

Predictors of Successful Laser Capsulotomy for Significant Posterior Capsule Opacification after Phacoemulsification

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Abstract

Purpose: This study aimed to determine the reasons behind the failure of laser capsulotomy (LC) performed for significant posterior capsular opacification (PCO).

Methods: Eighty-eight eyes of 88 patients referred for LC at a tertiary care center were retrospectively analyzed. The data recorded included the cause of cataract, visual acuity, duration of PCO, location of PCO, intraocular lens (IOL) position, IOL type, and lens capsule status. These data were later analyzed for determining the requirement of high pulse energy during LC and the success rate of primary LC.

Results: The mean age of the participants was 55.77 ± 18.60 years with 58 (65.9%) male patients. The mean duration between cataract and LC surgeries was 45.58 ± 37.33 months. Senile ($n=58$), uveitic ($n=12$), post-pars plana vitrectomy (PPV) ($n=12$), and traumatic ($n=6$) cataracts were the common causes. Late-presenting PCO, trauma, uveitis, sulcus placement of IOLs, irregular capsulorhexis shape, and polymethyl methacrylate (PMMA) IOLs were significantly associated with unsuccessful LC and/or higher pulse energy settings during LC.

Conclusion: Significant PCO is often associated with cataract caused by uveitis or trauma, and after PPV. PCO associated with trauma, sulcus placement of IOLs, and PMMA IOLs may need multiple LCs.

Keywords: Cataract Surgery; Complications; Laser Capsulotomy; Visual Axis Opacification

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INTRODUCTION

Posterior capsular opacification (PCO) is a common cause of visual loss after successful implantation of an intraocular lens (IOL) in the posterior chamber.^[1] Focus

has shifted from surgical techniques^[2] and the search for better IOLs^[3] continues even as newer designs surface to counter this problem.^[4] With such advances, the rate of PCO should have decreased, but it still remains the commonest long-term complication after cataract surgery.^[5] Laser capsulotomy (LC) is the preferred and effective treatment for PCO.^[6]

The purpose of this study was to determine the attributes of the surgical technique and the causes of cataract that affect the outcomes of LC for PCO.

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METHODS

The study conformed to the tenets of the Declaration of Helsinki. This was a retrospective study of 88 eyes of 88 patients referred for Nd: YAG LC for PCO during the period of April to June, 2013. The patients included were those who had undergone phacoemulsification with posterior chamber IOL for various indications such as senile cataract, post-traumatic cataract, post-uveitic cataract, or post-pars plana vitrectomy (PPV, with/without silicone oil) cataract. Patients with secondary IOLs or those with a previous history of any other ocular surgery were excluded.

LC was performed by a single surgeon, using a single machine (Aura PT, Lumenis, Tel Aviv, Israel) and the same technique for every patient with the same offset. The data recorded included the type of IOL, duration from cataract surgery to vision loss, current Snellen distant best corrected visual acuity (BCVA), cause of cataract, location of PCO (central or diffuse), pulse energy setting used, and success of the surgery. Surgical parameters noted included the position of the optic and haptic (bag/sulcus), centration of the IOL, continuity of the posterior capsule, and the size and shape of the capsulorhexis.

Central PCO was defined as opacity involving only the central 3 mm, and similarly, LC was considered as successful when the central 3-mm PCO could be cleared in a single session of LC. The optimal size of the capsulorhexis opening was defined as 5.5 to 6.5 mm. IOLs with an optic center equidistant from the limbus in two meridians, perpendicular and parallel to the optic-haptic junction, were defined as "centered." Centration of the capsulorhexis was judged in a similar manner. Capsulorhexis margins with discontinuity or peripheral extension to the lens equator were defined as "extended." All the measurements were performed on the slit-lamp by using standard examination techniques. High pulse energy for LC was defined as an energy setting of more than 4 mJ. Statistical analysis was later performed using Microsoft Excel (version 12.0, Microsoft, Redmond, WA) data sheets and SPSS for Windows (Version 16.0, SPSS Inc., Chicago, IL).

RESULTS

Eighty-eight eyes of 88 patients were included in this study. The mean age of the patients was 55.77 ± 18.60 years; 58 (65.9%) of them were male and 30 (34.1%) were female. The mean presenting LogMAR BCVA was 1.07 ± 0.60 . The mean duration from cataract surgery to LC was 45.58 ± 47.33 months. The mean duration from cataract surgery to vision loss as noticed by the patient was 24.90 ± 28.58 months, while the mean duration from vision loss to LC was 13.24 ± 22.21 months.

Analysis of the cause of cataract revealed senile cataract (n = 58) was the most common type of cataract,

followed by post-uveitic cataract (n = 12), post-PPV cataract (n = 8), post-traumatic cataract (n = 6), and post-PPV with silicone oil cataract (n = 4) [Table 1]. While the mean time from phacoemulsification to LC was similar (nearly 40 months) in most of the groups, it was higher (134 months) in the post-traumatic cataract group and lower in the post-PPV with silicone oil cataract group (3 months) ($P = 0.493$). Moreover, diffuse PCO was predominant in most of the groups, apart from the post-traumatic and post-PPV with silicone oil cataract groups. All of the patients in the post-traumatic and post-uveitic cataract groups ($P = 0.005$) needed higher pulse energies for LC. The success rate of LC was the lowest for post-traumatic cataract (33%) and the highest for senile cataract (89%) ($P = 0.016$) [Table 1].

Polymethyl methacrylate (PMMA) IOLs had been implanted in 36 (41%) while foldable acrylic IOLs had been used in 52 (59%). Acrylic IOLs were predominant in all cataract groups: 30/58 in the senile, 4/6 in the post-traumatic, 7/12 in the post-uveitic, 8/8 in the post-PPV, and 3/4 in the post-PPV with silicone oil cataract groups. Presenting visual acuity was significantly ($P = 0.009$) better in the acrylic IOL group than in the PMMA IOL group. No significant difference could be established between the location of PCO between the type of IOLs. However, cases requiring higher energy settings ($P = 0.015$) and the success rate of LC ($P = 0.046$) were similar in both the groups.

Amongst the IOL position parameters analyzed, no statistically significant relationship could be established for the effect on the time of presentation or the location of PCO [Table 1]. However, cases with optic in the sulcus had higher LC energy settings (61% vs. 35%, $P = 0.005$) and lower success rates (77% vs. 87%, $P = 0.026$) than did cases with optic in the bag. Similarly, cases with haptic in the sulcus had higher energy settings (50% vs. 39%, $P = 0.001$) and lower success rates (38% vs. 93%, $P = 0.005$) than did cases with haptic in the bag. Centration of the IOL had no statistically significant effect on either of these parameters [Table 1].

The integrity of the posterior capsule had no statistically significant effect on any of the PCO-related parameters. PCO presented earlier in cases with extended capsulorhexis (29 months) than in those with decentered (34 months) or centered (43 months) capsulorhexis margins ($P = 0.004$). Extended (60%) and decentered (50%) capsulorhexes needed higher energy settings than did centered (30%) capsulorhexes ($P = 0.049$). The shape of the capsulorhexis had no significant effect on either the location of PCO or the success rate of LC. Similarly, variation in the size of the capsulorhexis had no statistically significant effect on any of the PCO-related parameters [Table 1].

Seventy-two (81.8%) of the 88 LCs performed were successful. Presenting BCVA was better in the successful

Table 1. Posterior capsular opacity - patterns and outcomes

Predictors of PCO	N	Time to presentation	LogMAR BCVA	Diffuse PCO	Central PCO (%)	High pulse setting (%)	Successful LC (%)
Type of cataract							
Senile	58	40.05±35.16	0.95±0.55	34 (59)	28 (41)	16 (28)	52 (89)
Traumatic	6	134±90.49	1.48±0.45	2 (33)	4 (67)	6 (100)	2 (33)
Postuveitic	12	38±37.43	1.14±0.75	6 (50)	6 (50)	12 (100)	10 (83)
Post-PPV	8	40±34.50	0.29±0.13	6 (75)	2 (25)	2 (25)	6 (75)
Post-PPV + oil	4	3±2	-	0	4 (100)	2 (50)	2 (50)
<i>P</i>		0.493	0.005	0.085	0.075	0.005	0.016
IOL position							
Optic position							
Bag	62	42.77±35.01	0.94±0.55	38 (61)	24 (39)	22 (35)	54 (87)
Sulcus	26	52.85±45.82	1.36±0.63	12 (46)	14 (54)	16 (61)	20 (77)
<i>P</i>		0.141	0.005	0.126	0.101	0.005	0.026
Haptic position							
Bag	56	43.53±34.97	1.16±0.55	34 (61)	22 (39)	22 (39)	52 (93)
Sulcus	32	48.88±38.63	1.3±0.32	14 (43)	18 (57)	16 (50)	12 (38)
<i>P</i>		0.06	0.208	0.133	0.083	0.001	0.005
IOL centration							
Yes	78	46.25±39.21	0.3±0.21	42 (54)	36 (46)	32 (41)	66 (84)
No	10	42.82±32.40	0.89±0.55	6 (60)	4 (40)	6 (60)	6 (60)
<i>P</i>		0.934	0.307	0.777	0.523	0.211	0.057
IOL type							
PMMA	36	61.69±54.35	1.26±0.55	22 (61)	14 (39)	16 (44)	28 (77)
Acrylic	52	33.50±27.53	0.92±0.61	26 (50)	26 (50)	22 (42)	44 (85)
<i>P</i>		0.016	0.009	0.401	0.085	0.015	0.046
Lens capsule-related factors							
PC status							
Intact	76	42.25±32.82	0.99±0.57	44 (58)	32 (42)	30 (39)	64 (84)
Ruptured	12	70.2±50.88	1.48±0.67	6 (50)	6 (50)	8 (67)	8 (67)
<i>P</i>		0.542	0.015	0.231	0.224	0.074	0.143
Capsulorhexis shape							
Centered	66	43.30±35.13	1.00±0.60	40 (61)	26 (39)	20 (30)	58 (88)
Decentered	12	34.06±19.4	0.92±0.75	4 (33)	8 (67)	6 (50)	10 (83)
Extended	10	29.8±21.62	1.24±0.47	6 (60)	4 (40)	6 (60)	6 (60)
<i>P</i>		0.004	0.642	0.175	0.112	0.049	0.234
Capsulorhexis size							
Small	10	24.75±19.195	1.11±0.82	4 (40)	6 (60)	8 (80)	6 (60)
Optimal	49	42.50±30.67	0.98±0.60	31 (63)	18 (37)	16 (32)	40 (81)
Large	27	39.64±25.56	1.2±0.51	16 (59)	11 (41)	14 (51)	21 (77)
<i>P</i>		0.048	0.29	0.231	0.189	0.077	0.213

PCO, posterior capsular opacification; BCVA, best corrected visual acuity; LC, laser capsulotomy; PPV, pars plana vitrectomy; IOL, intraocular lens; PMMA, polymethyl methacrylate; PC, posterior capsule; LogMAR, logarithm of the minimum angle of resolution; N, number

group than in the unsuccessful group (0.95 ± 0.57 vs. 1.71 ± 0.36 LogMAR units, $P = 0.046$), whereas the time to presentation after the cataract surgery was longer in the unsuccessful group than in the successful group (64.28 ± 54.76 vs. 41.84 ± 45.22 months, $P = 0.039$).

DISCUSSION

Posterior capsular opacification is known to be dependent on the surgical technique, IOL-related factors, and patient

factors.^[7] The IOL design has seen significant advances such as square-edge technology, IOL biocompatibility, and chemically coated IOLs amongst many others. Similarly, surgical aspects such as a good cortical clean up, in-the-bag placement of IOLs, adequate capsulorhexis size^[7-9] etc., have also been shown to be important in PCO prevention. However, even the best techniques have only enabled the delay of PCO onset and no method has been able to completely prevent the lens epithelial cells, the progenitors of PCO,^[2] from migrating behind the IOL and

causing opacification. This highlights the fact that patient factors can be controlled but not completely removed.

In our series, senile cataract was the most common indication for surgery (66%). This is obvious because senile cataract is commoner than other ocular diseases. Uveitis-related cataract was another common cause. PCO rates after uveitic cataract surgery are known to be as high as 30%.^[10] PPV with or without silicone oil is associated with PCO because of many reasons including surgical and biochemical factors.^[11] A previous study reported post-PPV PCO rate to be 20%,^[12] which is consistent with the 14% (12 out of 88) post-PPV PCO rate found in our study. Visual axis opacification rates have been noted to be 12% after surgery for trauma-related cataract,^[13] which affected 7% of the eyes in our series operated for traumatic cataract. Hence, our findings are well supported by documented literature.

The mean time taken for visual loss to be perceived by the patient after cataract surgery was around two years. This is consistent with the findings of previous studies that have documented the occurrence of PCO gradually over years.^[7,14] Interestingly, the mean duration from cataract surgery to LC was close to 4 years. This represents the time taken for the PCO to become visually significant, or in some cases (patients undergoing PPV with silicone oil), significant enough to hamper retinal examination. While this duration was similar in most groups, it was higher (more than 5 years) in patients operated for traumatic cataract than for other causes [Table 1]. Late perception of visual loss by the patient with a visually compromised eye because of other manifestations of trauma could be a reason for the late presentation. Moreover, the incidence of unsuccessful LCs was the highest among patients with traumatic cataracts and all patients required a pulse setting of more than 4 mJ. Lax zonules observed after trauma^[15] may be the cause of such resistant PCO, as these decrease the mechanical barrier effect of the IOL to the lens epithelial cells.^[11] Both the diffuse and central variants of PCO were found in all groups except for those with vitrectomized eyes injected with silicone oil; this group only showed central PCO [Table 1]. This finding is possible because silicone oil is known to induce posterior fibrous pseudometaplasia of the lens epithelial cells.^[16] These data were, however, statistically insignificant.

While LC is generally a successful procedure,^[6] multiple sessions may be needed in some cases with dense PCO. The pulse setting required usually is in the order of 1.7 mJ^[17] but thick PCOs may need higher energy in the order of 4 mJ. In our study, around 20% of the LCs were unsuccessful, which is similar to the rates after the first LC reported elsewhere (30%).^[18] Further analysis revealed LC failure to be associated with trauma, lower presenting BCVA, and late-presenting PCO. Trauma, uveitis, and silicone oil tamponade were also associated

with the use of higher pulse settings for successful LC. Furthermore, the odds of having successful LC were maximum for senile cataract (4.33) followed by uveitic cataract (1.12), post-PPV cataract (0.63), post-PPV with silicone oil cataract (0.2), and post-traumatic cataract (0.08).

Owing to the retrospective nature of this study, no single PCO classification system could be used. Our study lacks a comparison amongst the various designs of IOLs, as it would have required a large number of groups. Difference in the number of cases in some groups could also have masked otherwise statistically significant results. Lastly, the effects of confounding factors such as the choice of IOLs and surgical parameters cannot be nullified because of the retrospective design of the study.

In conclusion, PCO remains an important cause of visual loss after cataract surgery. Significant PCO is often associated with cataract caused by uveitis or trauma and following PPV. Dense PCO may need higher energy settings during LC because of a higher incidence of unsuccessful LCs in cases of trauma, late-presenting PCO, PMMA IOLs, and sulcus-placed IOLs.

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Conflicts of Interest

There are no conflicts of interest.

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