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Original Article

Ophthalmology Section

# Contrast Sensitivity and Visual Acuity Before and After Nd:YAG Capsulotomy in Patients with Posterior Capsular Opacification: A Prospective Study

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## ABSTRACT

**Introduction:** Posterior Capsular Opacification (PCO) not only affects Visual Acuity (VA) but also Contrast Sensitivity (CS). Although main motive of performing Neodymium: Yttrium-Aluminium-Garnet laser (Nd: YAG laser) remains improvement in VA, an added benefit of improved contrast sensitivity makes the patient more satisfied in terms of quality of vision.

**Aim:** To evaluate the changes in VA and CS before and after Nd:YAG capsulotomy.

**Materials and Methods:** This was a hospital based prospective study conducted over a period of six months. Thirty five patients with PCO after uncomplicated cataract surgery were evaluated for VA and CS using Snellen's chart and Pelli-Robson chart respectively. Nd:YAG capsulotomy was done in one eye and patients were followed up on 4th week and the same parameters were measured.

**Results:** There was an improvement in VA in the range of 6/12-6/9 and the patients with Grade 3-4 of PCO were found to have CS in the ranges of 0.60-1.05 and 0-0.45 with the singular exception of one patient with CS in range of 1.20-1.65.

**Conclusion:** Nd:YAG capsulotomy in patients with PCO following uncomplicated cataract surgery results in an improved visual outcome not only in terms of VA but also in terms of CS. There was a significant difference in pre-laser CS based on the grade of PCO.


**Keywords:** Laser capsulotomy, Pelli-Robson, Visual performance

## INTRODUCTION

The Contrast Sensitivity (CS) refers to the measurement of the ability of the human eye to measure even a slight difference in luminance of two areas not separated by definite borders. Even though evaluation of diminution of vision is largely attributed to inability to identify form of an object, what the patient finds more disturbing in carrying out daily activities is the disruption of CS. Many diseases and conditions may be associated with a high VA but the patient may still complain of 'flat' or 'misty' vision [1]. In PCO, the commonest complaints of the patient include glare, difficulty in driving, reading, inability to reach nearby objects and blurring of vision. Many studies have found that morphological characteristics of PCO affect vision and CS [2]. While cataract affects higher spatial frequencies of CS, PCO has been found to affect lower frequencies [3]. PCO is the most common and widely found complication of Extracapsular Cataract Extraction (ECCE) and it is found in approximately 10% to 50% of all cases [4-6]. It is also considered to be the most common cause of impaired postoperative VA [6-8]. The varied nature of PCO may influence the way vision is affected. The thick PCO are thought to cause less forward scatter than Elshnig's pearls [9]. Patients with PCO are found to have lower CS which may be improved by laser capsulotomy [3,10,11].

Treatment of PCO involves the formation of an opening in the posterior capsule to clear the pathway of the visual axis by photo disruption with the help of Nd: YAG laser, commonly termed YAG laser capsulotomy [12]. This is a simple procedure in most cases, but is not without risks. Complications include Intraocular Lens (IOL) damage, IOL subluxation or dislocation, retinal detachment, and secondary glaucoma [13].

Karahan E et al., found that rise in Intraocular Pressure (IOP) was inevitable after laser capsulotomy as there was increase in macular thickness. This can be avoided by using less energy and reducing size of the laser spots [14].

In contrast Hu CY et al., found that laser capsulotomy did not significantly change the anterior chamber depth or IOP but improvement was noted in terms of refractive astigmatism which stabilised after one week [15]. While many studies have been conducted to evaluate the improvement in visual performance before and after Nd:YAG capsulotomy, studies correlating grade of PCO and CS are few in number [3,10]. The advantages of Pelli-Robson chart are that it measures low spatial frequency CS which is primarily affected in PCO. CS at lower spatial frequencies, particularly with letter targets, has shown to be a better indicator than VA measurements of the visibility of "real world" targets [16], orientation [17], and reading performance.

The primary aim of this study was to study the CS and VA before and after Nd:YAG capsulotomy in patients with PCO, to assess the improvement in visual performance if any by comparing the CS and VA of patients before and after Nd:YAG capsulotomy as well as to assess the correlation between Grade of PCO and deterioration of vision and CS.

## MATERIALS AND METHODS

A hospital based prospective study was conducted from April 2019 to September 2019 in the Department of Ophthalmology Acharya Vinoba Bhave Rural Hospital, Wardha, Maharashtra, India and all procedures were performed by a single surgeon. All patients who underwent uncomplicated cataract extraction at Acharya Vinoba Bhave Rural hospital and now presented to the hospital with PCO were selected for the study after taking the inclusion and exclusion criteria into consideration.

### Inclusion Criteria

1) Patients who underwent cataract extraction presenting with PCO at eye OPD.

### Exclusion Criteria

1) Patients with media opacities not suitable for capsulotomy.
2) Patients with disc or macular pathologies.
3) Patients with vitreoretinal diseases affecting VA.
4) Patient not giving valid consent.

A total of 35 patients were sequentially collected after considering inclusion and exclusion criteria. The study adhered to the tenets of the Declaration of Helsinki and was approved by an institutional ethics committee (IEC NUMBER-DMIMS/IEC/2018-19/7402). Informed consent was obtained from all subjects after the nature of the study was explained to them. A comprehensive ophthalmic examination, including Best-Corrected Visual Acuity (BCVA), slit-lamp examination, IOP measurement, and fundus examination, was undertaken for all participants. Snellen's chart was used to assess VA and improvement with pinhole if any was noted. All the patients were subjected to CS testing employing the Pelli-Robson chart. All the patients were made to read the chart at a distance of 1 meter from the top until he/she couldn't read anymore. The patient was given a credit of 0.05 log units for each letter correctly read by him/her. The final score in log units was calculated according to the number of letters correctly read by the patients. The degree of PCO was determined using the slit lamp technique described by "Sellman and Lindstrom" [18].

Grade 0- No PCO visible

Grade 1- PCO visible but not reaching to IOL edge

Grade 2- PCO at IOL edge

Grade 3- PCO crossing IOL edge but the visual axis is clear

Grade 4- PCO crossing visual axis

The capsulotomies were performed by applying punctures in a cruciate pattern to create an adequately sized central opening in the posterior capsule (2 to 4 mm approx.). The number of shots was variable depending upon the thickness of the capsule. Patients were reassessed post-procedure for evaluating CS, VA, and complications if any after four weeks period.

## STATISTICAL ANALYSIS

Statistical analysis was done by using descriptive and inferential statistics using chi-square test and Wilcoxon signed-rank test and software used in the analysis were SPSS 24.0 version and GraphPad Prism 7.0 version and $p<0.05$ is considered as the level of significance.

## RESULTS

Out of 35 patients evaluated, 21 patients were males and 14 patients were females indicating a higher male preponderance. The majority of patients in the study belonged to the age group between 41-50 years i.e., 10 patients (28.5%) [Table/Fig-1].

| Age group | No. of patients | Percentage | Male | Female |
|---|---|---|---|---|
| 21-30 yr | 2 | 5.71 | 2 | 0 |
| 31-40 yr | 5 | 14.29 | 5 | 0 |
| 41-50 yr | 10 | 28.57 | 8 | 2 |
| 51-60 yr | 9 | 25.71 | 4 | 5 |
| 61-70 yr | 7 | 20 | 2 | 5 |
| 71-80 yr | 2 | 5.71 | 0 | 2 |
| Total | 35 | 100 | 21 | 14 |
| Mean±SD | 51.14±12.37 | | 45.04±10.54 | 60.28±8.91 |

**[Table/Fig-1]:** Age and gender wise distribution of patients.

More than half i.e., 60% of patients in the study group presented with Grade 4 PCO while Grade 1 PCO was only seen in one patient accounting for 2.9% of the study group [Table/Fig-2].

| Grading of PCO | No. of patients | Percentage |
|---|---|---|
| Grade 0 | 0 | 0 |
| Grade 1 | 1 | 2.9 |
| Grade 2 | 5 | 14.3 |
| Grade 3 | 8 | 22.9 |
| Grade 4 | 21 | 60 |
| Total | 35 | 100 |

**[Table/Fig-2]:** Distribution of patients according to grading of PCO.

No complications occurred in any patient during or after the procedure.

The patients with Grade 3-4 of PCO were found to have CS in the ranges of 0.60-1.05 and 0-0.45 with the singular exception of one patient with CS in range of 1.20-1.65. According to the student's t-test, the result was highly significant with p-value <0.05 [Table/Fig-3]. There was no significant correlation between post-laser CS and grade of PCO [Table/Fig-4].

| | | Grading of PCO | | | | | |
|---|---|---|---|---|---|---|---|
| | | Grade 1 | Grade 2 | Grade 3 | Grade 4 | Total | $\chi^2$-value |
| Contrast sensitivity | 0-0.45 | 1 | 0 | 4 | 19 | 24 (68.57%) | 20.77 p=0.002, Significant |
| | 0.60-1.05 | 0 | 5 | 4 | 1 | 10 (28.57%) | |
| | 1.20-1.65 | 0 | 0 | 0 | 1 | 1 (2.86%) | |
| Total | | 1 | 5 | 8 | 21 | 35 | |

**[Table/Fig-3]:** Distribution of patients according to relationship between pre capsulotomy contrast sensitivity and grading of PCO.

| | | Grading of PCO | | | | | |
|---|---|---|---|---|---|---|---|
| | | Grade 1 | Grade 2 | Grade 3 | Grade 4 | Total | $\chi^2$-value |
| Contrast sensitivity | 0-0.45 | 0 | 0 | 1 | 3 | 4 (11.43%) | 3.63 p=0.93, Not significant |
| | 0.60-1.05 | 0 | 2 | 2 | 4 | 8 (22.86%) | |
| | 1.20-1.65 | 1 | 2 | 3 | 7 | 13 (37.14%) | |
| | >1.65 | 0 | 1 | 2 | 7 | 10 (28.57%) | |
| Total | | 1 | 5 | 8 | 21 | 35 (100%) | |

**[Table/Fig-4]:** Distribution of patients according to relationship between grade of PCO and contrast sensitivity after capsulotomy.

Before capsulotomy maximum patients presented with VA in the range of 6/18-6/24 followed by 31.43% in the range of 6/36 -6/60 and 4 cases with VA less than 6/60. The VA improved in 62.86% of cases in the range between 6/9-6/12 (22 cases), 22.86% of cases in the range between 6/18 to 6/24 (8 cases). The improvement in visual performance after ND:YAG capsulotomy, in terms of VA, was significant with a p-value of 0.0003 [Table/Fig-5].

| Visual acuity | Pre-capsulotomy | Percentage | Post-capsulotomy | Percentage |
|---|---|---|---|---|
| >6/9 | 0 | 0 | 2 | 5.71 |
| 6/9-6/12 | 6 | 17.14 | 22 | 62.86 |
| 6/18-6/24 | 14 | 40 | 8 | 22.86 |
| 6/36-6/60 | 11 | 31.43 | 3 | 8.57 |
| <6/60 | 4 | 11.43 | 0 | 0 |
| Total | 35 | 100 | 35 | 100 |
| $\chi$2-value | 21.35, p-value=0.0003, Significant | | | |

**[Table/Fig-5]:** Distribution of patients according to visual acuity before and after capsulotomy.

Before capsulotomy majority of the patients (68.5%) had CS between 0-0.45 log units followed by 28.5% between 0.60-1.05 log units. After capsulotomy, the majority of the patients had CS between 1.80 to 2.25 log units followed by 28.5% in the range of 1.20-1.65 log units. According to student's t-test the result was

highly significant with p-value 0.008. According to the Wilcoxson Signed Rank test, the result was highly significant with z-value 5.08. Therefore, it can be concluded that CS showed significant improvement after the ND:YAG capsulotomy [Table/Fig-6].

| Contrast sensitivity | Pre-capsulotomy | Percentage | Post-capsulotomy | Percentage |
|---|---|---|---|---|
| 0-0.45 | 24 | 68.57% | 5 | 14.29% |
| 0.60-1.05 | 10 | 28.57% | 6 | 17.14% |
| 1.20-1.65 | 1 | 2.86% | 10 | 28.57% |
| 1.80-2.25 | 0 | 0% | 14 | 40% |
| Total | 35 | 100 | 35 | 100 |
| Mean±SD | 0.46±0.28 | | 1.34±0.49 | |
| z-value | 5.08, p-value=0.008, Significant | | | |

**[Table/Fig-6]:** Distribution of patients according to contrast sensitivity before and after capsulotomy.

## DISCUSSION

Patients with PCO find it more difficult to perform daily tasks when CS is compromised as compared to VA. Therefore, a better understanding of the effect of ND:YAG capsulotomy, the most cost-effective means of treating PCO, on these visual parameters is important. In present study, we found the mean age of patients presenting with PCO to be 51.14±12.37 which is consistent with findings in other studies. In a similar study conducted by Sharma P et al., the maximum number of patients belonged to the age group between 61 to 70 years which included 18 cases (36%), followed by 51 to 60 years which included 14 cases (28%) [18]. The mean age of patients was 52.54+11.89 years. Grade 4 PCO had CS between 0-1.50. Two patients with Grade 1 PCO had CS between 1.85-1.95 therefore patients with higher grades of PCO had low CS. Similarly, in the current study patients with Grade 3-4 of PCO were found to have CS in the ranges of 0.60-1.05 and 0-0.45 with the singular exception of one patient with CS in range of 1.20-1.65.

Magno BV et al., measured visual functions before and after capsulotomy in 24 patients, using the Pelli-Robson chart [3]. CS showed improvement in the range of 0.24 log units with p<0.0001. While 22 eyes (92%) had a post-laser acuity of 20/32 or better, with 13 eyes (54%) showing at least 20/20 acuity. There was a significant average increase in CS. Likewise in the present study, the VA improved in 62.86% of cases in the range between 6/9-6/12 (22 cases) and 22.86% of cases in the range between 6/18 to 6/24 (8 cases). The improvement in visual performance after ND:YAG capsulotomy, in terms of VA, was significant with a p-value of 0.0003.

Cheng CY et al., reported an improvement of CS in patients with both types of PCO in 29 patients [19]. Another study with Wang J et al., measured CS in 67 cases before and after capsulotomy and found CS improved in all cases [20]. There was a very significant difference (p<0.01). This resounds very well with the present study wherein after capsulotomy, the majority of the patients had CS between 1.80 to 2.25 log units followed by 28.5% in range of 1.20-1.65 log units and the result was highly significant with p-value 0.008.

Meacock WR et al., conducted a study to evaluate the effect of PCO on visual function by documenting PCO using retro illumination photography of posterior capsule [21]. In this study they found optical aberrations, such as PCO, cause forward light-scatter inside the eye, which results in a masking that covers the retinal image, resulting in a loss in CS. This can also explain why VA is not enough to assess real-time visual performance in patients with PCO as VA may be affected by other factors such as neuronal degeneration as well as age-related optic nerve changes and less due to the effect of PCO alone. An assessment of CS is thus imperative.

It has been argued that the Pelli-Robson chart only tests three letters at each contrast level, subjecting it to misreporting [22], however it remains a valuable determinant of CS in present study as it can measure CS at lower spatial frequencies which occur in PCO. Also, a larger sample size could have ensured a stronger correlation between the grade of PCO and CS in this study. A study conducted by Cheng CY et al., found patients with pearl-type PCO suffered generalised lower CS at all spatial frequencies than those with fibrosis-type PCO [19].

### Limitation(s)

The present study did not take into consideration the qualitative component of PCO which can further add to understanding of the effect of PCO on CS. Future research in this field should aim to employ better techniques to grade PCO such as using retro-illumination photography, as the technique used in this study is subjective.

## CONCLUSION(S)

PCO adversely affects the visual performance of patients in terms of reduction of CS and VA. After ND:YAG capsulotomy both parameters improved significantly on measuring with Pelli-Robson chart and employing statistical tests.

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