物测量数据,并使用光学相干断层扫描(OCT)测定角膜上皮厚度。囊袋内植入单焦点人工晶状体(Hoya iSert 250)。术后 3 mo 测量术后屈光度。以角膜上皮厚度中位数 57.0 μm 作为分组界值: $\geq 57.0 \mu\text{m}$ (厚上皮组), $<57.0 \mu\text{m}$ (薄上皮组)。评估两组预测误差落在 $\pm 0.25 \text{ D}$ 、 $\pm 0.50 \text{ D}$ 、 $\pm 0.75 \text{ D}$ 和 $\pm 1.00 \text{ D}$ 范围内的眼数占比、平均绝对误差(MAE)和中位绝对误差(MedAE)。

结果:本研究共纳入 59 例患者 59 眼,女性 34 例,男性 25

例,平均年龄 68.85 ± 8.71 岁。其中薄上皮组 30 眼,厚上皮组 29 眼。全部 59 眼中,Barrett Universal II 公式预测误差在 $\pm 0.50 \text{ D}$ 内的眼占比最高(83%),其次为 Hill-RBF(81%)。Kane(71%)与 EVO(73%)占比最低。7 种 IOL 计算公式分析显示:与薄上皮组相比,多数公式在厚上皮组的预测准确性显著下降($U=6.00, P<0.05$)。Hill-RBF 公式在角膜上皮增厚眼表现出更优的预测效能,其预测误差落在 $\pm 0.25 \text{ D}$ 、 $\pm 0.50 \text{ D}$ 范围内的眼占比分别可达 52%、83%。

结论:IOL 计算准确性与角膜上皮增厚存在相关性,Hill-RBF 公式对于角膜上皮增厚患眼具有更好的适用价值。

关键词:角膜上皮;白内障;人工晶状体计算公式

Abstract

• **AIM:** To explore and compare the effect of corneal epithelial thickening on predictability of 7 common intraocular lens (IOL) calculation formulas: the Barrett Universal II, Haigis, Holladay 2, Kane, EVO, Hill-RBF and SRK/T.

• **METHODS:** Patients undergoing phacoemulsification and IOL implantation surgery from July 2023 to September 2023 were included. Before the surgery, biometry data was obtained by IOLMaster 700 and epithelial thickness was determined using optical coherence tomography. A monofocal IOL (Hoya iSert 250) was inserted into the capsular bag. The postoperative refraction was measured 3 mo after the surgery. The median epithelial thickness of $57.0 \mu\text{m}$ was set as a grouping criterion: $\geq 57.0 \mu\text{m}$ (thick group) and $<57.0 \mu\text{m}$ (thin group). The percentage of eyes within prediction errors of $\pm 0.25 \text{ D}$, $\pm 0.50 \text{ D}$, $\pm 0.75 \text{ D}$ and $\pm 1.00 \text{ D}$, mean absolute error (MAE), and median absolute error (MedAE) were reviewed.

• **RESULTS:** Fifty-nine eyes of 59 patients (34 females, 25 males, mean age $68.85 \pm 8.71 \text{ y}$) were included in the study. The thin group included 30 eyes and the thick group included 29 eyes. Among all 59 eyes, Barrett Universal II showed the highest percentage of prediction error within $\pm 0.50 \text{ D}$ (83%), followed by Hill RBF (81%). Kane (71%) and EVO (73%) exhibited the lowest percentages. When calculating the percentage of eyes with absolute error within $\pm 0.25 \text{ D}$ using seven IOL calculation formulas, most formulas showed significant declined accuracy in the thick group compared with the thin group ($U=6.00, P<0.05$). Hill RBF showed better accuracy in eyes with thickened epithelium, with higher percentage of prediction error within $\pm 0.25 \text{ D}$ (52%) and $\pm 0.50 \text{ D}$ (83%).

• **CONCLUSION:** The accuracy of IOL calculation is

associated with corneal epithelium thickening. Hill – RBF has better validity in eyes with thickened corneal epithelium.

• KEYWORDS: corneal epithelium; cataract; intraocular lens calculation formulas

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INTRODUCTION

Up to now, cataract is still the world’s leading cause of blindness^[1]. Technological progress has made cataract surgery well-established^[2]. Modern cataract surgery pursues both visual improvement and precise postoperative refractive outcomes^[3]. Two key determinants govern postoperative refractive accuracy: biometric parameters and intraocular lens (IOL) calculation formulas^[4-5].

The corneal epithelium serves as a barrier that protects the outer surface of the cornea from external insults^[6]. It is known that some ocular surface diseases like epithelial basement membrane dystrophy (EBMD) and Salzmann’s nodules could lead to the thickening of the corneal epithelium producing uneven surface^[7-8], and was associated with keratometry measuring errors and refractive surprise after cataract surgery^[9]. Other factors such as dry eye, vernal keratoconjunctivitis, soft contact lenses wearing and blepharoptosis would also affect epithelial thickness^[10-13]. These factors are common in elderly candidates for cataract surgery, and could cause significant variations in their corneal epithelial thickness (Figure 1). It remains unknown whether this kind of corneal epithelial thickening, similar to that observed in EBMD or Salzmann’s nodules, leads to unexpected refractive outcomes after cataract surgery.

Traditional theoretical formulas like SRK/T and Haigis are based on geometric optical models of human eyes and clinical data, thus the accuracy of prediction will decrease when facing extreme parameters^[14-16]. Focusing on the third generation formulas, in both Holladay 1 and Hoffer Q, only axial length (AL) and keratometry are needed for IOL power calculation. SRK/T integrates mathematical models with empirical regression considered to have higher accuracy than

other third generation formulas in eyes with long AL^[17-19]. In essence, all third – generation formulas attempt to mathematically establish a positive correlation between anterior chamber depth (ACD) and AL^[20]. The application of new generation of formulas includes Barrett Universal II and EVO improved the accuracy of IOL refractive power calculation greatly. Haigis^[21] introduced three independent constants including a0, a1, a2, mathematically altering the IOL prediction curve, enhancing both flexibility and accuracy. Holladay 2 expands the number of parameters required for calculation to seven, namely AL, keratometry, ACD, white-to – white (WTW), lens thickness (LT), preoperative refraction, and age, thereby improving the accuracy of predictions, especially in eyes with short to medium AL^[17-20]. Barrett Universal II is regarded as the most accurate in the third generation, thus being widely used all over the world^[22]. With the wide application of AI, some other new calculation formulas like Hill-RBF as well as Kane begin to appear. Hill-RBF forecast IOL diopter by combining AI with actual postoperative refractive results. Since the prediction results are highly dependent on empirical data, the predictability will decline when patient’s ocular data is unconventional^[23]. Kane formula is based on the combination of AI and theoretical optics reported to have smaller absolute error than other formulas^[20].

This study aimed to explore the effect of corneal epithelial thickening on predictability of 7 common formulas including Haigis, Holladay 2, SRK/T, Barrett Universal II, Kane, EVO and Hill-RBF for cataract surgery.

PARTICIPANTS AND METHODS

Ethical Approval The Tianjin Eye Hospital Medical Science Research Ethics Committee approved the study protocol (Approval No.M2022809), which adhered to the tenets of the Declaration of Helsinki. Written consent was obtained from all participants, and data were analyzed anonymously.

Participants This retrospective study comprised the 59 eyes of 59 patients undergoing uncomplicated phacoemulsification and IOL implantation surgery by the same surgeon at the Tianjin Eye Hospital from July 2023 to September 2023. Some studies^[24] have shown that both ACD and AL should be taken into account when selecting an IOL power calculation formula. For this reason, only eyes with ACD from 2.0 to 4.0 mm and

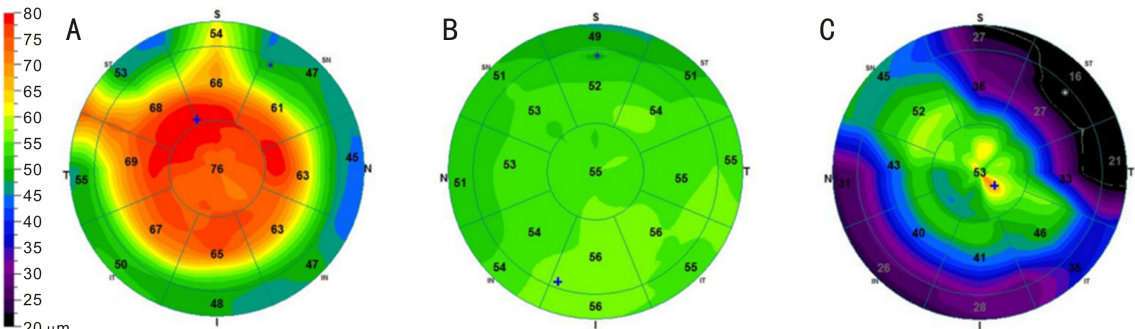


Figure 1 Images of corneal epithelial thickness A: Corneal epithelial thickening; B: Normal corneal epithelial thickness; C: Corneal epithelial thinning.

AL from 22 to 25.5 mm were included. Exclusion criteria were: patients who had undergone any previous ocular surgeries, corneal diseases, combined surgical procedures with cataract surgery and eyes with incomplete data. Furthermore, patients with postoperative best-corrected visual acuity (BCVA) of less than 20/40 were also excluded from the study to ensure the accuracy of refractive measurements. If both eyes of one participant met the inclusion criteria, only one eye was randomly selected *via* the random number table. A standard preoperative ophthalmic examination was conducted on each patient before surgery. Preoperative measurements of AL, keratometry, ACD, WTW, LT, and central corneal thickness (CCT) were obtained using a swept-source optical coherence tomography device (IOLMaster 700; Carl Zeiss, Oberkochen, Germany). The required refractive power of the IOL calculating by formulas Haigis, Holladay 2, SRK/T and Barrett Universal II were acquired from the IOLMaster 700 software. The results of other formulas include Kane, EVO and Hill-RBF were obtained through online calculators. Preoperative corneal epithelial thickness was obtained by the DREAM OCT™ (Intalight, Henan, China). Epithelial statistics within a 3-mm-diameter map were used. The mean thickness of five quadrants (temporal, superior, nasal, inferior, and central) was recorded (Figure 2). To investigate the effect of corneal epithelial thickness on the prediction accuracy of each formula, the median thickness of whole population participating in the research (57.0 μm) was set as the grouping criterion: ≥ 57.0 μm (thick group) and <57.0 μm (thin group). All surgeries were performed by one specialist according to the standard protocol (Zhou Z). A 2.0-mm corneal microincision was made, followed by continuous curvilinear capsulorhexis, hydrodissection, phacoemulsification and aspiration, and IOL implantation. A monofocal IOL (HOYA iSert 250, HOYA Ltd, Tokyo, Japan) was inserted into the capsular bag. The postoperative refraction 3 mo after the surgery was recorded. Mean absolute error (MAE) was defined as the absolute value of the difference between the actual and expected refractive error after surgery was the main outcome reflecting the IOL power prediction accuracy of each formula. The percentages of eyes with prediction errors within ±0.25 D

and ± 0.50 D were also considered important indicators. ±0.50 D was defined as the pre-specified primary endpoint, since this threshold is widely accepted as a clinically meaningful target for patient satisfaction after cataract surgery. Other outcomes such as median absolute error (MedAE) and percentage of eyes within prediction errors of ± 0.75 D and ±1.00 D were also considered. **Statistical Analysis** In this study, SPSS (version 26, Chicago, USA) and Microsoft Excel software (Microsoft Inc., Redmond, Washington, USA) were used for statistical analysis. Mann-Whitney *U* test applied to individual raw prediction errors was used to access whether predicted refractive error differed significantly between the thick and the thin groups. *P* value of <0.05 was considered significant.

RESULTS Clinical data from 59 eyes of 59 patients who met the inclusion criteria were collected and analyzed (Table 1). The average age of patients was 68.85±8.71 years old, of whom 58% were female. Table 2 presented the MAE, MedAE and the percentage of eyes within specific prediction error ranges (± 0.25 D, ±0.50 D, ±0.75 D, ±1.00 D, and >±2.00 D) for the seven IOL formulas. Considering the percentage of eyes with prediction error within ±0.25 D, EVO and Hill-RBF yielded the highest percentage of eyes with a prediction error

Table 1 Clinical baseline characteristics of all patients			
Characteristics	Thin	Thick	<i>P</i>
Female (%)	63	52	0.38
Right eye (%)	47	45	0.89
Age (y)	66.57	71.21	0.04 ^a
AL (mm)	23.41	23.44	0.87
ACD (mm)	3.01	2.97	0.70
LT (mm)	4.50	4.56	0.61
K1 (D)	43.95	44.14	0.61
K2 (D)	44.78	45.04	0.51
CET (μm)	54.10	60.32	0.00 ^a
ST (μm)			
IOL power (D)	20.30	20.00	0.56

AL: Axial length; ACD: Anterior chamber depth; LT: Lens thickness; CET: Corneal epithelial thickness; ST: Stromal thickness; IOL: Intraocular lens. ^a*P*<0.05.

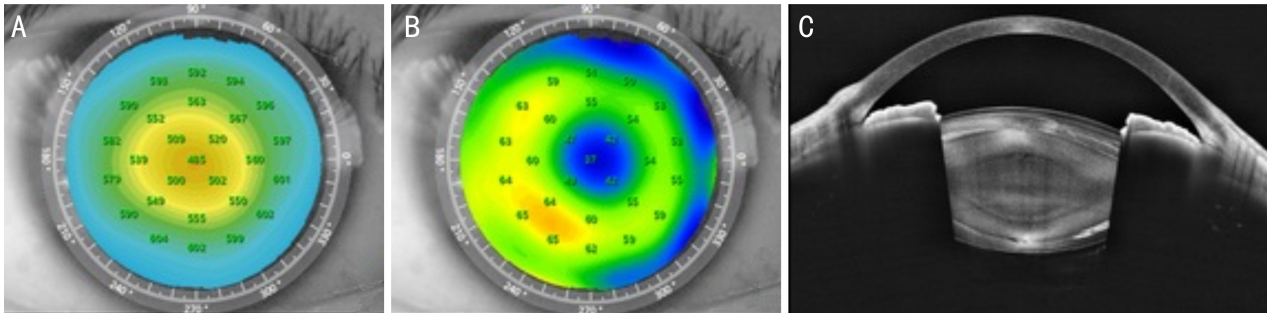


Figure 2 Corneal epithelial thickness was measured in patients using the DREAM OCT™ (Intalight, Henan, China), which can perform corneal epithelial topography, AS-OCT imaging, and related measurements A: Corneal thickness topography; B: Corneal epithelial thickness topography; C: AS-OCT images. AS-OCT: Anterior segment optical coherence tomography.

within ± 0.25 D (53%), followed by Barrett Universal II (51%), Haigis (49%), and Holladay 2 (49%). SRK/T and Kane had the lowest accuracy at this threshold (44%). Within the ± 0.50 D range, Barrett Universal II performed best (83%), followed by Hill – RBF (81%) and Holladay 2 (80%), whereas Kane (71%) and EVO (73%) yielded the lowest percentages.

The percentage of eyes within prediction errors of ± 0.25 D, ± 0.50 D, ± 0.75 D, ± 1.00 D and ± 2.00 D were presented in Table 3. In thin group, concentrating on percentage of eyes within prediction error of ± 0.25 D, Holladay 2 provided the best result (60%), followed by EVO, Haigis and Barrett Universal II who shared the same result (57%). Hill – RBF (53%) and SRK/T (50%) didn't do well while Kane (40%) was the last one in predictability. When enlarging acceptable error to ± 0.50 D, Barrett Universal II (87%) was the most accurate followed by Holladay 2 (83%); while Hill RBF, Haigis and SRK/T shared the same result (80%). EVO and Kane were the last-place formulas at 73% each.

In thick group, Hill – RBF surpassed other formulas in both error within ± 0.25 D (52%) and ± 0.50 D (83%). EVO (48%) and Kane (48%) performed well in generating prediction error within ± 0.25 D but gave the worst performance within ± 0.50 D (EVO : 72%, Kane : 69%).

Barrett Universal II (45%), Haigis (41%), Holladay 2 (38%), SRK/T (38%) performed not very well in generating prediction error within ± 0.25 D, However, they provided better accuracy within ± 0.50 D, 79%, 76%, 76% and 76% respectively.

Figure 3 showed the percentage of eyes within specific diopter ranges of prediction errors including ± 0.25 D, ± 0.50 D, ± 0.75 D, ± 1.00 D, >2.00 D. In general, all of the formulas in thick group showed significant decline compared with the one in thin group. In thin corneal epithelial thickness group, Barrett Universal II was the only calculation method leading all the eyes to have prediction error less than ± 1.00 D. In thick corneal epithelial thickness group, none of formulas can lead all eyes to prediction error within ± 1.00 D but all formula except Kane could limit the error to ± 2.00 D.

The Mann – Whitney *U* test was conducted to compare the percentage of eyes with an absolute error of ± 0.25 D and ± 0.50 D between the thin group and the thick group. It was found that the difference between the two groups was significant at ± 0.25 D (*U*=6.00, *P*<0.05; Table 4). All of the formulas except for Kane, the percentage of eyes with an error of ± 0.25 D was higher in the thin group than in the thick group. When the acceptable error was expanded to ± 0.5 D, the same results were observed except for Hill – RBF.

Table 2 Comparison of 7 formulas for IOL power prediction error in all 59 eyes							
Items	EVO	Kane	Hill–RBF	Haigis	BU II	Holladay 2	SRK/T
MAE ($\bar{x}\pm s$, D)	0.37±0.35	0.41±0.43	0.33±0.35	0.34±0.29	0.31±0.27	0.33±0.30	0.33±0.27
MedAE(D)	0.24	0.29	0.23	0.25	0.25	0.25	0.26
± 0.25 D	53%	44%	53%	49%	51%	49%	44%
± 0.5 D	73%	71%	81%	78%	83%	80%	78%
± 0.75 D	85%	85%	88%	92%	90%	90%	90%
± 1 D	93%	90%	97%	93%	98%	95%	95%
>2 D	0	2%	2%	0	0	0	0

IOL: Intraocular lens; MAE: Mean absolute error; MedAE: Median absolute error; SD: Standard deviation; BU II: Barrett Universal II.

Table 3 Comparison of 7 formulas in 2 groups based on corneal epithelial thickness							
Items	EVO	Kane	Hill–RBF	Haigis	BU II	Holladay 2	SRK/T
Thin thickness group (<i>n</i> = 30)							
MAE ($\bar{x}\pm s$, D)	0.38±0.38	0.40±0.39	0.34±0.41	0.32±0.28	0.28±0.25	0.27±0.28	0.31±0.26
MedAE (D)	0.22	0.30	0.22	0.22	0.23	0.20	0.25
± 0.25 D	57%	40%	53%	57%	57%	60%	50%
± 0.5 D	73%	73%	80%	80%	87%	83%	80%
± 0.75 D	87%	87%	87%	93%	90%	90%	90%
± 1 D	93%	90%	97%	93%	100%	97%	97%
>2 D	0	0	3%	0	0	0	0
Thick thickness group (<i>n</i> = 29)							
MAE ($\bar{x}\pm s$, D)	0.36±0.32	0.43±0.48	0.33±0.28	0.36±0.30	0.34±0.28	0.38±0.32	0.36±0.29
MedAE (D)	0.26	0.25	0.24	0.28	0.29	0.32	0.30
± 0.25 D	48%	48%	52%	41%	45%	38%	38%
± 0.5 D	72%	69%	83%	76%	79%	76%	76%
± 0.75 D	83%	83%	90%	90%	90%	90%	90%
± 1 D	93%	90%	97%	93%	97%	93%	93%
>2 D	0	3%	0	0	0	0	0

MAE: Mean absolute error; MedAE: Median absolute error; SD: Standard deviation; BU II: Barrett Universal II.

Table 4 Percentage of eyes with absolute error within ±0.25 D and ±0.50 D

Items	EVO	Kane	Hill-RBF	Haigis	BU II	Holladay 2	SRK/T	U value	P value
≤0.25 D								6.00	0.017 ^a
Thin	57%	40%	53%	57%	57%	60%	50%		
Thick	48%	48%	52%	41%	45%	38%	38%		
≤0.50 D								13.5	0.16
Thin	73%	73%	80%	80%	87%	83%	80%		
Thick	72%	69%	83%	76%	79%	76%	76%		

^a*P* <0.05. BU II; Barrett Universal II; Thin; The thin corneal epithelial thickness group; Thick; The thick corneal epithelial thickness group.

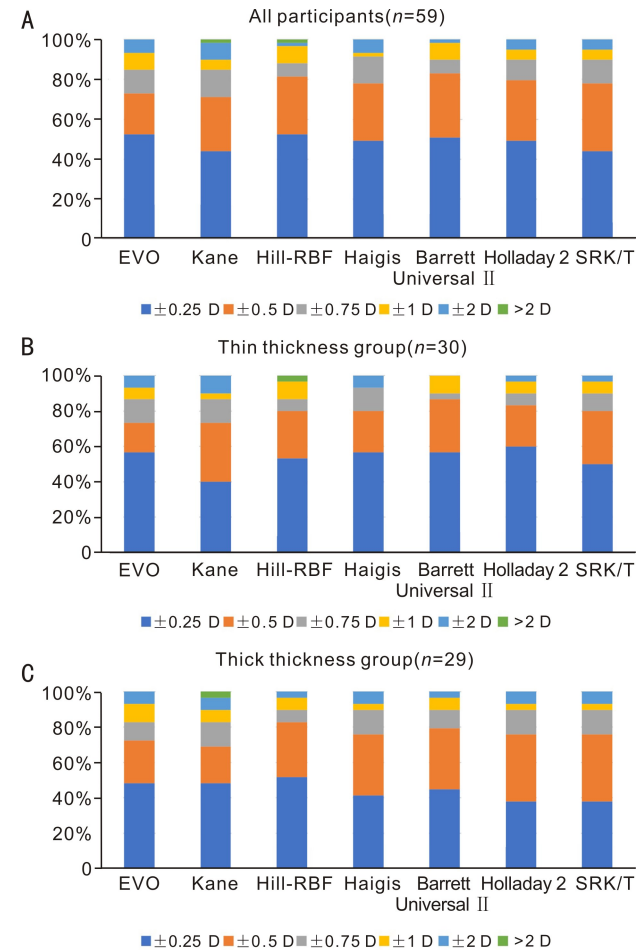


Figure 3 Percentage of eyes with prediction error in the range of ±0.25 D, ±0.5 D, ±0.75 D, ±1.0 D, and ±2.0 D in all participants (A), thin thickness group (B) and thick thickness group (C).

However, Hill-RBF performed best in both groups with more than 80% of eyes with an error of ±0.5 D.

DISCUSSION

Corneal epithelial cells are metabolically active and are able to respond to a wide range of stimuli^[25–26]. Corneal surface diseases with epithelial thickening have been proved to impact biometry and IOL calculation^[27–29]. A variety of factors could lead to epithelial thickening in the elderly. The variation in corneal epithelial thickness is far more pronounced in those individuals than previously recognized. The impact of this epithelial thickness variability on the accuracy of cataract IOL power calculation formulas needs to be explored. Comparison of the accuracy of IOL formulas is a hot topic. For

postoperative refractive outcomes after cataract surgery, spherical equivalent <0.5 D is generally considered to be an acceptable target refractive range, and any postoperative refractive error outside this range may lead to a decrease in patient postoperative satisfaction^[30]. The MAEs based on the different formulas in the present study were more in line with previous studies^[31]. When analyzing the overall cohort without stratification by epithelial thickness, our results were broadly consistent with the prevailing literature, where Barrett Universal II emerged as the most accurate formula, achieving the lowest MAE (0.31±0.27 D) and the highest percentage of eyes within ±0.50 D (83%) and ±1.00 D (98%). This aligns with previous large-scale studies identifying Barrett Universal II as a top-performing formula in unselected populations. However, several differences were observed. In contrast to most reports where Kane and EVO ranked among the top three formulas^[29,32–34], they performed less favorably in our cohort, with Kane showing the highest MAE (0.41±0.43 D) and the lowest proportion of eyes within ±0.50 D (71%). Meanwhile, Hill-RBF outperformed expectations, ranking second overall with 81% of eyes within ±0.50 D, a finding that is less commonly reported in general population studies. Hill-RBF has been widely evaluated in previous studies as a data-driven artificial intelligence-based IOL formula. In large-scale comparative studies, Hill-RBF 2.0 consistently ranked behind Kane, EVO 2.0, and Barrett Universal II across all AL subgroups.

Numerous studies have performed subgroup analyses based on ocular anatomical parameters to evaluate IOL formula accuracy, including ACD, AL, and corneal curvature. Beyond preoperative biometry, effective lens position (ELP) substantially influences postoperative refractive outcomes. ELP depends on ACD, IOL thickness, IOL geometry, and corneal power, and postoperative changes in ACD often reduce ELP prediction accuracy. Yan and Yao^[35] compared seven IOL formulas in eyes with shallow ACD and reported that Barrett Universal II achieved the highest percentage of eyes within ±0.25 D (54.52%), followed by Haigis (52.58%) and Kane (51.61%). In our cohort, mean ACD values were comparable between subgroups (3.01 mm vs 2.97 mm, *P* = 0.70), indicating no confounding effect from extreme ACD. AL-based stratification has also been widely adopted. Muzyka-Wozniak and Ogar^[36] reported greater relative ACD change after surgery in short eyes (AL<22.0 mm) than in

normal or long eyes. Furthermore, formula accuracy may be affected by IOL model and sample size across studies. Hipólito–Fernandes *et al*^[37] compared 13 IOL formulas, including VRF–G, Barrett Universal II, EVO 2.0, Hill–RBF 2.0, and Kane, and found Kane achieved the highest percentage of eyes within ± 0.25 D (47%) in medium AL eyes, consistent with key trends in modern formula performance. Similarly, Carmona–González *et al*^[38] evaluated 11 formulas in 481 eyes and demonstrated that Barrett Universal II and Haigis yielded the lowest MAEs. In eyes with AL between 22 and 25 mm, Barrett Universal II provided superior predictive accuracy.

Some of the currently applied IOL calculation formulas, including HILL–RBF2.0, KANE, and EVO2.0 incorporate the CCT in their calculations. However, there are no studies addressing the effect of corneal epithelial thickness on the choice of IOL formula. The present study demonstrated that in eyes with a thin corneal epithelium ($< 57\ \mu\text{m}$), Barrett Universal II remained the most accurate formula, with a higher proportion of eyes achieving postoperative refractive error within ± 0.50 D. In contrast, in eyes with thickened corneal epithelium ($\geq 57\ \mu\text{m}$), Hill–RBF achieved better predictive accuracy than Barrett Universal II, accompanied by a lower MAE. As a purely data–driven artificial intelligence–based method, Hill–RBF relies on a large training dataset to refine predictions. In previous studies that did not consider corneal epithelial thickness, Hill–RBF generally performed slightly inferiorly to Barrett Universal II^[39]. Wu and Wang^[40] reported that corneal epithelial thickness is unevenly distributed across the corneal surface, being thickest in the inferonasal region, and is associated with myopia, gender, and age. We therefore hypothesize that the superior performance of Hill–RBF in eyes with thickened epithelium may be attributed to its integration of CCT and gender variables, which may partially compensate for biometric variations introduced by uneven or increased epithelial thickness.

Limitations of this study include its retrospective, single–center design. The subgroup division of corneal epithelial thickness was based on the median value of the study cohort rather than an established cutoff from the general population, which may limit the generalizability of the findings. This grouping strategy was referenced to previously published authoritative ophthalmic studies^[35]. However, we acknowledge that this binary grouping approach discards partial information of corneal epithelial thickness as a continuous variable, which could not fully reveal the potential linear relationship or critical threshold between corneal epithelial thickness and IOL formula prediction error. In addition, the sample size of this study was relatively small, and selection bias could not be completely avoided due to its retrospective nature. Moreover, multivariate regression analysis adjusted for potential confounding factors (*e.g.*, age) was not performed due to the limited sample size. Therefore, further prospective, multicenter, large–sample studies are warranted to verify

these results. In future research, we will combine median–based grouping comparison with continuous regression analysis, and conduct multivariate analysis to adjust for relevant confounding factors, so as to confirm the effect of corneal epithelial thickness on IOL formula accuracy and enhance the comprehensiveness and rigor of the conclusions.

In conclusion, this study found that there was significant variability in corneal epithelial thickness among the elderly candidates for cataract surgery. The accuracy of IOL calculation formulas is associated with corneal epithelium thickening. Specifically, Hill–RBF might have better validity in eyes with thickened corneal epithelium.

Conflicts of Interest: Zhou Z, None; Tan SM, None; Guo JQ, None; Liu ZY, None.

Authors’ contributions: Concept: Liu ZY; Data: Zhou Z; Analysis, Zhou Z, Tan SM and Guo JQ; Draft: Zhou Z, Tan SM and Guo JQ; Supervision: Liu ZY.

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