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A clinical study of lens-induced glaucoma and its outcome after cataract surgery

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ABSTRACT

Background: Lens-induced glaucomas (LIGs) occur due to the lens's size, position, or inflammation, causing either open-angle or angle-closure mechanisms. These conditions vary clinically, and understanding their effect on post-operative cataract surgery outcomes is crucial for achieving better visual results. **Aims and Objectives:** The aim of the study was to evaluate the characteristics, risk factors, and their consequences in LIG on post-operative visual outcome, intraocular pressure, inflammation, and optic disc changes. **Materials and Methods:** Patients diagnosed with LIG between December 2019 and April 2021 underwent cataract surgery and were assessed pre-and postoperatively for visual outcomes, intraocular pressure (IOP), inflammation, and optic disc changes. **Results:** During the 18-month study, 2700 cataract cases attended the outpatient department at Oxford Medical College, Bangalore. Among them, 50 cases (1.85%) were diagnosed with LIG. The age range was 37–75 years, with a mean of 60.02 (61.70 years for females, 58.04 years for males). Best-corrected visual acuity (BCVA) of 6/12 or better was achieved in 48% of cases, while severe inflammation resulted in BCVA below 6/60 in 69.23%. Elevated IOP was noted in cases with symptoms lasting 2–4 weeks (39.67 mmHg). Glaucomatous disc damage affected 36% of cases, more common in phacomorphic glaucoma (54%) than phacolytic (28%), and significantly correlated with symptom duration over 2 weeks ($P<0.01$). **Conclusions:** Planned small incision cataract surgery with intraocular lens implantation along with minimal tissue handling and a good follow-up protocol with efficient management of complications and inflammation play a major role in management and allow for good visual outcome and fewer complications post-surgery.

Key words: Lens-induced glaucoma; Intraocular pressure; Cataract

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INTRODUCTION

Blindness affects an estimated 12.5 million people in India, with cataract as the cause in 50–80% of this group. This together with social and economic factors often results in delayed presentation until advanced stages such as intumescent, mature, and hypermature cataracts. Hence, complications such as lens-induced glaucomas (LIGs) are more common.[1] Glaucomas in which the lens plays a role, either by size or by position or by causing inflammation have been classified as LIGs. In the past, significant confusion existed about the terminology and mechanisms causing the glaucoma. Terms such as phacotoxic reaction, phacogenetic glaucoma, phacotopic glaucoma, lens-induced uveitis, and endophthalmitis phacoanaphylactic were used.[2]

These are heterogeneous group of uncommon maladies, which can develop through either open-angle or angle-closure mechanisms.[3] Lens-induced open-angle glaucoma may develop in several different clinical situations:

1. Hypermature or mature (rarely immature) cataract may leak proteins into the aqueous humor and obstruct the aqueous outflow channels. This form of lens-induced

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open angle glaucoma is classically termed phacolytic glaucoma (PLG)

2. After extracapsular cataract surgery, phacoemulsification, lens injury, or Nd YAG laser posterior capsulotomy, liberated lens particles and debris may obstruct the outflow pathways. This is sometimes mislabeled phacotoxic or phacoanaphylactic glaucoma because the cellular response to the liberated lens material is incorrectly assumed to be responsible for the obstruction of aqueous outflow a more appropriate term which is lens particle glaucoma
3. When lens material is sequestered in the eye after cataract surgery or trauma, true phacoanaphylaxis may develop although it rarely results in glaucoma. Phacoanaphylaxis may also develop when sensitization to the lens protein antigens occurs in a fellow eye and a hypermature cataract leaks lens proteins or a traumatic or surgical rupture of the lens releases lens proteins.[4] Phacoanaphylactic uveitis, now termed as lens-induced uveitis, is not truly an anaphylactic reaction but is a granulomatous reaction that can result in glaucoma with either open-angle, angle-closure or combined open-angle and angle-closure glaucoma.[2]

Phacomorphic glaucoma (PMG) and lens displacement glaucoma are secondary angle-closure glaucomas.

It has long been recognized clinically that several forms of glaucoma may occur in association with the formation of cataracts, which are an important cause of secondary glaucoma in the developing world.[4,5] In the developing world, like India, financial, cultural, and psychosocial barriers to accessing excellent surgical services still exist. There is an ever-increasing backlog of cataract due to the population explosion, increased life expectancy, and low productivity in terms of utilization of the available surgical services. The uptake of eye care services by the rural community has also been suboptimal in countries like India, where LIG is a common cause of ocular morbidity.[5] The common occurrence of LIGs is hardly surprising in a situation where the incident of cataract cases far exceeds the total number of surgeries performed currently.[6]

Although, historically intracapsular cataract extraction and extracapsular cataract extraction were the preferred techniques for LIG, there is a perceptible shift toward manual small incision cataract surgery (MSICS). MSICS is popular in developing countries as it is inexpensive and allows high-volume cataract surgery without compromising the quality of medical care.[7-9] Such surgeries undertaken within a day or two after onset of symptoms have been shown to be effective in controlling intraocular pressure (IOP) and restoring vision. Whatever the mode of surgical intervention, the prognosis for good post-operative visual recovery in these conditions remains guarded, unless diagnosed early and managed efficiently.

History of LIG dates back to the 19th century. Since then, numerous studies have been done, which have determined and described the characteristics, risk factors, and causes for the visual outcome and intraocular pressure in LIG, also appropriate medical and surgical line of management have been formulated. Nevertheless, there are scanty reports and studies on the inflammation and its consequences in LIG.

The present study has endeavored to determine the characteristics, risk factors, and their consequences on post-operative visual outcome, IOP, and inflammation including corneal changes, and optic disc changes in LIG.

Aims and objectives

To evaluate the characteristics, risk factors and their consequences in lens-induced glaucoma on post-operative Visual outcome, Intra ocular pressure, Inflammation and Optic disc changes.

MATERIALS AND METHODS

All patients attending outpatient and in-patient of the Department of Ophthalmology, the Oxford Medical College and Hospital, Bengaluru, diagnosed as LIG during the study period of 11/2 years between December 2019 and April 2021.

Inclusion criteria

- Patients with LIG
- Patients who gave written and informed consent.

Exclusion criteria

- Patients with co-incident cataract and glaucoma
- Long standing LIG (>6 months), with no PL
- Patients with very poor general condition.

After patients signed the written and informed consent, visual acuity, applanation tonometry, and slit-lamp examination were recorded, which were repeated after giving medical line of treatment.

In some eyes with advanced cataract formation, the lens may become swollen or intumescent, with a progressive reduction in the anterior chamber angle eventually leading to a form of angle-closure glaucoma. This condition has been referred to as PMG. PMG was diagnosed, when patients presented with red eye, acute pain, and reduction of vision, and on clinical examination, the eye showed circumcorneal congestion, corneal edema, shallow anterior chamber, dilated and fixed or sluggish pupil, intumescent cataract, and IOP more than 21 mmHg.[10]

PLG should be reserved for the sudden onset of open-angle glaucoma caused by leaking of lens matter through a relatively intact capsule in a mature or hypermature cataract. PLG was diagnosed, when patients presented with acute pain in the eye with long-standing poor vision and on slit-lamp, corneal edema, floating lens particles in the anterior chamber and/or pseudohypopyon in severe cases, and hypermature morgagnian cataractous lens in few cases. Dense flare was seen with extensive keratic precipitates.[10]

Lens particle glaucoma was diagnosed, when patients presented with free cortical material in the anterior chamber, elevated IOP, moderate anterior chamber reaction, and microcystic corneal edema. Phacoanaphylaxis is diagnosed, when the patient came with moderate anterior chamber reaction, keratic precipitates on both corneal endothelium and anterior lens surface, low-grade vitritis, synechial formation, and residual lens material in the anterior chamber.[11]

Patients with ectopia lentis have symptoms of decreased visual acuity, and on examination, phacodonesis and iridodonesis can be seen.

Preoperatively, to reduce IOP topical timolol 0.5% twice-a-day, oral acetazolamide 500 mg twice-a-day are given. Intravenous mannitol 20% stratum is given if IOP more than 40 mmHg and before the surgery in refractory cases. Topical mydriatics and phenylephrine 10% were started just before surgery. Systemic, oral ciprofloxacin (500 mg) 12 hourly was given as prophylaxis to prevent post-operative infection.

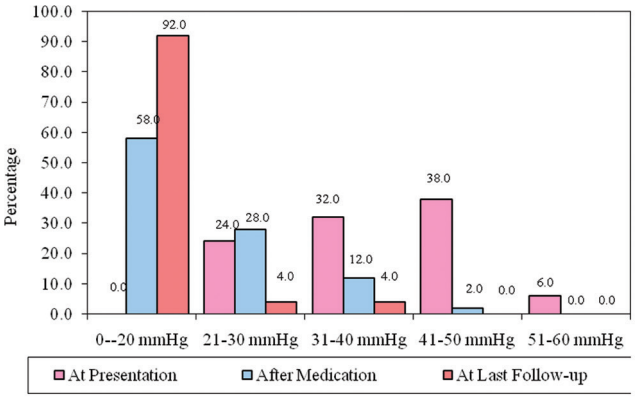
Surgical line of management

In all patients, small incision cataract surgery with intraocular lens (IOL) implantation under peribulbar block was offered under guarded prognosis. At the end of the procedure, subconjunctival injection of steroid and antibiotic was given.

Postoperatively in the ward, all the patients received a topical antibiotic-steroid combination, 8 times a day, and mydriatic-cycloplegic, twice a day, and systemic steroids were given if there is severe uveal inflammation. If the tension appeared to be on the higher side, topical timolol 0.5% twice daily was instilled. In severe cases, oral acetazolamide or IV mannitol 20% stratum was given.

All the patients were followed up at 1, 4, and 6 weeks postoperatively. At every visit, patients were evaluated for visual acuity with Snellen's chart, IOP by Goldmann applanation tonometer, slit-lamp examination of the anterior segment, and posterior pole examination with direct ophthalmoscope and 90D.

The results were tabulated, and data were statistically analyzed using various tests such as Paired "t" test, Chi-square test with a significant $P<0.05$.



Comparison of IOP at presentation , after medication and last follow up

RESULTS

During the study period of 11/2 years between December 2019 and April 2021 (time bound study), 2700 cases of cataract, attended the outpatient department of Oxford Medical College, Bangalore. The number of LIG cases among these cataract cases in our study was 50, giving a prevalence of 1.85%.

In this study, age range was 37–75 years with a mean of 60.02, with 61.70 years in females and 58.04 years in males. The most frequent age group among both males and females was 60–70 years.

PMG was the most common LIG with 31 cases (62%), followed by PLG with 17 cases (34%). None of the cases, in this study, presented with phacoanaphylactic reaction (Table 1).

It is observed that the mean duration of symptoms in PMG cases was 20.19 days, and in PLG, it was 11.14. Of a total of 50 cases, 26 (52.00%) have presented with symptoms of more than 2 weeks, and 24 (48.00%) cases with symptoms of <2 weeks. Seventeen (54.84%) of 31 PMG cases and 07 (41.18%) of 17 phacolytic cases presented with symptoms of more than 2 weeks.

In this study, it was observed that none of the cases at presentation had visual acuity better than hand movements. At the last follow-up, a majority of 24 (48.00%) cases gained good visual acuity of 6/12 or better (Table 2).

In this study, the total mean IOP, at presentation, was 39.32 mmHg, after medication, it was 22.48 mmHg, and at the last follow-up, it was 16.51 mmHg (Table 3).

Table 1: Distribution of patients by diagnosis

Diagnosis	Number of patients	% of patients
Phacomorphic glaucoma	31	62.00
Phacolytic glaucoma	17	34.00
ADL\PBG\PLG\PDL	2	4.00
Total	50	100.00

PBG: Pupillary block glaucoma, PLG: phacolytic glaucoma

Table 2: Visual acuity at presentation to last follow-up

Visual acuity	On discharge	%	Last follow-up	%
6/6–6/12	0	0.00	24	48.00
6/18–6/60	0	0.00	12	24.00
>6/60	50	100.00	14	28.00
Total	50	100.00	50	100.00

Inflammation at presentation was most commonly mild-to-moderate in 37 cases (74.00%). There were 12 cases (24.00%) with severe inflammation. At last follow-up, 46 cases (92.00%) were free of inflammation, none had severe inflammation and the rest had mild-to-moderate inflammation (Table 4).

Pupillary reaction at presentation was abnormal in 44 cases (88.00%) normal in one (2.00%). There was a statistically significant change from abnormal pupillary reaction at presentation to normal, on discharge in 25 (50.00%) cases and at last follow-up in 32 (64.00%) cases.

In this study, uveitis was the most common complication in 18 cases (36.00%), also there were 2 cases (04.00%) of retinal detachment and 1 case (02.00%) each of pupillary capture of IOL, posterior capsular opacity, and vitreous hemorrhage.

Good visual acuity at the last follow-up of 6/12 or better was achieved in 20 (54.05%) of 37 cases with mild-to-moderate inflammation at presentation and in 04 (30.77%) of 13 cases with severe to very severe inflammation. Poor visual acuity of <6/60 at last follow-up was seen in 5 (13.51%) of 37 cases and 9 (69.23%) of 13 cases, with mild-to-moderate inflammation and severe to very severe inflammation, respectively. The severity of inflammation at presentation was directly proportional to the poor visual outcome and was statistically significant (Chi-square=21.8506, P=0.00129).

Twenty (86.96%) of 23 cases with normal fundus and 3 (16.67%) of 18 cases with glaucomatous disc damage (GDD) achieved the best-corrected visual acuity of 6/12 or better at last follow-up, whereas 9 (50.00%) of 18 cases with GDD and none of normal fundus cases had visual acuity of <6/60. Poor visual acuity of <6/60 in cases with GDD was found to be statistically significant (P=0.00001).

The optic disc changes at the end of the last follow-up were, normal in 13 cases (41.94%) and 10 cases (58.82%) of phacomorphic and PLG, respectively. Mild-to-moderate GDD was seen in 07 cases (22.58%) of phacomorphic and in only 4 cases (23.53%) of PLG, whereas severe damage was seen in 7 cases (22.58%) and none in PLG group. The difference in the optic disc appearance among subgroups was statistically significant (Chi-square=14.3126 P=0.0263) (Table 5).

DISCUSSION

The LIGs are a condition of old age with increased risk in females among lower socioeconomic strata.

In this study, good visual acuity achieved by cases with PLG (58.82%) was more than PMG (45.16%) that this difference was clinically significant but statistically not significant (P>0.05). Poor outcome of <6/60 showed no significant difference between PLG (23.53%) and PMG (29.03%). The 1994, Madurai study series found no statistical difference between the two groups on the final post-operative visual recovery (P=0.68).[6]

Good visual acuity achieved, in cases presented within 2 weeks (79.20%) was more than the cases presented beyond 2 weeks (20.80%), whereas poor visual acuity of <6/60 was more in cases presented beyond 2 weeks (85.71%).

The Lahan study of 1998 found that duration of pain and high level of intraocular pressure at presentation in PMG was associated with poor visual outcome at discharge, while in phacolytic group, no such association was made out.[10]

In this study, the influence of inflammation on final visual outcome was analyzed. Good visual acuity achieved in cases with mild-to-moderate (54.05%) inflammation was higher than cases with severe to very severe inflammation (30.77%). Poor vision was found to be higher in cases with severe inflammation (69.23%) than with mild-to-moderate inflammation (13.5%). The severity of the inflammation directly affects the final visual results, which were clinically and statistically significant (P<0.05).

Clinically, a significant proportion of cases with IOP at presentation <35 mmHg (62.50%) achieved good visual acuity, than cases with IOP more than 35 mmHg (41.18%), whereas no significant difference was found for poor outcome. Madurai study also had found no statistically significant association between the level of pre-operative IOP and final visual acuity.[6]

Table 3: IOP at presentation, after medication, and at last follow-up

IOP (mmHg)	At presentation	%	After medication	%	At last follow-up	%
0–20 mmHg	0	0.00	29	58.00	46	92.00
21–30 mmHg	12	24.00	14	28.00	2	4.00
31–40 mmHg	16	32.00	6	12.00	2	4.00
41–50 mmHg	19	38.00	1	2.00	0	0.00
51–60 mmHg	3	6.00	0	0.00	0	0.00
Total	50	100.00	50	100.00	50	100.00

IOP: Intraocular pressure

Table 4: Inflammation at presentation and at last follow-up

Grade	At presentation	%	At last follow-up	%
Normal	0	0.00	46	92.00
Mild	20	40.00	2	4.00
Moderate	17	34.00	2	4.00
Severe	12	24.00	0	0.00
Very severe	1	2.00	0	0.00
Total	50	100.00	50	100.00

Table 5: Optic disc changes at last follow-up

Fundus (optic disc)	No of patients	% of patients
Normal	23	46.00
Mild-moderate	11	22.00
Severe	7	14.00
Hazy media/RD/others	9	18.00
Total	50	100.00

The mean IOP at presentation was 39.32 mmHg and after medication 22.48 mmHg and at last follow-up, it was 16.50 mmHg. The IOP at the last follow-up was reduced to normal limits. This indicates that, in LIG, IOP should be reduced by the medical line of treatment preoperatively to as normal as possible, to achieve stable IOP postoperatively with no further anti-glaucoma medications. It is found that the IOP tends to be higher with the delay in presentation beyond 30 days (43.60 mmHg) than the duration of presentation of <2 weeks (34.67 mmHg). Although mean IOP at last follow-up was normal (16.50 mmHg), cases with delay in presentation more than 30 days tend to be on the higher end of normal (20.00 mmHg). Thus, delay in presentation would result in higher IOP, especially if the delay is beyond 30 days, which is clinically significant.

The inflammation at presentation of severe to very severe was high in PLG (41.94%) than PMG (20.00%). At the last follow-up, the reduction to normal in PMG was (93.44%) and in PLG, it was 94.55%. Clinically, PLG had severe inflammation at presentation. The inflammation was significantly high of severe to very severe grade in cases delayed beyond 2 weeks (38.46%) than the cases presented before 2 weeks (12.50%).

The severity of inflammation was proportional to the duration of symptoms, which was statistically significant (P<0.05). The inflammation was also severe to very severe, in cases with IOP at presentation of more than 35 mmHg (38.23%), compared to cases with IOP <35 mmHg (06.25%). Furthermore, the inflammation tends to be mild in cases with IOP <35 mmHg at presentation (62.50%) than cases with IOP more than 35 mmHg (20.58%). Therefore, inflammation is found to be proportional to the duration of symptoms and height of IOP, which was clinically and statistically significant (P<0.05).

Optic disc at the last follow-up in the affected eyes was normal in the majority (46.00%). There were two cases of retinal detachment including one case of resolving vitreous hemorrhage. GDD was found in 36% of cases. Clinically, significant disc damage was 22.58% in PMG and none had significant disc damage in PLG, the difference was statistically significant (P<0.05). There was significant damage in cases presented beyond 2 weeks (41.67%) and especially beyond 30 days (60.00%), and none in cases presented before 2 weeks. Fundus was normal in the majority (80.95%) of cases presented before 2 weeks. The severity of GDD was directly proportional to the duration of symptoms with which was clinically and statistically significant (P<0.01).

In Madurai study, 5 patients (10.2%) with PMG and 6 patients (13.6%) with PLG had visual acuity <6/60. All five patients with PMG and four of the six patients with PLG had compromised optic nerves due to the glaucomatous process itself, showing close association with our study inference.[6] In Lahan study series, the percentage of optic atrophy cases (34.0%) is comparatively high from our study (15.56%).[10]

Limitations of the study

The study's limitations include a small sample size, short follow-up period, single-center design, lack of a control group, variability in surgical techniques, and limited demographic diversity, which may affect the generalizability of the findings.

CONCLUSIONS

The main objectives of this study were to determine the characteristics, the risk factors, and their consequences on post-operative visual outcome, intraocular pressure, inflammation, and optic disc changes.

In other words, a delay in presentation of more than 2 weeks, and IOP of more than 35 mmHg would result in severe inflammation affecting the optic nerve which would result in potentially blinding LIG.

It is important to create awareness regarding lens-induced cataract and its implications among the rural community, ophthalmic assistants, and peripheral health workers. With meticulous surgery, an appropriate post-operative management and follow-up would probably achieve an excellent visual prognosis.

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PG- Definition of intellectual content, literature survey, prepared first draft of manuscript, implementation of study protocol, data collection, data analysis, manuscript preparation; **PP**- Concept, design, clinical protocol, manuscript preparation, editing, and manuscript revision; **SS**- Design of study, statistical analysis and interpretation; **AM**- Review of manuscript, literature survey and preparation of figures, submission of article, coordination and manuscript revision; **BB**- Statistical analysis and interpretation.

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