# Interocular optical biometry differences as predictors of postoperative cataract surgery refractive outcomes: A retrospective cohort study

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**ABSTRACT**

**Introduction: Few studies have reported the impact of preoperative interocular discrepancy in optical biometry (axial length, corneal power, white-to-white, central corneal thickness) on postoperative refractive outcomes. This study aims to investigate any predictive value of preoperative optical biometry differences between eyes on postoperative refractive outcomes.**

**Materials and methods: A retrospective cohort study of patients who have undergone optical biometry measurement before unilateral phacoemulsification in the Queen Elizabeth Hospital, Sabah, Malaysia from 2018 to 2020. Biometry data of interest includes axial length (AL), keratometry(K), white-to-white (WTW) and central corneal thickness (CCT). The postoperative outcomes of interest were the patient's preoperative refractive target, postoperative best-corrected visual acuity (BCVA), post-operative refractive outcomes, and optical biometry prediction error.**

**Results: The interocular biometry discrepancies which were associated with higher odds of prediction error >0.5D from the refractive target were Interocular Corneal Power Difference (IKD)-average≥0.8 D (Odds Ratio, OR=1.97; 95% Confidence Intervals, 95%CI: 1.06, 3.67) and Interocular WTW Difference ≥1.5 mm (OR=2.77; 95%CI: 1.11, 6.92). In cases with prediction error >1.0D, the measurements were Interocular AL Difference ≥0.4 mm (OR=2.99; 95%CI: 1.11, 8.06), IKD flat≥0.4D (OR=2.76; 95%CI: 1.31, 5.82) and Interocular CCT Difference ≥15μm (OR=3.53; 95%CI: 1.29, 9.64).**

**Conclusion: Interocular axial length difference ≥0.4mm and interocular central corneal thickness difference ≥15μm are associated with refractive error >1.0D from the pre-operative target. Interocular average corneal power difference ≥0.8D and interocular white-to-white difference ≥1.5mm have higher odds of refractive drift >0.5D from the refractive aim. The above cutoff values help clinicians to identify which patients have a higher risk of refractive shift post-cataract surgery and counsel the patient before cataract operation.**

**KEYWORDS:**
*Cataract, interocular discrepancy, interocular optical biometry differences, refractive outcomes*

## INTRODUCTION

Ocular biometry has become an important tool in pre-cataract surgery assessment. It is one of the parameters which determine the postoperative visual acuity of patients. Modern cataract surgery is no longer performed solely as a medical procedure; it is now considered a refractive surgery procedure on which both patients and surgeons have placed high expectations on a good outcome. Hence, reliable biometric measurements are of paramount importance to generate accurate Intraocular Lens (IOL) power calculations. Optical biometry has become the gold standard for the measurements of ocular Axial Length (AL), automated keratometry for Corneal Power (K), Anterior Chamber Depth (ACD), White-to-White (WTW) and Central Corneal Thickness (CCT).[1] Likewise, Lenstar (model LS 900, Haag-Streit AG, Koeniz, Switzerland) uses optical low coherence reflectometry technology for the above measurements.[2]

The axial length must be accurately estimated to ensure there are no errors. Inaccurate measurement of axial length by only 0.10mm can result in the skewed measurement of 0.27diopters (D) from the target refractive outcome in the standard eye.[3] This poses a significant impact on postoperative results. The variation of refractive error from the target refractive outcomes are proven to be wider in myopic and hyperopic eyes.[4] Similarly, deviation in the measurement of corneal power (K) by 1.0D causes 0.9D of refractive error.[3]

In daily clinical practice, one of the methods to ascertain the precision of biometry measurement is to compare the biometry measurements between both eyes to detect interocular discrepancies. Knox Cartwright et al suggest that biometry measurements should be repeated if an intraindividual asymmetry of axial length is more than 0.70mm or the mean keratometry difference is more than 0.90D.[5] Nonetheless, this figure is estimated based on 95%

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distribution of a large biometry dataset performed using the Zeiss IOLMaster (Carl Zeiss Meditec, Oberkocen, Germany) without taking into consideration of the postoperative refractive outcomes.[5]

There are limited studies in the literature that report the impact of Interocular Axial Length Difference (IALD) on visual outcome postoperatively. Lal et al., demonstrated an important relationship between IALD and visual outcomes in paediatric cataract patients.[6] Gochnauer et al., affirmed that best-corrected visual acuity (BCVA) ≥6/12 is associated with lower IALD in paediatric cataract population.[7]

However, these results might be confounded by amblyopia. In the adult population, there are two studies that investigate IALD; Rajan et al., concluded that in patients with age-related cataracts, the increase in AL is associated with increased IALD and postoperative anisometropia.[8] However, this study did not compare the IALD and refractive outcomes. Kansal et al., is the only published study to the best of our knowledge that found that IALD ≥0.2mm is associated with >0.5D of refractive error from the target, and at the same time correlates with worse uncorrected visual acuity.[9]

Studies exploring the relationship between preoperative Interocular Corneal Power Difference (IKD) and postoperative refractive error is lacking. The article published by Vinay et al is the sole article to the best of our knowledge who reported that IKD was not associated with worse refractive error from the target.[9]

The association of the Interocular White-to-White (IWTWD) and Interocular Central Corneal Thickness Differences (ICCTD) with the postoperative refractive error has not been explored. To our best knowledge, ours is the first study that study the impact of IWTWD and ICCTD on postoperative refractive outcome.

## MATERIALS AND METHODS

The study was registered with the National Medical Research Registry and acquired ethical approval from the National Research and Ethics Committee of The Ministry of Health of Malaysia. This study was conducted in accordance with the tenets of the Declaration of Helsinki. This study received ethical approval from Medical Research & Ethics Committee of Ministry of Health Malaysia (NMRR-20-1022-54779).

Retrospectively, all electronic reports of the patients who had undergone optical biometry measurement in Queen Elizabeth Hospital (QEH), Kota Kinabalu, Sabah, Malaysia from January 2018 to January 2020 were extracted from the Lenstar in QEH (model LS 900, Haag-Streit AG, Koeniz, Switzerland). Lenstar optical biometry measurements were only performed on cataract that were not dense or mature by an experienced optometrist before cataract surgery. Bilateral eyes' biometry was measured by an experienced optometrist before the cataract surgery. The optometrist would repeat the optical biometry measurement when there were any discrepancies between the eyes to double check the accuracy of the data.

The demography, surgical details, the preoperative refraction target, and postoperative refractive outcomes of patients were extracted from the Malaysian Cataract Surgery Registry (CSR), a web-based password-protected surveillance system collecting data on eye diseases and clinical performance of the Ophthalmology Service in Malaysia. It consists of systematic data entry according to predefined sets of preoperative, operative and outcome forms by designated paramedical staff. Ministry of Health (MOH) Ophthalmology Departments nationwide contribute data to the CSR database. Details on the CSR have been published elsewhere.[10-12] Post-operative refractive outcomes were entered into the CSR 6 weeks post-cataract surgery. The optical biometry data from Lenstar and surgical details with post-operative refractive outcomes from CSR were matched and analysed.

Inclusion criteria were all patients in QEH who have undergone bilateral optical biometry measurement prior to unilateral phacoemulsification who underwent uncomplicated phacoemulsification with IOL implantation during the period from January 2018 to January 2020. Exclusion criteria were patients of age less than 40 years, any ocular co-morbidities (glaucoma, corneal pathology, diabetic retinopathy and others), traumatic or secondary cataract, history of cataract surgery on either of the eyes, previous strabismus, vitreoretinal and refractive surgery before the cataract surgery. Surgery performed by junior specialists or trainee were excluded.

Pre-operative biometry data of interest comprised Axial Length (AL), corneal keratometry (K), white-to-white diameter (WTW) and central corneal thickness (CCT). All data were compared between the right and left eye to identify any discrepancies. The outcome obtained were IALD, IKD-Flat (over flat meridian), IKD-Steep (over steep meridian), IKD-Average, ICCTD and IWTWD.

Different formulas to calculate the IOL power were used depending on the axial length. In AL of <22.0mm, Hoffer Q was used.[13] SRK-T was chosen for AL between 22.0mm and 24.99mm.[14] If the AL fell within 25.0mm to 25.99mm, Holladay was applied. SRK-T was utilized for eyes with long AL (26.0mm or more).[15] The monofocal posterior chamber intraocular lens was selected from the biometry.

Phacoemulsification surgery was performed by three experienced surgeons in the same centre. All 337 patients have only unilateral phacoemulsification done throughout the study. Only uneventful surgeries were included in the study. Complicated cataract surgeries were excluded to reduce the confounding effect on the results. The postoperative refractive assessment was done six weeks after cataract surgery; results were documented into the CSR on the same day.

The outcomes of interest in CSR were the preoperative refractive target, postoperative best-corrected visual acuity (BCVA), postoperative refractive outcomes and optical biometry prediction error of patients. The optical biometry prediction error is defined as the difference between postoperative refractive outcomes and preoperative refractive target.

**Table I: Characteristics of the study population (N=337)**

| | n | | (%) |
|---|---|---|---|
| Age (years): | | | |
| Mean (SD) | | 67.77 (8.22) | |
| Range | | 43.00, 94.00 | |
| Age group: | | | |
| 40-50 years | 10 | | (3.0) |
| 51-60 years | 47 | | (13.9) |
| 61-70 years | 160 | | (47.5) |
| 71-80 years | 105 | | (31.2) |
| >80 years | 15 | | (4.5) |
| Gender: | | | |
| Female | 169 | (50.1) | |
| Male | 168 | (49.9) | |
| Preoperative Visual Acuity, BCVA (logMAR): | | | |
| Median (IQR) | | 0.50 (0.30–0.60) | |
| Range | | 0.00, 3.00 | |
| Preoperative Visual Acuity group: | | | |
| BCVA better than 6/15 (<0.4logMAR) | 124 | | (36.8) |
| BCVA 6/15 or worse (≥0.4logMAR) | 213 | | (63.2) |
| Preoperative Biometry: | | | |
| Axial length (mm): | | | |
| Median (IQR) | | 23.42 (22.75–24.13) | |
| Range | | 20.69, 30.79 | |
| Interocular Axial Length Difference (IALD) (mm): | | | |
| Median (IQR) | | 0.10 (0.05–0.22) | |
| Range | | 0.00, 3.20 | |
| Flat K (D): | | | |
| Mean (SD) | | 43.86 (1.47) | |
| Range | | 39.24, 48.37 | |
| Steep K (D): | | | |
| Mean (SD) | | 44.78 (1.53) | |
| Range | | 40.58, 49.05 | |
| Corneal Astigmatism (D): | | | |
| Median (IQR) | | 0.78 (0.45–1.21) | |
| Range | | 0.00, 3.65 | |
| Interocular K Difference (D): | | | |
| Median (IQR) | | 0.33 (0.15–0.62) | |
| Range | | 0.00, 2.58 | |
| Central Corneal Thickness (CCT) (µm): | | | |
| Mean (SD) | | 532.54 (33.43) | |
| Range | | 443.00, 614.00 | |
| Interocular Central Corneal Thickness Difference (ICCTD) (µm): | | | |
| Median (IQR) | | 5.00 (2.00–8.00) | |
| Range | | 0.00, 80.00 | |
| White-to-white Diameter (WTW) (mm): | | | |
| Median (IQR) | | 11.70 (11.36–12.02) | |
| Range | | 8.60, 12.86 | |
| Interocular WTW difference (mm): | | | |
| Median (IQR) | | 0.16 (0.07–0.38) | |
| Range | | 0.00, 12.53 | |
| Preoperative Refractive Target: | | | |
| Median (IQR) | | -0.43 (-0.50, -0.35) | |
| Range | | -2.04, +0.58 | |
| Preoperative Refractive Target: | | | |
| +2.00 to 0.00 D | 2 | | (0.6) |
| -0.01 to -0.25 D | 23 | | (6.8) |
| -0.26 to -0.50 D | 235 | | (69.7) |
| -0.51 to -1.00 D | 72 | | (21.4) |
| <-1.00 D | 5 | | (1.5) |

SD = Standard deviation.
IQR = Interquartile range, reported as 25th percentile–75th percentile.
Range is reported as minimum, maximum

**Table II: Relationship between Interocular Biometry Differences and Odds of Optical Biometry Predictive Error 0.5D**

| IALD (mm | ≤0.5D (n=179) | | >0.5D (n=158) | | OR (95% CI) | P-value |
|---|---|---|---|---|---|---|
| | n | (%) | n | (%) | | |
| <0.1mm | 86 | (56.2) | 67 | (43.8) | 1.00 | 0.300 |
| ≥0.1mm | 93 | (50.5) | 91 | (49.5) | 1.26 (0.82, 1.93) | |
| <0.2mm | 132 | (53.9) | 113 | (46.1) | 1.00 | 0.648 |
| ≥0.2mm | 47 | (51.1) | 45 | (48.9) | 1.12 (0.69, 1.81) | |
| <0.3mm | 150 | (53.8) | 129 | (46.2) | 1.00 | 0.601 |
| ≥0.3mm | 29 | (50.0) | 29 | (50.0) | 1.16 (0.66, 2.05) | |
| <0.4mm | 164 | (52.9) | 146 | (47.1) | 1.00 | 0.791 |
| ≥0.4mm | 15 | (55.6) | 12 | (44.4) | 0.90 (0.41, 1.98) | |
| **IKD-Flat (D)** | | | | | | |
| <0.2D | 56 | (48.7) | 59 | (51.3) | 1.00 | 0.242 |
| ≥0.2D | 123 | (55.4) | 99 | (44.6) | 0.76 (0.49, 1.20) | |
| <0.4D | 112 | (56.6) | 86 | (43.4) | 1.00 | 0.130 |
| ≥0.4D | 67 | (48.2) | 72 | (51.8) | 1.40 (0.91, 2.16) | |
| <0.6D | 147 | (54.2) | 124 | (45.8) | 1.00 | 0.401 |
| ≥0.6D | 32 | (48.5) | 34 | (51.5) | 1.26 (0.74, 2.16) | |
| <0.8D | 164 | (53.9) | 140 | (46.1) | 1.00 | 0.355 |
| ≥0.8D | 15 | (45.5) | 18 | (54.5) | 1.41 (0.68, 2.89) | |
| **IKD-Steep (D)** | | | | | | |
| <0.2D | 64 | (51.2) | 61 | (48.8) | 1.00 | 0.588 |
| ≥0.2D | 115 | (54.2) | 97 | (45.8) | 0.88 (0.57, 1.38) | |
| <0.4D | 113 | (52.3) | 103 | (47.7) | 1.00 | 0.694 |
| ≥0.4D | 66 | (54.5) | 55 | (45.5) | 0.91 (0.59, 1.43) | |
| <0.6D | 149 | (54.0) | 127 | (46.0) | 1.00 | 0.496 |
| ≥0.6D | 30 | (49.2) | 31 | (50.8) | 1.21 (0.70, 2.11) | |
| <0.8D | 163 | (53.6) | 141 | (46.4) | 1.00 | 0.575 |
| ≥0.8D | 16 | (48.5) | 17 | (51.5) | 1.23 (0.60, 2.52) | |
| **IKD-Average (D)** | | | | | | |
| <0.2 D | 66 | (60.0) | 44 | (40.0) | 1.00 | 0.079 |
| ≥0.2 D | 113 | (49.8) | 114 | (50.2) | 1.51 (0.95, 2.40) | |
| <0.4 D | 110 | (57.0) | 83 | (43.0) | 1.00 | 0.099 |
| ≥0.4 D | 69 | (47.9) | 75 | (52.1) | 1.44 (0.93, 2.22) | |
| <0.6 D | 133 | (54.7) | 110 | (45.3) | 1.00 | 0.339 |
| ≥0.6 D | 46 | (48.9) | 48 | (51.1) | 1.26 (0.78, 2.03) | |
| <0.8 D | 160 | (55.6) | 128 | (44.4) | 1.00 | 0.032 |
| ≥0.8 D | 19 | (38.8) | 30 | (61.2) | 1.97 (1.06, 3.67) | |
| **ICCTD (μm)** | | | | | | |
| <5μm | 88 | (54.0) | 75 | (46.0) | 1.00 | 0.756 |
| ≥5μm | 91 | (52.3) | 83 | (47.7) | 1.07 (0.70, 1.64) | |
| <10μm | 148 | (53.2) | 130 | (46.8) | 1.00 | 0.923 |
| ≥10μm | 31 | (52.5) | 28 | (47.5) | 1.03 (0.59, 1.81) | |
| <15μm | 167 | (53.4) | 146 | (46.6) | 1.00 | 0.751 |
| ≥15μm | 12 | (50.0) | 12 | (50.0) | 1.14 (0.50, 2.62) | |
| **IWTWD (mm)** | | | | | | |
| <0.5mm | 150 | (83.8) | 121 | (76.6) | 1.00 | 0.097 |
| ≥0.5mm | 29 | (16.2) | 37 | (23.4) | 1.58 (0.92, 2.72) | |
| <1.0mm | 166 | (92.7) | 137 | (86.7) | 1.00 | 0.070 |
| ≥1.0mm | 13 | (7.3) | 21 | (13.3) | 1.96 (0.95, 4.05) | |
| <1.5mm | 172 | (96.1) | 142 | (89.9) | 1.00 | 0.029 |
| ≥1.5mm | 7 | (3.9) | 16 | (10.1) | 2.77 (1.11, 6.92) | |

OR = Odds ratio; CI = Confidence interval; IALD = Interocular Axial Length Difference; IKD = Interocular Corneal Power Difference; ICCTD = Interocular Central Corneal Thickness Difference; IWTWD = Interocular White-to-White Difference

IBM SPSS Statistics 20 (IBM SPSS Statistics for Windows, IBM) was used for data analysis. Continuous variables were presented by the mean and standard deviation for normally distributed data. Skewed data were presented by the median and interquartile range (IQR). Categorical variables were described in frequency and percentage.

Simple logistic regression was used to estimate the Odds Ratio (OR) and 95% confidence intervals (95%CI) to determine the association between interocular biometry difference and optical biometry predictive error. P-values of less than 0.05 were considered statistically significant throughout the study.

The relationship between IALD and optical biometry prediction error was compared at 0.1mm, 0.2mm, 0.3mm and 0.4mm cutoffs. In the same way, the association between optical biometry prediction error and IKD-Flat, IKD-Steep and IKD-Average were tested at 0.2D, 0.4D, 0.6D, and 0.8D. Besides that, both IWTWD and ICCTD were compared to optical biometry prediction error at cutoff points of 0.5mm,

**Table III: Relationship between Interocular Biometry Differences and Odds of Optical Biometry Predictive Error 1.0D**

| IALD (mm) | ≤1.0D (n=304) | | >1.0D (n=33) | | OR (95%CI) | P-value |
|---|---|---|---|---|---|---|
| | n | (%) | n | (%) | | |
| <0.1mm | 137 | (89.5) | 16 | (10.5) | 1.00 | 0.708 |
| ≥0.1mm | 167 | (90.8) | 17 | (9.2) | 0.87 (0.42, 1.79) | |
| <0.2mm | 223 | (91.0) | 22 | (9.0) | 1.00 | 0.414 |
| ≥0.2mm | 81 | (88.0) | 11 | (12.0) | 1.38 (0.64, 2.96) | |
| <0.3mm | 254 | (91.0) | 25 | (9.0) | 1.00 | 0.264 |
| ≥0.3mm | 50 | (86.2) | 8 | (13.8) | 1.63 (0.69, 3.81) | |
| <0.4mm | 283 | (91.3) | 27 | (8.7) | 1.00 | 0.030 |
| ≥0.4mm | 21 | (77.8) | 6 | (22.2) | 2.99 (1.11, 8.06) | |
| **IKD-Flat (D)** | | | | | | |
| <0.2D | 108 | (93.9) | 7 | (6.1) | 1.00 | 0.105 |
| ≥0.2D | 196 | (88.3) | 26 | (11.7) | 2.05 (0.86, 4.87) | |
| <0.4D | 186 | (93.9) | 12 | (6.1) | 1.00 | 0.008 |
| ≥0.4D | 118 | (84.9) | 21 | (15.1) | 2.76 (1.31, 5.82) | |
| <0.6D | 246 | (90.8) | 25 | (9.2) | 1.00 | 0.479 |
| ≥0.6D | 58 | (87.9) | 8 | (12.1) | 1.36 (0.58, 3.16) | |
| <0.8D | 276 | (90.8) | 28 | (9.2) | 1.00 | 0.281 |
| ≥0.8D | 28 | (84.8) | 5 | (15.2) | 1.76 (0.63, 4.92) | |
| **IKD-Steep (D)** | | | | | | |
| <0.2D | 112 | (89.6) | 13 | (10.4) | 1.00 | 0.773 |
| ≥0.2D | 192 | (90.6) | 20 | (9.4) | 0.90 (0.43, 1.87) | |
| <0.4D | 196 | (90.7) | 20 | (9.3) | 1.00 | 0.660 |
| ≥0.4D | 108 | (89.3) | 13 | (10.7) | 1.18 (0.56, 2.46) | |
| <0.6D | 251 | (90.9) | 25 | (9.1) | 1.00 | 0.337 |
| ≥0.6D | 53 | (86.9) | 8 | (13.1) | 1.52 (0.65, 3.54) | |
| <0.8D | 276 | (90.8) | 28 | (9.2) | 1.00 | 0.281 |
| ≥0.8D | 28 | (84.8) | 5 | (15.2) | 1.76 (0.63, 4.92) | |
| **IKD-Average (D)** | | | | | | |
| <0.2D | 102 | (92.7) | 8 | (7.3) | 1.00 | 0.282 |
| ≥0.2D | 202 | (89.0) | 25 | (11.0) | 1.58 (0.69, 3.62) | |
| <0.4D | 179 | (92.7) | 14 | (7.3) | 1.00 | 0.073 |
| ≥0.4D | 125 | (86.8) | 19 | (13.2) | 1.94 (0.94, 4.02) | |
| <0.6D | 222 | (91.4) | 21 | (8.6) | 1.00 | 0.256 |
| ≥0.6D | 82 | (87.2) | 12 | (12.8) | 1.55 (0.73, 3.29) | |
| <0.8D | 263 | (91.3) | 25 | (8.7) | 1.00 | 0.102 |
| ≥0.8D | 41 | (83.7) | 8 | (16.3) | 2.05 (0.87, 4.86) | |
| **ICCTD (μm)** | | | | | | |
| <5μm | 148 | (90.8) | 15 | (9.2) | 1.00 | 0.725 |
| ≥5μm | 156 | (89.7) | 18 | (10.3) | 1.14 (0.55, 2.34) | |
| <10μm | 253 | (91.0) | 25 | (9.0) | 1.00 | 0.287 |
| ≥10μm | 51 | (86.4) | 8 | (13.6) | 1.59 (0.68, 3.72) | |
| <15μm | 286 | (91.4) | 27 | (8.6) | 1.00 | 0.014 |
| ≥15μm | 18 | (75.0) | 6 | (25.0) | 3.53 (1.29, 9.64) | |
| **IWTWD (mm)** | | | | | | |
| <0.5mm | 248 | (91.5) | 23 | (8.5) | 1.00 | 0.107 |
| ≥0.5mm | 56 | (84.8) | 10 | (15.2) | 1.93 (0.87, 4.27) | |
| <1.0mm | 274 | (90.4) | 29 | 9.6) | 1.00 | 0.684 |
| ≥1.0mm | 30 | (88.2) | 4 | (11.8) | 1.26 (0.41, 3.83) | |
| <1.5mm | 285 | (90.8) | 29 | (9.2) | 1.00 | 0.213 |
| ≥1.5mm | 19 | (82.6) | 4 | (17.4) | 2.07 (0.66, 6.49) | |

OR = Odds ratio; 95%CI = 95% Confidence interval; IALD = Interocular Axial Length Difference; IKD = Interocular Corneal Power Difference; ICCTD = Interocular Central Corneal Thickness Difference; IWTWD = Interocular White-to-White Difference

1.0mm, 1.5mm and 5μm, 10μm, 15μm respectively. The cutoff point was determined by using the histogram method.

Optical biometry predictive error was tested in both 0.5D and 1.0D for all of the parameters stated above.

## RESULTS

Out of a total of 1012 patients who had undergone cataract surgery, only 337 patients were eligible for analysis. The mean age was 67.7±8.2 years with 160 (47.5%) within the age group of 61-70 years old. The percentage of surgeries with BCVA 6/15 or worse (≥0.4logMAR) was 213 (63.2%). Most of the surgeries were targeted to achieve slight myopia at -0.26 to -0.50D. (Table I)

Among the 337 patients who had undergone surgery, 179 patients (53.1%) were within 0.5D of the refractive target, and 304 patients (90.2%) were within 1.0D. A total of 33 patients (9.8%) had an optical biometry prediction error of more than 1.0D from the refractive target.

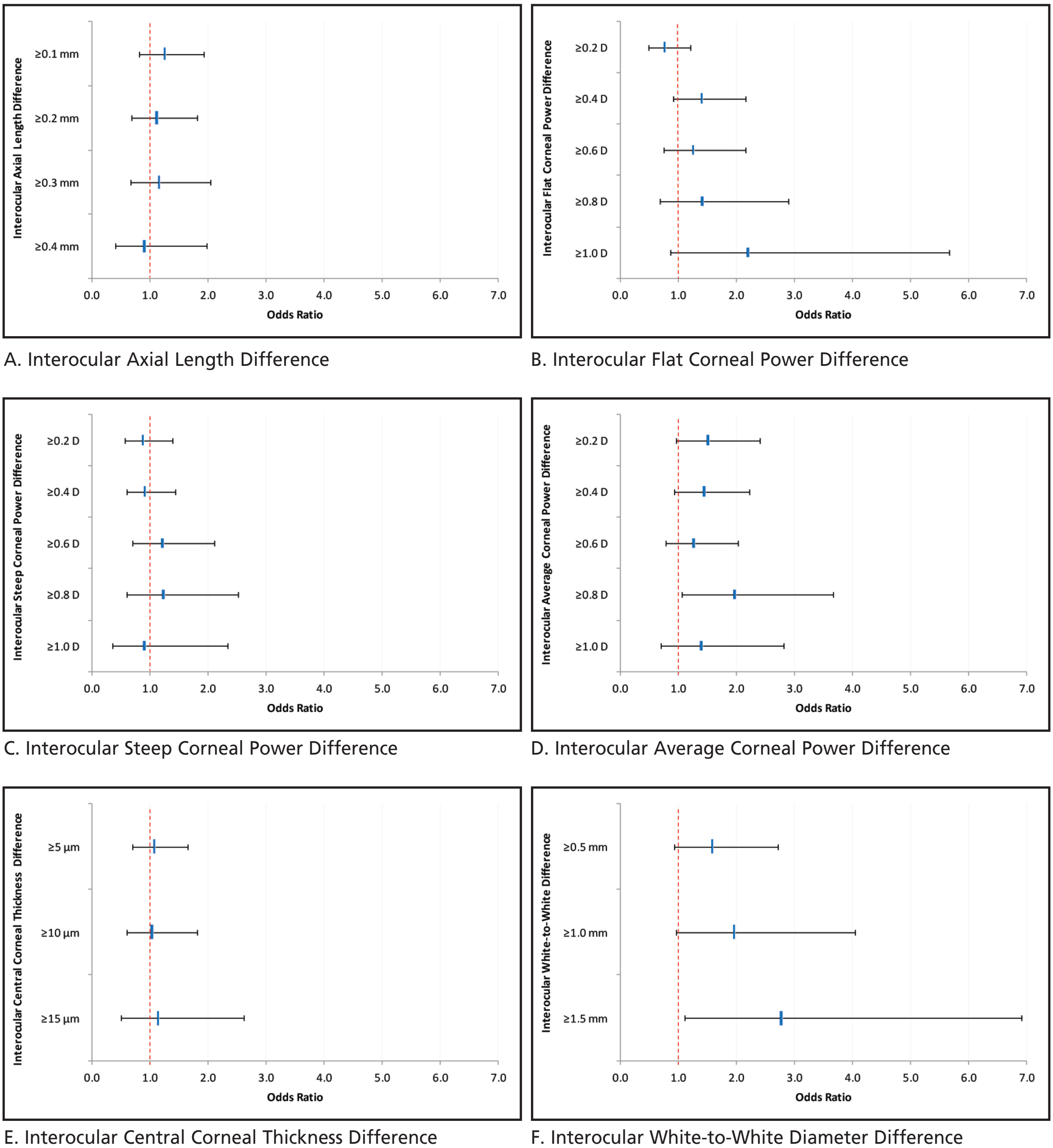


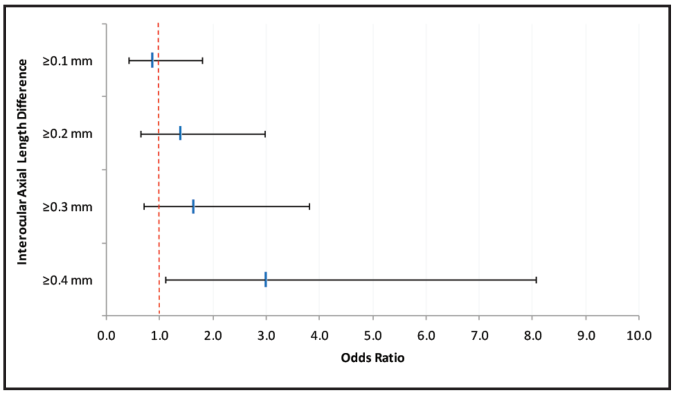

**Fig. 1:** Odds of Predictive Error >0.5D, By Each Interocular Difference.

Significant proportions of the interocular biometry measurements differences from the refractive target which were associated with higher odds of prediction error >0.5D were IKD-average ≥0.8 D (Odds Ratio, OR=1.97; 95%CI 1.06, 3.67) and IWTWD ≥1.5mm (OR=2.77; 95%CI: 1.11, 6.92) was observed. (Table II)

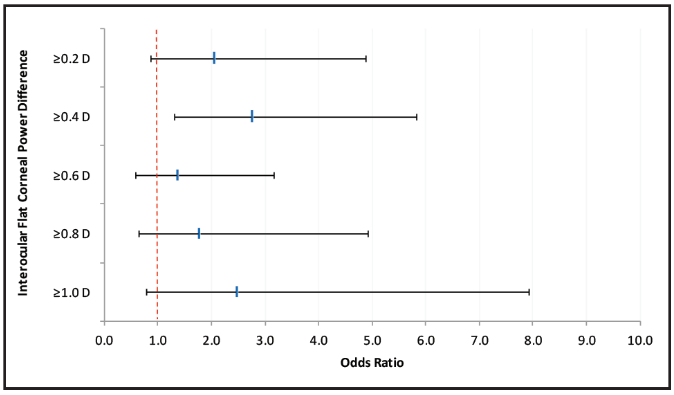
While for the prediction error >1.0D, the measurements were IALD ≥0.4mm (OR=2.99; 95%CI: 1.11, 8.06), IKD flat ≥0.4D (OR=2.76; 95%CI: 1.31, 5.82) and ICCTD ≥15µm (OR=3.53; 95%CI: 1.29, 9.64). (Table III)

## DISCUSSION

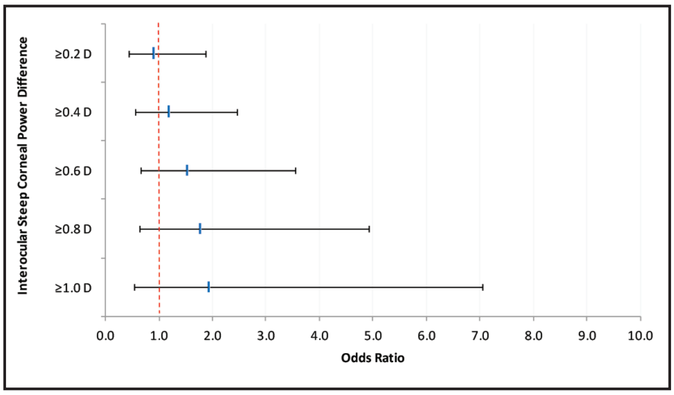
In cataract surgery, surgeons aim to achieve the refractive target which is determined preoperatively during IOL power measurement. Other important ocular biometry parameters are AL, K, CCT and WTW Distance. During the preoperative assessment, the discrepancy in interocular parameters should ideally be measured to determine the reliability of the ocular biometry to ensure quality visual and refractive outcomes. It is not done in practice due to a busy clinic setting and high-volume of surgeries. Besides, the evidence to recommend the routine evaluation of interocular differences for those



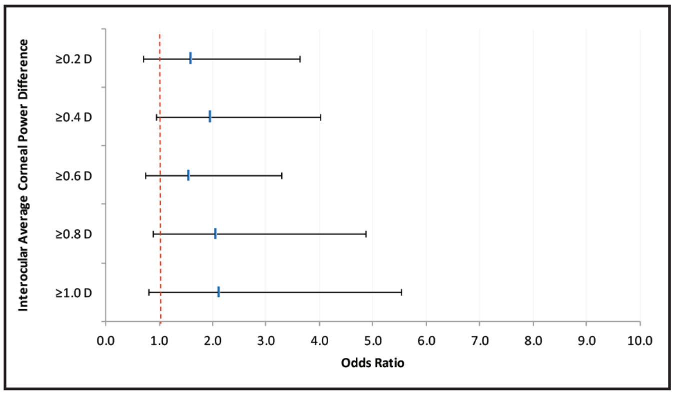

Interocular Axial Length Difference



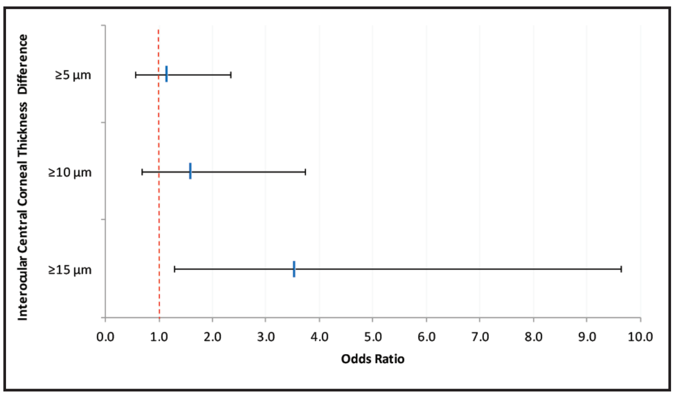

Interocular Flat Corneal Power Difference



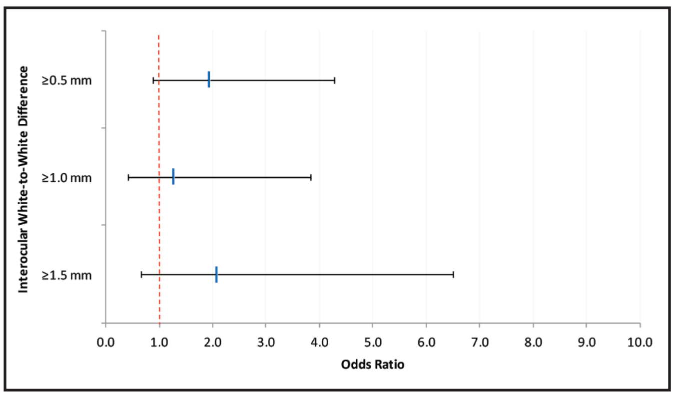

Interocular Steep Corneal Power Difference




Interocular Average Corneal Power Difference




Interocular Central Corneal Thickness Difference




Interocular White-to-White Diameter Difference

**Fig. 2:** Odds of Predictive Error >1.0 D, By Each Interocular Difference.

parameters are lacking. There are limited studies published in literature regarding the impact of interocular biometry discrepancy on refractive outcomes of cataract surgeries.

In our study, preoperative optical biometric data and postoperative refractive outcomes were analyzed in 337 patients. In the AL analysis, IALD of ≥0.4mm was found to be associated with a higher odds ratio for 1.0D residual refractive error from the target. None of the other subgroups in IALD was associated with a refractive error of 0.5D from the target.

The finding of an increased IALD associated with higher odds of refractive drift from the target is consistent with the previous study.[9] Kansal et al., found IALD of 0.2mm or more is associated with >0.5D of refractive error from the target[9]. Although the cutoff point of significant IALD and refractive error was slightly different from our results, the magnitude of IALD is still significant in predicting postoperative refractive error from the target. Kansal's study has a large number of patients who underwent femtosecond laser-assisted cataract surgery (52.8% of the sample), compared to our study which solely investigates phacoemulsification. This could attribute to the difference of our cut-off value.

The IKD analysis showed an average corneal power difference (IKD-average) of ≥0.8D has higher odds of residual refractive error of 0.5D from the target. Certain IKD cutoffs showed increased odds, however, the results were not significant. This result is incongruous with other studies, as they found no significant relationship between the IKD and refractive outcomes.[9] The reason may be due to different formulas selected according to AL in our study. Factors that can influence keratometry include ocular surface dryness, recent contact lens wear and gonioscopy should be taken into consideration. Interocular average corneal power astigmatism discrepancy of more than 0.8D could be one of the indicators of refractive drift from the target. However, more studies are needed to explore the reliability of this parameter.

The association of Interocular Central Corneal Thickness Difference (ICCTD) with the postoperative refractive outcome is a possibility that has not been explored in other studies. In this study, ICCTD of ≥15µm had the predictive error of 1.0D in the postoperative refractive outcome. To the best of our knowledge, there are no published reports in the literature on the relationship between ICCTD and postoperative prediction error. The limitation in this parameter's measurement is, ICCTD of ≥15µm cannot be labelled as abnormal because there is no reference range for normal ICCTD in literature. Thus, our inability to compare it with other studies. Further studies need to be done to find out the normal range of ICCTD and how ICCTD affects the postoperative refractive outcomes.

The IWTWD of ≥1.5mm was associated with >0.5D of refractive error from the target. To the best of our knowledge, the normal range of IWTWD and its impact on postoperative refractive is not normally evaluated or reported in practice. We hypothesized that an increased IWTWD could be attributed to inconsistent ocular biometry. Given the limited studies on IWTWD, we suggest clinicians repeat the optical biometric measurement if IWTWD is ≥1.5mm until the IWTWD is <1.5mm. If the measurement is persistently high despite repeating the biometry measurement, the possibility of postoperative refractive error of 0.5D from the target needs to be explained to the patient.

There are two limitations in our study that could be addressed in future research. Firstly, this study is a retrospective cohort study which may be biased due to confounders. Hence, a future prospective cohort study is needed to mitigate the possibility of bias. Secondly, the involvement of multiple surgeons in this study is another confounding factor that may induce performance bias.

The strength of this study is to explore the impact of IALD, IKD, ICCTD and IWTWD on postoperative refractive outcomes. There are only limited studies discussing this topic in the literature. To our best knowledge, this is the first paper exploring the impact of ICCTD and IWTWD on the postoperative refractive outcome. The predictive value of the parameters described above is useful for clinicians in decision making and during preoperative counselling of patients. To reduce postoperative refraction drift from the target, the preoperative interocular discrepancy should be reduced to the cut-off value as mentioned. Clinicians can perform biometry by using more than 1 type of instrument (immersion or other optical biometry) when in doubt. Whether repetitive ocular biometric measurements need to be done to reduce the interocular biometric discrepancy remains questionable. This study did not focus on eliciting repetitive ocular biometry consistency owing to the retrospective nature of the study design. Further directions for this investigation will be to establish the role of repetitive ocular measurement on patients who have interocular discrepancy exceeding the cut-off points as determined in this study.

## CONCLUSION

The IALD ≥0.4mm and ICCTD ≥15µm are associated with increased odds of greater than 1.0D of postoperative residual refractive error, while both IKD-average ≥0.8D and IWTWD ≥1.5mm have a higher risk of greater than 0.5D of residual refractive error from the target after cataract surgery. To our best knowledge, this is the first study that evaluates the impact of interocular central corneal thickness difference and interocular white-to-white difference on postoperative refractive outcome. Future research is encouraged to narrow the gap in acceptable range of interocular discrepancy value. True interocular discrepancies above these values shall serve as indicators to alert ophthalmologists on the potential risk of postoperative refractive drift and advice patients accordingly.

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## CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest in this study.

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