Discrepancy between Actual and Theoretical Anterior Chamber Depth in Patients with Morcher Posterior Chamber Intraocular Lens

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Abstract

Purpose: Cataract surgery is the most common ocular surgery worldwide and in modern era of phacoemulsification with posterior chamber intraocular lens (PC IOL) implantation, refractive aspects of surgery is as important as the surgery itself. After the IOL implantation, the anterior chamber depth (ACD) is increased and the iridocorneal angle is widened. These changes should be considered for accurate IOL selection. In this study we evaluated the actual ACD following implantation of Morcher foldable PC IOL and compared it with the predicted depth.

Methods: In a cross-sectional analytic study, ninety four cataractous eyes were operated with standard phacoemulsification and a foldable PC IOL (Morcher Bio Com Fold Type 93 IOL) was implanted. ACD, axial length (AL), refraction, and visual acuity were checked before and 3 months after the surgery.

Results: ACD after the surgery was significantly increased, but it was smaller than the predicted depth (5.61 mm). Best corrected visual acuity (BCVA) after the surgery was significantly improved. There was a myopic trend in postoperative refraction.

Conclusion: ACD after cataract surgery combined with Morcher Bio Com Fold type 93 lens was different from the predicted depth and this made most patients myopic.

Keywords: Anterior Chamber Depth, Cataract Surgery, Intraocular Lens

Introduction

Cataract surgery is the most common ocular surgery worldwide. In phacoemulsification the cataractous lens is extracted after the lens is crushed by the ultrasound waves and then suctioned out of the capsule and foldable intraocular lens (IOL) is implanted in the capsule.\(^1\) Nowadays, with the phacoemulsification technique combined with posterior chamber intraocular lens (PC IOL) implantation, refractive aspects of surgery is as important as the surgery itself. In addition to smooth surgical procedure, optimal spectacle-free vision in postoperative period relies on proper preoperative IOL calculation. After the implantation, the anterior chamber depth (ACD) is increased and the iridocorneal angle is widened.\(^2\) These changes should be considered for accurate IOL selection. The IOL is designed to be implanted in a new ACD. Manufacturers suggest a theoretical ACD for calculating the desired IOL power for each IOL design; hence, achieving postoperative emmetropia depends on accurate estimation of postoperative ACD.\(^3\) In Iran, like other Middle Eastern and European countries, Morcher company’s IOLs and other products are marketing and have official agents. In our experience and despite using similar biometric and IOL calculation protocols, patients implanted with Morcher Bio Com Fold type 93 IOL were more likely to become myopic in the immediate postoperative period than patients implanted with other brands. In this study we investigated the actual ACD and axial length (AL) before and after the implantation of Morcher Bio Com Fold type 93 IOL and compare it with the theoretical ACD as a possible culprit for the refractive surprise.

Methods

In a cross-sectional analytic study, we evaluated biometric data of cataract patients before and after surgery. The study subjects were selected among patients presenting to the anterior segment clinic of Khatam-al-Anbia Eye Hospital, a tertiary referral hospital in North-East of Iran. The inclusion criteria were senile cataract, age between 40 and 85 year old, good cooperation for accurate ultrasonic biometry and compliance for adequate follow-up. Patients with AL less than 21 mm or more than 25 mm, complicated surgical procedures, history of previous ocular surgeries including keratorefractive surgeries, corneal scars, or haziness of ocular media were excluded. Written or oral informed consent was obtained from all participants. The study strictly adhered to the Tents of Declaration of Helsinki and the protocol was approved by the Ethical Committee of Mashhad University of Medical Sciences.

Visual acuity of the patients was tested by Snellen acuity chart. For keratometric evaluation, a Topcon KR8800 autokeratorefractometer (Topcon, Tokyo, Japan) was used. ACD and AL were measured using an A-mode ultrasonic biometer (Optikon 2000 Biometer; Bioline S.p.A, Rome, Italy). The IOL power was calculated using Sanders-Retzlaff-Kraff (SRK) II and Holladay formulas. A single expert optometrist performed all of the measurements. Patients underwent standard phacoemulsification and the Morcher Bio Com Fold type 93s IOL was implanted in the capsular bag. This IOL is a foldable one piece posterior chamber intraocular lens. The IOL has a haptic angulation of 10 degrees. Its optic diameter is 6.00 mm and overall diameter is 14.00 mm. One surgeon (A.D.) performed all of the operations using a standard divide and conquer surgical technique. In summary, after creation of a temporal 3.2 mm clear corneal incision, the anterior chamber was inflated with viscoelastic device and a central capsulorhexis of approximately 5mm was made. After removing the cataractous lens, the IOL was implanted in the capsular bag and the surgery was terminated sutureless. Three months after the surgery best corrected visual acuity (BCVA), keratometric data, ACD and AL were rechecked.

Data are presented as mean±standard deviation (SD). Kolmogorov-Smirnov test was used to test the normal distribution. Paired T-test and correlation coefficient were used for data with normal distributions. Wilcoxon Signed Ranks test was used in instance of non-normal distribution. All statistical tests were two-tailed and a statistical significance level of 0.05 was adopted. All statistical analyses were performed using SPSS version 13 (SPSS Inc., Chicago, IL, USA).
Results

Ninety-four subjects were enrolled during study period. There were 50 male patients (53.2%) in the study. Mean age of the included patients was 69.4±12.7 years.

ACD, AL and BCVA were measured before and after surgery. The data are summarized in table 1.

Kolmogorov-Smirnov test is used to test the normal distribution of the ACD, AL, and BCVA before and after the surgery. AL and ACD before and after the surgery had a normal distribution; however BCVA had not a normal distribution, neither before nor after the surgery.

ACD was significantly increased from a preoperative value of 3.05±0.88 mm to 3.68±1.04 mm after surgery (P<0.0001) (Figure 1).

The AL was 23.100±1.41 preoperatively and increased to 23.106±1.22 after surgery; although statistically significant, this was not clinically or optically significant (Figure 2).

Obviously and predictably, there was a significant improvement in postoperative BCVA from 0.196±0.466 preoperatively to 0.864±0.344 after surgery (P<0.0001, Figure 3).

The manufacturer suggested a theoretical ACD of 5.61 mm for the Morcher Bio Com Fold type 93s IOL. The actual postoperative ACD in our study was significantly lower (3.68±0.57 mm) which is significantly different both clinically and statistically from theoretical ACD (P<0.0001).

There was no association between postoperative ACD and BCVA (Pearson test, r=0.072, P=0.50). Likewise, there was no correlation between postoperative ACD and AL (r=0.128, P=0.218).

Table 1. Pre and postoperative age, anterior chamber depth, axial length and visual acuity and P-values

<table>
<thead>
<tr>
<th></th>
<th>Preoperative</th>
<th>Postoperative</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>67.55±17.73</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>ACD (mm)</td>
<td>3.06±0.88</td>
<td>3.68±1.04</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>AL (mm)</td>
<td>23.100±1.41</td>
<td>23.106±1.22</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>VA</td>
<td>0.196±0.466</td>
<td>0.864±0.344</td>
<td>&lt;0.001</td>
</tr>
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</table>

ACD: Anterior chamber depth
AL: Axial length
VA: Visual acuity

Figure 1. Anterior chamber depth before and after the phaco
Discussion

Using phacoemulsification technique, the cataractous lens is extracted through a small incision and a foldable PC IOL is implanted.\textsuperscript{1,2} Disturbing the normal eye anatomy during this surgery, the special relationship between remaining eye structures in the anterior segment is obviously altered following surgery. Several studies concerned these changes, especially in patients with angle-closure glaucoma.\textsuperscript{4-6} For calculating IOL
power numerous regression and theoretical formula have been proposed. All of these formulas rely on preoperative biometric parameters to predict optimal IOL power to achieve postoperative emmetropia or desired refraction. Predicting the postoperative IOL position within the eye is crucial for accurate IOL power calculation and many IOL calculation formulas rely on ACD for determining the implant power. In clinical practice we observed that many patients implanted with Morcher Bio Com Fold PCIOL have mild degrees of myopia following uneventful operation and IOL implantation in the capsular bag. A possible explanation would be non-accurate estimation of actual postoperative ACD. However, we could not find any study investigating the actual postoperative ACD following implantation of this specific type of IOL.

In a study, Cho and associates investigated ACD and AL changes on the first day, 13th day and 5th week after phacoemulsification cataract surgery using A-mode ultrasonographic measurements. Based on preoperative AL, patients were classified into four groups. It was concluded that ACD after the surgery increases and AL before the surgery predicts the increment amount. In another study by Alton and colleague, ACD, intraocular pressure (IOP), and Iridocorneal Angle (ICA) before and after the surgery were measured. IOP decreased, ACD increased and ICA was wider and the changes were statistically significant. Cecik and associates, prospectively studied ACD and IOP after uncomplicated phacoemulsification surgery and IOL implantation in 56 patients. IOP and ACD were measured before the surgery and one week, one month, three months, six month and nine month after the procedure. The peak of ACD and the lowest point of IOP were measured on the third month after the surgery. At the end of the study it was concluded that the IOP decreased and ACD increased after phacoemulsification. In a comprehensive study, Hayashi and associates evaluated variations of ACD after implantation of IOL in glaucomatous eyes. Seventy seven angle closure glaucomatous (ACG) eyes, 73 open angle glaucomatous (OAG) eyes and 74 control eyes without previous history of glaucoma or ocular hypertension were undergone phacoemulsification surgery. The patients were evaluated on the first week and 1, 3, 6, 9, and 12 months after the surgery. Before the surgery angles in ACG patients were narrower than OAG or control patients. Although after the operation angle became wider in all groups, in ACG it was less than other groups. IOP in all groups decreased significantly.

Pereira and Cronemberger evaluated ACD and iris-lens angle using Ultrasound Biomicroscopy (UBM) in patients undergoing phacoemulsification. It was concluded that iris diaphragm is pushed backward, the angle become approximately 10 degrees wider and ACD increased 850 micron following the surgery. To the best of our knowledge, this is the first study investigating the discrepancy between theoretical “effective” ACD and actual ACD following phacoemulsification and Morcher Bio Com Fold type 93s IOL implantation. Although a discrepancy between theoretical ACD suggested by manufacturers and actual ACD is predictable and discussed previously in details, the discrepancy is much more than expected in our study. Oslen showed that the postoperative ACD is predictable based on several preoperative variables, most importantly including preoperative AL and ACD. Holladay and Maverick calculated the relationship between actual thick lens position within the eye and presumed thin lens position used in IOL calculation formula. According to the calculation for an average IOL power of 21.19 diopters with a lens thickness of 1 mm, the lens is located approximately 0.10 mm anterior to same power thin IOL. This is much less than the mean difference of 1.93 mm found in our study between actual and presumed ACD and we think that the difference could not be explained based on the presumption of a thin lens during IOL manufacturing and prediction of ACD and A constant. This could be a reason for refractive surprise found in patients implanted with Morcher Bio Com Fold type 93 s IOL. As the IOL position is more anteriorly and farther from nodal point, the effective lens power is increased and a myopic shift in patient is expected. This is in accordance with our clinical experience of myopic shift in patients implanted with this type of Morcher IOL.
We measured anatomical ACD and did not include corneal thickness in our analysis. However, assuming a mean central corneal thickness of 0.55 mm, the difference with optical ACD would not explain the discrepancy.

**Conclusion**
In conclusion, we found a mismatch between proposed theoretical ACD and actual postoperative ACD in patients implanted with Morcher Bio Com Fold 93 s PC IOL. This could induce significant refractive error in patients and considering the results for adjusting IOL power would improve surgical outcome and spectacle-independence.

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**References**