Original Article

Effect of Pupil Dilation on Ocular Biometric Measurements in High Myopes

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ABSTRACT

Purpose: To determine the effect of pupil dilation on different biometric measurements of eye in high myopes.

Study Design: Descriptive observational study.

Place and Duration of Study: The study was carried out eye out-patient department of Mayo Hospital, Lahore from August 2018 to December 2018.

Methods: We recruited 72 (144 eyes) young, non-cataractous myopes of -6 diopters or more (mean spherical equivalent -7.41 ± 1.35) and age above 15 years (range 15 – 38 years). Sampling was based on non-probability convenient sampling whereas those with any ocular pathology and history of surgery were excluded. Biometric measurements were taken with non-contact biometer Len Star (LS900) with Haigis formula used for IOL power calculation, before and after pupil dilation Data was analyzed on SPSS (v25) and *P* < .001 was taken as significant.

Results: Mean axial length (AL) difference between pre- and post-dilation was -0.006 ± 0.17 (p = 0.66), mean central corneal thickness (CCT) difference was -1.70 ± 8.95 (p = 0.024), mean anterior chamber depth (ACD) difference was -0.018 ± 0.04 (p = 0.001), mean lens thickness (LT) difference was 0.001 ± 0.53 (p = 0.81), mean Keratometry difference was 0.0013 ± 0.14 (p = 0.91), mean white to white (WTW) difference was 0.003 ± 0.01 (p = 0.67) and mean IOL power difference was 0.000 ± 0.22 (p = 1.00). Bland Altman plots were drawn to indicate the 95% limits of agreement between pre- and post-dilation measurements.

Conclusion: There was a statistically significant difference between pre and post dilation measurements of ACD but no clinically significant change was noted in IOL power calculations indicating that pupil dilation does not affect the biometric measurements.

Key Words: Biometry, Len Star, Myopia, Axial length, Anterior chamber depth.

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INTRODUCTION

Intraocular lens (IOL) implantation is one of the most frequent procedures performed on eye. The success of this procedure depends largely upon accurate biometric measurements. The modernization of ocular biometry has progressed the cataract surgery into refractive cataract surgery where in the surgeon can customize the refractive outcomes of the surgery. In order to achieve desired results, it is very important that accurate IOL power be calculated.

Optical biometry has now replaced acoustic biometry. Len Star (Haag Streit), a non-contact optical biometer, uses the principle of optical low coherence reflectometry (OLCR) and provides with one click, repeatable and accurate measurements of axial length (AL), anterior chamber depth (ACD), keratometry, central corneal thickness (CCT), lens thickness (LT), white to white (WTW) distance.[1] Studies have shown good agreement between both gold standard IOL Master and Len Star with no clinically significant

differences in their measurements.[2,3] Len Star, also used in current research, has all IOL power calculation formulas built into its system and has the capability to incorporate future generation of such formulas and hence a reliable instrument for biometry.

It is well known that anterior chamber depth increases in high myopes and it is also known that ACD is altered with pupil dilation[4,5] which leads to the idea that there is a difference in IOL power calculations made with and without pupil dilation. Since dilation causes the lens to relax its accommodation, the lens flattens and moves backward, hence deepening the anterior chamber and since anterior chamber is already deep in myopic eyes, so a significant increase may be expected in ACD measurements post-dilation. e.g., one study reported significant change in ACD post-dilation whereas another study reported a change in keratometric readings after dilation.[6,7] An Indian study, however, concluded with a decrease in AL, CCT, LT and increase in ACD in pediatric sample.[8]

Our study intends to explore the effect of pupil dilation on biometric parameters in high myopes owing to the fact that there are several factors that influence IOL power calculation which when calculated for lower errors may be ignored and that highly myopic eyes when operated for cataract often result in hyperopic post-op error. So, an appropriate IOL power calculation must be done in order to achieve desired post-operative refraction.

METHODS

We included 144 eyes of 72 high myopes with spherical equivalent of -6Ds or above and mean spherical equivalent of -7.411 ± 1.355 (range -6Ds to -12Ds). Mean age was 23.81 ± 7.058 (range 15 – 38 years). Forty (56%) out of total subjects were males and 32 (44%) were females.

This study was carried out at the eye department of Mayo Hospital Lahore, Pakistan from August to December 2018. The subjects were enrolled based on non-probability convenient sampling. All patients underwent refraction and complete ocular examination to rule out any ocular (including cataract and pathological myopia) and systemic diseases. Institutional review board (IRB) granted approval before the study could be started. The subjects/ guardians who agreed to be a part of the study were requested to sign the consent form.

The biometric measurements were obtained on Len Star (LS900, software Eyesuite^{TM} IOL, V4.2.1), a non-optical biometer. The drug used for dilation was cyclopentolate 1% whereas the IOL power calculation was done with Haigis formula which is suitable for eyes with longer axial lengths.[9,10] Dilatation was considered achieved with at least a 4mm difference between dilated and non-dilated pupil.

RESULTS

All biometric measurements: AL, CCT, ACD, LT, keratometry, WTW and IOL power were measured three times consecutively before and after pupil dilation and the average measurements were recorded for analysis. IOL power calculations were done with Haigis formula with A constant as 118.30. The data was entered and analyzed on IBM SPSS (version 25.0) for Windows. Descriptive analysis was performed on all individual variables followed by comparative analysis using *paired t*-test (Table 1). Bland Altman scatter plots were used to establish limits of agreement (LoA) between measurements taken before and after pupil dilation (Figure 1). $P < .001$ was taken as significant. The results showed that there was no statistically significant difference between the pre dilation and post dilation measurements of axial length, CCT, keratometry, WTW and lens thickness as presented in Table 1. Only ACD presented with a statistically significant increase on post-dilation measurements with p-value as 0.001.

Table 1: *Comparative analysis of biometric parameters*

	Variable	Pre-Dilation Mean ± SD	Post-Dilation Mean ± SD	Mean Difference ± SD	P-Value
1.	Axial Length	25.92 ± 1.09	25.99 ± 1.09	-0.006 ± 0.17	0.66
2.	Central Corneal Thickness	528.13 ± 33.04	529.83 ± 33.06	-1.70 ± 8.95	0.024
3.	Anterior Chamber Depth	3.66 ± 0.311	3.67 ± 0.300	-0.018 ± 0.04	**0.001**
4.	Lens Thickness	3.44 ± 0.28	3.44 ± 0.27	0.001 ± 0.53	0.815
5.	Keratometry (average)	45.07 ± 1.09	45.07 ± 1.08	0.0013 ± 0.14	0.910
6.	White to White Distance	11.99 ± 0.35	11.99 ± 0.34	0.003 ± 0.01	0.581
7.	Intraocular Lens Power	11.72 ± 2.67	11.72 ± 2.64	.000 ± 0.22	1.00

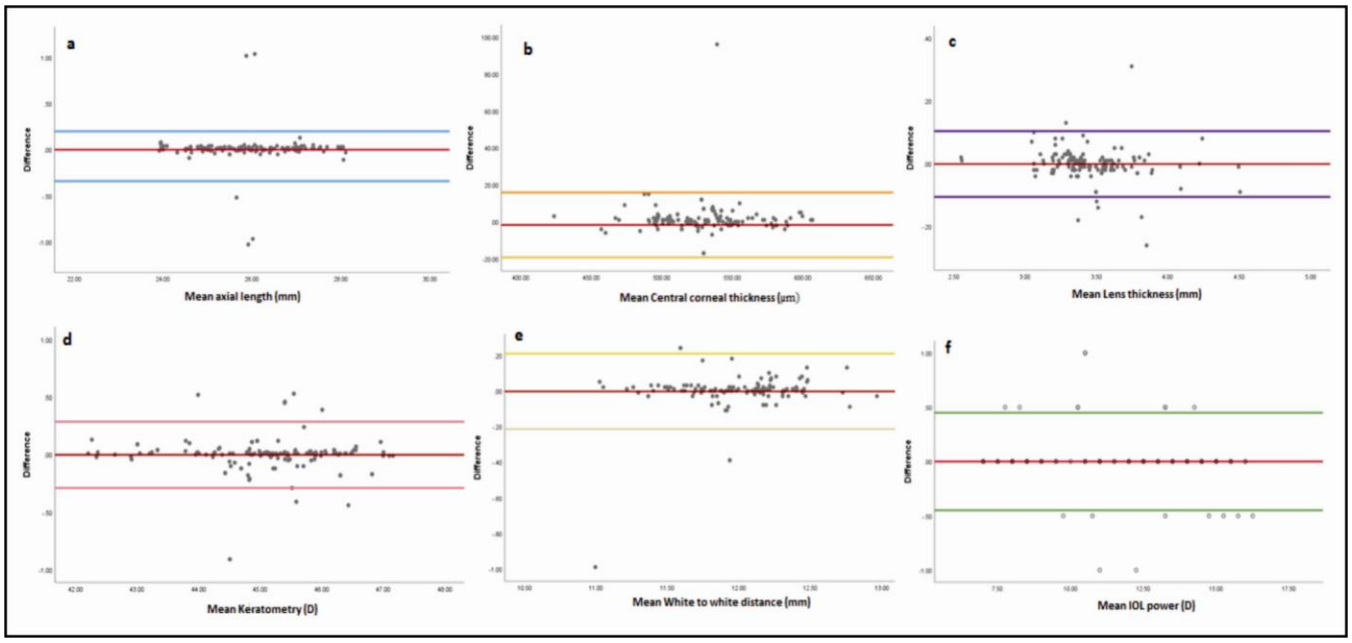

Figure 1: Bland Altman plots for limits of agreement between pre and post- dilation biometric parameters: Graphs (a-e) indicate good agreement between both measurements.

Table 2: C*omparison with different studies on ocular biometry taken with and without pupil dilation*

Device used	Our Data Len Star	Babbak et al[21] Len Star	Arriola-Villalobos et al[22] Len Star	Huang et al[23] Len Star
Sample size	144 eyes	24 cases 22 controls	72 eyes	43 eyes
Age	23.81 ± 7.05	61.9 ± 8.4	74.71± 7.53	22.1 ± 4.7
Dilating agent	Cyclopentolate	Tropicamide	Tropicamide	Tropicamide + phenylephrine
AL mm	-0.006 ± 0.17 p=0.66	-0.04 ± 0.23 p = 0.313	0.0035 ± 0.018 p = 0.102	0.00 ± 0.02 P = 0.427
CCT	-1.70 ± 8.95 p=0.024	NSA	1.125 ± 5.454 p=0.084	NSA
ACD (mm)	-0.018 ± 0.04 ***p<0.001****	-0.05 ± 0.04 ***p<0.001****	0.048 ± 0.032 ***p<0.001****	-0.06 ± 0.07 ***P < 0.01****
LT (mm)	0.001 ± 0.53 P = 0.81	NSA	−0.00125 ± 0.055 p= 0.847	NSA
Median K (D)	0.0013 ± 0.14 P = 0.91	p = 0.006	0.033 ± 0.247 p = 0.261	0.02 ± 0.15 p = 0.34
WTW (mm)	0.003 ± 0.01 P = 0.67	NSA	NSA	0.10 ± 0.17 ***P = 0.001****
IOL power	0.000 ± 0.22 P = 1.00	Change of 0.5D in 9.1% of cases	Holladay II -0.006 ± 0.33, p = 0.869 SRK/T -0.05 ± 0.28, p = 0.128	***P = 0.008****
Formula used	Haigis	SRK/T	SRK/T, Holladay II	SRK/T, Holladay 1, Hoffer Q, Haigis
Refractive error	High myopia	No specifications Cataractous eyes	No specifications Cataractous eyes	Low, moderate and high myopia

NSA: no statistical analysis/variable not part of study.
**Indicates significant results*

DISCUSSION

Optical biometry is a very useful method of biometry and surgeons rely on this method except in the cases where there is central and dense cataract where only acoustic biometry can be done. It has been reported that Len Star and partial coherence interferometry

(PCI) based IOL Master can be used interchangeably because Len Star provides as accurate measurements as IOLMaster.[1,11]

Calculation of IOL power depends upon accurate measurements of keratometry and axial length as well as IOL power calculation formula and any change in these parameters will produce considerable change in refractive results.[12] Wang et al evaluated the accuracy of IOL formulas for prediction of IOL power and reported that all formulae provide similar accurate outcomes but Haigis predicted the best post-operative refraction for long eyes.[13] Haigis is also most sensitive to changes in post-operative refractive changes.

The results of our study (Table 1) indicated no effect of pupil dilation on AL, CCT, LT, keratometry, WTW and IOL power which suggests that measurements taken with or without dilation are interchangeable. While the LT, in our study doesnot change, studies have reported decrease in LT with pupil dilation.[14,15] Another research reported changes in WTW post-dilation.[16] The increase in ACD, in our study, could be attributed to the backward movement of the iris-lens plane during dilation. An increase in depth of anterior chamber with dilation has also been reported in many studies.[17,18] The results of our study also agree well with published evidence that pupil dilation produces statistically significant change in ACD measurements.[19,20] The results can also be compared with other studies as shown in Table 2.[21-23] There is, however, little evidence available related with the refractive error. The IOL power remains unaffected to the changes in ACD.

Bland Altman plots (Figure 1) illustrate the 95% limits of agreement between biometric measurements taken before and after pupil dilation with mean plotted against x-axis and difference plotted on y-axis. As recommended, the data on the resulting scatter plot must lie within ± 1.96 of mean difference.[24] For figure 01, the graphs ***a-e*** display that most of the scatter points lie within the prescribed limit of Bland Altman analysis hence indicating no change in biometrics after dilation. The graph ***f*** shows that although some points lie outside of upper and lower limits but the difference is clinically insignificant and less than 0.5DS therefore producing no effect on final IOL power calculation. There was no respective graph plotted for ACD for Bland Altman plotting cannot be done if the results/p-value of a variable is significant,[25] which in our case was 0.001 for ACD.

This study only evaluated high myopic eyes with no comparison made to low/moderate myopes, hyperopes and emmetropes to establish the effect of dilation on biometrics of eyes. Another limitation is the lack of effective sample size as well as comparison between children, adults and elderly and cataractous eyes. These limitations, hence, provide proposals for further research into this matter.

CONCLUSION

It is recommended that Haigis formula/any formula with ACD measurements incorporated within it, must be used to calculate IOL power to avoid any post-op refractive surprises especially in eyes with longer axial lengths. It is also advisable to mention whether the measurements were taken with or without pupil dilation in order to eliminate any possible change in predicted IOL powers.

Ethical Approval

The study was approved by the Institutional review board/ Ethical review board **(209-RC/KEMU/).**

Conflict of Interest

Authors declared no conflict of interest.

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Authors' Designation and Contribution

Nida Haider; Refractionist: *Concepts, Design, Data acquisition, Data analysis, Statistical analysis, Manuscript preparation, Manuscript editing, Manuscript review.*

Nighat Parveen; Refractionist: *Concepts, Design, Data acquisition, Manuscript editing, Manuscript review.*

Sadaf Rani; Refractionist: *Design, Literature search, Data acquisition, Manuscript preparation, Manuscript review.*

Sarfraz Hussain Anwar; Refractionist: *Literature search, Data acquisition, Manuscript editing, Manuscript review.*