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Original Research Article

Evaluation of changes in anterior chamber parameters before and after Nd:YAG laser peripheral iridotomy in primary angle closure suspects using pentacam

Vidyadevi Mahadevappa[1], Drishya Sudev[1]*, Anuradha Appaji[1], Nandini Haugeppa[1], Sai Dheera Mulasthanam[1], Hima Bhatt[1]

[1]Minto Ophthalmic Hospital, Bangalore Medical College and Research Institute, Bangalore, Karnataka, India

Abstract

Background: Primary angle closure glaucoma is characterized by elevated intraocular pressure as a result of mechanical obstruction of the trabecular meshwork by either apposition of the peripheral iris to the trabecular meshwork or by a synechial closed angle. It carries a heavier risk of ocular morbidity compared to open angle glaucoma. With the development of imaging devices for the anterior segment of the eye, like Pentacam a better understanding of the pathogenesis and of angle closure has been reached.

Objectives: To determine anterior chamber parameter changes (ACV-anterior chamber volume, ACD-anterior chamber depth, ACA-anterior chamber angle, CCT-central corneal thickness) before and after Nd:YAG laser peripheral iridotomy (LPI) in primary angle closure suspect (PACS) patients using Pentacam.

Materials and Methods: Hospital based prospective observational study conducted on patients attending our tertiary care hospital. A total of 45 patients (60 eyes), fulfilling inclusion criteria were included in the study conducted over a period of 18 months from February 2021 to September 2022.

Results: Total 60 eyes of 45 patients were included in the study. Following Nd:YAG LPI, there was significant widening of ACA according to Shaffer's grading. The change in ACV from baseline to first week (65.35 ± 16.44 mm^3 to 74.93 ± 16.93 mm^3) and first month (65.35 ± 16.44 mm^3 to 83.98 ± 18.66 mm^3) were statistically significant. The mean ACA increased from baseline to first week (23.18 ± 4.53 degree to 25.12 ± 5.40 degree) and first month (23.18 ± 4.53 degree to 26.09 ± 4.92 degree) and was statistically significant. The increase in mean ACD from baseline to first week (2.06 ± 0.35 mm to 2.25 ± 0.38 mm) and first month (2.06 ± 0.35 mm to 2.42 ± 0.33 mm) was also statistically significant. The shift in the values of CCT from baseline wasn't statistically significant.

Conclusion: Our study confirms previous reports of increased ACV, ACA, ACD after LPI in PACS. Pentacam is an extremely useful tool in quantifying these changes.

Keywords: Laser peripheral iridotomy, Oculus pentacam, Primary angle closure suspect.

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1. Introduction

Glaucoma is defined as disturbance of structural and functional integrity of optic nerve which can usually be arrested by adequate lowering of intraocular pressure.[1] Eventhough earlier angle closure glaucoma was considered to be less common than open angle glaucoma, now it has been observed that angle closure is as common as open-angle glaucoma in South Asia.[6] According to a landmark study conducted in India by Aravind eye hospital, PACG was found to have a prevalence of 0.5%.[6] Gonioscopy is the gold standard examination in diagnosing angle closure glaucoma, which grades the angle in the four quadrants.[11,12] It aids in identifying angle closure suspects.[2] Soon after increase in intraocular pressure, optic nerve damage ensues which emphasizes the need of identifying potentially occludable angles and taking appropriate action before an attack.[9,14,15] Prophylactic peripheral iridotomy is warranted if angles appear occludable.[3,4] The fellow eye should also be examined, and if observed to be occludable, it is better to proceed with peripheral iridotomy at the same sitting.[5]

Numerous qualitative and quantitative parameters were made to use classically to evaluate the effect of LPI (Laser

*Corresponding author: Drishya Sudev
Email: drishyasudev@gmail.com

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peripheral iridotomy) on angle width (Gonioscopic descriptive factors included mean Shaffer grading, width of angle in degrees, proportion of eyes with persistent iridotrabecular contact after LPI.[7,8] The angle opening distance (AOD), which is the perpendicular distance between the anterior iris surface and a position 500 mm (AOD 500) or 750 mm (AOD 750) anterior to the scleral spur, was the most commonly reported imaging-based quantitative metric. In order to objectively document the remodelling of anterior chamber architecture following laser peripheral iridotomy in PACS (primary angle closure suspect) eyes, we are using anterior chamber parameters like ACD (anterior chamber depth), ACV (anterior chamber volume), ACA (anterior chamber angle), and CCT (central corneal thickness) assessed by pentacam in this study.[9,10] The aim of the study is to evaluate the changes in anterior chamber parameters following Nd YAG laser peripheral iridotomy in primary angle closure suspects objectively using Pentacam.

2. Materials and Methods

This hospital based prospective observational study included 60 eyes (45 patients) fulfilling the inclusion criteria, attending outpatient or inpatients admitted in our tertiary care hospital, which was conducted over a period of 18 months from February 2021 to September 2022. Written informed consent was acquired from each patient taking part in the research. The protocol of this study was approved by the institutional ethics committee and complied with the ethical principles as mentioned in the Declaration of Helsinki.

Patients older than 18 years of age diagnosed to be primary angle closure suspects according to ISGEO criteria (180 degrees or more of posterior trabecular meshwork not visible on gonioscopy, IOP < 21 mm Hg, no peripheral anterior synechiae, normal cup disc ratio and visual field) who were fit to undergo laser peripheral iridotomy were included in the study. Patients with past history of glaucoma, ocular hypertension, trauma, corneal disorders e.g: keratoconus, pterygium or corneal opacity and patients who have undergone any previous laser therapy to eye including refractive surgery were excluded.

Snellen's chart visual acuity, anterior segment evaluation, fundus examination by indirect ophthalmoscopy, IOP measurement by Goldman applanation tonometry, gonioscopy using Sussman 4 mirror lens examination, and evaluation of anterior chamber parameters such as anterior chamber depth (ACD), anterior chamber angle (ACA), anterior chamber volume (ACV), and central corneal thickness (CCT) using Oculus Pentacam, were performed on all patients prior to, one week following, and one month following Neodymium-doped yttrium aluminium garnet (Nd:YAG) laser peripheral iridotomy, and the changes were assessed.

The study's numerical variables were presented as mean and standard deviation, while the categorical variables were portrayed as percentages and frequencies. The paired t test was used for parametric variables and the Wilcoxon signed rank test for non-parametric variables to compare the mean differences of the study variables from the baseline to the one-month time period. The data was imported into Microsoft Excel, and IBM SPSS version 25 was used for analysis. p-values less than 0.05 were regarded as statistically significant.

3. Results

In this hospital-based prospective observational study, 45 patients (60 eyes) who met the eligibility requirements underwent gonioscopy using the Sussman four mirror lens examination, and the changes were assessed before, one week, and one month after Nd:YAG laser peripheral iridotomy. Various parameters of the anterior chamber, such as anterior chamber depth (ACD), anterior chamber angle (ACA), anterior chamber volume (ACV), and central corneal thickness (CCT), were assessed using Oculus Pentacam.

In this study, out of 45 patients 11 (24.4%) participants were in the age group of ≤ 50 years, 16 (35.6%) were aged 50-60 years and 18 (40.0%) were aged >60 years among whom 25 (55.6%) participants were Female and 20 (44.4%) were male. The mean age in our study was 57.73 ± 9.20.(**Table 1**)

Table 1: Age distribution of study participants

Age	Frequency	Percentage
≤ 50	11	24.4
50-60	16	35.6
> 60	18	40.0
Total	45	100.0
Mean ± SD	57.73 ± 9.20	

The mean IOP value was 15.52 ± 1.82, ACV value was 65.35 ± 16.44, ACA was 23.18 ± 4.53, ACD was 2.06 ± 0.35 and CCT was 550.47 ± 25.69.

Baseline findings in gonioscopy (Shaffer's grading) showed superior quadrant had Grade 0 in 11 (18.3%), Grade I in 26 (43.3%) and Grade II in 23 (38.3%). In inferior quadrant had Grade 0 in 12 (20.0%), Grade I in 33 (55.0%) and Grade II in 15 (25.0%). In nasal quadrant had Grade 0 in 10 (16.7%), Grade I in 15 (25.0%) and Grade II in 35 (58.3%). In temporal quadrant had Grade 0 in 7 (11.7%), Grade I in 25 (41.7%) and Grade II in 28 (46.7%).

Gonioscopy findings after 1 week of peripheral iridotomy showed superior quadrant had Grade 1 in 7 (11.7%), Grade II in 35 (58.3%) and Grade III in 18 (30.0%). In inferior quadrant had Grade 1 in 17 (28.3%), Grade II in 35 (58.3%) and Grade III in 8 (13.3%). In nasal quadrant had Grade 0 in 1 (1.7%), Grade I in 8 (13.3%), Grade II in 38 (63.3%) and Grade III in 13 (21.7%). In temporal quadrant had Grade I in 11 (18.3%), Grade II in 36 (60.0%) and Grade III in 13 (21.7%).

In superior quadrant had Grade 1 in 1 (1.7%), Grade II in 21 (35.0%) and Grade III in 38 (63.3%). In inferior quadrant had Grade II in 38 (63.3%) and Grade III in 22 (36.7%). In nasal quadrant had Grade I in 1 (1.7%), Grade II in 34 (56.7%) and Grade III in 25 (41.7%). In temporal quadrant had Grade I in 2 (3.3%), Grade II in 33 (55.0%) and Grade III in 25 (41.7%).

In the superior quadrant, from baseline to 1 week Shaffer grades increased in 52 (86.7%) eyes and remained unchanged in 8 (13.3%) eyes. The median value was increased from baseline to first week (1 to 2).

From baseline to 1 month, Shaffer grades were increased in 55 (91.7%) eyes, decreased in 1 (1.6%) eye and remained unchanged in 4 (6.7%) eyes. The median value was increased from baseline to first week (1 to 3).

In the inferior quadrant, from baseline to 1 week Shaffer grades increased in 44 (73.3%) eyes and remained unchanged in 16 (26.7%) eyes. The median value was increased from baseline to first week (1 to 2).

From baseline to 1 month, Shaffer grades were increased in 55 (91.7%) eyes and remained unchanged in 5 (8.3%) eyes. The median value was increased from baseline to first week (1 to 2).

In the nasal quadrant, from baseline to 1 week Shaffer grades increased in 34 (56.7%) eyes and remained unchanged in 26 (43.3%) eyes. From baseline to 1 month, Shaffer grades were increased in 44 (73.3%) eyes and remained unchanged in 16 (26.7%) eyes. It was statistically significant.

In the temporal quadrant, from baseline to 1 week Shaffer grades increased in 36 (60.0%) eyes and remained unchanged in 24 (40.0%) eyes. The median value was increased from baseline to first week (1 to 2). From baseline to 1 month, Shaffer grades were increased in 48 (80.0%) eyes and remained unchanged in 12 (20.0%) eyes. The median value was increased from baseline to first week (1 to 2).

The mean ACV was increased significantly from baseline to first week (65.35 ± 16.44 mm^3 to 74.93 ± 16.93 mm^3) and baseline to first month (65.35 ± 16.44 mm^3 to 83.98 ± 18.66 mm^3). The mean ACA was increased significantly from baseline to first week (23.18 ± 4.53 degree to 25.12 ± 5.40 degree) and baseline to first month (23.18 ± 4.53 degree to 26.09 ± 4.92 degree). The mean ACD was increased significantly from baseline to first week (2.06 ± 0.35 mm to 2.25 ± 0.38 mm) and baseline to first month (2.06 ± 0.35 mm to 2.42 ± 0.33 mm).

The increase in the values of CCT from baseline (550.47 ± 25.69 μm) to 1 week (548.82 ± 27.83 μm) and 1 month (548.57 ± 25.60 μm) was statistically not significant.

Table 2: Baseline intraocular pressure and anterior chamber parameters measured using Pentacam

Variables	N	Minimum	Maximum	Mean	SD
IOP	60	12	18	15.52	1.82
ACV (mm^3)	60	45	111	65.35	16.44
ACA	60	17.8	46.6	23.18	4.53
ACD (mm)	60	1.52	2.76	2.06	0.35
CCT	60	498	610	550.47	25.69

Table 3: Comparison of ACV (Anterior chamber volume) from baseline to 1 week and 1 month

Time Interval	N	ACV (mm3)		t value	p value
		Mean	SD		
Baseline	60	65.35	16.44		
1 Week	60	74.93	16.93	7.835	<0.001
1 Month	60	83.98	18.66	12.306	<0.001

Table 4: Comparison of ACD (Anterior chamber depth) value from baseline to 1 week and 1 month

Time Interval	N	ACD (mm)		t Value	p Value
		Mean	SD		
Baseline	60	2.06	0.35		
1 Week	60	2.25	0.38	8.667	<0.001
1 Month	60	2.42	0.33	14.086	<0.001

Table 5: Comparison of CCT (Central corneal thickness) values from baseline to 1 week and 1 month

Time Interval	N	CCT		t Value	p Value
		Mean	SD		
Baseline	60	550.47	25.69		
1 Week	60	548.82	27.83	0.849	0.399
1 Month	60	548.57	25.60	1.154	0.253

4. Discussion

The incidence and prevalence of Primary angle closure disease in a population are determined by several factors including patients age, gender, refractive status of the eye and heredity factors. Important ocular risk factors are shallow anterior chamber, decreased anterior chamber volume, short axial length of the globe, small corneal diameter, anterior position of the lens with respect to the ciliary body, increased curvature of the anterior lens surface, and increased lens thickness.

In our study, 11 (24.4%) participants were in the age group of ≤ 50 years, 16 (35.6%) were aged 50-60 years and 18 (40.0%) were aged above 60 years. The mean age in our study was 57.73 ± 9.20. This points towards the finding that the prevalence of angle closure disease increases after the age of 40 years as cited in previous studies. Out of 45 participants, 25 (55.6%) participants were female and 20(44.4%) were male. This validates the finding that there is a statistically significant predominance of females among patients with angle closure glaucoma, which is probably caused by the shallower anterior chamber among women in general which was observed in previous studies.

Gonioscopy remains the mainstay of identifying narrow angles. Shaffer grading system is universally used to assess the risk of angle closure. It helps in identifying the patients at risk of angle closure. When carried out by an experienced individual, gonioscopy is a dependable and helpful means of grading and evaluating the anterior chamber angle, despite being a subjective method of assessment. In our study the mean Shaffer's grade increased similar to the Liwan eye study findings.[13] In our study the Shaffer's Grade increased by 86.7% in the superior angle one week after PI. According to the Liwan eye study there was increase in Shaffer's Grade by 72.4% in the superior angle after PI. Other quadrants also exhibited a similar finding.

In the superior quadrant, from baseline to 1 week Shaffer grades increased in 52 (86.7%) eyes and remained unchanged in 8 (13.3%) eyes. The median value was increased from baseline to first week (1 to 2). From baseline to 1 month, Shaffer grades were increased in 55 (91.7%) eyes, decreased in 1 (1.6%) eye and remained unchanged in 4 (6.7%) eyes. The median value was increased from baseline to first week (1 to 3). In the inferior quadrant, from baseline to 1 week Shaffer grades increased in 44 (73.3%) eyes and remained unchanged in 16 (26.7%) eyes. The median value was increased from baseline to first week (1 to 2). From baseline to 1 month, Shaffer grades were increased in 55 (91.7%) eyes and remained unchanged in 5 (8.3%) eyes. The median value was increased from baseline to first week.

In the nasal quadrant, from baseline to 1 week Shaffer grades increased in 34 (56.7%) eyes and remained unchanged in 26 (43.3%) eyes. From baseline to 1 month, Shaffer grades were increased in 44 (73.3%) eyes and remained unchanged in 16 (26.7%) eyes. It was statistically significant in the temporal quadrant, from baseline to 1 week Shaffer grades increased in 36 (60.0%) eyes and remained unchanged in 24 (40.0%) eyes. The median value was increased from baseline to first week. From baseline to 1 month, Shaffer grades were increased in 48 (80.0%) eyes and remained unchanged in 12 (20.0%) eyes. The median value was increased from baseline to first week.(**Figure 1**-**Figure 3**)

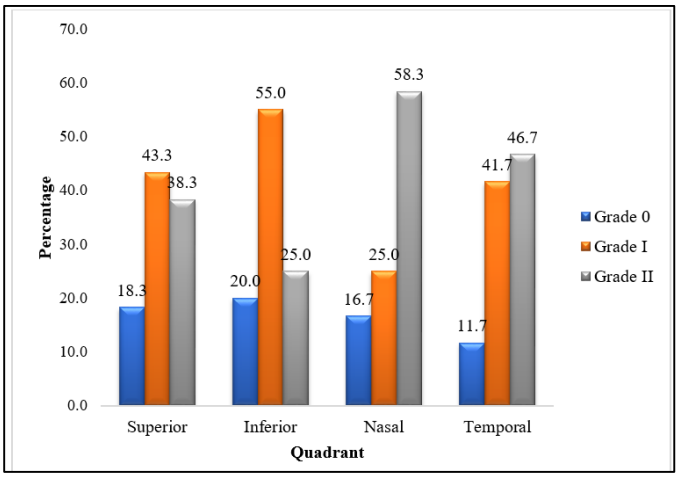

Figure 1: Distribution of gonioscopy (Shaffer's grading) baseline findings

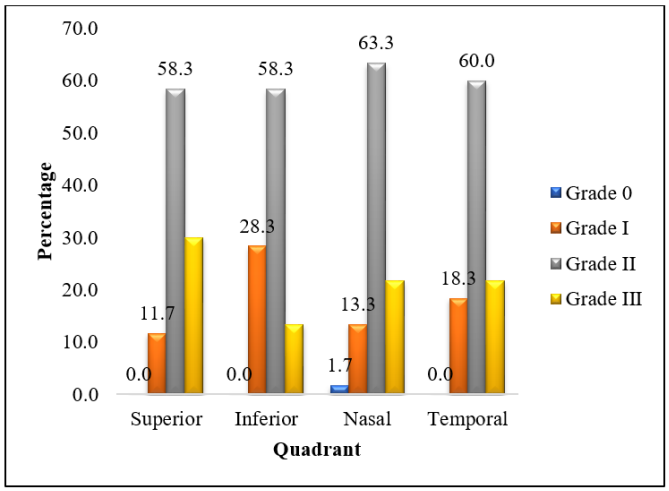

Figure 2: Distribution of gonioscopy (Shaffer's grading)-one week after peripheral iridotomy

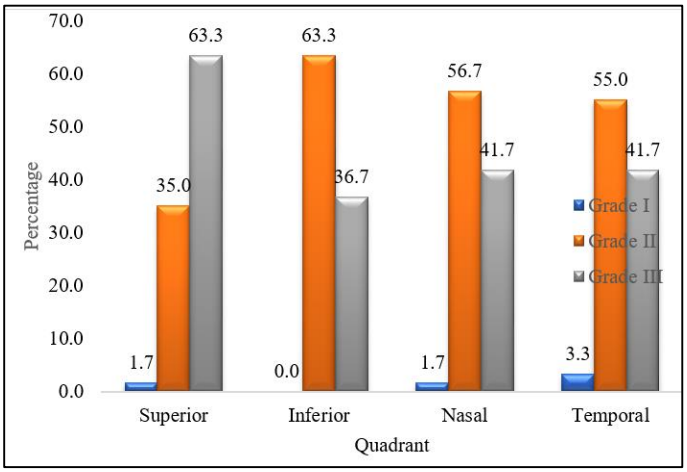

Figure 3: Distribution of gonioscopy (Shaffer's grading)-one month after peripheral iridotomy

Anterior chamber parameters measured using pentacam laser peripheral iridotomy is the first-line mode of treatment for patients with acute and chronic angle closure glaucoma.(**Figure 4**) This method has also been proposed as

a preventive treatment option for minimalising the risk of recurrent acute attacks. This intervention works by allowing aqueous to flow directly through the iridotomy site into the angle.

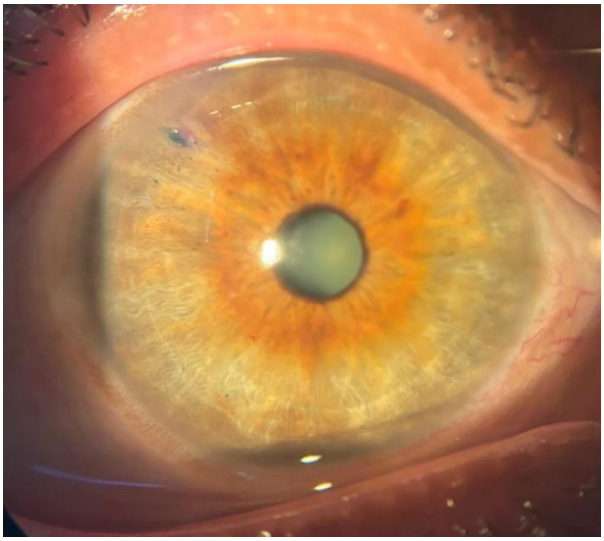

Figure 4: Clinical photograph showing a patent peripheral iridotomy at 11 o clock position in a PACS eye

The purpose of this study was to look into the efficacy of the PI in the management of subjects with PACS using the Pentacam. Our study showed significant changes in ACV, ACA, ACD following PI, but the changes in CCT was not significant statistically. A similar study conducted by Esraeli et al in 2013, showed significant changes in ACV and ACA, however the changes in ACD, CCT did not reach the significant level.

Before Nd:YAG Laser peripheral iridotomy, the baseline mean IOP value was 15.52 ± 1.82, ACV value was 65.35 ± 16.44, ACA was 23.18 ± 4.53, ACD was 2.06 ± 0.35 and CCT was 550.47 ± 25.69.(**Table 2**)

After Nd:YAG Laser peripheral iridotomy, The mean ACV was increased significantly from baseline to first week (65.35 ± 16.44 mm3 to 74.93 ± 16.93 mm 3) and baseline to first month (65.35 ± 16.44 mm 3 to 83.98 ± 18.66 mm3) which was statistically significant.(**Table 3**)

The mean ACA was increased significantly from baseline to first week (23.18 ± 4.53 degree to 25.12 ± 5.40 degree) and baseline to first month (23.18 ± 4.53 degree to 26.09 ± 4.920) which was statistically significant.(**Figure 5**)

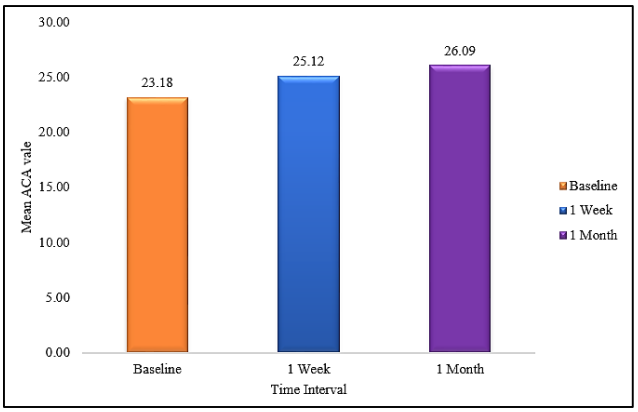

Figure 5: Comparison of ACA (Anterior chamber angle) values at different time interval

The mean ACD was increased significantly from baseline to first week (2.06 ± 0.35 mm to 2.25 ± 0.38 mm) and baseline to first month (2.06 ± 0.35 mm to 2.42 ± 0.33 mm) which was statistically significant. (**Table 4**)

The increase in the values of CCT from baseline (550.47 ± 25.69 µm) to 1 week (548.82 ± 27.83 µm, p value: 0.399) and 1 month (548.57 ± 25.60 µm, p value: 0.253) was statistically not significant.(**Table 5**) Persistent angle closure after Laser Peripheral Iridotomy was observed in 3 eyes which had presence of peripheral anterior synechiae in addition to iridotrabecular contact.

5. Study Limitations

Our study's lacunae is its limited period of followup post Nd:YAG laser peripheral iridotomy, and also a small sample size. Considering that all eyes had patent peripheral iridotomies on their first followup, parameters would be different if augmentation of PI was required.

6. Conclusion

As laser iridotomy essentially eliminates the likelihood of an acute attack in the fellow eye and prevents the recurrence of acute attacks, it is considered the conventional first-line solution in both acute and chronic forms of angle closure glaucoma. With a newer imaging modality like Pentacam, anterior segment morphology before and after Nd:YAG laser peripheral iridotomy can be assessed and quantified without the need for probe contact or an immersion bath.

Our study showed that there was significant changes in ACV, ACA and ACD following Nd:YAG laser PI in primary angle closure suspects; but the change in CCT was not statistically significant. Furthermore, there was significant widening of the angle in all 4 quadrants following PI based on gonioscopic examination. This study validates earlier findings that patients with primary angle closure suspicions have increased anterior chamber volume, angle, and depth following laser peripheral iridotomy. It was concluded that Pentacam is an extremely useful tool in quantifying the

changes in anterior chamber parameters following laser peripheral iridotomy in primary angle closure suspects.

7. Ethical

Ethical No.: BMCRI/PG/131/2020-21.

8. Source of Funding

None

9. Conflict of Interest

None.

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