



Predictive Value of Anterior Segment Parameters for Post-op Anterior Chamber Depth after IOL Implant

A uthor's Affiliation

Sohail Sarwar

Uzma Sattar

Shaheer Suhail Sarwar

Mohammad Ali Sadiq

Asad Aslam Khan

Correspondence Author:

Correspondence to:

Dr. Sohail Sarwar

Assistant Professor

Diagnostic Ophthalmology

College of Ophthalmology &

Allied Vision Sciences (COAVS)

Objective: This study was conducted to predict the post-operative anterior chamber depth depending on pre-operative parameters.

Methods: 50 patients coming in Mayo hospital with lenticular changes underwent biometry for intraocular lens power calculation. By using keratometer, K-readings of the cornea and by using A-scan, the axial length (AL) of the eyeball, anterior chamber depth and crystalline lens thickness measured while the patient laying in supine position. Then measured the IOL power using the SRK-II formula. After cataract surgery, again measured the anterior chamber depth by using A-scan to see any change in the depth of the anterior chamber and the effect of various ocular parameters.

Results: Pre-operative anterior chamber depth (pre-ACD) mean was 2.98 ± 0.42 mm. Post-operative anterior chamber depth (Post-ACD) was 4.41 ± 0.40 mm. The change was statistically significant with $p < 0.001$ (Paired sample t-Test). The mean increase of ACD was 1.43 ± 0.28 mm ranging from 0.21 to 2.26 mm. The parameter that showed significant correlation with the post-ACD was pre-ACD with $r^2 = 0.62$ and anterior segment length (ASL) with $r^2 = 0.4$. Other parameters do not influence post-ACD much.

Conclusion: This study proposes following regression formula to calculate post-ACD, preoperatively. $\text{Post-ACD} = 4.14 + 1.13 * \text{Pre-ACD} + 0.38 * \text{LT} - (0.02 * \text{WTW} + 0.42 * \text{ASL} + 0.17 * \text{Kavg})$



Introduction:

Accurate measurement of intraocular lens power calculation in cataractous eyes is crucial for achieving the postoperative uncorrected visual acuity. For the measurement of IOL power, cornea is very important in ocular system.¹

Corneal radius of curvature can be measured by various devices most of which measure the curvature of anterior surface of cornea by assuming that anterior surface of cornea act as a convex mirror. Anterior chamber depth is also very important in IOL power calculation. The volume of anterior chamber and depth changes with advancing age and it is also affected by the refractive error in eye.²

In eyes with lenticular changes, the calculated power of intraocular lens is also affected by the depth of anterior chamber. Depth of anterior chamber also affects the IOL positioning in cataractous eye. Pre-operative deep anterior chamber will result in deep post-operative anterior chamber. Depth of anterior chamber is also related with the anterior segment length. Deep anterior chamber results in more anterior segment length. Thickness of crystalline lens, which is a biconvex structure located directly behind the pupil in the posterior chamber, also affects the anterior segment length. The shape and size of crystalline lens is determined by factors depending upon whether the eye is used under photopic or scotopic vision or in air or water.³ Lens thickness increases with increasing age due to multiple factors.⁴ Axial length and lens thickness are inversely related i.e. with increasing lens thickness, axial length of eye decreases and there is a positive correlation between AL and anterior chamber depth in cataractous eye i.e. with increasing anterior chamber depth, axial length increases.⁵

To calculate the IOL power for IOL implantation in an eye having cataract, it is necessary to know all the parameters of the optical system of the eye such as anterior chamber depth, White-to-white (WTW) corneal distance and crystalline lens thickness.⁶ Anterior to posterior length of eyeball, horizontal and vertical diameters, corneal horizontal and vertical (white to white) diameters and posterior pole to limbus distances all are required to measured accurately in some situations.⁷

Aims and Objectives:

The aim of the study was to find the relationship of keratometry, pre-op anterior chamber depth, lens thickness, anterior segment length, WTW distance of cornea in predicting the post-operative anterior chamber depth. The results of this study would indirectly influence in predicting correct IOL power to be implanted. Hypothesis of this study was that Post-ACD depends on corneal curvature, pre-op

anterior chamber depth, anterior segment length, crystalline lens thickness and WTW corneal distance.

Materials and Methods:

Inclusion criteria were individuals of different age groups, male and female both included and patients with lenticular changes going for cataract surgery. Exclusion criteria were patients with all types of ocular and systemic pathologies except for cataract. Dependent variable was post-op anterior chamber depth and Independent variables were central corneal thickness, corneal diameter (WTW), lens thickness, anterior segment length, and AL. Place of study was eye department, Mayo hospital, Lahore, associated with College of Ophthalmology and Allied Vision Sciences. The study was done from July to September 2013. Population of the study was patients coming at Mayo hospital OPD. Non-probability convenient sample of 50 eyes were taken. Study design was cohort. Automated Keratometer and contact ultrasound based A-scan was used. Data was analyzed in SPSS and correlation and regression was used to predict dependent variable.

Results:

According to this study, pre-op anterior chamber depth is directly related with the post-op anterior chamber depth.

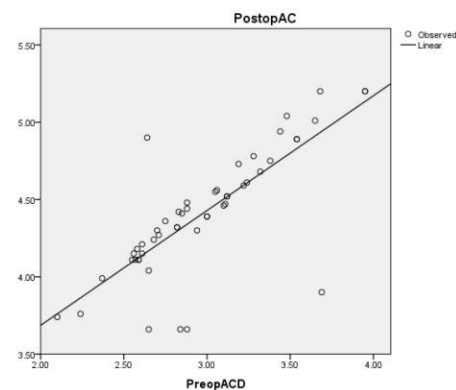


Figure 1: Relation of pre-op anterior chamber depth with post-op anterior chamber depth. There exists a positive correlation. With deep pre-op anterior chamber depth, post-op anterior chamber depth also increases.

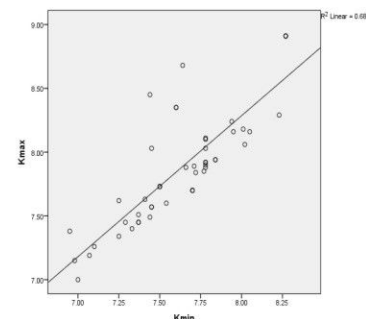


Figure 2: Relation of K_{max} with K_{min} , with increase of K_{max} value, K_{min} value also increases

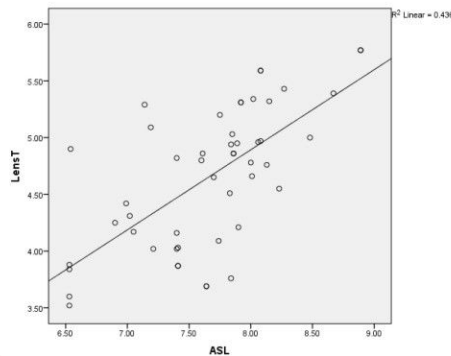


Figure 3: more the crystalline lens thickness, more is the anterior segment length

Discussion:

In this study various anterior segment parameters i.e. pre-operative anterior chamber depth, crystalline lens thickness, white to white corneal distance are related with the post-operative anterior chamber depth. In literature, various studies have performed about the effect of anterior segment parameters i.e. corneal radius of curvature, white to white distance of cornea, crystalline lens thickness on the anterior chamber depth (pre and post operatively). One study was done by Aarhus Kunehospital, Aarhus and Denmark in University Eye Clinic. They investigated methods to predict the effective postoperative anterior chamber depth (ACD). They recorded the postoperative anterior chamber depth after cataract surgery and then studied the calculated ACD by multiple linear regression for covariance with a number of various defined variables which includes the AL measurement by ultrasonography, anterior chamber depth postoperatively, crystalline lens thickness, radius of curvature of cornea by keratometry, subjective refraction, age of patient, and corneal white to white distance. They noticed that the after the cataract surgery, ACD was significantly correlated with 6 preoperative variables i.e. AL of eyeball, preoperative ACD, keratometry readings of cornea, crystalline lens thickness, refraction and patient age. They concluded that the anterior chamber depth is correlated and can be predicted by 5 variable regression method which include the preoperative AL of eyeball, ACD, keratometry readings of cornea, crystalline lens thickness and refraction as the most significant and important variable.⁸ In another, the accuracy of IOL power calculation by using the SRK II formula was studied in cataractous eyes with posterior chamber IOL implant. The result was, the SRK II formula is inaccurate for myopic eyes or very long eyes, and this requires that new formulas are needed, by taking into account the other factors that contribute in dioptric power of eye.⁹ Another study was

done to predict the formula for IOL power calculation according to the AL of the eyeball. These formulas were SRK-II, Binkhorst-II, Hoffer Q, and Holladay y SRK/T. according to the AL (AL). According to that study, for small eyes (<22 mm) the Binkhorst-II and Hoffer Q formulas provided the best predictive results, whereas in long eyes (>28 mm) the SRK/T is the most accurate for IOL calculation.¹⁰ In a previously done study, the SRK/T formula for IOL calculation was analyzed. As for the prediction algorithm for the "optical anterior chamber depth" was taken into account, it was shown that there is a critical value for the corneal radius of curvature which marks the onset of a non-physiologic formula behavior. Within the algorithmic framework of the SRK/T formula, it was found that corneal curvature was solely dependent on the AL of eyeball. However, clinically, the effect of this insufficiency of the SRK/T formula was not of great importance. A check has shown that on biometry base only 4 out of 1000 patient were affected.^{11,12}

In this study, pre-ACD, corneal WTW distance, crystalline lens thickness, and ASL is measured via using keratometer and A-scan and then studied. Then measured the anterior chamber depth after intraocular lens implantation and relate the post-operative anterior chamber depth with various anterior segment parameters. According to this study, pre-op anterior chamber depth is negatively co-related with crystalline lens thickness and IOL power and is positively correlated with anterior segment length, total length and post-operative anterior chamber depth. WTW corneal distance is negatively co-related with lens thickness, anterior segment length, K_{max} , K_{min} and IOL power and is positively co-related with pre-ACD, post-ACD and AL of the eyeball. Lens thickness is negatively co-related with pre-op anterior chamber depth, WTW corneal distance, K_{min} and AL and post-op anterior chamber depth and is positively co-related with IOL, ASL and K_{max} . ASL is negatively co-related with WTW distance, K_{max} , K_{min} and AL and is positively co-related with pre-ACD, lens thickness, IOL power and with post-ACD. K_{max} is negatively co-related with WTW corneal distance and ASL and is negatively co-related with pre-ACD, lens thickness, K_{min} , AL, IOL power and post-ACD. K_{min} is negatively co-related with WTW corneal distance, lens thickness, ASL and post-ACD and is positively co-related with pre-ACD, AL and IOL power. AL of eyeball is negatively co-related with lens thickness, ASL and post-ACD and is positively co-related with pre-ACD, WTW corneal distance, K_{max} , K_{min} and post-ACD. IOL power is negatively co-related with pre-ACD, WTW corneal distance, AL and post-ACD and is positively co-related with lens thickness, anterior segment length, K_{max} and K_{min} . Post-ACD is negatively co-related with lens thickness, K_{min} and IOL power and is positively co-related with pre-ACD, WTW corneal distance, anterior segment length, K_{max} and AL of the eyeball. For the prediction of post-op anterior chamber



depth, the relationship between various anterior segment parameters is found by linear regression. According to this, $PostACD = 4.14 + 1.13*PreACD + 0.38*LT - (0.02*WTW + 0.42*ASL + 0.17*K_{avg})$

Here 4.14 is a constant. Since the factor of WTW distance is very small, so tried to ignore this factor by subtracting this factor from constant value and then compared the results with and without ignoring WTW distance factor by independent sample t-test. The results showed significant difference between two ($p < 0.05$) which means that we can't ignore the WTW distance factor from the predictive formula.

Recommendation:

The change in the depth of anterior chamber after cataract surgery and within bag IOL implant can be predicted pre-operatively by using the formula based on various anterior segment variables.

$$PostACD = 4.14 + 1.13*PreACD + 0.38*LT - (0.02*WTW + 0.42*ASL + 0.17*K_{avg})$$

PostACD = post-operative anterior chamber depth, PreACD = pre-op anterior chamber depth, LT = lens thickness, WTW = horizontal white to white corneal distance, ASL = ASL and K_{avg} = average corneal radius of curvature

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