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Comparison of Two Nd:YAG Laser Posterior Capsulotomy: Cruciate Pattern vs Circular Pattern

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Abstract

Cataract is the principal cause of visual impairment worldwide. Despite improvements in cataract surgery techniques, years after surgery, lens epithelial cells can colonize causing development of posterior capsule opacification (PCO). Neodymium Yttrium Aluminum Garnet (Nd: YAG) laser capsulotomy is an effective technique in treating visually significant PCO. The aim of the work is to compare circular and cruciate methods of YAG laser capsulotomy. This study included 30 eyes of 30 patients with PCO underwent YAG laser capsulotomy. They were divided into two groups: *Group 1 (G1):* undergo cruciate pattern, *Group (G2):* undergo circular pattern with vitreous strand cutting. We examined all patients whome ages were above 25 years old and had posterior capsule opacification affecting the vision and had no previous ocular disease or ocular surgery other than cataract. Nd:YAG laser significantly improved visual functions ($P<0.05$). There is a slight increase in ocular tension post laser which returned to normal values within 1 week which were insignificant ($P>0.05$). Group 2 needed a little bit higher energy which were with non-significant difference between both groups. (Nd: YAG) laser is an effective technique in treating visually significant PCO Cruciate method proved to be more popular as it uses less energy and subsequent less possible complications.

Keywords: Two Nd:YAG Laser Posterior Capsulotomy, Cruciate Pattern, Circular Pattern.

1. Introduction

Cataract is the principal cause of treatable blindness and visual impairment in the world Phacoemulsification is the most frequent technique applied in cataract surgery. Despite substantial improvements in cataract surgery techniques and intraocular lenses (IOLs), months or years after surgery, lens epithelial cells spared by surgical abrasion can colonize the previously cell-free posterior capsule causing the development of posterior capsule opacification (PCO) with glare or vision deterioration [1]. Nd: YAG laser capsulotomy is an effective technique in treating visually significant PCO [2]. Several techniques have been described for Nd:YAG laser capsulotomy. The most popular is the cruciate pattern, which has a short procedure time. However, the procedure can damage the IOL, involving the visual axis and glare due to the posterior capsule remnant. The circular pattern is also a widely used technique, which has the advantage that it does not make IOL pits in

the visual axis. However, this procedure can lead to a floating posterior capsule remnant that causes floaters [3].
Nd:YAG laser capsulotomy can cause complications, such as elevation of intraocular pressure (IOP), cystoid macular edema, retinal detachment, and changes in the refractive index [4].
The aim of this study is to compare circular and cruciate methods YAG laser capsulotomy.

2. Patients and Methods

This study was a prospective study, was performed at Ophthalmology department of Al-Zahraa University Hospital, Cairo, Egypt, from June 2020 to July 2021. This study included 30 eyes of 30 patients with PCO underwent YAG laser capsulotomy, they were divided into two groups: Group 1 (G1): Included 15 eyes undergo YAG laser capsulotomy with cruciate pattern, Group (G2): Included 15 eyes undergo YAG laser capsulotomy with circular pattern with vitreous strand cutting.

2.1 Inclusion Criteria

- Patients above 25 years old with posterior capsular opacification
- PCO affecting vision.

2.2 Exclusion Criteria

- Patients aged less than 25 years old.
- Patients with ocular surgery other than cataract.
- Patients with ocular disease other than PCO.

2.3. Ethical consideration

- This study was approved by ethics committee of Faculty of Medicine for Girls AL-Azhar University.
- An informed written consent was obtained from each participant after explaining the purpose of study.

2.4 Study tools and procedures

- History taking (name, sex, age, occupation, past ophthalmic history and medical history). All patients underwent complete ophthalmic examination including visual acuity using Snellen's C chart; Refraction using autorefractometer. Some patients had no autorefractor reading before YAG laser posterior capsulotomy because of density of the posterior capsule; intraocular pressure measurement (IOP) by NIDEX air puff tonometer; slit lamp examination of the cornea and anterior segment. Anterior segment examination revealed dense posterior capsule; assessment of density of the opacity; fundus examination by indirect ophthalmoscope if possible.
- Photographs assessment: photos were taken to assess the case pre and post laser capsulotomy.

2.5 Nd:YAG laser posterior capsulotomy procedures

The patients were randomly subjected to Nd:YAG laser capsulotomy of either the cruciate pattern or the circular pattern with vitreous strand cutting .The pupils were dilated. Single shots were performed starting at 0.8 mJ and gradually increased until a 3-4mm capsular opening was created. In the ***cruciate pattern*** group, the laser treatment was initiated off-axis in a horizontal line across the center, followed by a line in the vertical axis to form a cross. In the ***circular pattern*** group, capsulotomy was performed using a circular pattern of laser treatment. The laser was aimed 125 µm posterior to the posterior IOL surface following an imaginary circle that was 0.5 mm inside the optic margin. After circular application of the laser, the vitreous strands that were attached to the posterior capsule fragment were cut with the laser. Patients

were instructed to apply topical steroids and beta blockers for a week.

2.6 Post-Operative evaluation and follow up

- Follow up includes Visual acuity using Snellen's C chart, refraction: patients with no reading turned to positive readings, intraocular pressure measurement (IOP), slit lamp examination of the cornea and anterior segment and fundus examination.
- Clinical examination and measurements evaluation were repeated at one week and one month after the procedures.

2.7 Statistical Analysis

Data were collected, revised, coded and entered to the Statistical Package for Social Science (IBM SPSS) version 23. The quantitative data were presented as mean, standard deviations and ranges when parametric. Also, qualitative variables were presented as numbers and percentages. The p-value was considered significant as the following: P-value > 0.05: Non-significant (NS), P-value < 0.05: Significant (S), P-value <0.01: Highly significant (HS).

3 .Results

30 eyes of 30 patients were included in this study. Their mean age was 60.27 ± 11.19 (range, 43-88). Males were 19 (63.3%) and females were 11 (36.7%). Right eyes were 15(50%) and left eye were 15 (50%) as shown in Table. 1. Table. 2 shows A highly significant improvement in VA in the 2 groups after 1 week and 1 month. Table.3 shows a non-significant difference in BCVA in group I and group II after 1 week and 1 month. Table.4 shows an improvement in spherical and cylindrical refraction in group I and II after 1 week and 1 month and there is a non-significant difference between group I and group II.
Table. 5 shows non-significant change in intra ocular pressure between pre and post capsulotomy. Table. 6 shows non-significant difference between group I and group II in total energy, total shots and energy/pulse.

Table (1): Distribution of studied sample regarding patients.

		Total no. = 30
Sex	Female	11 (36.7%)
	Male	19 (63.3%)
Age (years)	Mean ± SD	60.27 ± 11.19
	Range	43 – 88
Affected eye	Right	15 (50.0%)
	Left	15 (50.0%)

Table (2): Concerning visual acuity.

		Group I			**Test value**	**P-value**	**Sig.**
		Pre	**1 week post**	**1 month post**			
BCVA	Mean ± SD	0.51 ± 0.20	0.21 ± 0.15	0.21 ± 0.15	30.000≠	<0.001	HS
	Range	0.18 – 0.78	0 – 0.6	0 – 0.6			
		Group II			**Test value**	**P-value**	**Sig.**
		Pre	**1 week post**	**1 month post**			
BCVA	Mean ± SD	0.61 ± 0.22	0.34 ± 0.17	0.34 ± 0.17	28.000≠	0.000	HS
	Range	0.3 – 1	0.18 – 0.78	0.18 – 0.78			

Table (3): A Non-significant difference in BCVA in group I and group II after 1 week and 1 month.

BCVA		Group I No. = 15	Group II No. = 15	Test value	P-value	Sig.
Pre	Mean ± SD	0.51 ± 0.20	0.61 ± 0.22	-1.322≠	0.186	NS
	Range	0.18 – 0.78	0.3 – 1			
1 week post	Mean ± SD	0.21 ± 0.15	0.34 ± 0.17	-1.999≠	0.046	S
	Range	0 – 0.6	0.18 – 0.78			
1 month post	Mean ± SD	0.21 ± 0.15	0.34 ± 0.17	-1.999≠	0.046	S
	Range	0 – 0.6	0.18 – 0.78			
Difference after 1 week	Mean ± SD	-0.30 ± 0.17	-0.31 ± 0.20	-0.315•	0.753	NS
	Range	-0.78 – -0.12	-0.7 – -0.12			
Difference after 1 month	Mean ± SD	-0.30 ± 0.17	-0.31 ± 0.20	-0.315•	0.753	NS
	Range	-0.78 – -0.12	-0.7 – -0.12			

Table (4): Refraction.

Refraction		Group I No. = 15	Group II No. = 15	Test value	P-value	Sig.
Pre						
Sphere	Mean ± SD	0.62 ± 1.60	0.08 ± 2.77	-0.604≠	0.546	NS
	Range	-1 – 4.75	-7.75 – 3.75			
Cylinder	Mean ± SD	-2.28 ± 1.88	-1.87 ± 1.40	-0.270≠	0.787	NS
	Range	-5.5 – -0.25	-4 – 0.75			
Axis	Mean ± SD	74.73 ± 40.65	97.27 ± 44.33	-1.411≠	0.158	NS
	Range	7 – 150	15 – 170			
1 week post						
Sphere	Mean ± SD	0.23 ± 1.53	-0.89 ± 2.17	-1.408≠	0.159	NS
	Range	-1.5 – 4.5	-7 – 2.75			
Cylinder	Mean ± SD	-1.70 ± 1.55	-0.95 ± 1.49	-0.878≠	0.380	NS
	Range	-5.5 – -0.25	-3 – 3.75			
Axis	Mean ± SD	87.87 ± 27.64	81.00 ± 53.66	-0.311≠	0.756	NS
	Range	24 – 139	0 – 170			
1 month post						
Sphere	Mean ± SD	0.23 ± 1.53	-0.89 ± 2.17	-1.408≠	0.159	NS
	Range	-1.5 – 4.5	-7 – 2.75			
Cylinder	Mean ± SD	-1.70 ± 1.55	-0.95 ± 1.49	-0.878≠	0.380	NS
	Range	-5.5 – -0.25	-3 – 3.75			
Axis	Mean ± SD	87.87 ± 27.64	81.00 ± 53.66	-0.311≠	0.756	NS
	Range	24 – 139	0 – 170			

Table (5): Intra ocular pressure.

IOP		Group I No. = 15	Group II No. = 15	Test value	P-value	Sig.
Pre	Mean ± SD	14.33 ± 1.91	16.20 ± 2.73	-2.168•	0.039	S
	Range	12 – 18	12 – 21			
1 week post	Mean ± SD	15.87 ± 2.47	17.40 ± 3.44	-1.402•	0.172	NS
	Range	13 – 21	12 – 22			
1 month post	Mean ± SD	15.53 ± 2.59	16.60 ± 2.75	-1.095•	0.283	NS
	Range	12 – 21	12 – 21			
Difference after 1 week	Mean ± SD	1.53 ± 1.64	1.20 ± 1.93	-0.783≠	0.434	NS
	Range	0 – 4	0 – 6			
Difference after 1 month	Mean ± SD	1.20 ± 1.66	0.40 ± 0.91	-1.385≠	0.166	NS
	Range	0 – 4	0 – 3			

Table (6): Total energy, total shots and energy/pulse.

		Group I No. = 15	Group II No. = 15	Test value	P-value	Sig.
Total energy/ patient (mJ/patient)	Mean ± SD	64.27 ± 22.00	74.60 ± 12.88	-1.494≠	0.135	NS
	Range	25 – 107	51 – 101			
Total shots no.	Mean ± SD	31.20 ± 14.54	38.73 ± 7.36	-1.930≠	0.054	NS
	Range	11 – 66	28 – 52			
Energy/pulse	Mean ± SD	2.25 ± 0.91	1.95 ± 0.37	1.180•	0.248	NS
	Range	1.2 – 3.9	1.2 – 2.6			

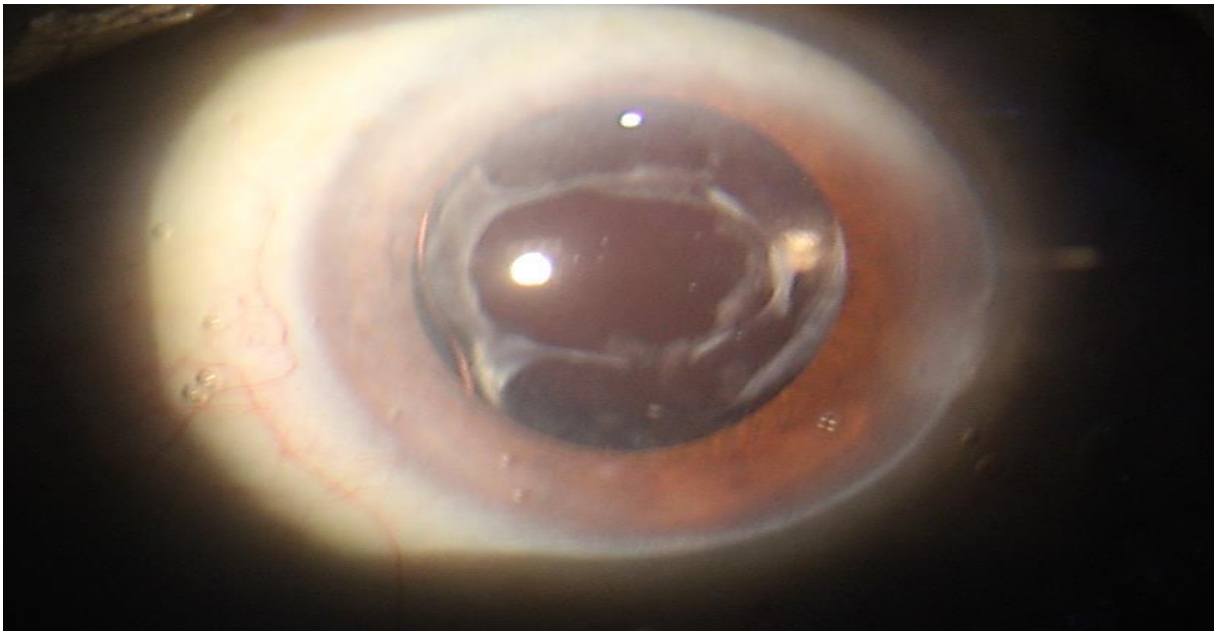

Figure (1): Representative image of circular pattern YAG laser posterior capsulotomy (Case No 13).

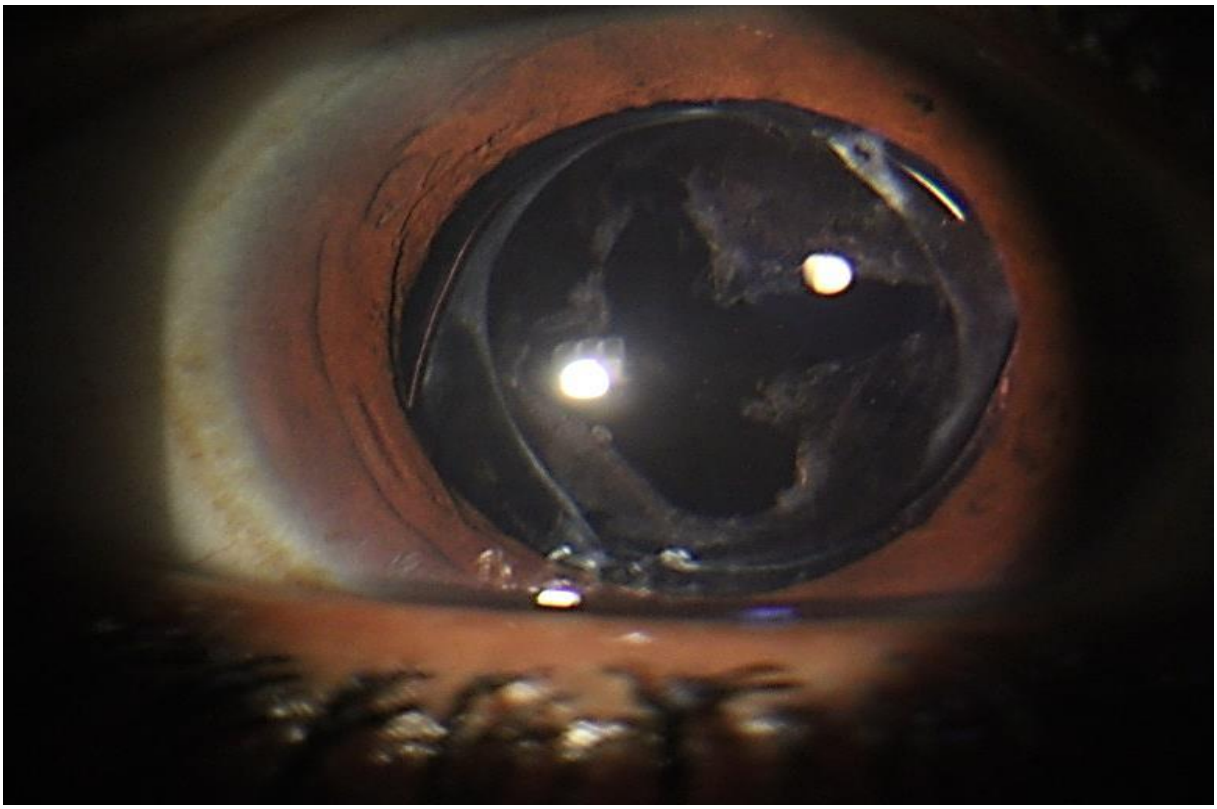

Figure (2): Representative image of cruciate pattern YAG laser posterior capsulotomy (Case No 21).

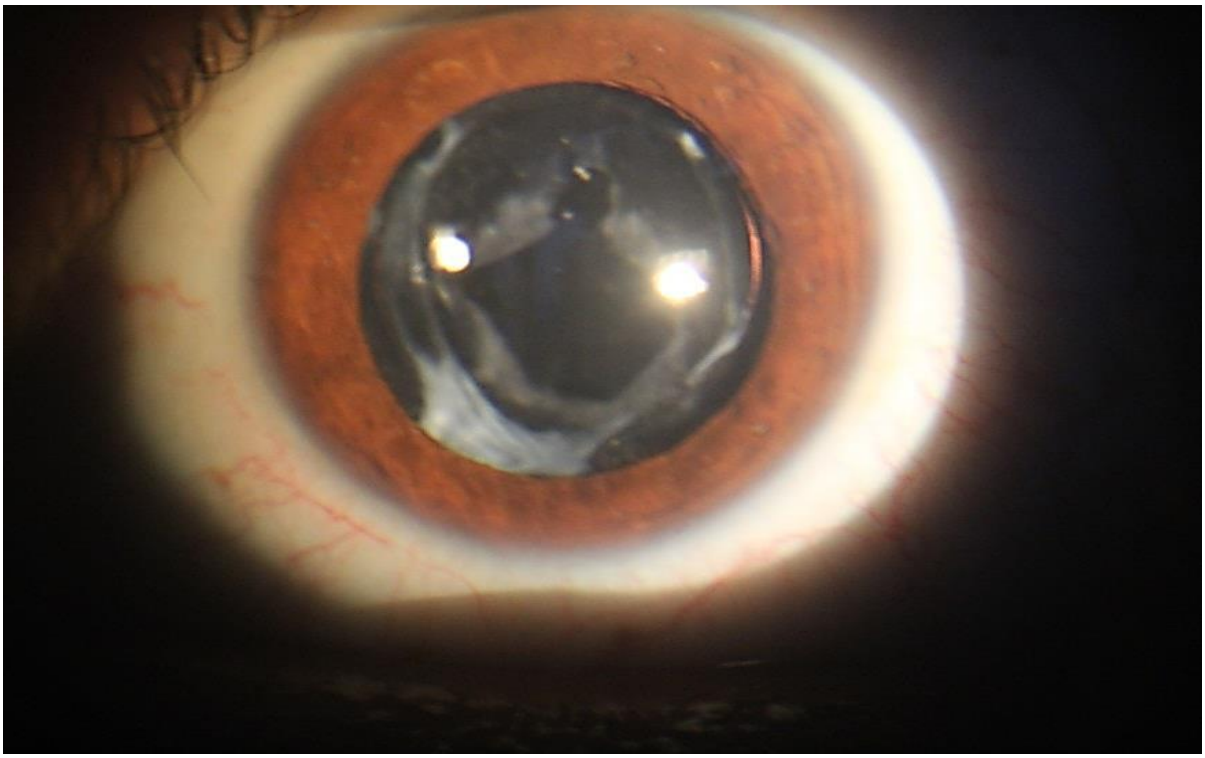

Figure (3): Representative image of cruciate pattern YAG laser posterior capsulotomy (Case No 24).

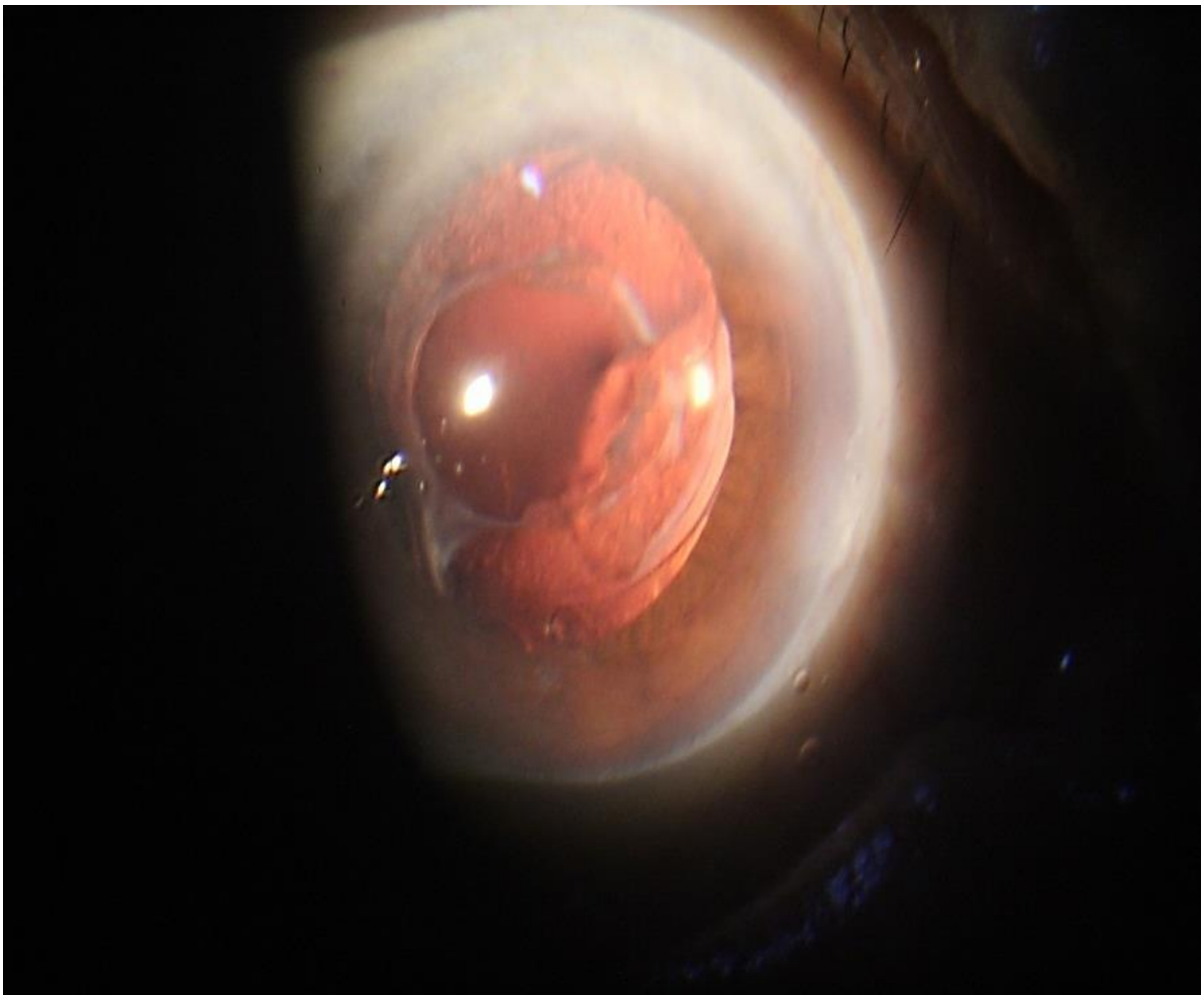

Figure (4): Representative image of cruciate pattern YAG laser posterior capsulotomy (Case No 29).

4. Discussion

The In our study we included 30 eyes of 19 males and 11 females. Their mean age was 60.27 years ± 11.19 (SD). The patients were divided into two groups. Group 1 underwent cruciate pattern and group 2 underwent circular pattern Nd:YAG laser posterior capsulotomy.

Visual acuity:

In our study we found a significant improvement in the visual acuity in both the groups; however, the improvement was not significantly different between the two groups. This was matched with Kara et al., [3]. Contrary to our study Mortazavi et al., [5] found that posterior capsulotomy improves visual acuity, however, sensitivity to contrast and the light source of visual acuity is not related to the type of lens used.

Best corrected visual acuity:

As regards BCVA we found that there is a statistical significance of improvement in BCVA (log MAR) where mean BCVA was 0.51 ± 0.20 (SD) and changes into 0.21 ± 0.15 (SD) after capsulotomy in group1 and was 0.61 ± 0.22 (SD) and changes into 0.34 ± 0.17 (SD) after capsulotomy in group2. These results were similar to Ramachandra and Kuriakose, 2016 [6].

Refractive errors:

1)Refractive sphere:

In our study we found a statistical non significance of myopic shift in the refractive sphere with mean refractive sphere changing from0.62 ± 1.60 (SD) before capsulotomy to be 0.23 ± 1.53 (SD) after capsulotomy in group 1,and changing from 0.08 ± 2.77 (SD) before capsulotomy to be -0.89 ± 2.17 (SD) after capsulotomy in group 2; that means a non-significant change in refractive sphere where p value was 0.159.These results were similar to Ramachandra and Kuriakose, 2016 [6]. This was not similar to results reported by Nassar and Heba, 2016 [7] who reported that there's a change of the refractive spherical equivalent towards mild myopia where mean spherical equivalent before capsulotomy was 0.41±0.31 (SD) and changed to 0.11±0.30(SD) but with no statistical significance where P value=0.425.

2)Refractive cylinder:

As regards the Refractive Cylinder In our study we found that the mean Refractive Cylinder was -2.28 ± 1.88 (SD) before capsulotomy and changed into-1.70 ± 1.55 (SD) after capsulotomy in group 1, and was -1.87 ± 1.40 (SD) before capsulotomy and changed into-0.95 ± 1.49 (SD) after capsulotomy in group 2 these changes are statistically non-significant where the p value was 0.787.Our results were in agreement with results reported by Monteiro et al., 2018 [8]. This was not similar to results reported by Ramachandra and Kuriakose, 2016 [6] who demonstrated that they found a statistically significant hyperopic shift in the cylindrical error where mean changed from 0.45±0.91(SD) to 1.62±2.3(SD) with a p value = 0.036.

Number of shots and energy used:

Our results revealed that the number and energy of laser firing did not differ significantly among groups.

However, Cetinkaya et al.,2015 [9] found that circular shape capsulotomies required more laser firings to be formed.

Complications of Nd: YAG laser:

Intraocular pressure

In the current study, IOP was generally non-statistically significant elevated. This was in agreement with Cetinkaya et al., 2015 [9]. However, Mortazavi et al., [5] found that increased intraocular pressure during the first day and first week was more in circular group.

Other Nd:YAG complications

In our study, we did not find any complications associated with Nd:YAG laser capsulotomy. This result is supported by the results of (Cetinkaya et al., 2015) [9]. However, Khan et al., 2006 found IOL pitting in 22.4% cases. On the other hand, Muhammad et al., 2013 [10] reported that anterior uveitis was seen in 8.0% cases. While Khanzada et al., 2007 [11] reported that cystoid macular edema was seen in

0.2% cases. This was not similar to results reported by Burq & Taqui., 2008 [12] whom found that frequency of retinal detachment after Nd:Yag laser capsulotomy was about 1.9%.

5. Conclusion

- Intra Nd:YAG laser is an easily performed, very economical and non-invasive procedure with immediate results .
- The circular and cruciate Nd: YAG laser capsulotomy applications are two of the most common laser capsulotomy techniques. Although visual results and IOP values were similar in both groups, cruciate laser applications have advantages such as fewer energy applications and a lower rate of floater symptoms.

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