ORIGINAL ARTICLE

Comparing Effect of Pre and Post Pupil Dilatation on Biometry Obtained by AL-Scan

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Abstract:
To assess the effect of pharmacologic pupil dilation on ocular biometric measurements and to determine whether dilation influences intraocular lens (IOL) power calculations or not.
Methods: A cross-sectional study, was conducted at the Department of Ophthalmology, Civil Hospital Karachi. Data was collected in designed questionnaire via non probability consecutive sampling technique. Biometric assessments including axial length (AL), anterior chamber depth (ACD), kerato-metric values (K) and central corneal thickness (CCT) were obtained using the AL-Scan device. All parameters were recorded twice, first under un dilated conditions and then after dilation with 1% tropicamide. The power of the intraocular lens (IOL) was determined with the SRK/T formula, keeping target of an emmetropic postoperative refraction. SPSS 26 was used for analysis. Paired t-test was applied to examine relationships between variables. A p-value of ≤0.05 was considered statistically significant.
Results: 100 eyes were examined, with twice as many male participants as female. The average age of participants was 66.1 years. The mean intraocular lens (IOL) power measured was 19.9 D both before and after pupil dilation, showing no significant change following mydriasis. No clinically significant difference was evaluated for parameters like AL, Avg K readings, CCT and IOL power in pre and post dilated phase ($p>0.01$). Whereas a mean increase of 0.09mm was noted in ACD ($p>0.01$).
Conclusion: Biometric values recorded via AL-Scan showed pupil size has no significant effect on measurement accuracy. This support's device's consistency and effectiveness and hence helping in reducing unnecessary follow-up, time, and cost. *Al-Shifa Journal of Ophthalmology 2026; 22(1): 9-16.*

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Originally Received: 5 Nov 2025
Revised: 30 Dec 2025
Accepted: 8 Feb 2026

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Introduction:

Among eye surgeries, cataract extraction is performed more often than most other procedures worldwide. In addition to restoring vision impaired by cataracts, it is also classified as a form of refractive surgery, as it aims to correct pre-existing refractive errors to the greatest extent possible, thereby improving the patient's overall visual outcome[1]. In modern day Cataract extraction is referred as cataract refractive surgery[2]. The effectiveness and overall success of cataract surgery are influenced by several important factors, including the patient's pre -existing refractive condition, the skill and experience of the surgeon, as well as the precision of intraocular lens (IOL) power calculations performed before the operation[3]. Visual expectations after cataract surgery are the prime concern of all

patients. With the recent advancement in Femto laser, these expectations have been met to a large extent. Yet accurate calculations and measurements is a need to be encountered for satisfying results. Thomas Olsen in a review in 2007 concluded that Axial Length (AL) contributes to 36% in rate of errors of IOL calculations while anterior chamber depth (ACD) and keratometry (k) lead to 42 and 22% respectively[4]. Thus concluding ACD, AL and K are primary parameters of IOL measurements. Sanders–Retzlaf f–Kraf f (SRK II), second generation formula uses same parameters. Whereas some fourth-generation formulae like Holladay 2 and SRK/T also call for lens thickness (LT) and white-to-white thickness[5]. Over time, optical biometry has largely replaced ultrasound biometry due to its superior accuracy in measuring axial length (AL), a key factor in selecting the correct intraocular lens power for cataract surgery. Its non-contact approach avoids errors caused by corneal compression, which often occur with applanation A-scan ultrasound. While immersion A-scan is more accurate than applanation, it involves a more complex process and can still introduce variability. Optical biometry offers a faster, more comfortable and operator-independent method, improving both efficiency and patient experience. Additionally, it carries a lower risk of infection since the procedure does not involve direct contact with the eye[6]. These advantages make optical biometry a preferred and reliable tool for preoperative evaluation in cataract surgery.

Presently practiced optical techniques encompass, the IOL Master 500© (Carl Zeiss Medi tec AG, Jena, Germany), the LENSTAR900© (Haag-Streit AG, Koeniz, Switzerland), AL-Scan Optical Biometer (Nidek CO., Gamagori, Japan) and the recently evolved IOL Master 700© (Carl Zeiss Medi tec AG, Jena, Germany) built upon on swept-source optical coherence tomography technology[7]. The AL-Scan (Nidek Co., Gamagori, Japan) optical biometer operates using a non-invasive method and incorporates a three-dimensional automated ocular surveillance detection integrated with an automatic capture feature[8]. It can determine axial length (AL), anterior chamber depth (ACD), keratometry (K), central corneal thickness (CCT), and the white-to-white distance. The AL-Scan functions are based on optical low-coherence interferometry, utilizing the low-coherence interference of light waves generated by an 830 nm super luminescent diode are used to assess the axial length (AL) of the eye within a span of 14 to 40 mm**.** Keratometry is assessed using concentric mire rings projected onto the cornea within zones of 2.4 mm and 3.3 mm in diameter. The ACD is measured following the Scheimpflug imaging principle, by gauging the space between the reflective points on the anterior corneal surface and the front surface of the lens[9]. The intraocular lens (IOL) power is computed using the Sanders–Retzlaff–Kraff/theoretical (SRK/T) formula, aiming for a postoperative refraction of 0 diopters (D)[10].

Tropicamide is a commonly used parasympathetic antagonist mydriatic that relaxes pupillary sphincter muscle. But radial muscles of iris are innervated by sympathetic nervous system hence remain unaffected, contract and therefore cause pupillary dilation[11]. In clinical settings, pupils of patients are dilated before performing biometry to save time. Sometimes surgeons forget to perform biometry before dilating the pupil for fundus examination[12]. If pre- vs. post-dilation measurements differ, inconsistent dilation status at the time of biometry could introduce systematic error in IOL selection and surgical planning. Establishing whether dilation meaningfully changes AL-Scan outputs (and whether any change is clinically relevant for IOL power) will guide protocols (measure un dilated vs. dilated or require consistent state) and improve refractive predictability.

Methodology:

A cross-sectional study was carried out in the Department of Ophthalmology, Unit-I of Dow Medical College. This project was conducted in coordination with Dr. Ruth K.M. Pfau Civil Hospital and the Shaheed Mohtarma Benazir Bhutto Trauma Centre, both located in Karachi. Study was conducted from November 2025 till January 2026. Approval to begin the research was granted by the Institutional Review Board (IRB) of Dow University of Health Sciences (DUHS), with ethical clearance officially documented in an approval letter dated IRB-4141/DUHS/Approval/2025/440.

Participants meeting the study inclusion criteria were asked to join the research. Before enrollment, the study procedures were explained to each individual. Written informed consent was obtained to ensure voluntary participation and compliance with ethical standards. The inclusion criteria were carefully defined to maintain consistency and reliability in the data. Both men and women aged 40 to 80 years with a confirmed diagnosis of cataracts were enrolled in the study. Only those with normal intraocular pressure and a healthy posterior segment on examination were considered suitable. This helped to prevent interference from unrelated ocular issues.

Patients were not included if they had experienced eye trauma in past or had undergone any ophthalmic surgery, or had inflammatory eye conditions such as uveitis. Likewise, anyone diagnosed with retinal pathology or glaucoma was exclude. Since all these findings could distort the results. Systemic illnesses known to affect ocular measurements specifically hypertension and diabetes were also added exclusion factors. Individuals who struggled to maintain steady fixation on a target, refused participation, or showed corneal surface abnormalities during examination were excluded. These problems can compromise the accuracy of biometric readings hence were eliminated.

Non probability consecutive sampling technique was used. Altogether, 100 individuals fulfilled the criteria and were enrolled. The required sample size had been determined beforehand using Open Epi software. Earlier studies reporting a cataract prevalence of more than 90% in Asian populations were used for reference[13]. At a 95% confidence level, the study's sample size was estimated to be 101, and the final number of participants closely aligned with this estimate.

Biometric assessments were performed twice before and after pharmacologic dilation. Baseline readings were collected under natural pupillary conditions. Mydriasis was produced with three drops of 1% tropicamide administered five minutes apart. Roughly 45 minutes from the first instillation were allowed to achieve full dilation prior to repeating the measurements.

To prevent corneal factors from affecting the measurements, intraocular pressure was assessed using a non-contact tonometer. Participants were asked to blink normally prior to each reading to ensure a smooth tear film as irregularities on the corneal surface can influence optical scans. All measurements were taken under dim lighting to avoid pupil constriction caused by bright light.

Biometric data were collected using the AL-Scan optical biometer. This device measured anterior chamber depth, axial length, and corneal curvature (K1, K2, and mean keratometry). Each measurement was taken in both un dilated and dilated states. Intraocular lens (IOL) power was calculated using the SRK/T formula, which is suitable for eyes with standard axial lengths and is commonly used in clinical practice.

To ensure consistency, a single consultant ophthalmologist at Civil Hospital Karachi performed all measurements and IOL calculations. Data for each participant were recorded on a structured data form. Participants were recruited using a

consecutive, non-probability sampling method.

Data were analyzed using SPSS version 26. Quantitative variables were expressed as mean ± standard deviation, while categorical variables were presented as frequencies and percentages. Pre- and post-dilation biometric measurements were compared using paired t-tests. A p-value of ≤0.05 was considered statistically significant. Tables and charts were created to illustrate changes in biometric and kerato-metric parameters before and after pupil dilation.

Results:

The study included a total of 100 participants. The average age of participants was 66.1 ± 6.46 years. The age range was from 56 to 75 years, indicating a relatively uniform distribution. Two-thirds of the participants were male 67 (67%) and one-third were female 33 (33%), yielding an approximate male-to-female ratio of 2:1. Both eyes were equally represented in the study as right and left eyes accounted for 50 (50%) of the cases. Table 1 summarizes Demographic details of the participants.

Table 1: Demographics of Participants (n=100)

Variables	Mean ± SD
Age (years)	66±6.46
Variables	N(%age)
Gender	
Male	67(67%)
Female	33(33%)
Laterality	
Right eye	50(50%)
Left Eye	50(50%)

Comparisons of biometric measurements before and after pharmacologic dilation showed that most parameters remained largely unchanged. Axial length had a mean value of 23.7 ± 1.16 mm and did not vary after dilation. Mean keratometry values were similarly stable at 44.4 ± 2.25 D. Calculated intraocular lens (IOL) power remained consistent, averaging 19.9 ± 2.7 D. Slight changes were observed in central corneal thickness (CCT) and anterior chamber depth (ACD). Following dilation, CCT decreased marginally, with an average reduction of 0.87 µm compared to pre-dilation measurements. Conversely, ACD showed a slight increase of +0.09 mm following dilation. Statistical analysis using paired t-test showed that the changes in AL, CCT, K mean, and IOL power between pre- and post-dilation were not significant ($p > 0.05$). In contrast, the increase in ACD was statistically significant, with a p-value of less than 0.01, suggesting a measurable clinical difference in anterior chamber depth after dilation. These observations are further detailed in Table 2

Table 2: Clinical correlation in parameters between pre and post dilation phase

Variables	Pre-Dilation (Mean ± SD)	Post Dilation (Mean ± SD)	Mean difference between pre and post dilation	P value
Axial Length (mm)	23.728±1.16	23.730±1.17	0.02	0.24
Keratometry (D)	44.374±2.25	44.377±2.26	0.003	0.23
Central Corneal thickness (µm)	524.56±38.29	523.69±37.53	-0.870	0.25
Anterior Chamber Depth (mm)	3.12±0.34	3.21±0.37	0.09	0.0001
IOL Power (D)	19.89±2.78	19.86±2.74	-0.03	0.007

Only a few isolated readings differed from this overall pattern. Two participants showed a slight decrease of 0.5 D in IOL power after dilation, while one participant exhibited a 1.0 D increase. These outliers were rare and did not affect the overall statistical results. Overall, the findings indicate that pharmacologic dilation does not have a significant impact on axial length, keratometry, or IOL power. The isolated outlier changes in IOL power are illustrated in
Figure 1.

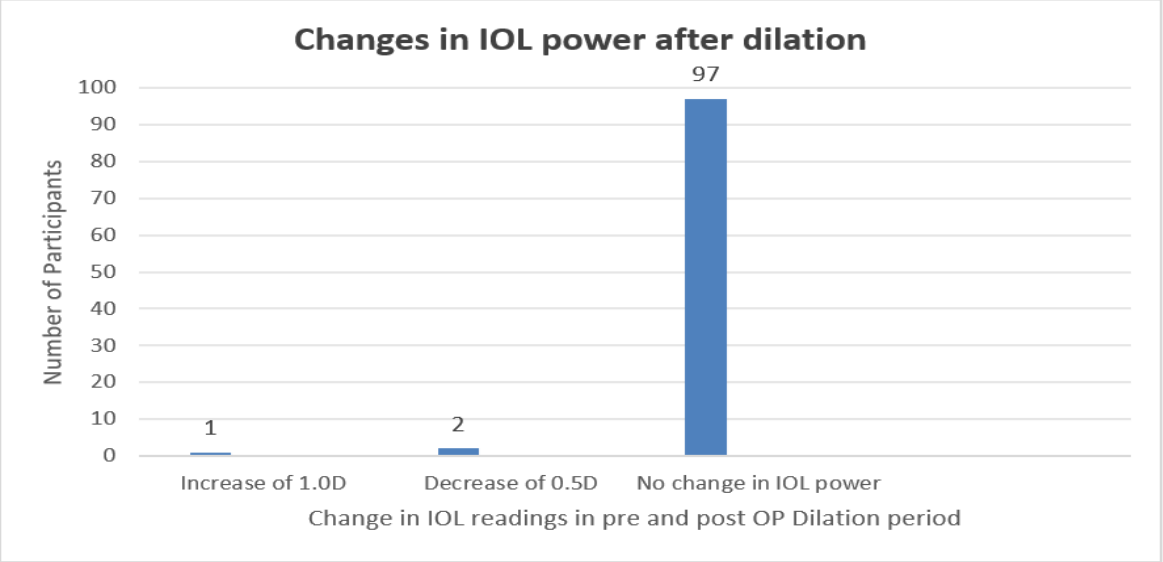

Figure 1: Distribution of isolated changes in intraocular lens (IOL) power following pharmacologic pupil dilation among study participants.

Discussion:

With the advancement in technology there is a drift towards the use of multivariant formulae for calculating IOL power. Changes in different parameters of SRK-T formula was compared in the pre and post pupil dilation phase in our study. A cross sectional study by Momeni-Moghaddam H et al., 2019 in Masha University of Medical Sciences showed a mean age of 35.2 ± 9.4years with a female predominance. Participants in our study had a mean age was 66.1±6.46 years with a male predominance of twice compared to females[14]. From our study results no change in axial length was recorded in the two periods; before and after dilation (p-value=0.23). Study by Huang J et al., 2012 revealed that axial length measured with both Lenstar AL and IOL Master showed that while statistically significant ($p < 0.001$), the variation between pre- and post-cycloplegic measurements (0.03 ± 0.03 mm compared to 0.02 ± 0.03 mm) was too small to be clinically important[15]. A study on 64 patients by Sadiq SA et al., 1996 published in European Journal of ophthalmology measured axial length before and after dilation of pupil, concluding a minimum difference of < ±0.3mm with a p value of 0.1[16].

Ozcaliskan S et al., 2019 investigated the impact of pupil dilation on IOL calculation parameters and found a statistically significant increase in central corneal thickness, which was also considered clinically relevant ($p < 0.05$)[17]. Similarly, a study comparing parameters among different age groups showed central corneal

thickness was significantly different in pre and post dilation phase for age range 50-60 years and 10-20 years[18]. Our study results were not in this favor, since, no clinical or statistical difference in central corneal thickness was noted.

Like our study reported no change in kerato-metric readings after pupil dilation, similarly study measuring biometry parameters using IOL Master concluded no significant change in the keratometry values ($p>0.5$)[19]. in contrast a prospective studied in 2014 analyzed 114 patients and derived the conclusion that there is short term change in the mean, maximum and minimum values of keratometry after dilation[20].

The two parameters that came out to be clinically and statistically significant in our study were Anterior Chamber Depth and IOL readings. ACD increased by 0.09mm in our study after dilation. These results are supported by other study like by Arriola-Villalobos P et al., 2021 that reported deepening of ACD after pupil dilation[21]. Another study from Turkey found that anterior chamber depth (ACD) increased significantly following pupil dilation, with a mean change of $–0.0821 \pm 0.0489$ mm ($p < 0.001$)[22]. This occurs because cycloplegia relaxes the ciliary muscles, eliminating accommodation. As a result, the lens is pulled radially, becoming flatter and shifting slightly toward the back of the eye. This change reduces lens thickness and leads to an increase in anterior chamber depth.

When calculating IOL power in using SRKT formula, our results showed that despite having statistically significance ($p< 0.05$) difference after dilation, clinically only a difference of 0.03D was noted. Can et al., 2016 reported that cycloplegia had no significant effect on intraocular lens (IOL) power calculations using the SRK/T formula with the AL-Scan in healthy participants, who had a mean age of 33.12 years. The only exceptions were two cases in which IOL power increased by more than 0.50 D[23]. An observational study by Rodriguez-Raton A et al., 2015 used SRK/T and Haigis formula for IOL calculation. The results revealed that pupil dilation did not have a significant effect on IOL power calculations using the SRK/T formula, whether the target was emmetropia or residual myopic refraction. In contrast, calculations based on the Haigis formula showed significant changes for both emmetropia and the lowest myopic refraction ($p = 0.01$)[24]. A study conducted at Rohilkhand Hospital in India in 2018 found that changes in intraocular lens (IOL) power after pupil dilation, calculated using the SRK/T formula, were neither statistically nor clinically significant ($p = 0.5$)[25].

There were several limitations of the study, we measured IOL power using only SRK/T formula. Comparison with other formula was not made like Haigis and Holladay. Likewise, all types of cataracts were taken under one roof and no classification system for different cataracts was taken into account. Our study data had elder patients only hence effect of different age groups on IOL calculation was eliminated unintentionally. Our post op target refraction of emmetropia was in focus, minor difference of refraction error in post op period was not validated in the study. So further multi centered study on a larger sample size incorporating the variables addressed in limitations is needed for better understanding of their effect on IOL power calculation.

Conclusion:

Pupil dilation by tropicamide 1% has no effect on the IOL calculation obtained by Nidek AL-Scan using SRK/T formula. The findings of this study assisted us to decide that none of the techniques with or without dilation is superior. Therefore, IOL calculation can be performed on the same day of OPD either before or after dilation immediately after examination to save time, money and effort for follow up just for biometry.

References:

1. Khoramnia R, Auffarth G, Łabuz G, Pettit G, Suryakumar R. Refractive outcomes after cataract surgery. Diagnostics. 2022 Jan 19;12(2):243.
2. Ang M, Gatinel D, Reinstein DZ, Mertens E, Alió del Barrio JL, Alió JL. Refractive surgery beyond 2020. Eye. 2021 Feb;35(2):362-82.
3. Elfalah M, Alryalat SA, Elfalah M, Hoffer K. Clinical Review of Cataract and Power Calculation: Part II. In Ophthalmology Board and FRCS Part 2 Exams: Eye Yield Clinical 2025 Mar 14 (pp. 393-407). Singapore: Springer Nature Singapore.
4. Debourdeau E, Pineau P, Chamard C, Plat J, Hoa D, Manna F, Akouete S, Mura T, Villain M, Molinari N, Daien V. Clinical and Biometric Factors Associated with Prediction Errors Related to Lens Position in Vitrectomized Patients. Ophthalmic Research. 2025 Dec 11;68(1):52-60.
5. Stopyra W, Langenbucher A, Grzybowski A. Intraocular lens power calculation formulas—a systematic review. Ophthalmology and Therapy. 2023 Dec;12(6):2881-902.
6. Nenning M, Hirnschall N, Findl O. Optical Biometry. InIntraocular Lens Calculations 2024 Jul 4 (pp. 177-196). Cham: Springer International Publishing.
7. Pathak M, Sahu V, Kumar A, Kaur K, Gurnani B. Current Concepts and Recent Updates of Optical Biometry-A Comprehensive Review. Clinical Ophthalmology. 2024 Dec 31:1191-206.
8. Yu J, Wen D, Zhao J, Wang Y, Feng K, Wan T, Savini G, McAlinden C, Lin X, Niu L, Chen S. Comprehensive comparisons of ocular biometry: A network-based big data analysis. Eye and Vision. 2023 Jan 3;10(1):1
9. Gologorsky D, Rosen R. Principles of Ocular Imaging. CRC Press; 2024 Jun 1.
10. Paritekar P, Nayak A, Umesh Y, Sirivella I, Manoharan S, Khatib Z. Special Focus, Cataract, Original Article Comparison of newer Kane formula with Sanders Retzlaff Kraff/Theoretical and Barrett Universal II for calculation of intraocular lens power in Indian eyes. Indian Journal of Ophthalmology. 2022;70(4).
11. Joos KM, Longmuir R. Autonomic control of the pupil. InPrimer on the Autonomic Nervous System 2023 Jan 1 (pp. 209-212). Academic Press.
12. Bettach E, Weill Y, Aronovitz Y, Zadok D, Gelman E, Abulafia A. Advantageous effect of pupil dilation on the quality of optical biometry axial length measurement in individuals with dense cataract. Journal of Cataract & Refractive Surgery. 2022 Nov 1;48(11):1248-52.
13. Hashemi H, Pakzad R, Yekta A, Aghamirsalim M, Pakbin M, Ramin S, Khabazkhoob M. Global and regional prevalence of age-related cataract: a comprehensive systematic review and meta-analysis. Eye. 2020 Aug;34(8):1357-70.
14. Momeni-Moghaddam H, Maddah N, Wolffsohn JS, Etezad-Razavi M, Zarei-Ghanavati S, Akhavan Rezayat A, Moshirfar M. The effect of cycloplegia on the ocular biometric and anterior segment parameters: a cross-sectional study. Ophthalmology and therapy. 2019 Sep 1;8(3):387-95.
15. Huang J, McAlinden C, Su B, Pesudovs K, Feng Y, Hua Y, Yang F, Pan C, Zhou H, Wang Q. The effect of cycloplegia on the lenstar and the IOLMaster biometry. Optometry and Vision Science. 2012 Dec 1;89(12):1691-6.
16. Sadiq SA, McElvanney AM. Pupillary dilation and axial length measurement for preoperative assessment of intraocular lens power. European journal of ophthalmology. 1996 Apr;6(2):147-9.
17. Ozcaliskan S, Yenerel NM. The effect of cycloplegia on biometric

measurements using swept-source optical coherence tomography-based biometry. Clinical and Experimental Optometry. 2019 Sep 1;102(5):501-5.
18. Tuncer I, Zengin MÖ, Yıldız S. The effect of cycloplegia on the ocular biometry and intraocular lens power based on age. Eye. 2021 Feb;35(2):676-81.
19. Adler G, Shahar J, Kesner R, Rosenfeld E, Fischer N, Loewenstein A, Kurtz S. Effect of pupil size on biometry measurements using the IOLMaster. American Journal of Ophthalmology. 2015 May 1;159(5):940-4.
20. Cheng HC, Hsieh YT. Short-term refractive change and ocular parameter changes after cycloplegia. Optometry and Vision Science. 2014 Sep 1;91(9):1113-7.
21. Arriola-Villalobos P, Díaz-Valle D, Garzon N, Ruiz-Medrano J, Fernández-Pérez C, Alejandre-Alba N, García-Feijoó J. Effect of pharmacologic pupil dilation on OLCR optical biometry measurements for IOL predictions. European journal of ophthalmology. 2014 Jan;24(1):53-7
22. Üçer MB, Bozkurt E, Gökmen H. The Effect of Pupil Dilation on Ocular Biometry Measurements in the Senile Cataractous Eyes. Online Turkish Journal of Health Sciences. 2023 Jan 1;8(1):74-80.
23. Can E, Duran M, Çetinkaya T, Arıtürk N. The effect of pupil dilation on AL-Scan biometric parameters. International ophthalmology. 2016 Apr;36(2):179-83.
24. Rodriguez-Raton A, Jimenez-Alvarez M, Arteche-Limousin L, Mediavilla-Peña E, Larrucea-Martinez I. Effect of pupil dilation on biometry measurements with partial coherence interferometry and its effect on IOL power formula calculation. European Journal of Ophthalmology. 2015 Jul;25(4):309-14.
25. Gupta P, Goyal E, Dokania A. Effect of Pupillary Dilation on Intraocular Lens Power Calculation. JK Science. 2018 Oct 1;20(4):195-7.

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