Impact of anterior capsular polishing on capsule opacification rate in eyes undergoing femtosecond laser-assisted cataract surgery

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**Purpose:** To evaluate the impact of anterior capsular polishing on capsule opacification and contraction in eyes undergoing femtosecond laser-assisted cataract surgery (FLACS). **Methods:** This prospective interventional comparative analysis included patients undergoing FLACS between August 2016 and May 2017. The eyes were subdivided into three groups based on the extent of intraoperative anterior capsular polishing performed: complete 360-degree polishing; inferior 180-degree polishing; and no polishing. Visual acuity, posterior capsular opacification (PCO) score, anterior capsular opacification (ACO) grade, and capsulorhexis diameter were evaluated at 1-week, 6-months, and 1-year postoperative visits. **Results:** The study included 99 eyes of 90 patients. No significant differences were observed between the three groups in ACO grade and capsulorhexis contraction at all follow-up visits. There was a statistically significant difference in PCO grade among the groups at 6-month and 1-year follow-up but it was found to be clinically insignificant. One eye in the no polishing group underwent neodymium:yttrium-aluminum-garnet (Nd:YAG) capsulotomy at the 1-year follow-up visit. **Conclusion:** A lower incidence of PCO was demonstrated in the 360-degree polishing group, although it was visually insignificant. No significant difference in postoperative capsular contraction was demonstrated between the cohorts up to one-year follow-up.

**Key words:** Anterior capsular polishing, capsular contraction, capsular opacification, femtosecond laser-assisted cataract surgery

Posterior capsular opacification (PCO) is the most common cause of visual loss following uneventful cataract extraction. The proliferation and subsequent migration of the residual equatorial lens epithelial cells (LECs) result in the opacification of the anterior and posterior capsule.\[^1,2^] Moreover, the transdifferentiation into myofibroblasts causes subsequent fibrosis and anterior capsular contraction. The resultant features include decline in visual acuity with loss of contrast sensitivity, and intraocular lens (IOL) tilt or decentration.\[^3^]

Numerous studies have demonstrated the impact of anterior capsular polishing on the incidence of PCO, wherein some authors have demonstrated a reduction in the incidence,\[^4,5^]\ while other studies provide contrary data.\[^2,3,6^]\ However, one of the major limitations in the previous reports is the construct of a manual capsulorhexis with its associated variations in uniform capsular-IOL overlap (affecting IOL centration, tilt, and PCO formation) and capsulorhexis dimensions (affecting extent of capsular contraction). Our study demonstrates the effect of anterior capsular polishing in eyes undergoing femtosecond laser-assisted cataract surgery (FLACS) which enables a well-centered and consistent capsulotomy allowing a 360-degree IOL overlap.\[^7,8^]\  

**Methods**

This prospective interventional comparative analysis was conducted at a tertiary eye care hospital in South India. The study was approved by the local ethics committee and adhered to the tenets of the declaration of Helsinki. Informed consent was obtained from all participants. Patients undergoing FLACS between August 2016 and May 2017 were included in the study. Exclusion criteria were dense corneal or media opacities interfering with imaging and subsequent femtosecond laser delivery, inadequate pharmacomydriasis not allowing construct of a 5 mm capsulotomy, ocular comorbidities affecting visual acuity, traumatic or subluxated cataracts, primary PCO, conditions associated with increased incidence of capsular phimosis including pseudoxfoliation, high myopia, and retinitis pigmentosa and intraoperative complications precluding in-the-bag IOL implantation with adequate centration.

The following investigations were carried out at 1 week, 6 months, and 12 months’ postoperative visit: corrected Snellen’s visual acuity, slit-lamp biomicroscopy and dilated fundus evaluation; intraocular pressure evaluation (Goldmann applanation tonometry); PCO score using slit-lamp examination.

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imaging system (Topcon SL-D701) and EPCO software;\[10\] capsulorhexis diameter measurement using slit-lamp imaging system (Topcon SL-D701) and ImageJ software system;\[10,11\] and contrast sensitivity using ETDRS contrast (Aurochart, Aurolab, India) in both mesopic and scotopic conditions. Anterior capsule opacification (ACO) was graded into four groups based on slit-lamp evaluation (grade 0—no opacification, grade 1—only the edge of capsulotomy is opacified, grade 2—diffuse opacification with folds, grade 3—intense opacification with folds, grade 4—constriction of capsulotomy opening).\[12\]

Surgical technique
All surgeries were performed by a single experienced surgeon (DR) on the Centurion platform (Alcon, USA). The Catalys femtosecond platform (Optimedica, CA, USA) was utilized to construct a 5 mm capsulotomy (centered on the scanned capsule), lens fragmentation, and corneal incisions. The direct chop technique was utilized for emulsification of the prefragmented nuclear segments followed by complete cortical removal. The irrigation and aspiration cannulas (sandblasted) were swiped to achieve complete 360-degree anterior capsular polishing (CP group), inferior 180-degree polishing (IP group), or no polishing (NP group). Based on randomization, eyes were equally divided into three groups using random number tables. Posterior capsular polishing was done in all necessary cases. A single-piece IOL (TecnisZCB00, AMO, USA) was implanted in the capsular bag with a 360-degree capsular overlay.

Postoperative regimen included tapering doses of topical steroids (loteprednol suspension 0.5% w/v), antibiotics (ofloxacin 0.3% drops), and nonsteroidal anti-inflammatory drops (ketorolac tromethamine 0.5%).

Statistical analysis
Descriptive analysis was carried out by mean and standard deviation for quantitative variables, frequency, and proportion for categorical variables. A Shapiro-Wilk’s test (P > 0.05) and a visual inspection of their histograms, normal Q-Q plots, and box plots showed that the ACO and PCO grade (pixels), contrast sensitivity, and capsulotomy diameter parameters were abnormally distributed and were assessed by comparing the median values. Kruskal-Wallis test and Wilcoxon test were used to assess statistical significance. P < 0.05 was considered statistically significant. IBM SPSS version 22 was used for statistical analysis.

Results
A total of 120 eyes were enrolled and equally randomized into three groups. Twenty-one eyes were lost to follow-up at subsequent visits and were excluded from the final analysis. The study included 99 eyes of 90 patients with a one-year follow-up. Among these, 33 eyes (33.33%) underwent complete 360-degree polishing (CP group), 36 eyes (36.36%) underwent inferior 180-degree polishing (IP group), and the remaining 30 eyes (30.3%) underwent no polishing (NP group).

The median age of the patients in all 3 groups was 60 years. Among the 99 eyes, 58 (58.6%) were males and 41 (41.4%) were females. The median preoperative corrected visual acuity in the CP, IP, and NP groups were LogMAR 0.20, 0.25, and 0.20, respectively (P = 0.420).

Visual outcomes
Figs. 1-3 represent the visual outcomes in the three groups. No significant difference was demonstrated in the postoperative median corrected distance visual acuity (CDVA) at all follow-up visits (P = 1, 0.98, and 0.97 at 1 week, 6 months and 1 year, respectively).

Anterior capsular opacification (ACO) grade
Comparison of the ACO grade between the three groups [Fig. 4] demonstrates no statistically significant difference at all follow-ups (P = 0.80, 0.36, and 0.24 at 1 week, 6 months, and 1 year, respectively).

Posterior capsular opacification (PCO)
Table 1 demonstrates the PCO grade (pixels) across the three groups, with significantly higher EPCO grade in the NP group at 6-month (P = 0.01) and at 1-year follow-up (P = 0.01) period. However, this was not clinically significant as no impairment of visual acuity was noted. One eye in the NP group underwent neodymium:ytrrium-aluminum-garnet (Nd:YAG) capsulotomy at 1-year follow-up visit. This was secondary to glare and a loss of contrast in the eye with a multifocal implant, although no loss of CDVA was noted.

Capsular contraction
Intergroup comparison of median vertical, horizontal, and diagonal axes (155 degrees and 45 degrees) diameters [Table 1] showed no statistical difference at all follow-up visits (P > 0.05).

Contrast sensitivity
Intergroup comparison of median light-on high contrast, light-off high contrast, light-on low contrast, and light-off low contrast showed no statistically significant difference at 1st week, 6th month, and 1 year (P > 0.05).

Discussion
The development of postoperative ACO and PCO is considered as a wound healing response of the residual LECs and may be decreased by the removal of these cells.\[15-17\] To date, only mechanical removal of the LECs by anterior lens capsule (ALC) polishing has been used clinically and other physical or pharmacological methods have not found application due to lack of sensitivity and specificity.\[18-21\] The ultrasound irrigation and aspiration tip was found to be the most effective instrument for mechanical polishing.\[22\]

Previous publications demonstrating the effect of anterior capsular polishing on subsequent opacification provide contrarian views. An ex vivo study conducted by Liu and cowokers revealed that anterior capsular polishing removed many LECs but it did not reduce residual cell growth and increased cell proliferation in capsular bag cultures.\[23\] Shah et al. demonstrated no obvious advantage of scraping on ACO development in a cohort of 120 eyes with a 6-month follow-up.\[19\] Similar results were noted by Matthias et al. over a longer follow-up of three years. The study revealed that anterior capsular polishing did not prevent the formation of PCO, on the other hand, it allowed for more regenerative cataract.\[24\]

However, numerous other studies have reported a reduction in the incidence of opacification in eyes that underwent ALC polishing. Bolz et al. demonstrated...
Figure 1: Standard graphs for reporting surgical outcomes following femtosecond laser-assisted cataract surgery (FLACS) with complete anterior capsular polishing (a) cumulative visual acuity, (b) safety, (c) accuracy, (d) spherical equivalent

Figure 2: Standard graphs for reporting surgical outcomes following FLACS with inferior anterior capsular polishing (a) cumulative visual acuity, (b) safety, (c) accuracy, (d) spherical equivalent
Table 1: Comparison of median PCO grade and capsulotomy diameters in the three intervention groups at different follow-up time periods

| Parameter                        | Follow-up period | Polishing | Kruskal-Wallis test (P) |
|----------------------------------|------------------|-----------|-------------------------|
|                                  | Inferior (Median) | 360° (Median) | No (Median) |                      |
| PCO score (Pixels)               | 1 week            | 0.00      | 0.00                    | 0.00                   | 0.368                  |
|                                  | 6 months          | 0.012     | 0.00                    | 0.014                  | 0.010                  |
|                                  | 1 year            | 0.018     | 0.00                    | 0.019                  | 0.019                  |
| Capsulotomy diameter (Pixels)    | 1 week            | 375       | 370                     | 373.5                  | 0.052                  |
|                                  | 6 months          | 371       | 369                     | 368                    | 0.253                  |
|                                  | 1 year            | 371       | 368                     | 366                    | 0.07                   |
| Vertical                         | 1 week            | 361       | 363                     | 358                    | 0.67                   |
|                                  | 6 months          | 362       | 358                     | 361                    | 0.754                  |
|                                  | 1 year            | 362       | 359                     | 358                    | 0.196                  |
| Horizontal                       | 1 week            | 369       | 368                     | 366.5                  | 0.558                  |
|                                  | 6 months          | 365       | 366.5                   | 362                    | 0.582                  |
|                                  | 1 year            | 367       | 363.5                   | 363.5                  | 0.391                  |
| Diagonal (155°)                  | 1 week            | 375       | 368                     | 368                    | 0.067                  |
|                                  | 6 months          | 368       | 365                     | 365                    | 0.367                  |
|                                  | 1 year            | 366       | 363                     | 363.5                  | 0.249                  |
| Diagonal (45°)                   | 1 week            | 375       | 368                     | 368                    | 0.067                  |
|                                  | 6 months          | 368       | 365                     | 365                    | 0.367                  |
|                                  | 1 year            | 366       | 363                     | 363.5                  | 0.249                  |

PCO: Posterior capsular opacification

Similarly, Baile et al. showed a decrease in the rate of ACO and capsular phimosis in eyes that had undergone anterior capsular polishing at 1 year. [4] Sacu et al. demonstrated lower ACO and fibrotic PCO with round-edged silicone IOLs 3-years postoperatively. [23]
The data published thus far is limited by the fact that a number of these studies implanted silicon IOLs with a greater incidence of PCO. Another major limitation was the construct of a manual capsulorhexis, with its associated variations in capsular-IOL overlap (affecting IOL centration, tilt, and PCO formation) and inconsistent capsulorhexis dimensions (affecting extent of capsular contraction).

We studied the effect of complete, inferior and no capsular polishing in eyes undergoing FLACS. Our study demonstrates a higher incidence of PCO at both 6-month and 1-year follow-up in the non-polishing arm. However, no clinical significance was found as visual outcomes between the three groups were not significantly different. This could be attributed to a more peripheral opacification with a longer follow-up required to determine the incidence of central opacification. Additionally, the impact on contrast sensitivity as a function of visual loss has not been studied in the previous cohorts. Contrast sensitivity was not statistically as well as clinically different between groups and among each group between follow-ups. The anterior capsular opacification and subsequent contraction revealed no significant difference.

Figure 4: Cluster bar diagram comparison of polishing with anterior capsular opacification (ACO) grade at different follow-up periods (a) 1-week, (b) 6-month, and (c) 1-year postoperative visit

**Conclusion**

In conclusion, no advantage of anterior capsular polishing was noted on the postoperative visual outcomes and contrast in eyes undergoing FLACS, at 1-year follow-up visit. The incidence of PCO was similar in the inferior and no polishing group. Longer follow-up data is necessary to study the long term impact.

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**Conflicts of interest**

There are no conflicts of interest.

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