Effects of Capsulotomy Methods on Posterior Capsule Opacification after Cataract Surgery

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Abstract

Purpose: To determine the effect of anterior capsulotomy methods on posterior capsule opacification (PCO) after cataract surgery.

Settings: Department of Ophthalmology, Iran Medical Sciences University, Tehran, Iran.

Patients and methods: 314 eyes were examined retrospectively following intraocular lens implantation within the capsular bag between February 1991 and December 1999. Patients were divided into 2 groups according to anterior capsulotomy techniques. Envelop capsulotomy and continuous curvilinear capsulorhexis (CCC) patients were followed for 6-94 (mean 42) months.

Results: Posterior capsule opacification developed in 57 of 314 eyes. The distributions of PCO were 40 of 168 eyes (23.8%) in envelope capsulotomy and 17 of 146 eyes (11.6%) in CCC. Posterior capsule opacification occurred significantly less ($X^2$P<0.005) in the patients who had an anterior capsulotomy with CCC compared to envelope capsulotomy. Hazard of occurring PCO was significantly greater in envelope than CCC group (log. rank, p=0.004).

Conclusion: CCC decreases the incidence of PCO compared to envelope capsulotomy.

Key words: Cataract surgery, anterior capsulotomy, posterior capsule opacity

Introduction

One of the most common complications following planned extracapsular cataract extraction (ECCE) is opacification of the intact posterior capsule. This complication has been shown to develop in as many as 50% of adult cases and occurs in nearly all pediatric cases. Two mechanisms are involved in the development of PCO following ECCE: The first involves migration of equatorial lens epithelial cells (LECs) onto the posterior capsule with subsequent Elschnig pearl formation. The second involves metaplasia of migrated LECs into myofibroblastes with subsequent induction of fibrosis and posterior capsule contracture. Studies have suggested a host of contributing factors in the development of secondary membranes following cataract surgery. These include age, cataract type, intraocular lens (IOL) design, method of lens fixation, Glaucoma, hypertension, and diabetes also have been implicated.

Anterior capsulotomy is one of the most critical steps in extracapsular cataract extraction. Secure long-term capsular fixation and centration of a posterior chamber IOL can best be achieved if the integrity of the central opening is maintained.

There are several methods to perform the anterior capsulotomy: can opener capsulotomy in which multiple, small tears are connected to create large, central opening; Envelope capsulotomy in which a horizontal slit allows removal of lens substance and PC-IOL implantation, this procedure protects the corneal endothelium. Circular continuous capsulorhexis (CCC) in which a smooth-edged circular opening without serration is made by a tearing motion with a bent cystotome or forceps. The main rationale for this technique is to preserve the integrity of the capsulotomy margin and to reduce the propensity for radial tear formation and subsequent decentration of the IOL. In this study, the effects of envelope capsulotomy and CCC on the incidence of PCO were compared in patients who had ECCE with capsular bag IOL implantation by one surgeon.

Patients and Methods

This study was conducted by reviewing the 567 eyes which underwent planned extracapsular cataract extraction and capsular bag IOL implantation at the department of ophthalmology of Rasoul-Akram & Day Hospital, Iran Medical Science University, Tehran, Iran between February 1991 and December 1999 (94 months).

Patients who did not have previous eye surgery or ocular diseases were over 45 years old and had senile cataract including the posterior subcapsular, cortical and nuclear cataract types were entered in this study. Visual acuity, keratometry, slit lamp examination, intraocular

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pressure, B-scan ultrasonography, fundus examination, intraocular lens power calculation with biometric measurement and systemic examination were performed preoperatively for all patients. The method of anterior capsulotomy was selected randomly, 6-7mm CCC or envelope technique which consists of making a superior slit in anterior capsule at papillary margin through which the cataractous lens substance is extracted and IOL was implanted in the bag. Then by forceps and scissors anterior capsulotomy is completed by capsulorhexis 6-7mm in size.

All these patients were followed for at least 6 months. The surgical technique was as follows: 3mm posterior to limbus, 3 step scleral flap incision[13], (approximately 80-120 degree) was made superiority. Viscoelastic material (Sodium hyaluronate 1%) was instilled in the anterior chamber before either the CCC or envelope capsulotomy. After hydrodissection the cataract was removed by the extra capsular technique and one piece PMMA IOL with 6-7mm optical and 13mm diameter implanted within the capsular bag. Postoperative subconjunctival 40mg of gentamycin and 3mg of betamethasone was given in all cases.

The appropriate patients entered in this study were divided into two groups:
Group 1: patients who underwent envelope capsulotomy
Group 2: patients who underwent CCC.

Patients were post-operatively followed on third & fifth day, then in second week, first, third, sixth and twelfth months & subsequently each year. Examinations comprised visual acuity, autorefractometry, slit-lamp examination, intraocular pressure measurement and fundus.

Patients with decreased visual acuity were evaluated for other pathologies whether or not they had posterior capsule opacification. Grading of PCO was done according to slit lamp findings, clarity of the fundus view and extent of visual acuity decrement.4
Grade 1: Opacification was absent or slight. Fundus was seen clearly, visual acuity decrease was absent or 1 Snellen.

Grade 2: Mild opacification. Fundus wasn’t seen clearly, visual acuity decreased 2-3 Snellen line.

Grade 3: Milk white opacification. Fundus wasn’t seen, visual acuity decreased by 4 or more Snellen line.

Grade 2 and 3 patients were evaluated according to the interval between cataract surgery, PCO, and anterior capsulotomy technique. Statistical analysis of categorical variable was done by Chi-Square method. Cumulative hazard of PCO was calculated using Kaplan-Meier analysis and comparison between groups was done by log rank test.

Results
Gender distribution and mean ages of cases are shown in Table 1. No statistical difference was found in the distribution of age and sex among the groups (p>0.05).
All patients were followed for at least 6 months. Follow-up intervals of the patients were in the range of 6 to 92 months, mean of 42 months. There was no significant difference among groups for the follow-up time (p>0.05) (Table 2).

Table 1: Gender distribution & mean patient’s ages

<table>
<thead>
<tr>
<th></th>
<th>Group 1</th>
<th>Group 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>91 (54.1%)</td>
<td>77 (52.7%)</td>
</tr>
<tr>
<td>Male</td>
<td>77 (42.9%)</td>
<td>69 (47.3%)</td>
</tr>
<tr>
<td>Mean Age ± SD</td>
<td>168</td>
<td>146</td>
</tr>
<tr>
<td>Total</td>
<td>66.7±3.12</td>
<td>64.2±2.77</td>
</tr>
</tbody>
</table>

Chi-square: p>0.05

Table 2: The classification of patients according to follow-up period

<table>
<thead>
<tr>
<th>Months</th>
<th>Group 1</th>
<th>Group 2</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>6-12</td>
<td>36 (21.4%)</td>
<td>31 (21.2%)</td>
<td>67 (21.3%)</td>
</tr>
<tr>
<td>13-48</td>
<td>64 (38.1%)</td>
<td>75 (51.4%)</td>
<td>139 (44.3%)</td>
</tr>
<tr>
<td>49-94</td>
<td>68 (40.5%)</td>
<td>40 (27.4%)</td>
<td>108 (34.4%)</td>
</tr>
<tr>
<td>Median</td>
<td>37</td>
<td>35</td>
<td>36</td>
</tr>
<tr>
<td>Mean*</td>
<td>42.7</td>
<td>40.8</td>
<td>41.8</td>
</tr>
<tr>
<td>Total</td>
<td>168</td>
<td>146</td>
<td>314</td>
</tr>
</tbody>
</table>

*Chi-square: p>0.05

57 cases (18.2%) of PCO here were detected among 314 cases. The distribution of these groups according to capsulotomy technique can be found in Fig.1.
Group 1: 40 of 168 patients (23.8%) had PCO.
Group 2: 17 of 146 patients (11.6%) had PCO.
Among the 57 cases with PCO, 40 (70.2%) had anterior capsulotomy with the envelope technique and 17 (29.8%) with CCC. The difference was statistically significant (Chi-square P<0.005) between these groups.
I found a mean time to PCO formation of 16.3 months, with 17.0 months in group 1 (envelope) and 15.2 months in group Types of capsulotomy variation over time in both groups is shown in Fig.2. Hazard of occurring PCO was significantly greater in envelope comparing to CCC group (log rank P=0.0044). Probability of persistent capsular transparency in both groups is shown in Fig.3.


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The concepts of barrier effect and "no space, no cells" still play a role and relate to IOL manufacture and design. The generic group of capsular IOLs are effective in providing a symmetrical stretch on the posterior capsule if implanted in the capsular bag, especially after CCC. By direct mechanical effect, in-the-bag implantation causes less PCO formation as contact of the IOL with the posterior capsule prevents further investigation of lens epithelial cells. Blood aqueous barrier breakdown and inflammation caused by uveal friction in IOLs with sulcus fixation. However, in-the-bag lens implantation was used in all our cases.

In the present study, patients who underwent capsulectomy were not included. Envelope capsulotomy and CCC were performed in groups 1 and 2 respectively. Consequently, capsulotomy techniques were compared. In patients with PCO, 23.5% had capsulotomy with the envelope technique and 11.4% had the CCC technique. This difference was statistically significant (P<0.005).

Continuous curvilinear capsulorhexis (CCC) has become the preferred method of anterior capsulotomy because of its apparent advantages. The absence of
capsular bag preserves the capsular bag and allows stable in the bag IOL fixation. Furthermore, it decreases the rate of PCO associated with in-the-bag IOL implantation. There are three reasons, why this technique appears to be the best type of anterior capsulotomy to decrease the overall incidence of PCO: 1- long-term stable in-the-bag PC-IOL fixation and centration, 2-cortical cleanup is enhanced when combined with hydrodissection, 3-the adhesion between edge of the anterior capsular flap and posterior capsule may prevent in growth of retained epithelial cells into the visual axis.

Recently, complications of CCC have been reported, these include a capsular bag distension from the IOL optic occluding the circular anterior capsule opening. IOL dislocation into the vitreous after Neodiniyum: YAG laser posterior capsulotomy, a string to Eishaing pearls around the YAG laser posterior capsulotomy and progressive constriction of the anterior capsule opening. The envelope technique is like a two-step capsulorhexes. The main advantages of this technique were the ability to insert and retain the IOL in the capsular bag because of the easily visible edges of the anterior capsulotomy that provided ample haptic support after the IOL was inserted, and protection of the corneal endothelium during cortical substance removal provided by the abundant remaining anterior capsule. This technique does not provide the completely smooth capsular edge of a CCC. The capsular bag preserves the capsular bag and allows stable in the bag IOL fixation. Furthermore, it decreases the rate of PCO associated with in-the-bag IOL implantation. There are three reasons, why this technique appears to be the best type of anterior capsulotomy to decrease the overall incidence of PCO: 1-long-term stable in-the-bag PC-IOL fixation and centration, 2-cortical cleanup is enhanced when combined with hydrodissection, 3-the adhesion between edge of the anterior capsular flap and posterior capsule may prevent in-growth of retained epithelial cells into the visual axis.

The can opener technique has a high risk of radial tear, increased trauma and irregular capsulotomy with inadequate IOL centralization and increased incidence of PCO. The patients who had can-opener capsulotomy were not included in this study. The interval between surgery and opacification also varies widely. Wilhelmus and Emery reported an average opacification time of 26 months after surgery, with a range from three to four years. Dungel et al. reported the average time to the onset of opacification following cataract extraction was 27.6 months. We have found that the most opacification occurred during the period of 3-18 months with a mean of 16.3 months (15.2 months in group 1, 17.0 months in group 2). There is evidence of an early peak in the incidence of opacification within one year of ECCE, probably attributable to insufficient clean up of the posterior lens capsule.

There is an age related tendency toward PCO formation. In general, the older patients, the lower is the incidence of PCO. Which is why in this study only cases over 45 years of age were evaluated to minimize the effects of age on PCO. The continuing improvement of ECCE technique has decreased the incidence of lenticular epithelial hyperplasia leading to PCO. It is also clear that although a large anterior capsulotomy can be performed, the remaining anterior epithelium, at least in younger patients, has strong proliferative capabilities. As a result, the presence of a smooth anterior capsule edge after capsulotomy may result in less PCO development after cataract surgery.

Acknowledgement
I gratefully acknowledge Dr. Bahrami for his help in reviewing the statistical analysis.

References
