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KEY WORDS: Intra-Ocular Lens (IOL), Posterior Capsular Opacification (PCO), Secondary cataract, After cataract, posterior capsulotomy, Lens Epithelial Cells(LECs), Anterior capsular cataract(ACO), Intraocular pressure(IOP)

A CLINICAL STUDY ON POSTERIOR CAPSULAR OPACIFICATION IN A TERTIARY CARE HOSPITAL OF ASSAM

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ABSTRACT

1. Objectives:
a) To detect PCO early in order to alleviate patient discomfort and improve visual function.
b) To diagnose PCO and classify it according to its type.
c) To assess the visual outcome before and after Nd:YAG laser posterior capsulotomy in the study population.
2. Materials & Methods: A study was conducted taking 60 eyes to know about the aetiology and pathophysiology of development of PCO following cataract extraction and IOL implantation.
3. Results: In the study population including 60 eyes the most common age group affected were 61-80 years with slightly male preponderance (M:F::1.06:1). The visual acuity on presentation ranges from HM to 6/9 and after Nd:YAG laser capsulotomy all patients had improvement in visual acuity of 1 or more lines . The duration between the cataract surgery and development of PCO was high within 0-2 years of cataract surgery. The PMMA type of IOL was high (81.7%) in the study population. There was also increase in the IOP after Nd:YAG capsulotomy which was measured immediately and 2 hours post laser treatment.

Introduction:
Background: Posterior capsular opacification (PCO, secondary cataract, after cataract) is a nagging post-surgical complication following cataract surgery and intraocular lens implantation.

Posterior capsular Opacification (PCO, secondary cataract, after cataract) is the most common complication of modern cataract surgery occuring in upto 50% of patients by two years postoperatively. [1]

PCO is a misnomer because it is not the capsule which opacifies rather than an opaque membrane develops over it. PCO is the most common complication of cataract surgery. In pediatric cataract surgery, incidence of PCO approaches 100%. [2-4] PCO incidence has been reported to occur in 36-97% of patients 2 to 4 years after ECCE. The corresponding incidence within 1 year after phacoimulsification was 2-5% and within 3 years it was found to range between 2% and 63%. The younger patient are at a higher risk. The incidence of PCO is high in eyes with uveitis. [5] In these eyes, hydrophobic acrylic lenses provide a better visual outcome and lower incidences of PCO than silicone, PMMA IOLs.

The amount of PCO depends on many factors such as the quality of surgery, duration of implant in the eye and biocompatibility of IOL material. It has been reported that AcrySof IOL displays the lowest amount of cell proliferation and hence is most biocompatible. [6-9]

Patients with Myotonic dystrophy and Retinitis pigmentosa showed a higher incidence and density of PCO.

The continuous curvilinear capsulorrhexis (CCC) technique delays the development of central visual obscuration by facilitating fusion between the edge of CCC to posterior capsule forming a ring which provides a closed environment restricting LECs migration towards the central posterior capsule.

A capsulorrhexis smaller than IOL optic, the adhesion between the anterior capsule and the IOL optic keeps the anterior lens epithelium away from the posterior capsule and decreases the incidence of migration of the anterior LECs behind the IOL optic. [10]

The cortical clean-up hydrodissection is used by many surgeons to facilitate lens substance removal and enhance the safety of the surgery. The goal of hydrodissection is to remove equatorial cells and cortex, as opposed to single layer of anterior epithelium that does not migrate. [11-12]

Also the hydraulic force exerted by hydrodissection causes a cleavage between the lens capsule and the cortex, which could cleave mitotically active LECs from the capsule.

Thorough removal of the residual cortical fibres decreases the number of mitotically active cells; which have the potential to proliferate and migrate across the central visual axis. Polishing the anterior capsule has been effective in reducing fibrotic opacification.

A high rate of ACO as well as PCO (upto 65%) has been reported with the plate haptic design IOLs, due to incomplete fusion of the anterior and posterior capsule. Lenses with a plano convex optic (plano posterior) appear to have a lower rate of PCO than biconvex lenses due to mechanical barrier effect of the IOLs, which prevents the LEC proliferation and central migration. Again, the sharp optic edge design was found to be more effective in the prevention of PCO formation compared with IOLs with round optic edges.

PCO represents a significant cost to the health care system. Nd:YAG laser capsulotomy is the most common modality to treat PCO. In the USA, Nd:YAG laser treatments of almost one million patients per year cost upto **$250 million** annually. [1] In the developing countries, the facility of Nd:YAG laser posterior capsulotomy for management of posterior capsule opacification is not available at all places and all secondary cataract patients cannot afford the treatment.

A significant incidence of PCO means that cataract surgery alone may not restore lasting sight to the **25 million** people worldwide who are blind from cataract. [13]

Purpose of Study:
1. To detect PCO early so as to improve the patient discomfort and prevent further visual disturbances by providing treatment i.e. Nd:YAG posterior capsulotomy.
2. To establish the diagnosis of PCO and differentiate it from other causes of decreased vision after cataract surgery.
3. To assess the visual acuity (VA) before and after Nd:YAG laser posterior capsulotomy in various types of PCO.
4. To educate and involve the patients in management of this condition.
5. To prevent further loss of visual function.

Etiology and risk factors:
1. Residual lens epithelial cells (LECs) at the equator and the

anterior capsule.
2. Diabetic patients have significantly more severe PCO.
3. Myopic eyes where IOL implantation is deferred.
4. Hydrophilic IOL (silicone, PMMA) have higher incidence than hydrophobic IOL (acrylic).
5. Traumatic cataract.
6. Uveitis
7. Myotonic dystrophy
8. Retinitis pigmentosa

Pathophysiology:
The development of PCO is a very dynamic process and involves three basic phenomena: proliferation, migration, and differentiation of residual LECs.

The PCO has two forms, fibrous and pearl. Sometimes a combination of both is also found. Clinically, it is seen as a wrinkling on the posterior capsule at the site of fusion of the anterior and posterior capsules.

Most secondary cataract are caused by proliferation of equatorial LECs, forming the pearl form of Posterior Capsule Opacification (PCO).[14]

The epithelium of the lens consists of anterior epithelial cells known as A-cells, which is a single continuous cell line. These cells are continuous with the cells of equatorial lens bow. The cells of equatorial lens bow are the E-cells, which comprise of the germinal cells undergoing mitosis as they peel off from the equator.

A-cell tends to remain in place and not migrate and is prone to change towards fibrous tissue (fibrous tissue metaplasia) when disturbed. In contrast, E-cells of equatorial lens bow tend to migrate along the posterior capsule and form pearls to form PCO. These equatorial cells are primary sources of classical secondary cataract, especially the pearl form of PCO. Fibrous form of PCO occurs as a result of either posterior proliferation of A-cells or may result from a fibrous metaplasia of posteriorly migrating E-cells. [15]

The proliferation of residual LECs is highest in the **3** to **4** days after surgery [16]. Residual cortex may also promote proliferation of PCO.

PCO within the central **3** mm zone of the posterior capsule affects high contrast sensitivity, low contrast acuity, and sensitivity psychophysical test results with differing degrees of sensitivity.

Definition:
Secondary cataract, also known as Posterior Capsule Opacification (PCO), is the most common complication after cataract surgery, resulting from migration and proliferation of residual Lens Epithelial Cells (LECs) onto the central posterior capsule, leading to decrease in visual function, and ultimately in visual acuity. [17]

Madurai PCO grading scale: [18]

Level of Severity	Description
No PCO	No evidence of posterior capsule opacification (PCO) seen before and after pupillary dilation to a minimum of 6 mm. With a direct ophthalmoscope, a clear view of the optic disc, blood vessels, and the nerve fiber layer is obtained.
Grade I	No central PCO is seen. PCO is seen only with the pupil dilated to a minimum of 6 mm. With a direct ophthalmoscope, a clear view of the optic disc, blood vessels, and the nerve fiber layer is obtained.
Grade II	PCO is present in the central visual axis, detectable in an undilated pupil. With a direct ophthalmoscope, there is a mild obscuration of fundus detail, in that the optic nerve head is clearly seen but the retinal nerve fiber layer and the blood vessels are not clearly seen.
Grade III	PCO is present in the central visual axis with an undilated pupil. With direct ophthalmoscopy, there is a marked obscuration of fundus detail, in that even the margins of the optic nerve head are not clearly defined because of the PCO.

Materials & Methods:
Aims & Objectives:
1. To detect PCO early in order to alleviate patient discomfort and improve visual function.
2. To diagnose PCO and classify it according to its type.
3. To assess the visual outcome before and after Nd:YAG laser posterior capsulotomy in the study population.

Type of Study: Hospital-based cross-sectional study of 60 eyes.

Place of Study: Department of Ophthalmology, Assam Medical College & Hospital, Dibrugarh, Assam.

Duration of Study: 6 months.

Patients Population: Patients attending Out Patient Department of Department of Ophthalmology, Assam Medical College & Hospital, Dibrugarh, Assam.

Screening of Patients: Individuals of the age of 20 years and above, who presented with the symptoms and signs of posterior capsule Opacification, like, diminution of vision, glare, diplopia, decreased contrast sensitivity with history of previous cataract surgery in same eye, were selected.

Inclusion Criteria:
- Different types of PCO
- Patients above 20 years of age
- Both the sexes
- Informed consent

Exclusion Criteria:
- Below 20 years of age
- Any infective or degenerative condition of the eye
- Visual dysfunction due to any neurological cause, tumours and malignant cases.

Diagnosis:
Symptoms of PCO are persistent slowly worsening blurring, glare and sometimes monocular diplopia.

Each patient was evaluated in details before undergoing Nd:YAG laser capsulotomy to confirm that the visual loss was only due to after contract.

Thorough examination of both eyes of patients was done using the following methods:

- Distant and near visual acuity
- Torch Light examination
- Slit lamp biomicroscopy (including +90D)
- Fundus examination (direct & indirect ophthalmoscopy) to assess media clarity and retinal pathology.
- Applanation tonometry

PCO was diagnosed by calculating the area of opacity on slit-lamp acquired retro-illumination images after complete mydriasis. Signs typically include more than one pattern of Opacification.

Clinically, **fibrous type** of PCO is seen as a wrinkling on the posterior capsule at the site of fusion of the anterior and posterior capsule. On the other hand, **Elschnig's pearl type** of PCO is seen as clusters of swollen, opacified differentiated LECs called bladder or Wedl cells.[8] A third form of **mixed type** of PCO is seen with features having a combination of the above two types.

Following points were noted:
- Visual acuity before and after Nd:YAG capsulotomy
- Intraocular pressure before & after laser capsulotomy
- Duration between cataract extraction and development of PCO
- Types of capsular opening during cataract extraction
- Placement of IOL
- Material of intraocular lens
- Types of PCO

- Any post operative complication
- Presence of posterior segment pathology
- H/O any systemic disease

Results:

After a short term study of 6 months the following observations were made. 60 eyes were identified having PCO diagnosed by retro-illumination images on Slit lamp biomicroscopy. These cases were grouped according to age, sex, laterality, types of PCO, etc.

Table 1- Age & sex distribution of the study population

Age	Male	Female	Total n=60	Percentage (%)
21-40	3	2	5	8.33
41-60	7	12	19	31.67
61-80	19	13	32	53.33
81-100	2	2	4	6.67
Total	31	29	60	100

Among the study population, maximum percentage, **53.33% (32** out of **60),** were of the age group of **61-80** years; followed by **31.67% (19** out of **60)** of the age group of **41-60** years; **8.33% (5** out of **60**) of the age group of **21-40** years; **6.67% (4** out of **60)** of the age group of **81-100** years.

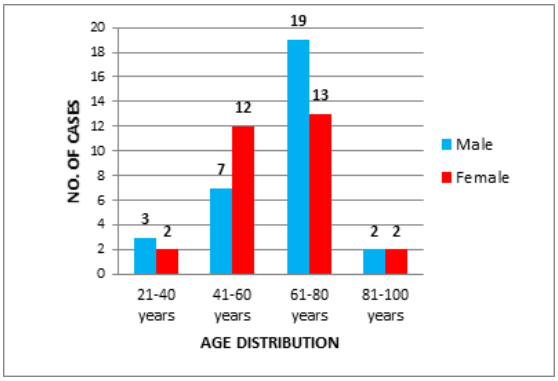

Fig. 1- Age & sex distribution of the study population.

Table 2- Sex distribution of the study population.

Sex	No. Of Cases	Percentage (%)	M:F Ratio
Male	31	51.67	1.06 : 1
Female	29	48.33	
Total	60	100	

Among the total number of patients, **31(51.67%)** were males and **29 (48.33%)** were females (**M:F =1.06:1**).

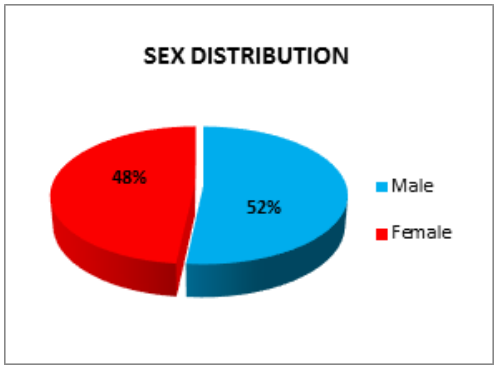

Fig. 2 – Sex distribution of the study population.

Table 3—Laterality of PCO.

Laterality	No. of cases	Percentage (%)
Right eye	33	55
Left eye	27	45

Among the study population, **33 (55%)** cases involved the right eye and **27 (45%)** cases involved the left eye.

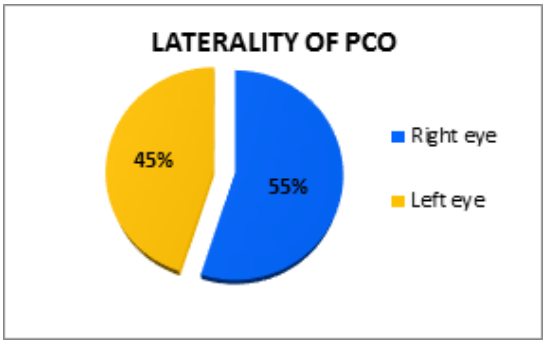

Fig. 3- Shows laterality of PCO in the study population.

Table 4-Visual acuity of the study population at presentation.

Visual acuity	No. of cases	Percentage (%)
HM – 3/60	10	16.7
4/60 - 6/60	19	31.7
6/36 – 6/18	27	45
6/12 – 6/9	4	6.6

The pre-laser visual acuity estimation showed that **45% (27** out of **60)** patients had a vision range of **6/36-6/18** on Snellens visual acuity chart. **31.7%** (**19** out of **60)** patients had a vision range of **4/60-6/60**; **16.7% (10** out of **60)** patients had a vision range of **HM-3/60**; **6.6% (4** out of **60)** patients had a vision range of **6/12 – 6/9** on Snellens visual acuity chart.

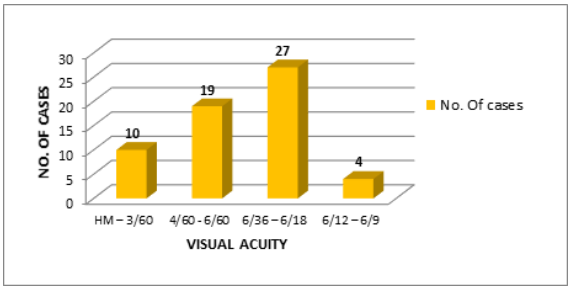

Fig. 4- Shows distribution of cases according to visual acuity before Nd:YAG laser capsulotomy.

Table 5- Duration between cataract extraction and Nd:YAG laser posterior capsulotomy.

Time interval (in years)	No. of cases n=60	Percentage (%)
0 - 2	24	40
2 - 4	19	31.7
4 - 6	8	13.3
6 - 8	3	5
8 - 10	3	5
10 - 12	2	3.3
12 - 14	0	0
14 - 16	1	1.7

Among the study population, **40% (24** out of **60**) were operated within **0-2** years; **31.7% (19** out of **60)** were operated between the time interval of **2-4** years; **13.3% (8** out of **60)** were operated between the time interval of **4-6** years; **5% (3** out of **60)** were operated between the time interval of **6-8** years; **5% (3** out of **60)** were operated between the time interval of **8-10** years; **3.3% (2** out of **60)** were operated between the time interval of **10-12** years; **1.7% (1** out of **60)** was operated between the time interval of **14-16** years and **0%** patient were operated between the time interval of **12-14** years.

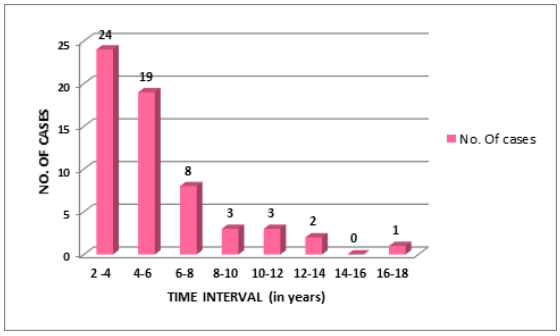

Fig. 5- Time interval between cataract extraction and Nd:YAG laser posterior capsulotomy.

Table 6- Morphological types of PCO seen in the study population.

Types of PCO	No. of cases	Percentage (%)
Elschnig's pearls	25	41.7
Fibrous	27	45
Mixed	8	13.3
Total	60	100

Among the study population, **45% (27** out of **60)** had fibrous type of PCO; **41.7% (25** out of **60)** had Elschnig's pearls type of PCO and **13.3% (8** out of **60)** had the mixed variety of PCO.

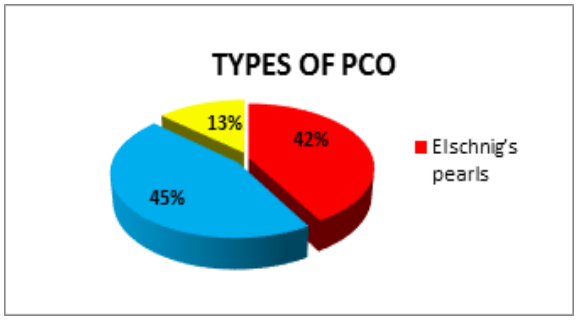

Fig. 6- Percentage of morphological types of PCO seen in the study population.

Table 7- Techniques of Anterior capsular opening during cataract extraction in the study population.

Techniques Of Anterior Capsular Opening	No. Of cases	Percentage (%)
Continuous curvilinear capsulorrhexis	43	71.7
Can opener	17	28.3

Among the study population, **71.7% (43** out of **60)** eyes had undergone Continuous Curvilinear Capsulorrhexis technique and **28.3% (17** out of **60)** eyes had undergone Can-Opener technique of anterior capsulotomy during cataract extraction.

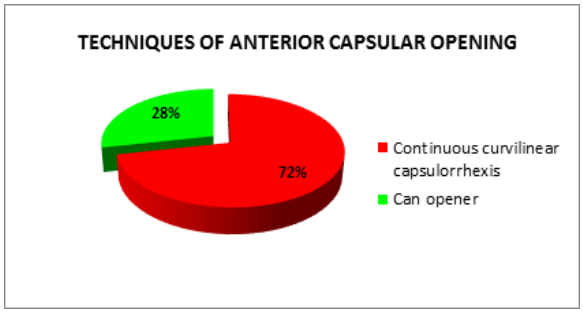

Fig. 7- Techniques of Anterior capsular opening during cataract extraction in the study population.

Table 8- Placement of IOL in the study population.

Placement of IOL	No. Of cases	Percentage (%)
In the bag	56	93.3
In the sulcus	1	1.7
One haptic in the bag and one in the sulcus	3	5

Among the study population, **93.3% (56** out of **60)** cases had the Intra Ocular Lens placed in the bag; **5% (3** out of **60)** cases of one haptic in the bag and one in the sulcus and **1.7% (1** out of **60)** was placed in the sulcus.

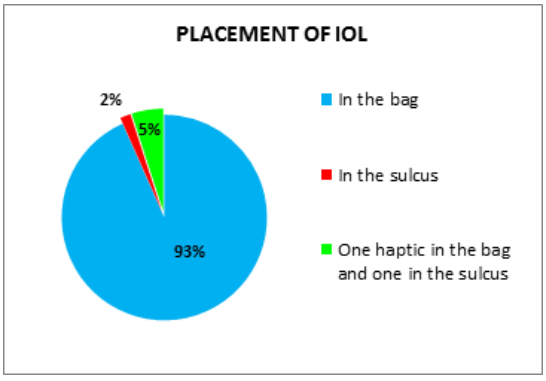

Fig 8- Shows placement of IOL in the study population

Table 9- Material of PCIOL used in cataract surgery in the study population.

Material of IOL	No. Of cases	Percentage (%)
PMMA	49	81.7
Acrylic	11	18.3

Among the study population, PMMA lens was used in **81.7% (49** out of **60)** cases and acrylic lens was used in **18.3% (11** out of **60).**

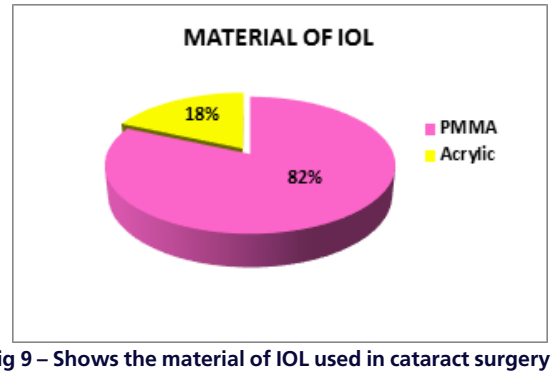

Fig 9 – Shows the material of IOL used in cataract surgery in the study population.

Table 10- Visual improvement after Nd:YAG laser posterior capsulotomy.

Pre-laser VA	Post-laser VA				
	6/6-6/9	6/12-6/18	6/24-6/36	6/60-5/60	<5/60
HM-3/60	0	0	2	5	3
4/60-6/60	2	12	5	0	0
6/36-6/18	15	9	3	0	0
6/12-6/9	4	0	0	0	0

The study population was grouped according to the pre-laser visual acuity and their post-laser visual acuity improvement. In the pre-laser VA group of **HM- 3/60, 2** patients gained vision upto the level of **6/24-6/36, 5** patients gained vision upto the level of **6/60-5/60** and **3** patients had vision **<5/60.** In the pre-laser VA group of **4/60- 6/60, 2** patients gained vision upto the level of **6/6-6/9, 12** patients gained vision upto the level of **6/12-6/18** and **5** patients gained vision upto the level of **6/24-6/36.** In the pre-laser VA

group of **6/36- 6/18, 15** patients gained vision upto the level of **6/6-6/9, 9** patients gained vision upto the level of **6/12-6/18** and **3** patients gained vision upto the level of **6/24-6/36.** In the pre-laser VA group of **6/12- 6/9, 4** patients gained vision upto the level of **6/6-6/9.**

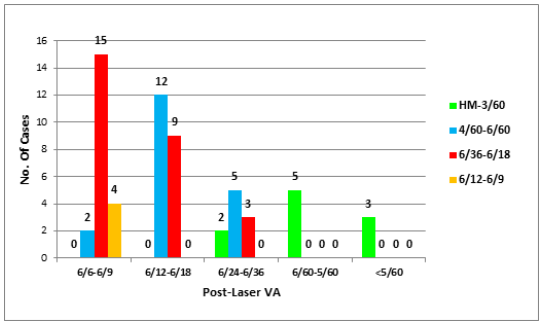

Fig. 10- Visual improvement after Nd:YAG laser posterior capsulotomy.

Table 11- Baseline IOP of the study population.

Baseline IOP (mmHg)	No. Of cases	Percentage (%)	Mean Baseline IOP (mmHg)
10-13	17	28.3	11.14
13-17	30	50	14.50
17-21	13	21.7	18.05

Among the study population, **50% (30** out of **60)** cases had baseline IOP between **13-17 mmHg; 28.3% (17** out of **60)** cases had baseline IOP between **10-13 mmHg** and **21.7% (13** out of **60)** cases had baseline IOP between **17-21 mmHg.**

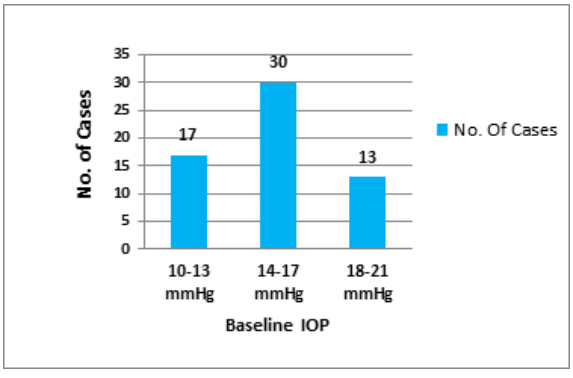

Fig. 11- Baseline IOP of the study population.

Table 12- Showing the difference between mean baseline IOP and immediate post-laser IOP and 2 hr post-laser IOP in the study population.

Baseline IOP (mmHg)	Mean Baseline IOP (mmHg)	Post-Laser mean IOP (in mmHg)	
		Immediate	After 2 hr
10-13	11.14	11.75	12.18
13-17	14.50	15.23	16.10
17-21	18.05	19.01	20.71

Among the study population, the baseline IOP group of **10-13 mmHg (**mean **11.14 mmHg)** showed immediate post-laser mean IOP of **11.75 mmHg** and **2** hr post-laser mean IOP of **12.18 mmHg.** The baseline IOP group of **13-17 mmHg (**mean **14.50 mmHg)** showed immediate post-laser mean IOP of **15.23 mmHg** and **2** hr post-laser mean IOP of **16.10 mmHg.** The baseline IOP group of **17-21 mmHg (**mean **18.05 mmHg)** showed immediate post-laser mean IOP of **19.01 mmHg** and **2** hr post-laser mean IOP of **20.71 mmHg.**

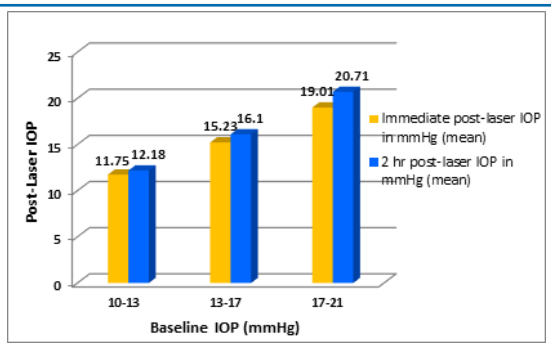

Fig. 12- Showing the difference between baseline IOP and immediate post-laser mean IOP and 2 hr post-laser mean IOP in the study population.

Discussion:

The study was conducted on 60 eyes attending the outpatient Department of Ophthalmology, Assam Medical College & Hospital, Dibrugarh who underwent cataract extraction with PCIOL implantation. The chief complaints of all the cases was diminished vision which varied from HM to 6/9.

1) The age and number of patients in each category has been analysed in our study and the most common age group affected was 61-80 years(53.33%). A clinical study of visual outcome in Nd:YAG laser capsulotomy done by B. Dharmaraju, et.al, 78% of the population having PCO in the age group of 41-80 years of age.
2) In our study there was no significant sex predilection was although number of male patients was higher i.e, 51.67%.
3) Right eye was involved in more number of patients in our study.
4) Most of the patients under study presented with a visual acuity between 6/36-6/18(45%) followed by visual acuity range of 4/60-6/60(31.7%). This finding is comparable to the study done by B. Dharamaraju, et al, where the maximum number of the patients had a pre-laser visual acuity range of 6/36-6/60.
5) In the study the duration between cataract extraction and development of PCO was found to be high within 0-2 years of cataract surgery. Spalton *(Eye 1999;13:489-92)* in their review article demonstrated that PCO is the commonest complication of cataract surgery occurring in up to 50% of patients after 2–3 years of surgery.
6) The most common morphology of PCO found in the study population was fibrous type (45%) followed by Elschnig's pearl (42%) which needs further evaluation.
7) In our study the continuous curvilinear capsulorhexis (CCC) technique of cataract extraction was higher than can opener technique. Ravalico *et al. (J Cataract Refract Surg 1996;22(1):98-103)* studied the relationship of capsulorhexis size with the occurrence of PCO and concluded that capsulorhexis with a slightly smaller diameter than the IOL optic appears to be better than a large-size capsulorhexis in reducing the incidence of PCO.
8) The most common type of intraocular lens implantation was in the capsular bag in the study group which needs further evaluation.
9) In our study the rate of PCO was high in PMMA group which is 81.7% than acrylic group with 18.3%. A laboratory study has shown that the AcrySof IOL has a relatively low propensity to induce cellular proliferation in the capsular bag and has less Sommering's ring formation than other IOL designs.
10) All the 60 patients had visual acuity improvement of 1 or more lines after capsulotomy. No one had further decline in visual acuity after capsulotomy.
11) On an average, patients with baseline IOP range between 10-13 mmHg had a mean IOP of 11.14 mmHg which raised upto 11.75 mmHg immediately post-laser and 12.18 mmHg 2 hour post-laser treatment. Similarly, patients with a baseline IOP range between 13-17 mmHg had a mean IOP of 14.50 mmHg which raised upto 15.23 mmHg immediately post-laser and 16.10 mmHg 2 hour post-laser treatment. Again, patients

with baseline IOP range between 17-21 mmHg had a mean IOP of 18.05 mmHg which raised upto 19.01 mmHg immediately post-laser and 20.71 mmHg 2 hour post-laser treatment. Wasserman *et al*. *(J Am Intraocul Implant Soc 1985;11(3):245-8)* presented results of a study of 367 Nd:YAG laser posterior capsulotomies and associated changes in intraocular pressure (IOP), corneal endothelial cell integrity, and visual acuities. The average maximum induced IOP rise was 1.4 mmHg and this occurred within 1 hour of the capsulotomy.

Keeping in view several vision-threatening complications of Nd: YAG laser capsulotomy or surgical capsulotomy, peeling or removal of epithelial cells from the posterior capsule in eyes with pearls type of PCO with automated irrigation mode or capsule vacuuming mode or using two-way Simcoe cannula is recommended particularly for high myopic patients where incidence of retinal detachment increases several folds after Nd: YAG laser or surgical posterior capsulotomy.

Conclusion:

Precise methods of evaluation are important to measure the progress of posterior capsule opacification. Nd:YAG laser posterior capsulotomy is a non- invasive, highly effective and relatively safe technique to restore vision in patients with after cataract.

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