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ORIGINAL ARTICLE

EFFECT OF TWO CAPSULOTOMY METHODS ON POSTERIOR CAPSULE OPACIFICATION AFTER CATARACT SURGERY

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Abstract

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

Methods-A total of 314 eyes was examined retrospectively following intraocular lens implantation within capsular bag between February 1991 and December 1999. Patients were divided into two groups according to anterior capsulotomy techniques, envelope capsulotomy and continuous curvilinear capsulorrhexis (CCC). Patients were followed up for 6 to 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. Occurance of posterior capsule opacification in anterior capsulotomy group with CCC was less than envelope capsulotomy group (p<0.005). Using log-rank test, the hazard of occurring PCO was significantly greater in envelope than CCC group (p=0.004).

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

Keywords • Cataract surgery • anterior capsulotomy • posterior capsule opacity

Introduction

One of the most common complications following planned extracapsular cataract extraction (ECCE) is opacification of the posterior capsule.[1-4]

This complication has been shown to develop in as many as 50% of adult cases and occurs in nearly all pediatric cases.[1-6] 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 myofibroblasts with subsequent induction of fibrosis and posterior capsule contracture.[2,7-9]

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, and method of lens fixation. Glaucoma, hypertension, and diabetes also have been indicated.[1-3]

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: 1) can-opener capsulotomy in which multiple, small tears are connected to create a large, central opening; 2) envelope capsulotomy in which a horizontal slit allows removal of lens substance and PC-IOL implantation. This type provides protection to the corneal endothelium during the procedure; and 3) circular continuous capsulorrhexis (CCC) in which a smooth-edged circular opening without serration is made by a

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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.[2,10-12]

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 undertaken by reviewing the 567 eyes who underwent ECCE and capsular bag IOL implantation at the Department of Ophthalmology at Rasoul-e-Akram and Day Hospitals, Tehran, Iran, between February 1991 and December 1999 (94 months).

A total of 314 patients who did not undergo previous eye operations, did not have ocular diseases, were over 45 years old with senile cataract including posterior subcapsular, cortical and nuclear cataract types were assigned to the study.

Visual acuity, keratometry, slit-lamp examination, intraocular pressure, B-scan ultrasonography, fundus examination, intraocular lens power calculation with biometric measurement and systemic examination were done prior to operation for all patients. The method of anterior capsulotomy was selected randomly (6-7 mm CCC or envelope technique), which consists of making a superior slit in anterior capsule at the pupillary margin through which the cataractous lens substance is extracted and IOL implanted in the bag. Then, with forceps and scissors, anterior capsulotomy was completed by capsulorrhexis, 6-7 mm in size. All these patients were followed up for at least 6 months.

The surgical technique was as follows: 3 mm posterior to the limbus, 3-step scleral flap incision[13], (approximately 80-120°) was made superiorly. Viscoelastic material (sodium hyaluronate 1%) was instilled in the anterior chamber before CCC or envelope capsulotomy. After hydrodissection, the cataract was removed using extracapsular technique and a piece of polymethylmethacrylate IOL with 6-7 mm optical and 13 mm diameter was implanted within the capsular bag. Gentamicin 40 mg and betamethasone 3 mg were given subconjunctively in all cases after the operation.

The appropriate patients were accepted to the study and divided into two groups: Group 1 and group 2 included patients who underwent envelope capsulotomy and CCC, respectively.

Patients were followed up at postoperative third and fifth days, second week, first, third, sixth and twelfth months and then annually. Examinations comprised of visual acuity, autorefractometry, slit-lamp examination, intraocular pressure measurement and funduscopy. 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 decrease in visual acuity:[14]

Opacification was absent or slight (grade 1): fundus was seen clearly and visual acuity decrease was absent or 1 Snellen line.

Mild opacification (grade 2): fundus wasn't seen clearly, visual acuity decreased by 2 or 3 Snellen lines.

Milky white opacification (grade 3): fundus was not seen and visual acuity decreased by 4 or more Snellen lines.

Grade 2 and 3 patients were evaluated according to the interval between cataract surgery, PCO and anterior capsulotomy technique.

Statistical analysis of categorial 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 age 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 up for at least 6 months. Follow-up intervals of the patients were in the range of 6 to 92 months with an average of 42 months. There was no significant difference among groups for the follow-up time ($p>0.05$).

Fifty-seven cases (18.2%) of PCO were

Table 1. Sex distribution and age of patients.

	Group 1 (%)	Group2 (%)
Female	91 (54.1)	77 (52.7)
Male	77 (42.9)	69 (47.3)
Total	168	146
Age ± SD	66.7 ± 3.12	64.2 ± 2.77

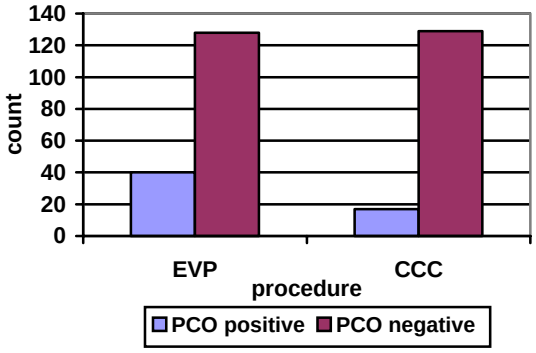

Figure 1. Distribution of patients with PCO among group 1 and 2 according to capsulotomy technique (p<0.005).

detected among 314 cases. The distribution of these groups according to capsulotomy technique is shown in Figure 1. In group 1, 40 of 168(23.8%) patients had PCO, while in group 2, 17 of 146 (11.6%) patients had PCO.

Among the 57 cases with PCO, 40 (70.2%) had anterior capsulotomy with the envelope technique and 17 (29.8%) with CCC. Using Chi-square test, the difference was statistically significant between these groups (p<0.005).

Mean time of formation of PCO was 16.3 months (17.0 months in group 1 and 15.2 months in group 2). PCO formation over time in both groups is shown in Figure 2. Hazard of occurring PCO was significantly greater in envelope comparing to CCC group (log rank test p=0.0044). Probability of persistent capsular transparency in both groups is shown in Figure 3.

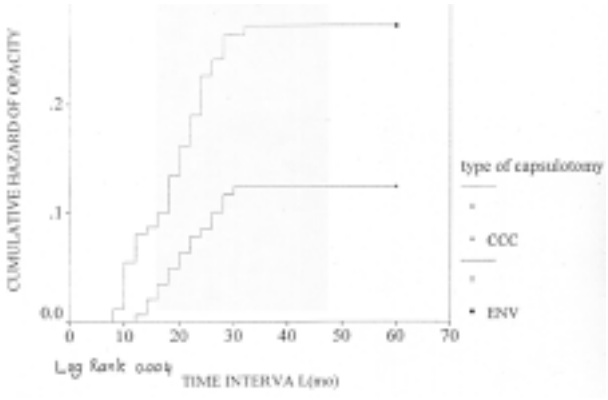

Figure 2. Observed cumulative probability of PCO after extracapsular cataract extraction with two different techniques (p=0.004).

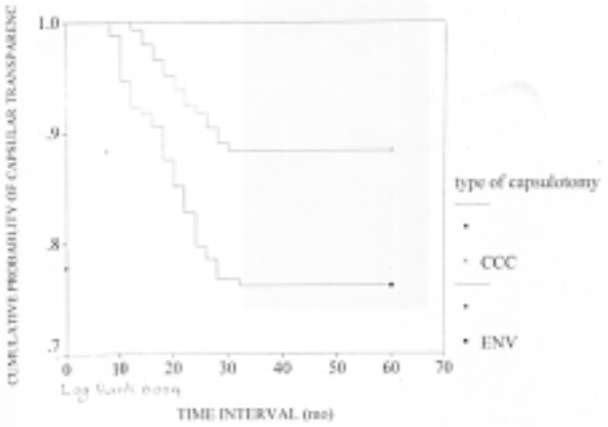

Figure 3. Observed cumulative probability of persistent capsular transparency with two different techniques. (p=0.004)

Discussion

Posterior capsule opacification is a common, significant complication of ECCE with IOL implantation.[6] The clinical implications are that an anterior capsulotomy provides a stimulus for epithelial cell proliferation. Variation in the location of the capsulotomy does not expose cells to greater proliferative potential. Creating a large capsulotomy will not reduce the risk of opacification by decreasing the number of epithelial cells in the eye, as suggested by Green and Mc Donnell.[15] On the contrary, a large capsulotomy, especially if irregular or zigzag as in the can-opener technique, releases a larger area of epithelial cells from contact inhibition. There is thus a theoretical advantage in performing a small capsulotomy or even letterbox capsulotomy as in the endocapsular technique.[9-15]

The concepts of barrier effect and "no space, no cells" still play a role and relate to IOL manufacturing 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.[1,2] By direct mechanical effect, in-the-bag implantation causes less PCO formation, because contact of the IOL with the posterior capsule prevents further investigation of lens epithelial cells. Blood-aqueous barrier breakdown and inflammation are caused by uveal friction in IOLs with sulcus fixation. However, in-the-bag IOL

implantation decreases uveal irritation[1,2,5] and was used in all of our cases.

In the present study, patients who underwent can-opener capsulotomy were not included. Envelope capsulotomy and CCC were performed in groups 1 and 2, respectively. Consequently, capsulotomy techniques were compared between groups 1 and 2. In patients with PCO, 23.8% had capsulotomy with the envelope technique and 11.6% with CCC technique. This difference was statistically significant ($p<0.005$).

CCC has become the method of choice in anterior capsulotomy because of its apparent advantages. The absence of capsular tags 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.[7,16] 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 clean-up is enhanced when combined with hydrodissection, and 3) the adhesion between edges of the anterior capsular flap and posterior capsule may prevent in-growth of retained epithelial cells into the visual axis.[2,4,16,17]

The envelope technique is like a two-step capsulorrhexis. The main advantages of this technique were the ability to insert and retain the IOL in the capsular bag because of the large and easily visible edges of the anterior capsulotomy that provide ample haptic support after the IOL was inserted[18], 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.[2,11,19]

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.[11,19] The patients who had can-opener capsulotomy were not included in this study.

The interval between surgery and opacification also varies widely.[2,3,20,21] Wilhelmus and Emery reported an average opacification time of 26 months after surgery, with a range from three months to four years.[22] Dangel et al reported the average time of onset of opacification following cataract extraction to be 27.6 months.[1] We have found that most opacification occurred during the period of 3-18 months with a mean of 16.3 months (15.2 months in group 1 and 17 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.[4]

There is an age-related tendency toward PCO formation.[20] In general, the older the patients, the lower the incidence of PCO.[22-24] For this reason, only cases more than 45 years of age were evaluated thereby minimizing the effects of age on PCO.[25] Continuing improvement of the ECCE technique has decreased the incidence of PCO due to lenticular epithelial hyperplasia. 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.[23,26]

As a result, the presence of a smooth anterior capsule edge after capsulotomy may result in less PCO development after cataract surgery.

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