Evaluation of Vitreoretinal Changes after Nd: YAG Laser Posterior Capsulotomy

Mohamed El-Moddather Ahmed Dardyr, Emad Abdel Aal Saliem, Hossam Ahmed Sabra
Ophthalmology Department, Faculty of Medicine, AL-Azhar University (Assuit), Egypt

ABSTRACT

Objective: To evaluate the vitreoretinal changes after Neodymium-Yttrium-Aluminum-Garnet (Nd: YAG) laser posterior capsulotomy in patients with posterior capsular opacification after cataract extraction.

Patients and Methods: 60 pseudophakic eyes of 50 patients with opacified posterior capsule after uncomplicated cataract surgery treated by Nd: YAG laser posterior capsulotomy. Patients were divided according to the preoperative refractive state of the eye into three groups (Myopic, Hypermetropic, and Emmetropic). Vitreoretinal assessment was done pre and post YAG capsulotomy.

Results: The mean best corrected visual acuity (BCVA) had improved after YAG laser posterior capsulotomy in all groups ($p < 0.001$). Although there was no significant correlation between the refractive state of the eye and changes in CMT measured by optical coherence tomography (OCT) ($p > 0.096$), however, there was a statistically significant increase in CMT before and one week after YAG posterior capsulotomy ($p < 0.001$) without any detectable clinical effect on the BCVA.

Conclusion: Nd: YAG laser posterior capsulotomy is the standard treatment for posterior capsular opacification [PCO] and gives rise to rapid improvement in visual acuity relieving the symptoms of blurring, photophobia, and glare.

Keywords: Capsular Opacification**,** Vitreoretinal changes, Nd: YAG laser posterior Capsulotomy.

INTRODUCTION

Cataract is the main cause of avoidable blindness in the world. Extracapsular cataract extraction [ECCE] and phacoemulsification [PHACO], with posterior chamber intraocular lens implantation [PC-IOL] are the surgical techniques mostly used to remove the cataract. Posterior capsular opacification [PCO] is one of the most common postoperative complication which results in decreased visual performance of the patient. It develops in approximately 20% of patients who have undergone cataract surgery. PCO is characterized by proliferation, transformation, and migration of lens epithelial cells remaining on the margin of anterior capsule which form plaques on the central portion of the posterior capsule. Over time, the capsule becomes opacified by various proteins within the eye and this will reduce the visual acuity of the patient [1]. Time from cataract surgery to visually significant posterior capsular opacification varies from months to years in adults. Almost 100% opacification occurs within 2 years after surgery in younger age groups. Rate of opacification declines with increasing age

The Neodymium-Yttrium-Aluminum-Garnet [Nd: YAG] laser is a solid state laser with a wavelength of 1064 nm that can disrupt ocular tissues by achieving optical breakdown with a short, high-power pulse. Optical breakdown results in ionization and plasma formation in the ocular tissue. This plasma formation then causes acoustic and shock waves that disrupt tissues [3]. The Nd: YAG posterior capsulotomy is an outpatient effective, and relatively safe technique for opening the opacified posterior capsule [4].

Although Nd:YAG laser capsulotomy is accepted as a standard treatment for PCO and has been found to be safe and effective, however it is not without complications, some of which can be sight-threatening. Several studies have described damages in the intraocular lens [IOL], increased intraocular pressure [IOP], iritis, corneal injury, hyphema, vitreous prolapse, vitritis, cystoid macular edema, retinal tear, retinal detachment [RD] and reactivation of dormant microorganism in the posterior capsule that may induce intraocular infection [5].

Evaluation of vitreoretinal changes after Nd-YAG laser posterior capsulotomy is carried out through a variety of measures including detailed fundus examination, B-scan and optical coherence tomography [OCT] which is one of the most helpful tool in vitreoretinal assessment [6]. The present study aimed to focus on vitreoretinal changes or complications that may occur after Nd: YAG laser posterior capsulotomy.

PATIENTS AND METHODS

This prospective study was performed in the Department of Ophthalmology at Al-Azhar University Hospital-Assuit between April 2018 and November 2018 and included 60 pseudophakic eyes of 50 patients with a significant visual loss due to posterior capsular opacification treated by Nd-YAG laser posterior capsulotomy. All of these patients had undergone non-complicated cataract surgery (phacoemulsification "46 eyes", extracapsular cataract extraction "8 eyes" and manual small incision cataract surgery [MSICS] "6 eyes". An informed written consent was obtained from each patient before the enrollment in the study. **Al-Azhar University Institutional Ethics Committee approval was obtained.** The age ranged between 26-84 years with the main age of 58.68±12.37 years.

Received:9/11/2018
Accepted:28/11/2018

Exclusion criteria include: Corneal scars or edema that precludes adequate visualization of the target aiming beam, abnormal measurement of the macula. Also patients with a history of uveitis or complicated cataract surgery and patients with any vitreoretinal pathology and a history of previous vitreoretinal surgery. All patients were clinically assessed by full history taking in terms of personal data, duration of blurring of vision, history, time and type of cataract surgery. All patients were undergone ophthalmological examination of the eye including ocular examination with slit lamp biomicroscopy, uncorrected visual acuity (UCVA), best corrected visual acuity (BCVA), intraocular pressure (IOP) measurements, detailed fundus examination, B-scan ultrasound and optical coherence tomography(OCT) of the macula were performed before YAG laser and re-evaluated at the 1st week, 1st month and at 3rd month after Nd: YAG laser capsulotomy. The studied eyes were divided into 3 groups according to the refractive state as follow:

Group (A): consisted of 20 **emmetropic** eyes of 16 pseudophakic patients, 6 males and 10 females.15 eyes post phaco , 2 eyes post ECCE and 3 eyes post MSICS.

Group (B): consisted of 20 **myopic** eyes of 17 pseudophakic patients, 9 males and 8 females 16 eyes post phaco , 2 eyes post ECCE and 2 eyes post MSICS.

Group (C): consisted of 20 **hypermetropic** eyes of 17 pseudophakic patients, 5 males and 12 females. 15 eyes post phaco, 4 eyes post ECCE and 1 eyes post MSICS.

All posterior capsulotomies were performed in a single session with an Nd: YAG laser (VISULAS YAG III, Carl Zeiss, Germany 2007) using Abraham YAG capsulotomy lens. The aiming beam was focused on the posterior capsule and the capsule was examined for wrinkles that indicate tension lines. Shots placed across tension lines result in the largest opening per pulse because the tension causes the initial opening to widen.Different techniques have been employed in YAG capsulotomy, the most popular is the cruciate pattern capsulotomy, which was easy technique with short procedure time [4,5]. The total energy, number of shots of each patient were recorded. After Nd: YAG laser, topical steroid, and Alpha 2 agonist eye drops were prescribed one week to control inflammation and IOP elevation respectively.

Statistical analysis

Categorical variables were described by number and percent (N, %) and continuous variables were described by range, mean and standard deviation (Mean±SD), median and IQ). For parametric data; one way ANOVA test, and paired-samples t-test were used to compare between data. For non-parametric data; Wilcoxon test was used to compare between data. For correlation; we used Pearson correlation. The significance level was set at $P < 0.05$. Statistical analysis was performed with IBM SPSS Statistics Version 20 for Windows.

RESULTS

This prospective study, evaluated a total number of 60 pseudophakic eyes of 50 patients diagnosed as PCO during the study period. These patients were 20 males (40%) and 30 females (60%). The age at the time of YAG laser capsulotomy ranged from 26 to 84 years, with a mean age of 58.68±12.37 years. The results showed that there was no significant difference among groups regarding age (p=0.546) and the mean interval between surgery and laser capsulotomy (p=0.509) (table 1).

Table (1): Distributing the age of patients and operative time among different groups.

	Myope	**Hypermetrope**	**Emmetrope**	**P value**
Age				
Range	26 – 69	35 - 76	33 - 84	
Mean ± SD	55.88 ± 11.6	59.56 ± 11.28	60.39 ± 14.28	0.546
Operative time				
Range	5 – 36	5 - 36	5 - 24	
Mean ± SD	13.2 ± 8.13	13.55 ± 8.88	10.95 ± 5.48	0.509

In the emmetropic eyes, the CMT was changed from 161 – 254 µm with a mean of 195.3±26.12 µm before YAG laser capsulotomy to169 – 305 µm with a mean of 233.95±30.11 µm one week after YAG capsulotomy that was statistically highly significant ($p < 0.001$). In the myopic eyes, the CMT was changed from 149 – 232 µm with a mean of 188.55±23.16 µm at baseline before YAG laser capsulotomy to 165 – 264 µm with a mean of 217.05±29.69 µm one week after YAG capsulotomy that was statistically highly significant ($p < 0.001$). In hypermetropic eyes the CMT was changed from 147 - 243 µm with a mean of 201.9±26.71 µm at baseline before YAG laser capsulotomy to 186 - 276 µm with a mean of 223.6±25.8 µm one week after YAG capsulotomy that was statistically highly significant ($p < 0.001$).

Though the changes in CMT before and after YAG capsulotomy was statistically highly significant ($p < 0.001$), however, the changes in the CMT between emmetropic, myopic and hypermetropic eyes both before and after YAG capsulotomy were statistically insignificant ($p < 0.096$) and there were no detectable clinical changes in the BCVA as the maximum thickness after one week was 290 µm which was within normal range by OCT macular cube (table 2 and figure 1).

Table (2): Distribution of the studied cases according to changes in CMT (µm) using OCT in correlation to the refractive state of the eye.

	Myope	Hypermetrope	Emmetrope
Pre YAG CMT (µm)			
Range	149 – 232	147 – 243	161 - 254
Mean±SD	188.55±23.16	201.9±26.71	195.3±26.12
Median (IQ)	186.5 (167.25-204.75)	202 (178.5-221.75)	187.5 (176.5-204)
One week post YAG CMT (µm)			
Range	165 – 264	186 – 276	169 - 305
Mean±SD	217.05±29.69	223.6±25.8	233.95±30.11
Median (IQ)	208 (191.75-244.25)	225 (206-238)	238 (210.75-254.75)
P. value	<0.001**	<0.001**	<0.001**
Wilcoxon	<0.001**	<0.001**	<0.001**

Paired-samples T test, Wilcoxon test.
** Highly statistically significant difference ($p<0.001$).

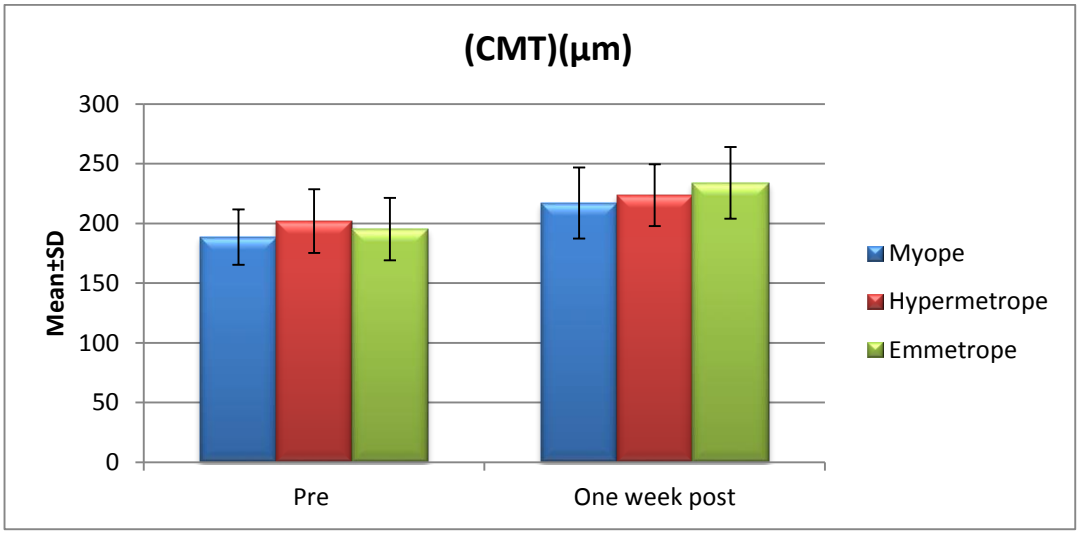

Figure (1): Distribution of the studied cases according to changes in CMT using OCT in correlation to the refractive state of the eye.

Changes in vitreous floaters after YAG capsulotomy were statistically insignificant ($p = 0.053$) in emmetropic eyes, in both myopic ($p = 0.741$) and hypermetropic eyes ($p = 0.222$). Also there was no induction of new PVD in all groups after YAG capsulotomy; this means YAG laser can produce mild vitreous floaters but cannot induce PVD (figure 2).

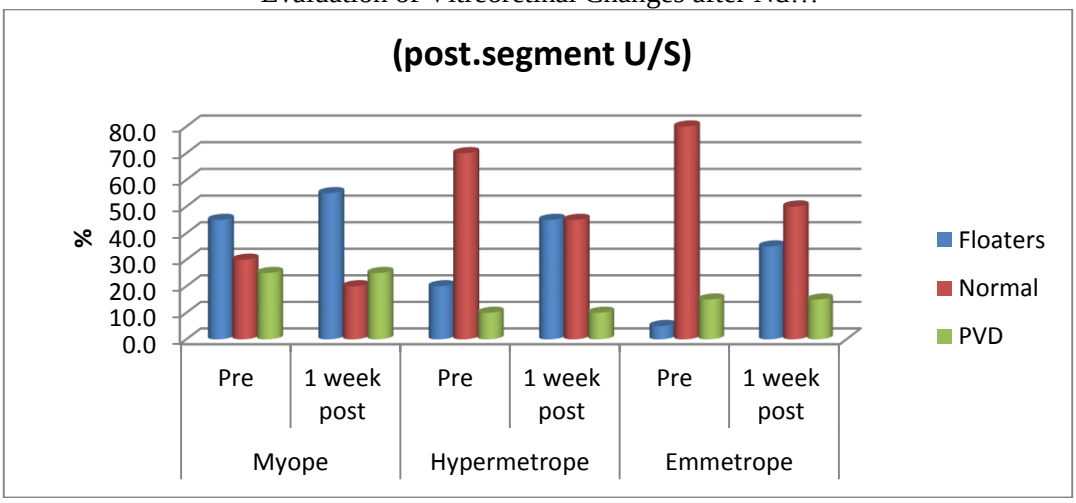

Figure (2): Distribution of the studied cases according to changes in sonographic finding in correlation to refractive state of the eye.

The pre YAG IOP ranged from 12 - 19 mmHg, with a mean of 15.03 ± 1.88 mmHg. Three days after YAG capsulotomy IOP was measured and ranged from 16 - 26 mmHg, with a mean of 20.73 ± 2.36 which mean a significant increase in IOP (P < 0.001). After one week of YAG capsulotomy IOP ranged from 15 - 22 mmHg with a mean of 17.73 ± 1.76. After two weeks of YAG capsulotomy IOP ranged from 10 – 18 mmHg with a mean of 14.6 ± 2.66 which is nearly similar to the pretreatment normal level of the patients. There was no statistically significant difference in IOP changes between three groups (p = 0.922) (table 3 and figure 3).

Table (3): Distribution of the studied cases according to changes in IOP in correlation to refractive state of the eye.

IOP (mmHg)	Myope	Hypermetrope	Emmetrope	P. value
Pre YAG				
Range	12 - 18	12 - 18	12 – 19	
Mean ± SD	15.25 ± 2.17	14.75 ± 1.55	15.1 ± 1.92	0.695
Median (IQ)	15(13.25 - 18)	15 (14 - 16)	15 (14 - 16)	
3 days post YAG				
Range	18 - 26	16 - 25	16 – 25	
Mean ± SD	20.9 ± 2.31	20.6 ± 2.04	20.7 ± 2.79	0.922
Median(IQ)	20 (19 - 22.75)	21 (19.25 - 21.75)	20.5 (18 - 23)	
One week post YAG				
Range	15 - 22	15 - 20	15 – 21	
Mean ± SD	17.9 ± 2.02	17.8±1.2	17.5±1.99	0.761
Median(IQ)	17 (16.25 - 19)	17.5 (17 - 19)	17 (16 - 19.5)	
Two weeks post YAG				
Range	12 - 18	10 - 18	10 – 18	
Mean ± SD	15.65 ± 1.81	14.45 ± 2.56	13.7 ± 3.18	0.069
Median (IQ)	14 (15.5 - 17)	12.5 (15 - 16)	11 (12.5 - 17)	
P1	<0.001**	<0.001**	<0.001**	
P2	<0.001**	<0.001**	<0.001**	
P3	<0.001**	<0.001**	<0.001**	
P4	0.531	0.656	0.100	
Wilcoxon 1	<0.001**	<0.001**	<0.001**	
Wilcoxon 2	<0.001**	<0.001**	<0.001**	
Wilcoxon 3	<0.001**	<0.001**	<0.001**	
Wilcoxon 4	0.531	0.656	0.100	

Paired-samples T test, Wilcoxon test, ** Highly statistically significant difference (p<0.01).
P1 and Wilcoxon1: Comparison between pre and 3days post YAG, P2 and Wilcoxon2: Comparison between pre and one week post YAG. P3 and Wilcoxon3: Comparison between 3days post and one week post YAG, P4 and Wilcoxo4: Comparison between pre and Two weeks post YAG, P. value Anova t test.

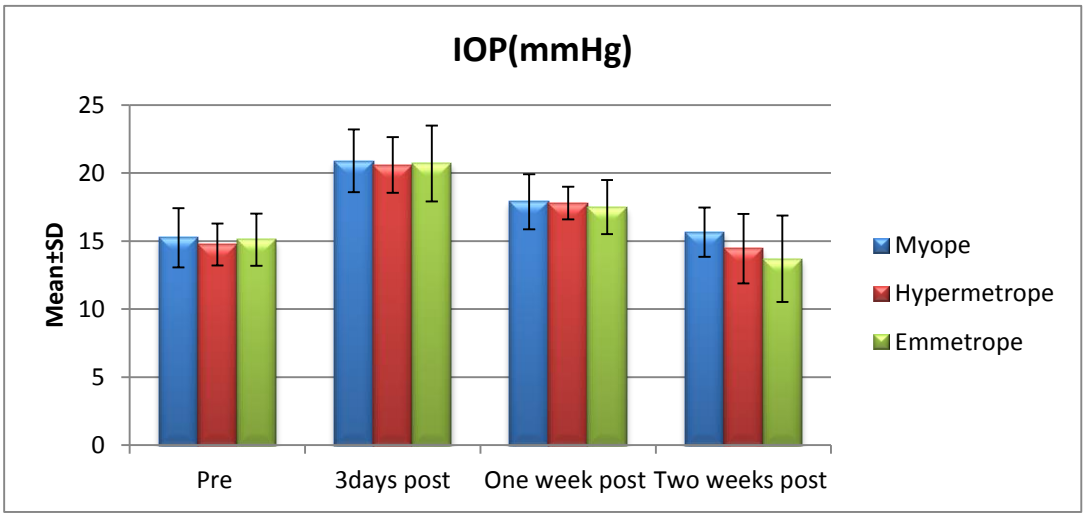

Figure (3): Distribution of the studied cases according to changes in IOP in correlation to the refractive state of the eye.

The pre YAG BCVA changed from 0.05 - 0.3 with the mean of 0.16 ± 0.06 to 0.4 - 1.00 with the mean of 0.9 ± 0.81 one week after YAG capsulotomy which was statistically highly significant (P <0.001**) (table 4 and figure 4).

Table (4): Distribution of the studied cases according to changes in BCVA in correlation to the refractive state of the eye.

	Myopes	Hypermetropes	Emmetropes
Pre YAG (BCVA)			
Range	0.05 - 0.3	0.05 - 0.3	0.1 - 0.3
Mean±SD	0.17±0.06	0.15±0.06	0.18±0.07
Median (IQ)	0.2(0.11-0.2)	0.15(0.1-0.15)	0.2(0.1-0.2)
Post YAG BCVA)			
Range	0.6 - 1	0.4 - 7	0.6 - 1
Mean±SD	0.82±0.1	1.05±1.41	0.83±0.14
Median (IQ)	0.8(0.7-0.9)	0.8(0.7-0.8)	0.8(0.7-1)
P. value	<0.001**	0.010*	<0.001**
Wilcoxon	<0.001**	<0.001**	<0.001**

Paired-samples T test, Wilcoxon test,

* Statistically significant difference (p<0.05), ** Highly statistically significant difference (p<0.001).

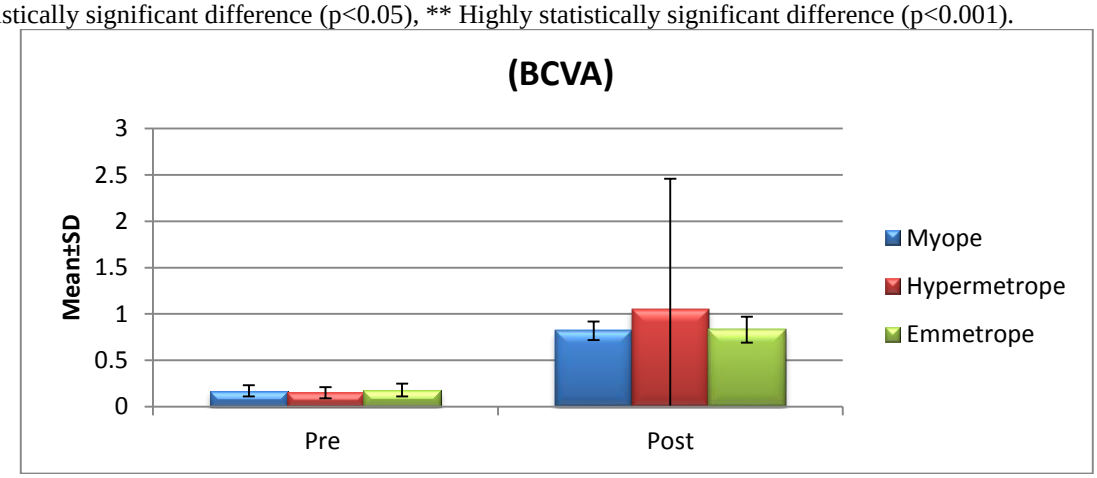

Figure (4) : Distribution of the studied cases according to changes in BCVA in correlation to the refractive state of the eye. In the current study there was a proportional relationship between the power of YAG laser and changes in CMT. However these changes were statistically insignificant (p < 0.334) with undetectable clinical changes in the BCVA after YAG capsulotomy (table 5).

Table (5): Correlation between the power of YAG laser and changes in CMT using OCT in correlation to the refractive state of the eye.

One week post YAG CMT		Total Energy	Energy\burst	Number of shots
Myope	r	0.228	0.010	0.349
	P	0.334	0.968	0.132
Hypermetrope	r	0.140	-0.013	0.161
	P	0.555	0.957	0.497
Emmetrope	r	0.074	0.327	-0.082
	P	0.756	0.159	0.730

Correlation is significant at the 0.05 level (2-tailed).

In the current study neither retinal breaks, retinal detachment, cystoid macular edema, macular hole, retinal nor vitreous hemorrhages were found after YAG laser posterior capsulotomy on short term follow up for three months.

DISCUSSION

Posterior capsular opacification [PCO] is one of the most common postoperative complication of cataract surgery which results in decreased visual performance of the patient. It develops in approximately 20% of patients who have undergone cataract surgery and more frequent in children and younger adults[4].

Nd: YAG laser posterior capsulotomy became the most frequently performed procedure after modern cataract surgeries for safe and effective management of posterior capsular opacification. However it is not away from complications, and some of which can be sight-threatening[5].

There were several studies, which reported the vitreoretinal changes and other complications after Nd: YAG laser posterior capsulotomy. As regard to changes in the central macular thickness, previous studies investigated changes of the central macular thickness after Nd: YAG laser capsulotomy. Although some of them have reported CME, many studies found no significant changes in macular thickness following Nd: YAG laser capsulotomy[6]. Ari et al., evaluated how different energy levels of Nd: YAG laser capsulotomy affect macular thickness. Ari et al. divided patients into two groups based on the energy levels used in Nd: YAG laser capsulotomy. They found that both groups had increased macular thickness compared to preoperative levels and macular thickness measurements of the patients treated with high energy levels were significantly greater compared to low energy levels [7].

In the present study we measured the central macular thickness one week before YAG laser capsulotomy and 1 week after YAG laser, there was a statistically highly significant ($p < 0.001$) changes in central macular thickness after YAG laser capsulotomy, but the changes in the CMT between emmetropic, myopic and hypermetropic eyes both before and after YAG capsulotomy were statistically insignificant ($p > 0.096$). So that there was no detectable clinical changes in the BCVA.

Harris et al. [11] reported 16 eyes [4.4%] out of 342 eyes with cystoid macular edema. However, most of the studies related to this complication are retrospective and therefore did not exclude the possibility of pre-existing pseudophakic CME. In the present study no CME was reported.

In the current study there was a proportional correlation between changes in central macular thickness and YAG power. However these changes were statistically insignificant ($p > 0.334$) with undetected clinical changes in the BCVA after YAG capsulotomy that was proved by other studies as Ari et al. in 2012, that found that the increase in macular thickness is inevitable after Nd: YAG laser capsulotomy, but the severity and duration are less when a total energy level less than 80 mJ is used [7].

In our study, Nd: YAG capsulotomy was not associated with a significantly greater incidence of new PVD, and that agrees with what was found that the presence or absence of PVD at the time of capsulotomy is not helpful in assessing the risk for RD in the first year after laser treatment [12].

As regard to retinal complications after Nd: YAG laser capsulotomy as retinal break and retinal detachment (RD). ***Raza et al.*** [13] reported 11 patients (2%) of RD after Nd: YAG laser capsulotomy. ***Steinert et al.*** [14] reported that eight patients of 897 patients treated with Nd: YAG laser capsulotomy developed RD. In the present study neither retinal breaks nor retinal detachment after YAG laser posterior capsulotomy was found during the short term follow up period, this disagrees with what was found in the study done by ***Ranta et al. in 2000*** [15] as retinal breaks and detachment occurred after YAG laser capsulotomy, where this study was performed to determine the 5-years incidence of retinal breaks and retinal detachment after Nd:YAG laser posterior capsulotomy. So there was limitation of the current study as the follow up was for three months only. In

the current study when we compared the BCVA before and after YAG laser capsulotomy for the 60 eyes, a significant improvement was found ($p < 0.001$), that was ascribed to the clearing of the visual axis. This was consistent with what was proved by other studies done by ***Ari et al.***[7] ***and Ruiz et al.***[8]**.**

As regard to changes in the intraocular pressure (IOP), in the current study there was a significant increase in IOP when measured before and after YAG, especially within first 3 days ($p < 0.001$). However, the IOP became normalized in most of cases within the first 2 weeks with topical antiglaucoma measures. This also was approved by ***Ari et al.***[7]**,** but against ***Ruiz et al.*** [8] who did not report any rise of IOP. Rare complications of ND: YAG laser capsulotomy as pupillary block glaucoma, aqueous misdirection syndrome, macular hole, retinal hemorrhage, spreading of endocapsular low-grade endophthalmitis, and secondary closure of capsulotomy aperture and other complications were reported in isolation in some studies [16-19], but no similar complications were found in our study.

CONCLUSIONS

Our study concluded that, Nd: YAG laser posterior capsulotomy is the standard treatment for PCO and gives rise to rapid improvement in visual acuity and relieving the symptoms of blurring, photophobia and glare. Nd: YAG laser posterior capsulotomy carries its own complications and risks. But most of these complications are less as compared to surgical dissection of the posterior capsule, so close follow up and careful observation of the patient after Nd: YAG laser posterior capsulotomy is mandatory. Further studies with larger number of patients and long term follow up are required.

Ethical considerations: The study was approved by the scientific committee of the Faculty of medicine, Al-Azhar university- Assuit, Egypt. An informed written consent was taken from all the participants in the study.

Acknowledgements: We acknowledge all participants included in this study, besides the clinical staff members of Ophthalmology Department, Al-Azhar University Hospital, Assuit, who were involved for the completion of the study.

REFERENCES

1. **Wormstone IM(2002):** Posterior capsule opacification: a cell biological perspective. Exp Eye Res ., 74:337–47.
2. **Baratz KH, Cook BE, Hodge DO(2000):** Probability of Nd; YAG laser capsulotomy after cataract surgery in Olmsted County, Minnesota. Am J Ophthalmic .,131:161-80.
3. **Hayashi H, Naka F, Hayashi H(2010):** Influence of size of Nd; YAG laser posterior capsulotomy on visual function of the. Eye ,24:101-6.
4. **Apple DJ, Peng Q, Visessook N *et al.* (2000):**Surgical prevention of posterior capsule opacification. Part 1: Progress in eliminating this complication of cataract surgery. J Catarac Refract Surg.,26:180-87.
5. **Billotte C, Berdeaux A(2004):** advers clinical consequences of neodymium :YAG laser treatment of posterior capsule opacification. J Cataract Refract Surg .,30:2064–71.
6. **Bend Schneider D, Tornow RP, Horn FK *et al*. (2010):** Retinal nerve fiber layer thickness in normals measured by spectral domain OCT. Journal of glaucoma ,19: 475-82.
7. **Ari S, Cingü AK, Sahin A *et al.* (2012):** The effects of Nd:YAG laser posterior capsulotomy on macular thickness, intraocular pressure, and visual acuity. Ophthalmic Surgery, Lasers & Imaging,43(5):395-400.
8. **Ruiz D, Barrancos C, Alio J *et al.* (2013):** Effect of posterior neodymium:YAG capsulotomy: safety evaluation of macular foveal thickness, intraocular pressure and endothelial cell loss in pseudophakic patients with posterior capsule opacification . Arch Soc Esp Opthalmol.,88(11):415-22.
9. **Wroblwska E, Wylegala E (2008):** Central corneal thickness measurement by optical coherence tomography after Nd: YAG capsulotomy in patients with posterior capsule opacity. Klin Oczna,110(7-9):259-64.
10. **Lewis H, Singer TR, Hanscom TA *et al.*(1987):** A prospective study of cystoid macular edema after neodymium: YAG laser posterior capsulotomy. Ophthalmology,94(5):478-82.
11. **Harris WS, Herman WK, Fagadau WR(1985):** Management of the posterior capsule complication, before and after the YAG laser. Trans Ophthalmol Soc UK.,104(5):533-5.
12. **Sheard RM, Goodburn SF, Comer MB *et al.* (2003):** Posterior vitreous detachment after neodymium :YAG laser posterior capsulotomy. J Cataract Refract Surg .,29(5):930-4.
13. **Raza A (2007):** Complications after Nd: Yag posterior capsulotomy. Journal of Rawalpindi Medical College.;11:27–29.
14. **Steinert RF, Puliafito CA, Kumar SR *et al.* (1991):** Cystoid macular edema, retinal detachment, and glaucoma after Nd:YAG laser posterior capsulotomy Am J Ophthalmol.,112(4):373-80.
15. **Ranta P, Tommila P, Immonen I (2000):** Retinal breaks before and after neodymium: YAG posterior capsulotomy. J Cataract Refract Surg.,26:1190–97.
16. **MacEwen CJ, Dutton GN, Holding D (1985):** Angle closure following neodymium-YAG (Nd-YAG) laser capsulotomy in the Aphakic Eye. Br J Ophthalmol.,69:795-6.
17. **Mastropasqua L, Ciancaglini M, Carpineto P (1994):** Aqueous misdirection syndrome: a complication of neodymium: YAG posterior capsulotomy. J Cataract Refract Surg.,20(5):563-5.
18. **Carlson AN, Koch DD (1988):** Endophthalmitis following Nd:YAG laser posterior capsulotomy. Ophthalmic Surg.,19(3):168-70.
19. **Jones NP, McLeod D, Boulton ME (1995):** Massive proliferation of lens epithelial remnants after Nd-YAG laser capsulotomy. Br J Ophthalmol.,79(3):261-3.