Original Article

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Relationship between Amount of Energy Used and Rise in Iop in Cases of Neodymium: Yttrium-Aluminum-Garnet Laser Posterior Capsulotomy

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Abstract

Objective: To find the relationship between the amount of energy used and significant rise in IOP (>5mmHg) after Nd:YAG laser posterior capsulotomy.

Materials and Methods: 100 pseudophakic eyes of adults age 30-70 yrs of either sex having PCO are included. Amount of laser energy (milli joules) used in each case noted, IOP was measured just before the procedure and at 1,4,24 hours after procedure in each case. Total energy used is grouped into low (<20mJ), intermediate (20-40mJ), high (>40mJ). Change of IOP at 3 post laser recording times categorized into 1) No change 2) Rise of 1-5mmHg 3) >5 mm Hg.

Results: 100 pseudophakic eyes, 61 males and 39 females. Number of patients in low, intermediate, high energy group were 43,45,12 respectively and significant rise in IOP (>5mm Hg) noted are 6/43 (13.9%), 12/45 (26.6%), 8/12 (66%) respectively. Significant rise in IOP noted at 1,4,24 hours post laser application are 7/26 (26.9%), 15/26 (57.6%), 4/26 (15.3%) respectively.

Conclusion: There is a directly proportionate relationship between the amount of laser energy used and IOP rise.

Keywords: Neodymium; Yttrium-Aluminum-Garnet Laser; Intraocular Pressure; Cataract.

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Introduction

Cataract is defined as any opacity in the crystalline lens of the eye that may be congenital or acquired that impairs vision. It is by far the most common curable cause of low vision and blindness worldwide. Cataract forms the major cause of blindness in India accounting for about 62.6% [1] amongst all the causes of blindness. Cataract extraction is the most frequently performed surgical procedure in patients over 60 years of age.

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The development of cataract surgery has led the world from the uncertain time of couching of lens to the ICCE, ECCE. The visual results of cataract surgery are at present very good and serious complications such as endophthalmitis and suprachoroidal haemorrhage are fortunately very rare, affecting less than 1 in 1000 patients in many series. In ECCE and phacoemulsification due to preservation of posterior capsule of lens, allows placement of posterior chamber IOL and prevent prolapse of vitreous into AC. It also reduces the risk of several complications, including vitreous loss and subsequent vitreous detachment, cystoid macular edema and retinal detachment. ECCE with posterior chamber IOL implantation is the common ocular surgery performed in all the eye care centers. Sometimes residual lens epithelial cells proliferate and migrate to form a dark cloud in front of visual field known as posterior capsule opacification. PCO otherwise also known as secondary cataract or after cataract is a frequent

and late complication of extracapsular cataract extraction (ECCE) either small incision cataract surgery (SICS) or phacoemulsification with or without IOL implantation as mentioned by Pandey et al. [2] PCO develops months to years after cataract surgery. Incidence of PCO varies from 20.7 % [3] at 2 years & 28.5% [3] at 5 years after cataract surgery. Schaumberg et al metanalysis of published articles showed that incidence of PCO during 5 years postoperative period is 25% [4]. PCO can lead to clinically significant reduction in visual acuity and impaired contrast sensitivity.

Management of PCO is surgical before the era of Nd:YAG laser posterior capsulotomy. PCO was treated with primary or secondary surgical capsulotomy and surgical polishing of posterior capsule [5], but because of complications associated with above procedure,YAG capsulotomy became the procedure of choice. Nd:YAG laser posterior capsulotomy is an ophthalmic procedure aimed at removing the opacified capsule from pupillary area in aphakic/pseudophakic eyes. The procedure is generally non-invasive, harmless and improvement of vision is marked.This laser works by photo-disruptive properties. Common complications include IOP rise, hyphema, cystoid macular edema, corneal haze, uveitis, IOL pits, retinal detachment. So it is common practice by the ophthalmologists to prescribe anti-glaucoma medications to lower IOP before and after procedure.

It has been postulated that the increase in IOP post YAG capsulotomy is due to reduced outflow facility because of blockade of trabecular meshwork by the inflammatory cells and capsular debris6,vitreous particles floating in the anterior chamber. The total energy used is an important factor leading to raised IOP after laser capsulotomy.Therefore, it was decided to conduct study on this important but less attended aspect. The objective of our study is to establish the relationship between total energy used and IOP rise by comparing the relative frequency of raised IOP into low, intermediate and high energy groups. We also determined the post YAG time interval in which this rise of IOP affects the patient population maximally.

Materials & Methods

This cross sectional observational study was conducted over a period of 12 months (August 2017 -August 2018) on 100 patients presenting with PCO after cataract surgery who attended ophthalmology OPD at Narayana Medical College and Hospital, Nellore.

Inclusion Criteria

All adult cases 30-70 yrs. of either sex having PCO with vision < 6/24 and giving informed consent are included in the study

Exclusion Criteria

- Age <30 years
- PCO associated with corneal scars, irregularities and oedema that interferes with target visualization.
- PCO associated with active intraocular inflammation.
- Patients having glaucoma/on glaucoma medication/ had trabeculectomy
- Patients on topical/systemic steroid therapy
- Postoperative cataract surgery patients of <8 weeks

Data Collection

- Name, age, sex and address of all the patients were noted.
- Local examination was done as follows:

a. Visual acuity – BCVA was noted from Snellen's chart

b. Slit lamp examination –Anterior segment was examined. PCO was examined and type of opacity is noted

c. Fundus examination – Dilated fundus examination done by slit lamp biomicroscopy

d. Tonometry – Preoperative baseline intraocular pressure was taken by Applanation tonometer, at least 1 hour before the procedure.

Technique

All patients with PCO and vision <6/24 were subjected to Nd:YAG laser capsulotomy. The procedure to be done & complications associated with it were explained to the patients and oral consent was taken. All capsulotomies were done using APPA YAG LASER machine at single burst per pulse and amount of energy used depended on thickness of PCO. The aiming beam was focused on posterior capsule. A cruciate opening in capsule begins superiorly at 12 o'clock position progressing towards 6 o'clock cut across at 3 o'clock and 9 o'clock positions. Any residual tags or freely floating fragments are cleared.

Postoperative Care

All patients were examined post laser. Total amount of laser energy used in each case and IOP at 1st hr, 4th hr and 24th hour after procedure recorded in each case. Total energy used is grouped into low (20mJ), intermediate (20-40 mJ), high (>40mJ). Change in IOP at 3 post laser recording times was categorised into 1) no change of IOP, 2) rise of (1-5mm Hg) 3) significant change (>5 mm Hg rise in IOP). No medication was administered until 24 hrs of procedure. For all patients, topical steroids (1% prednisolone) administered 4-6 times/ day and is tapered over 1-2 weeks. Patients with significant rise in IOP (>5mm Hg) treated with topical Brimonidine 0.2% eye drops BD for 1 week.

Results

100 pseudophakic eyes were studied, 61 males and 39 females. 62% were right eye and 38% left eye. Age ranged from 30-70 years. Maximum patients are seen in the age range of 51-60 (42%) followed by 61-70 (37%). Most common type of PCO is membranous type (72%). Number of patients receiving low, intermediate, high energy were 43, 45,12 respectively and significant rise in IOP (>5mm Hg) noted in 6/43 (13.9%), 14/45 (31%), 8/12 (66%) respectively. Significant rise in IOP (>5mm Hg) noted at 1,4,24 hrs post laser application are 10/28 (35.7%), 14/28 (50%), 4/28 (14.3%) respectively. A total of hundred eyes were studied, males were 61 (61%) and females were 39 (39%) (Tables 1-3).

Table 1: Age distribution

Age group in yrs.	No.of patients = 100	Percentage
30-40	4	4%
41-50	17	17%
51-60	42	42%
61-70	37	37%

Table 2: Laterality distribution

Eye	No.of patients = 100	Percentage
Right eye	62	62%
Left eye	38	38%
Total	100	100%

Table 3: Morphological type of PCO

PCO morphology	No.of patients = 100	Percentage
Membranous	72	72%
Elschnig's pearls	17	17%
Soemmering's ring	11	11%

In the present study, duration of onset of symptoms of PCO is more common between 1-2 years (42%) after surgery. The earlier is after 6 months and longest is > 4 years after surgery. In the present study IOL pitting was seen in 8 (8%) cases, 4 (4%) cases developed iritis, 2 (2%) cases developed CME, corneal burns and hyphema seen in 1 (1%) patient each (Table 4).

Table 4: Total energy used and IOP rise

Energy Groups	Total patients	No change in IOP	Rise of 1-5 mmHg	Rise of IOP >5 mmHg
Up to 20 mJ	43	11 (25.5%)	26 (60.4%)	6 (13.9%)
20 – 40 mJ	45	3 (7%)	28 (62%)	14 (31%)
>40 mJ	12	1 (9%)	3 (25%)	8 (66%)

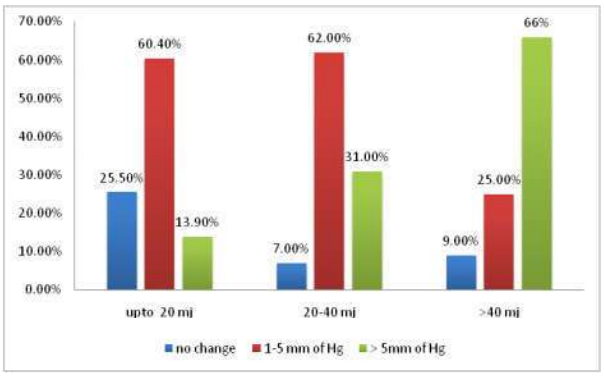

Fig. 1: Showing different categories of IOP responses in low, intermediate, high energy groups.

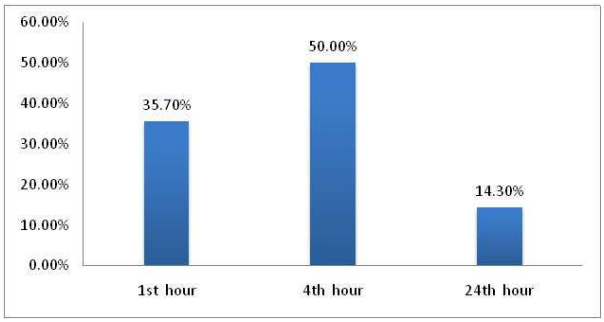

Fig. 2: Showing split of 26 patients with significant rise of IOP at 1,4, 24 hrs post laser.

Discussion

PCO is the most common delayed complication of cataract surgery. The incidence of PCO was reported to be 20.7% [3] at 2 years and 28.5% [3] at 5 years after cataract surgery. The standard treatment for PCO is Nd:YAG laser posterior capsulotomy. The visual outcome after Nd: YAG laser capsulotomy is significantly high. Even though the procedure is quiet safe it is associated

with complications like transient IOP rise, damage to IOL, cystoid macular oedema,retinal detachment, vitreous in anterior segment, anterior uveitis etc. Most common complication is rise in IOP and IOL pitting being the second most complication observed.

In our study 79% patients were in 50-70 years age group. This was the commonest age group who undergo cataract surgery. The minimum age was 31 years and maximum age was 70 years.

In the study conducted by Manav deep Singh et al. [7], the mean age of patients was 58 years. In the study conducted by Wajeeha Rasool et al. [8], the mean age of the patients was 66 years ,with a range of 50-85 years. In Ajite KO et al. [9], most of the patients were in the 41-80 years age range. This is perhaps the age at which patients with age related cataract presents to the ophthalmologists due to visual problems.

In the present study we had 61% males and 39% females. Male: female ratio is 1.56:1. In the study conducted by MY Khan et al. [10], 39 (67.2%) were males and 19 (32.8%) were females. In Wajeeha Rasool et al. [8], study sex incidence was 118 (59%) males and 82 (41%) females. Mirza Shafiq et al. [11], found a male preponderance in PCO in which males were 350 (70%) and females were 150 (30%). All the above studies correlate with our study of significant male preponderance. This may be related to predominant male population in our country and female population less commonly present to the hospital for their reduced vision and less commonly undergo cataract surgery.

In the present study most number of patients with PCO presented between 1-2 years after cataract surgery. The earliest onset is after 6 months and longest is 4 years after surgery.

In the study conducted by Jayne Ge et al. [12], the average time between cataract extraction and capsulotomy was 24 months. In Mirza Shafiq et al. [11], study the time period between surgery and YAG laser was between 6 months to 12 years. In prospective studies conducted by Ajite KO et al. [9]. and Lal Muhammad et al. [13], diagnosis of PCO is in between 3-12 months post surgery.This variation may be a result of the surgical technique employed by the surgeons or nature of the intraocular lenses implanted promoting the development of PCO.

In the present study most common type of PCO was found to be membranous type (76%), Elschnig's pearls constitute 17 (17%) and Soemmering's ring is present in 11 (11%) patients.

In the study conducted by Shankar Ganvit et al. [14], membranous PCO constitutes 57% of all types. In Mirza Shafiq et al. [11], study membranous PCO was found in 260 (51%) patients. However in Niharika K. Shetty et al. [1], study Elschnig's pearls constitute 74.28% of total PCO morphology and study of Ronald Holweger et al. [15], showed 61.38% patients has Elschnig's type PCO.

Rise of IOP is the most common complication after Nd:YAG laser capsulotomy. It has been postulated that the increase in IOP post YAG capsulotomy is due to reduced outflow facility because of blockade of trabecular meshwork by the inflammatory cells, capsular debris [6] and vitreous particles floating in the anterior chamber [6].

Risk Factors that Affect Iop after Laser Capsulotomy

1. Size of capsulotomy – small ones has small IOP rise
2. High total energy used – more IOP rise due to laser induced shock waves which damage trabecular meshwork
3. Capsular bag fixation IOLs– which provide barrier effect to debris produced by capsulotomy have minimal IOP rise
4. Patient dependant risk factors [16,17]:

   a. Aphakia

   b. Glaucoma

   c. High myopia

   d. Vitreoretinal disease

   All above are associated with higher IOP rise.

In our study amount of laser energy used was categorised into 3 groups i.e, upto 20 mJ (low), 20-40 mJ (medium) and >40 mJ (high). Significant rise of IOP (>5mm Hg) was seen in 13.9% in low energy group, 31% in medium energy group and in 66% in high energy group. Thus we found a proportionately rising rate of significant IOP rise (>5 mm Hg) in high energy groups when compared to lower energy ones which is statistically significant (p value = 0.001).

Similar study but with different energy values by Qamar Farooq et al. [18], shows that significant rise of IOP was noted in 30 out of 90 patients, 50% of them (15 out of 30 patients) belong to high energy group. In Muhammad Waseem and Haseeb Ahmed Khan et al. [19], study the mean rise in IOP value was 3.83 ± 1.84 mm Hg in Low energy category (<50 mJ) where as in 'High energy' category the mean rise in IOP value was 5.51 ± 1.58 mmHg which is statistically significant (p > 0.001).

In Niharika K. Shetty [1], Sriya Sridhar et al. [1] studies patients were exposed to total of 2-14 mJ energy & more rise in IOP was seen in patients receiving 11-14 mJ energy. In Richter CU et al. [16], while using > 200 mJ they noticed a rise of IOP (> 10 mm Hg) in their 67% of cases, 38% of which were having > 40 mm Hg rise in IOP. According to Bhargava R et al. [20], rise in IOP was seen in 12.6% of the patients in which average energy used was 57.8 mJ when compared to no rise of IOP in patients receiving 42.3 mJ of energy. Channel and Beckman et al. [3], study showed that higher IOP rise was associated with larger capsulotomies and increased laser energy use during YAG procedures

In the present study, out of 100 patients significant rise in IOP (>5 mm Hg) is seen in 28 patients. Out of these 28 patients, 10 (35.7%) showed IOP rise at 1st hour, 14 (50%) showed IOP rise at 4th hour and 4 (14.3%) patients at 24th hour. In 85.7% of patients IOP surge is seen in first 4 hours.

In Qamar Farooq et al. [18] study rise in IOP is seen in 63.3% patients in 1st hr, 33.3% at 4th hr, 3.3% at 24th hr after the procedure. Thus IOP surge is noted within first 4 hours in 97% of patients of this study. Similar study by Richter CU et al. [16], showed that 13 mm Hg IOP rise seen in first 3 hrs, 5 mm Hg in first 24 hrs and IOP returned to baseline within 1 week. In Manavsingh, Nidhisharma et al. [21], study rise of IOP from baseline at 1,3,5 hours post laser come down to insignificant levels at 24 hours. In Channell MM, Beckman et al. [3] study all eyes in which IOP increased > 5 mm Hg showed the rise within the first 48 hrs.

Even though laser posterior capsulotomy is very safe and non-invasive procedure several complications have been reported. In the present study IOL pitting was observed in 8 (8%) cases, which was not visually significant and didn't produce any glare or image distortion. 4 (4%) developed iritis which was treated with topical steroids and cycloplegics. 2 (2%) cases developed CME ,which was treated with topical 1% prednisolone acetate and NSAIDS. Corneal burns and hyphema is seen in 1 (1%) patient each.

Conclusion

PCO is the most common complication following cataract surgery which can be safely treated by Nd:YAG laser posterior capsulotomy as an OPD procedure. The common complication encountered after Nd:YAG laser capsulotomy is transient rise in IOP which returns to baseline within 48 hours in most patients. Correlation exists between total energy used and IOP rise. Some rise of IOP does occur in most of the cases, but those receiving higher amount of laser energy develop significant IOP elevations. This pressure rise is seen in first 4 hours in most of the cases. Minimal total energy possible should be used to perform laser capsulotomy and those requiring higher energy are worth monitoring.

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