Ten Years Follow-Up of Aphakia Treatment by a Foldable Posterior Chamber Intraocular Lens Implantation into the Anterior Chamber

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Abstract

Purpose

To report the 10 years’ results of aphakia treatment by a foldable posterior chamber intraocular lens (PCIOLs) implantation into the anterior chamber.

Methods

Retrospective observational case series. Patients who underwent implantation of foldable PCIOLs in the AC with the haptics passing through two iridectomies to the posterior chamber were studied. Preoperative and postoperative refractive status, postoperative corneal astigmatism, lenticular astigmatism, and complications were recorded. Anterior chamber depth (ACD) was detected by ultrasonic biomicroscopy (UBM).

Results

Fifty-one eyes of 51 patients were included in the study. Of these eyes, 21 eyes were examined at 10 years postoperatively. The mean preoperative corrected distance visual acuity (CDVA) was 1.06 ± 0.68 logMAR and postoperative was 0.49 ± 0.44 at 1 year (p < 0.01); 0.49 ± 0.44 (p < 0.01) at 2 years; and 0.45 ± 0.39 (p < 0.01) at 10 years. The mean lenticular astigmatism was 0.96 ± 0.78 D. Glaucoma in 11 eyes, retinal detachment in 3 eyes, cystoid macular edema in 6 eyes, corneal decompensation in 11 eyes, and haptic dislocation in 7 eyes were observed. The mean distance between the IOL and the endothelium was 3.03 ± 0.29 mm.

Conclusions

Advantages of our technique are lack of a need for special design lenses and surgical equipment, small learning curve, and faster surgical time. This technique is a practical alternative that leads to favorable visual outcomes and is comparable to the complications of other techniques in the eyes with the absence of capsular support.

Introduction:

The intraocular lens (IOL) may not be inserted into the bag in patients with the absence of capsular support who have had ocular trauma, complicated cataract surgery, or metabolic or hereditary conditions (such as Marfan syndrome or pseudo-exfoliation syndrome). Many more studies have described various techniques for IOL implantation in the absence of capsular support.[1–5] Anterior chamber (AC) IOL can be implanted in such cases however surgeons are unable to use ACIOLs in young patients or patients with glaucoma, uveitis, shallow anterior chambers, or endothelial dysfunction.[1, 6] Because of these
limitations of ACIOLs in treating aphakia, the scleral fixation technique was used in the absence of capsular support. However, in this technique longer operative time, late-term IOL dislocation, and suture erosion were reported in previous studies.[6, 7] A technique in which the end of the haptic is cauterized to form an end-bulb flange to fixate in the sclera was published. However, a strong, flexible haptic is needed, not all brands of 3-piece PCIOLs are recommended for use with this technique.[5, 8] A PCIOL in the AC with the haptics passing through two iridectomies to the posterior chamber implantation technique firstly has been described by Kükner et al. in 2014. 33 eyes of 33 patients with inadequate posterior capsular support were operated on by this technique and postoperative results were reliable.[9] Our study aimed to report the ten years results of a PCIOL in the AC with the haptics passing through two iridectomies to the posterior chamber implantation technique in cases of absence of capsular support.

**Methods:**

This retrospective analysis comprised 51 eyes of 51 patients who underwent implantation of foldable PCIOLs in the AC with the haptics passing through two iridectomies to the posterior chamber in the Sakarya University Training and Research Hospital between October 2009 and June 2012. Of these eyes, 21 eyes of 21 patients were examined at 10 years postoperatively. All operations were performed by the same senior surgeon (G.A).

Approval for the study was obtained from the Ethical Committee of Sakarya University Faculty of Medicine. The study conformed to the tenets of the Declaration of Helsinki. All participants agreed to participate in the study, and a written informed consent form was obtained from each participant.

Age, gender, cause of failed intracapsular implantation, preoperative and postoperative corrected distance visual acuity (CDVA), intraocular pressure (IOP), gonioscopy, postoperative corneal astigmatism, lenticular astigmatism, and complications were recorded for each patient. Pigment dispersion was graded as no, mild, and moderate in the gonioscopic examination. Lenticular astigmatism values were calculated through vector analysis. Anterior chamber depth (ACD) was detected by UBM in all eyes (Fig. 1).

**Surgical Technique**

The procedures were performed under topical anesthesia. An anterior vitrectomy was performed and acetylcholine (Miostat®0.01, Alcon, USA) was injected into the AC for miosis. The vacuum level of the vitrectomy was set to 50–100 mmHg and the frequency to 50 cuts/min. Two iridectomies were performed on the mid-peripheral iris with a vitrectomy cutter at the 6 and 12 o’clock positions. Single-piece foldable PC IOLs were implanted in the AC with the haptics passing through two iridectomies to the PC (Fig. 2).

**Statistical Analyses**
Statistical analyses were performed with IBM SPSS ver. 24 (IBM Corp., Armonk, NY, USA). The Wilcoxon test was used to compare dependent variables. To compare categorical variables with quantitative variables, ANOVA was used for data that showed normal distribution, and the Kruskal–Wallis H test was used for data that did not conform to normal distribution; in the case of differences, paired comparisons with post hoc tests were performed. A p-value of less than 0.01 was statistically significant.

Results:

The mean age of the 28 men and 23 women was 70.98 ± 9.16 years. Table 1 shows the demographic data of patients. The most common reason for cause of failed intracapsular implantation was complicated cataract surgery (35 eyes, %68,6), the second one was cataract surgery after trauma (11 eyes, 21,6%), and the third one was spontan IOL dislocation (5 eyes 9,8%). The mean follow-up period was 74.45 ± 38.7 months.

The mean preoperative CDVA was 1.06 ± 0.68 logMAR, the postoperative CDVA was 0.49 ± 0.44 at 1 year (p < 0.01); 0.49 ± 0.44 (p < 0.01) at 2 years; 0.50 ± 0.42 (p < 0.01) at 3 years and 0.45 ± 0.39 (p < 0.01) at 10 years. While the CDVA significantly increased at all postoperative visits compared to the baseline however no statistically significant difference was found among the CDVA levels at different follow-up visits (Table 2).

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eyes (N)</td>
<td>51</td>
</tr>
<tr>
<td>Right, n (%)</td>
<td>25 (49)</td>
</tr>
<tr>
<td>Left, n (%)</td>
<td>26 (51)</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
</tr>
<tr>
<td>Female, n (%)</td>
<td>28 (54,9)</td>
</tr>
<tr>
<td>Male, n (%)</td>
<td>23 (45,1)</td>
</tr>
<tr>
<td>Age (years)</td>
<td></td>
</tr>
<tr>
<td>Mean ± SD</td>
<td>70,98 ± 9,16</td>
</tr>
<tr>
<td>Range</td>
<td>36</td>
</tr>
<tr>
<td>Reason for surgery, n (%)</td>
<td></td>
</tr>
<tr>
<td>Complicated cataract surgery</td>
<td>35 (68,6)</td>
</tr>
<tr>
<td>Trauma</td>
<td>11 (21,6)</td>
</tr>
<tr>
<td>Spontan IOL dislocation</td>
<td>5 (9,8)</td>
</tr>
</tbody>
</table>
Table 2

Follow-up times and post-op visual acuity

<table>
<thead>
<tr>
<th>Follow-up time (Number)</th>
<th>Mean ± SD (min-max)</th>
<th>p* value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline (51)</td>
<td>1.06 ± 0.44</td>
<td></td>
</tr>
<tr>
<td>1 year (51)</td>
<td>0.49 ± 0.44</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>2 years (51)</td>
<td>0.49 ± 0.44</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>3 years (41)</td>
<td>0.50 ± 0.42</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>10 years (21)</td>
<td>0.45 ± 0.39</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

* Wilcoxon test

The mean corneal astigmatism was calculated to be $-2.42 \pm 1.37$ D (range $-6.00$ D to 0.50 D) and vector analysis showed lenticular astigmatism to be $0.96 \pm 0.78$ D (range $0.25$ D to 3.25 D). Of 51 eyes, 14 eyes (27.40%) had a postoperative lenticular astigmatism of > 1.00D, and 8 eyes (15.60%) had a postoperative lenticular astigmatism of > 2.00D. There was a significant difference between the etiological groups ($p < 0.001$), patients with traumatic aphakia had higher lenticular astigmatism values than the two other groups of patients (Table 3).

Pigment dispersion was not observed in 28 (54.9%) eyes. Mild dispersion in 15 (29.4%) eyes and moderate dispersion in 8 (15.7%) eyes were observed. Uveitis in 6 (11.8%) eyes and mild endothelial guttata in 17 (33.3%) eyes, postoperative glaucoma in 11 (21.6%) eyes, and mild iris atrophy in 14 (27.5%) eyes were seen. There was not a significant correlation between the angle pigmentation and glaucoma progression or iris atrophy ($p > 0.01$).
Table 3

<table>
<thead>
<tr>
<th>Correlation between etiology of aphakia and lenticular astigmatism</th>
<th>Mean ± SD</th>
<th>p* value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complicated cataract surgery</td>
<td>0.63 ± 0.45</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Trauma</td>
<td>1.96 ± 0.76</td>
<td></td>
</tr>
<tr>
<td>Spontan IOL dislocation</td>
<td>0.62 ± 0.24</td>
<td></td>
</tr>
</tbody>
</table>

* Anova test (post hoc)

Correlation between the results and complications

<table>
<thead>
<tr>
<th>p* value</th>
</tr>
</thead>
</table>
| Angle pigmentation- glaucoma progression                      | 0.20
| Post-op ACD (3.03 ± 0.29 mm)- corneal decompensation          | 0.72
| Haptic dislocation and corneal decompensation                 | 0.15

* Kruskal-Wallis Test

The distance between the IOL and the endothelium was 3.03 ± 0.29 (2.21-3.61) mm on average by UBM. There was not a significant difference between the etiological groups (p > 0.01). Corneal decompensation was seen in 11 eyes (21.6%) in long-term follow-up. There was a not statistically significant difference between the postoperative ACD and corneal decompensation (p = 0.72) however of 11 eyes, 6 eyes (11.7%) had ACD of < 3.00 mm. Haptic dislocation of the iridotomies into the AC was observed in 7 (13.7%) eyes. Of 7 eyes, IOL was not sutured to the iris in 6 eyes (11.7%). Haptic was resutured to the iris with a 10/0 nylon suture. Mild pupil distortion occurred in 6 (11.7%) eyes. There was not a significant difference between the haptic dislocation and corneal decompensation (p = 0.15) (Table 3).

In terms of other complications, transient hemorrhage occurred in 11 (21.5%) eyes during the iridectomies. Hyphema in these eyes resorbed in the first postoperative week without sequelae. Retinal detachment (RD) was seen in 3 (5.9%) eyes and were successfully operated on with the pars plana vitrectomy technique, using silicone oil tamponade. Cystoid macular edema (CME) was observed in 6 (11.8%) eyes, only one eye was treated with intravitreal dexamethasone others were consequently treated with topical drugs (Table 4).
Table 4
Postoperative complications

<table>
<thead>
<tr>
<th>Post-op complication</th>
<th>Number (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Haptic dislocation</td>
<td>7 (13.7%)</td>
</tr>
<tr>
<td>Uveitis</td>
<td>6 (11.8%)</td>
</tr>
<tr>
<td>Endothelial guttata</td>
<td>17 (33.3%)</td>
</tr>
<tr>
<td>Corneal decompensation</td>
<td>11 (21.6%)</td>
</tr>
<tr>
<td>Pupil distortion</td>
<td>6 (11.7%)</td>
</tr>
<tr>
<td>Pigment dispersion</td>
<td>27 (52.9%)</td>
</tr>
<tr>
<td>Transient hemorrhage</td>
<td>11 (21.5%)</td>
</tr>
<tr>
<td>Cystoid macular edema</td>
<td>6 (11.8%)</td>
</tr>
<tr>
<td>Retinal detachment</td>
<td>3 (5.9%)</td>
</tr>
</tbody>
</table>

**Discussion:**

The first choice in IOL implantation is in-the-bag implantation. If the posterior capsule is insufficient, IOL can be placed in the sulcus if the capsule rim is available. [3, 10] If the remaining capsule does not offer sufficient support for the IOL implantation, the surgeon may choose one of the following options: an AC IOL, an iris-claw IOL, an iris-sutured IOL, a PC iris-sutured IOL, a scleral-fixated IOL. [1–5, 8, 11] Each of these methods are safe and effective but shows procedure-specific limitations. So, surgeons must make a complex decision on the surgical technique that is best, based on their expertise, each patient’s ocular condition, and the available access to necessary operating room equipment and time, weighing all the potential patient risks and benefits.

In this study, CDVA statistically significantly increased at all postoperative visits compared to the baseline. Mean postoperative logMAR CDVA is comparable to other studies on ACIOL, SFIOL and iris fixated IOL.[7, 12–16] Aphakic eyes have a high refractive error, and the refractive correction is difficult, the higher spherical aberration of the spectacle lenses limits the preoperative levels of CDVA so that preoperative CDVA is inaccurately low. IOL implantation closer to the nodal point helps decrease the optical aberrations, resulting in significant improvements in visual acuity.

Ocular astigmatism can occur because of unequal curvature along the two principal meridians of the anterior and posterior cornea of the front and back surfaces of the crystalline lens, or decentration or tilting of the intraocular lens.[17] In this study, the mean postoperative corneal astigmatism was $-2.42 \pm 1.37$ D. The mean IOL-induced astigmatism was found $0.96 \pm 0.78$ D using the vector analysis method. In our study patients with traumatic aphakia (21.60%) had higher lenticular astigmatism values than the other groups. So that, in the long-term follow-up, 15.60% of the eyes had lenticular astigmatism higher
than 2.00D. However, according to these results, our technique is comparable to other studies in terms of IOL-induced astigmatism.[2, 7, 18]

Suturing to the iris can increase the pigment dispersion and the risk of uveitis, and chronic inflammation. Most studies reported less than 5% of eyes with postoperative uveitis[1] However, one study reported being higher at 7.7% with iris-claw IOLs.[19] Dadaya et al. reported 20% chronic uveitis in the AC IOL implantation group compared with 0% in the scleral-sutured PCIOL group.[20] Another comparison study reported opposite findings, with 1.1% chronic uveitis in the ACIOL group and 5.4% in the scleral-sutured PCIOL group.[12] It is not clear whether ACIOL implantation causes more uveitis. In our study moderate pigment dispersion was seen at 15.7%, mild iris atrophy was seen at 27.5%, and chronic uveitis was seen at 11.8%. Compare to previous studies chronic uveitis was seen higher rate in our study, this may be due to iridectomy and excess pigment dispersion.

Corneal decompensation has been a theoretical concern with ACIOL placement since they were first introduced. Many also argue that ACIOL surgery results in increased endothelial cell count loss.[21, 22] However, this point is controversial, surgical trauma, in general, results in endothelial cell count loss rather than specifically the implanted ACIOL.[23] Mahapatra et al. reported that no patient developed corneal decompensation in ACIOL implantation,[15] In our study. Mean ACD was measured at 3.03 ± 0.29 mm. Corneal decompensation was seen in 11 eyes (21.6%) in long-term follow-up. Although there was a not statistically significant difference between the postoperative ACD and corneal decompensation. Of 11 eyes, 6 eyes (11.7%) had ACD of < 3.00 mm. The main limitation of our study is we did not determine corneal endothelial cell count to look for endothelial decompensation. However, if the patient has ACD of < 3.00 mm, corneal decompensation may develop in our IOL implantation technique. Although there was not a significant correlation between the haptic dislocation and corneal decompensation, if the haptic dislocation occurs, IOL may touch the endothelium and corneal decompensation may develop. So that, one haptic must be sutured to the iris for stabilization.

CME range from 0–28% was reported in previous studies with all types of IOLs.[1] The highest rate of CME (28%) was in a study of iris-sutured IOLs.[24] Todorich et al. reported a 21% rate of CME in intrascleral haptic fixation PCIOLs.[25] In our study, the CME rate (1.8%) was comparable to previous studies.

Eyes with disruption of the vitreous are at risk for detachment. The presence or absence of vitreous removal at the time of surgery may impact the risk of retinal detachment. The highest rates of retinal detachment occurred in the scleral-sutured studies (4.2%-8.2%). However, iris sutured PCIOLs, not attached near the vitreous base, showed significant rates (0.5%-5.5%) of retinal detachment. Iris claw IOL and ACIOL studies showed the lowest rates of retinal detachment at 0–1%. [1] In our study, the rate of RD (5.9%) was comparable to previous studies.

Although AC IOLs are easily implanted, corneal complications at are a higher rate because of the corneal endothelium's proximity.[26–28] Scleral-fixated IOLs implantation is difficult, and extensive experience is required to perform the technique.[29, 30] Iris-claw IOLs may be a good alternative; however, higher costs
By implanting a PC IOL in the AC via two iridectomies, the optics and haptics of the IOL are placed in positions far from the corneal endothelium. Haptic dislocation may be due to large iridectomies or inappropriate positions of opposed iridectomies. If iridectomies are done with an appropriate position and size, IOL stabilization is good without sutures. However, IOL dislocation can easily be overcome by suturing the haptic into position.

The major limitation of our study is we did not assess corneal endothelial cell count pre-postoperatively and the retrospective nature. However, its greatest strengths are the long follow-up period (10 years).

**Conclusions:**

Advantages of our technique are lack of a need for special design lenses and surgical equipment, small learning curve, and faster surgical time. This study suggested that the applied technique is a practical alternative that leads to favorable visual outcomes and comparable the complications to other techniques in the eyes with the absence of capsular support.

**Declarations:**

**Funding**

The authors declare that no funds, grants, or other support were received during the preparation of this manuscript.

**Competing Interests**

The authors have no relevant financial or non-financial interests to disclose.

**Author Contributions**

All authors contributed to the study's conception and design. Material preparation, data collection, and analysis were performed by Ali Altan Ertan Boz and Mahmut Atum. The first draft of the manuscript was written by Erkan Çelik. Operations were performed by Gürsoy Alagöz. All authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

**Ethics approval**

This study was approved by the ethics committee of the Sakarya University Medical Faculty and tenets of the Declaration of Helsinki were followed.

No conflict of interest.

**References:**


**Figures**

(A) Patient who underwent implantation of foldable PCIOLs in the AC with the haptics passing through two iridectomies to the posterior chamber anterior segment photo and (B) Same patient's gonioscopic examination for pigment dispersion. (C) Ultrasonic biomicroscopy image of the anterior chamber.
Figure 2

Surgery technique (A) Inadequate capsular support was seen after complicated cataract surgery. (B) A 2,8 mm main incision was made at 11 o'clock. (C) An anterior chamber was filled with viscoelastic material. (D) Anterior vitrectomy was performed using a 20-gauge probe. (E-F) Two iridectomies were created at the 6 and 12 o'clock positions using the same probe at 50-100 mmHg vacuum. (G) Foldable posterior chamber intraocular lens was implanted anterior chamber. (H-I) IOL was centralized.