e-ISSN: 0975-1556, p-ISSN:2820-2643

Available online on www.ijpcr.com

International Journal of Pharmaceutical and Clinical Research 2023; 15(4); 1479-1485

Original Research Article

To Study Changes in Anterior Segment Morphology after Laser Peripheral Iridotomy (LPI) in Different Stages of Primary Angle Closure Glaucoma Using Gonioscopy and Ultrasound Biomicroscopy (UBM): A Comparative Study in a Tertiary Care Hospital

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Received: 30-01-2023 / Revised: 26-02-2023 / Accepted: 30-03-2023
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Conflict of interest: Nil

Abstract

Aim: To prospectively evaluate the efficacy and study the anatomical changes in the angle of anterior chamber following Nd- YAG laser Peripheral iridotomy (LPI) in different stages of primary angle closure glaucoma & complications of Nd YAG laser PI.

Materials & Methods: Between October 2019 to September 2021, 243 eyes of 243 patients of primary angle closure glaucoma presenting with less than 180 degree peripheral anterior synechiae were selected at the glaucoma clinic of SCBMCH, Cuttack and assement of angles and their comparision were done by Gonioscopy (Shaffer's Grading) and UBM imaging, before and 2 weeks after Nd:Yag Laser Iridotomy(LPI). The outcomes measured are Trabecular-iris angle (TIA) and angle-opening distance (AOD 500) and values compared before and after LPI. The present study have evaluated more on the actual effect on the angle as most studies in the past have concentrated on the disease progression or IOP control after LPI.

Results: Following the quadrant with LPI among the PAC group, the mean gonioscopy grade increased significantly from 1.33 to 1.84 (0.50 change) and on UBM mean superior TIA increased from 8.252±0.16 to 16.081±0.23 degrees, p <0.001; mean AOD500 increased from 0.106±0.04 to 0.209±0.02 mm . Among the PACG group, change in the goniosopy grading was found to be approximately 0.04 and on UBM the mean superior TIA increased from 4.109±0.86 to 4.385±0.14 degrees, p= 0.113,mean AOD500 increased from 0.0631±0.01 to 0.074±0.0, p =0.074.

Conclusion: The benefits of LPI was found to be in the quadrant with LPI resulting in significant widening of the anterior chamber angle and in other quadrant in eyes with PAC which was appreciated both in Gonioscopy and UBM. In Gonioscopy the anterior segment parameters were not markedly improved but changes was best appreciated by UBM in, eyes with PACG.UBM is far more preferred diagnostic modality than gonioscopy for observing the angle changes.

Keywords: Primary angle closure glaucoma, anterior chamber angle, Ultrasound Biomicroscope, laser peripheral iridotomy.

Introduction

Glaucoma is not a single disease process but a group of disorders characterised by a progressive optic neuropathy resulting in cupping of the optic nerve head and visual-field damage [1]. Glaucoma is a leading cause of irreversible blindness throughout the world , In Asia, it is however observed that Primary angle-closure glaucoma (PACG)is a leading cause of blindness than primary open angle glaucoma [2]. The prevalence of PACG has been reported to be 1.08 [3], 1.58 [4], and 4.32% [5] in population-based studies in Asian Indian eyes. Therefore, early detection and treatment are important in the prevention of blindness from PACG.

Angle closure disease is classified into different subtypes including primary angle closure suspect (PACS), acute angle closure (AAC), and PACG [2]. The pathogenesis of angle closure can be well understood by thorough Qualitative and quantitative evaluation of the anterior segment in these eyes. These evaluations are important to diagnose the PACS and to prevent its development into PACG.

Consensus speaks that laser peripheral iridotomy (LPI) is the treatment of choice for eyes with occludable iridocorneal angles [6]. It has been seen that in acute primary angle closure, LPI works wonderfully in preventing the recurrence of acute attacks, and also eliminates the risk of an acute attack in the fellow eye thus eliminating pupillary block by flattening the convex iris, widening the anterior chamber drainage angle and deepening of anterior chamber in primary angle closure (PAC) [7-10]. while these parameters do not change significantly in eyes with PACG [11]. In chronic PACG, portions of the anterior chamber angle are permanently closed by peripheral anterior synechiae (PAS) formation and the intraocular pressure (IOP) becomes chronically elevated, which however is reversed by LPI.

Gonioscopy is used to assess the microstructure of the angle and estimate the degree of opening of the anterior chamber angle which is graded by Shaffer's grading [12-14]. Gonioscopy is a limited by its inability to measure structures in the far periphery of the angle. Being a subjective evaluation, it is also limited by interobserver variation in angle assessment.

Ultrasound biomicroscopy (UBM) enables objective and quantitative estimations of angle anatomy [10]. It provides visualization of retroirideal structures, such as ciliary body, which cannot be seen on clinical examination. The technology of UBM is based on 50-MHz transducer incorporated into a B-mode clinical scanner. It provides lateral and axial physical resolutions of approximately 50 and 25 μm respectively, and has tissue penetration of approximately 5 mm. The scanner produces a 5 × 5 mm field with 256 vertical image lines (or A-scans) at a scan rate of 8 frames/second [12-14].

Among PACS LPI decrease the risk of acute angle closure (AAC) attacks and delay the development of PACG. Though LPI is being routinely done for all cases of angle closure disease, there are few studies in the past which have observed the changes that occur following LPI in PACG. In this study we compared the angle changes both in PAC and PACG before and after LPI by using parameters like Shaffer's grading of gonioscopy and quantitative assessment by UBM.

Materials & Methods

This prospective study was conducted in the Ophthalmology Outpatient Department at Regional Institute of Ophthalmology, SCB Medical College, Cuttack from October 2019

to September 2021. The study was approved by the Institutional Ethics Committee vide letter no.IEC/674, dated 10th March 2021. Patients were explained the procedures and written informed consent was obtained in the local language. Diagnosed case of angle closure patient and angle closure suspect group were evaluated for best-corrected visual acuity (BCVA), IOP, slit-lamp bio microscopy, disc evaluation using a 90D lens and underwent gonioscopic evaluation by ZEISS 4 mirror goniolens before and 2 weeks after LPI and further according to Shaffer's classification [15]. angles were graded in all four quadrants and the extension of synecia was noted.

Inclusion criteria: Patients with 18 yrs of age and above with diagnosed occludable angle and PACG with less than 180 degree of PAS were included in the study. The diagnosis of PACG was made in the presence of occludable angle as defined below and characteristic optic nerve head changes. (Occludable angle: three quarters of the posterior pigmented trabecular meshwork was not visible in the primary position of gaze without indentation or manipulation).

Exclusion criteria: Patients below 18 years of age, advanced glaucoma, more than 180 degree synechial angle closure, history of any ocular surgery, ocular trauma and disease such as uveitis & diabetic retinopathy, with secondary angle closure glaucoma and hazy cornea were excluded from the study.

Ultrasound Biomicroscopy:

Quantitative assessment of the anterior segment parameters were done by Marvel II A/ B - Scan with UBM by Appasamy Associates with a 50MHz transducer. Trabecular-iris angle (TIA), the angle-opening distance (AOD 500), were measured and compared before and 2 weeks after LPI. To avoid observer bias all examinations were performed by one investigator, who was blindfolded to the patients's diagnosis and gonioscopy finding.

Measurement of the angle

TIA (Trabecular-iris angle) is defined as an angle formed with the apex at the iris recess and the arms passing through the point on the meshwork 500 µm from the Scleral Spur (SS) and the point on the iris perpendicularly opposite. TIA was considered zero degree when the angle recess could not be observed due to irido-trabecular apposition. TIA were computed for each patient. Instead of measuring the anterior chamber angle in degree, Pavlin *et al* [16-17]. measured the distance from the point on the corneal endothelial surface 500 µm anterior to the SS to the iris surface perpendicular to the corneal endothelial surface, which was defined as the angle opening distance AOD 500. AOD 500 were measured for each patient.

LPI

Topical pilocarpine was given before the procedure to thin and stretch the peripheral iris. Using Abrahms lens and 4-6mJ energy LPI was done preferably between 11' to 1'0 clock position in the crypt of the peripheral iris. Depending on the penetrability of the iris tissue, one or more shots of single pulse were given and were instructed to use betamethasone-neomycin drops and Timolol maleate 0.5% drop twice a day for a week.

The follow up of the patients were done at 1and 2 weeks after LPI. A detailed ocular examination was carried out, for noting the BCVA, IOP, and gonioscopy. UBM scans were taken after 2 weeks following the LPI procedure, using the same protocol that was used in the pre-LPI evaluation. Gonioscopy grade and UBM parameters were computed for the angle quadrants with the LPI. The IOP and the angle parameters were scrupulously noted.

Statistical Analysis

Data collected were compiled and analysed using statistical package for social Scientist (SPSS) version 17. Descriptive and inferential statistics were used to describe and make inferences from the data where applicable. P value < 0.05 at 95% CI was used as criteria for statistical significance.

Results

243 eyes of 243 patients attending glaucoma clinic were categorised into 3 groups according to gonioscopy grading (2 no eyes with PACS, 185 no of eyes with PAC and 56 eyes with PACG) and were treated with LPI. Maximum number of patients(51%) were between ages 51-60 years and minimum (4%) patients were above 71 years. Female to male preponderance ratio is 2:1. Although the difference did not reach statistical significance, is shown in Table-1. Best corrected visual acuity was between 6/24 to 6/60 in most of the eyes (39%) followed by less than 6/60 (36%).

Table 1: Mean Shaffer's grading (Pre LPI & Post LPI) in different quadrants

PAC	Pre LPI (Shaffer degrees)	Post LPI (Shaffer degrees)	Change
Superior	1.33±0.47	1.87±0.39	0.54
Nasal	1.79±0.50	2.35±0.50	0.65
Inferior	1.50±0.50	1.94±0.24	0.50
Temporal	1.50±0.50	2.00±0.29	0.44
PACG	Pre LPI	Post LPI	Change
Superior	1.10±0.23	1.14±0.22	0.04
Nasal	1.35±0.34	1.30±0.34	0.05
Inferior	1.23±0.25	1.20±0.25	0.03
Temporal	1.23±0.25	1.20±0.25	0.03

Table-1: Among the PAC & PACG group Shaffer's grading was done in all four quadrants and mean was calculated. It was found that mean Shaffer's grading was increased in post LPI phase in all four quadrants.

Table 2: Comparison of Pre LPI & Post LPI UBM parameters among the study population

PAC	Pre LPI	Post LPI	Mean	SD	P value
AOD500(mm)	0.106	0.209	0.157	0.01	<0.001
SupTIA(deg)	8.25	16.00	8.252	0.16	<0.001
PACG	**Pre LPI**	**Post LPI**	**Mean**	**SD**	**P value**
AOD500(mm)	0.063	0.074	0.068	0.01	0.074
Sup TIA(deg)	4.10	4.38	4.109	0.86	0.113

Table-2: The mean AOD500 (in mm) increased from an average of 0.106±0.04 to 0.209±0.02 with p value <0.001 in PAC and from an average of 0.0631±0.01 to 0.074±0.0 with p value of 0.074 among the PACG group. The superior TIA (degree) increased from an average of 8.252±0.16 to 16.081±0.23 with a p-value of <0.001 in PAC and from an average of 4.109±0.86 to 4.385±0.14 with a p value of 0.113 among the PACG group.

At 2 weeks of post LPI phase the mean IOP in all the groups decreased which is shown in Table-3. In PACS mean IOP decreased from 17 mm of Hg before LPI to 15 mm of Hg after and in PAC decrease from 25.91mm of Hg to 21.23mm similarly mean IOP decreased from 27.78 mm of Hg to 25.83 mm of Hg in PACG group.

Table 3: Distributions of mean IOP (Pre LPI& Post LPI) among different stages of PACG

Mean IOP in mmHg		
	Pre LPI	Post LPI
PACS	17	15
PAC	25.91	21.23
PACG	27.78	25.83

Discussion

Primary angle closure glaucoma has significantly high incidence & forms half of all adult primary glaucoma seen in hospitals in India. Laser peripheral iridotomy (LPI) is the current standard of care to prevent the progression of primary angle closure to primary angle closure glaucoma. Early and timely intervention may prevent angle closure and disease progression. The present study have focused more about LPI and its actual effect on the angle which has now become feasible because of modern diagnostics like UBM unlike the past studies which have concentrated more on the disease progression or IOP control. The major limitation of gonioscopy is the observer bias and its inability to visualize the far recess of the angle. The UBM allows detailed imaging of qualitative changes in anterior segment morphology as well as quantitative measurement of angle with greater degree of precision following LPI.

The present study included 2 no eyes with PACS, 185 no of eyes with PAC and 56 eyes with PACG and less than 180 degree PAS. A study from European community [18] prove incidence of angle closure is more between 60-70 years group. Thus angle closure glaucoma occurs a decade earlier in this prospective study.

Our study revealed that there was good control of IOP in both PAC and PACG group after LPI, which was also seen by Aung [19]. and Allsagoff *et al* [20]. Jovina L S See *et al* [21] and AAO publication 2007 [22] have also observed that in 72% and 86.7% patients respectively IOP gets controlled with iridotomy. In our study 15(28.5%) eyes with PACG were presented with uncontrolled IOP at follow up visits at 2 weeks. It has been noted in the Asian communities that eyes not responding to LPI might require additional medication or surgery for IOP control [23-25]. The present study focussed more on the morphological changes in angle width following LPI, with simultaneous measurement of IOP which can be considered an indirect marker for functional angle opening.

In our study, we found widening of angle following LPI, the mean gonioscopy grade of the LPI quadrant and other quadrants increased by more than 0.5 in PAC group, but in PACG group there was no significant change in Shaffer's grade following LPI. Alicia C How *et al*, Sasan Moghini *et al*, Gus Gazzard, MA *et al* [26], T Dada *et al* [11], observed there was significant increase in the Shaffer's grades but they didn't include the PACG group of people into their study. In our study UBM measurements in superior quadrant were far more significant than gonioscopy changes.

Thus we found angle study by UBM is better than gonioscopy. The mean AOD500 (in mm) as measured by UBM increased both in PAC and PACG group. Kaushik *et al* [27] also observed that there was variation in the ACA widening in the superior quadrant as our study. Caronia *et al* [28] demonstrated an increase in the AOD and the lens–iris contact following LPI, with a flattening of the convex iris configuration. Yoon *et al* [29] compared the UBM change in angle morphology following LPI and trabeculectomy, and

demonstrated significant increase in AODs after both procedures [30].

The significant changes in angle parameters in superior quadrant following LPI was noted in PAC groups by both gonioscopy and UBM where as in PACG group changes were only observed by UBM. In PACG patients synechial angle closure prevents any significant change in the angle configuration following LPI which may be the reason for the observations noted above.

Conclusion

This study confirms that LPI results in a significant increase in the angle width thus reducing the IOP in all the quadrant in all PAC patients. It does not significantly change any anterior segment parameters in eyes with PACG patients, as persistent apposition angle closure is common even after LPI, which could be due to anterior rotation of ciliary body and plateau iris and overcrowding of anterior segment due to shorter axial length and relative anterior lens position. These angle changes were best appreciated by UBM than Gonioscopy.

It must be diagnosed and managed quickly and effectively to prevent visual loss. A timely laser peripheral iridotomy may retard the changes and control IOP thus evading further medical therapy or invasive surgical procedures.

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