

Assessment of the anterior chamber parameters after laser iridotomy in primary angle close suspect using Pentacam and gonioscopy

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Abstract

• **AIM:** To evaluate the changes in the anterior segment parameters of the subjects with primary angle closure suspect (PACS) before and after laser iridotomy (LI) using the Pentacam and gonioscopy.

• **METHODS:** Forty –eight eyes of 48 PACS were included. Anterior chamber angle (ACA), central anterior chamber depth (ACD), anterior chamber volume (ACV) and central corneal thickness (CCT) were recorded from the Pentacam before and one month after LI. ACA was graded according to Shaffer classification using Goldmann gonioscopy.

• **RESULTS:** ACA increased significantly from 25.59 ± 4.41 to 26.46 ± 4.33 degrees ($P=0.009$) and ACV changed from $85.97 \pm 16.07 \text{mm}^3$ to $99.25 \pm 15.83 \text{mm}^3$ ($P=0.000$). The changes in ACD, CCT and intraocular pressure were non-significant ($P>0.05$). Gonioscopy showed significant widening of the Shaffer angle in 4 quadrants ($P<0.001$).

• **CONCLUSION:** Pentacam can serve as the objective instrument in assessing the efficacy of LI.

• **KEYWORDS:** glaucoma; laser iridotomy; Pentacam; angle closure; gonioscopy

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INTRODUCTION

Glaucoma is the second leading cause of blindness in the world. The prevalence of glaucoma is estimated to be 1.44% in general population [1]. The epidemiological studies indicate the higher prevalence of primary open angle glaucoma (POAG) in comparison with primary angle closure glaucoma (PACG). However, the visual impairments in patients with PACG is 2 to 3 times more than POAG [2]. Shorter axial length, thickening of the lens in old adults, plateau iris, narrow anterior chamber angle (ACA), shallow anterior chamber depth (ACD) and shorter corneal diameter are considered as the major risk factors in the development of PACG [3].

The Goldmann gonioscopy is the gold standard in assessment of the anterior chamber angle and one of its most popular classifications was introduced by Shaffer. Although the angle grading by the use of gonioscopic contact lenses has been proved to be valuable, it depends on the skills of the examiner and its reproducibility is poor. Ultrasound biometry (USB), optical coherence tomography (OCT) and Pentacam Scheimpflug camera have the ability of measuring the anterior segment parameters with high reliability and reproducibility [4-7]. Pentacam is a fairly new machine that uses rotating Scheimpflug imaging technique to capture a 3D image from the anterior segment of the eye. During its measurements, extraneous eye movements are detected by a second pupil camera and corrected simultaneously.

Nowadays, laser iridotomy (LI) has been proposed as the standard prophylactic option for patients with primary angle closure suspect (PACS) and a treatment option for PACG [8-10]. Biometric studies in Asians and Europeans revealed the significant increase in angle width by bypassing the relative block at the pupil [11-13]. Although prophylactic efficacy of the LI has been proven in different studies, the outcome in asymptomatic cases highly depends on the nature of the closed angle and the stage of the disease [14,15]. Intermittent and chronic pupillary blocks are the LI indications in patients with PACG [16].

This study aimed to examine the impact of LI on anterior chamber parameters in Iranian patients with PACS using the

Pentacam rotating Scheimpflug camera and Goldmann gonioscopic contact lenses.

SUBJECTS AND METHODS

Subjects This was a prospective interventional case series study of the patients in Razavi Hospital, Mashhad, Iran. The study got the approval from the Human Ethics Committee of the Razavi Hospital. Written informed consents were obtained from all of the participants after explaining the procedures of the study. All the investigations were in accordance with the Declaration of Helsinki in 1975. It should be noted that this study included Iranian subjects with Caucasian ethnicity.

The day before the laser treatment, subjects underwent slit-lamp biomicroscopy, ophthalmoscopy with 75 Diopter lens (Volk Optical Inc., Mentor, OH, USA), gonioscopy (Goldmann 4 mirror contact lenses), visual field examination (Humphery, Ziess) and intraocular pressure measurement (IOP, Goldmann applanation). Best corrected visual acuity was determined using the logMAR chart (The Lighthouse, Long Island City, NY, USA) under artificial standard illumination at 4m and auto-refractometer (Topcon RM-8800, Topcon Corporation, Tokyo, Japan).

Subjects were diagnosed as PACS according to the criteria defined by previous studies: 180 degrees or more of the posterior trabecular meshwork was not visible on gonioscopy, IOP \leq 21mmHg and no peripheral anterior synechiae in the angle [17,18]. In addition, the visual field and optic nerve appearance of all subjects were normal. Patients with history of glaucoma, ocular hypertension, trauma, corneal disorders such as keratoconus, pterygium or corneal opacity and any previous laser treatments were excluded from the study.

Methods

Laser iridotomy procedure One hour before the LI, subjects received 1% Pilocarpine (4 times). The YAG (neodymium yttrium-aluminium-garnet) laser and Zeiss anterior segment YAG contact lens were used. The following setting was applied for the LI: a single 5-6mJ pulse was delivered to the treatment site and repeated until patency was achieved. The ophthalmologist assessed the patency by direct visualization of the posterior chamber. After the LI, subjects received 0.1% Dexamethasone for 3d and one dose of oral Acetazolamide (250mg). One hour post-LI, the IOP was measured and if it was more than 21mmHg, Timolol (0.5%) eye drop was prescribed twice a day for 3d.

Anterior segment measurements Anterior segment was imaged with Pentacam HR (Oculus, Germany) before and one month after the LI. For the measurement, the patient was seated in front of the instrument with his/her chin on a chin rest and the forehead against the forehead strap. During the measurements, subjects were asked to focus on the blue fixation target. When the real image was stable and focused,

the rotating Scheimpflug camera captured 50 images automatically around the optical axis of the eye. Following parameters were recorded from the Pentacam maps: ACA, degrees; anterior chamber depth along the optical axis (ACD, mm); ACV, mm³, central corneal thickness (CCT, μ m) and pupil diameter (PD, mm). In this experiment, only one Pentacam measurement was performed for each patient; however, if the quality specification was not white "OK", the examination was repeated.

After the Pentacam examination, the IOP was measured by Goldmann contact tonometer. Then gonioscopy examination was attempted with a 4 mirror gonioscopy contact lens at 16 \times magnification. Since no mydriatic was used, the vertical slit beam was set to 1mm to allow the maximum visualization. Before starting the examination, the Benoxinate hydrochloride 0.3% was applied as the corneal anesthetic and then 2% Hypromellose solution in saline was used as a coupling medium for the contact lens. The ACA was recorded in 4 quadrants (superior, inferior, nasal and temporal) and graded according to the Shaffer grading system. Grade 4, grade 3 and grade 2 were considered as a wide open angle (35 $^{\circ}$ -45 $^{\circ}$), moderately open (25 $^{\circ}$ -34 $^{\circ}$) and moderately narrow (10 $^{\circ}$ -20 $^{\circ}$), respectively. While grade 1 was classified as a very narrow angle (<10 $^{\circ}$), grade 0 was a closed angle (0 $^{\circ}$). All the measurements were performed by a glaucoma specialist between 10-12 a.m. in a dark room (12 \pm 0.5Lx using digital light meter).

Statistical Analysis Data were tabulated and Statistical Products and Services Solution (SPSS version 18.0, Chicago, IL, USA) was used for the statistical analysis. Normal distribution of data was assessed using the Shapiro-Wilk test. The paired samples *t* test and Wilcoxon signed-rank test were used to investigate the difference in anterior segment parameters before and after the LI. The $P < 0.05$ was considered statistically significant.

RESULTS

A total of 48 eyes of 48 patients including 12 male and 36 female subjects fulfilled the above inclusion criteria and were included in this study. The mean age of patients was 57.04 \pm 8.65 years (range 42-72 years).

The mean ACA increased significantly from 25.59 \pm 4.41 degrees to 26.46 \pm 4.33 degrees ($P = 0.009$). However, the rise in the ACD was not statistically significant ($P = 0.09$). On the other hand, the ACV increased sharply after the LI from 85.97 \pm 16.07mm³ to 99.25 \pm 15.83mm³ ($P < 0.000$). While the mean IOP and PD insignificantly decreased ($P > 0.05$), the mean CCT of the subjects after the LI treatment was slightly higher (2.13 μ m) than its value before LI, but this difference did not reach the statistical level ($P = 0.22$). Table 1 shows the mean and standard deviation (SD) for the measured parameters before and after the LI.

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Table 1 Anterior segment parameters records before and after laser iridotomy

Parameter	Pre-LI	Post-LI	P
ACA (degree)	25.59±4.41	26.46±4.33	¹ 0.009
ACD (mm)	2.06±0.19	2.08±0.19	0.09
ACV (mm ³)	85.97±16.07	99.25±15.83	¹ 0.000
CCT (µm)	522.60±26.70	524.73±27.05	0.22
PD (mm)	2.96±0.52	2.91±0.46	0.33
IOP (mmHg)	17.86±4.5	16.91±3.55	0.47

ACA: Anterior chamber angle; ACD: Anterior chamber depth; ACV: Anterior chamber volume; CCT: Central corneal thickness; PD: Pupil diameter; IOP: Intraocular pressure. ¹Statistically significant.

The angle width increased significantly in all quadrants ($P < 0.001$) according to the Wilcoxon signed-rank test (Table 2). In the superior quadrant, Shaffer grade increased in 27 eyes (56.3%) and remained unchanged in 21 eyes (43.7%) (the median increased from 1 to 2). Similar findings were observed in the nasal quadrant. In the temporal quadrant, Shaffer grade increased in 24 eyes (50%) and remained unchanged in 24 eyes (50%) and the median grade increased from 1 to 2. The angle width in the inferior quadrant of the 20 eyes remained unchanged, 26 eyes showed increase and 2 eyes had 1 level of decrease. Figures 1 and 2 present the number of eyes in each quadrant according to the Shaffer grading before and after the LI, respectively.

DISCUSSION

Laser peripheral iridotomy is considered as the first-line in the management of the patients with acute and chronic angle closure glaucoma ^[10]. This method has been also suggested as the preventive treatment option in eliminating the risk of recurrent acute attacks ^[11,19]. The mechanism of this intervention is allowing the aqueous to flow directly through the iridotomy site ^[20]. In the present study, we aimed to investigate the efficacy of the LI in the management of the subjects with PACS using the Pentacam. This study showed significant changes in ACV and ACA, however, the changes in ACD, CCT, PD and IOP did not reach the significant level. Furthermore, LI resulted in significant widening of the angle in 4 quadrants based on the gonioscopy examination.

In the present study, Pentacam Scheimpflug camera that is one of the fairly recent advances in anterior segment imaging was used. The Pentacam is a noninvasive imaging technology that records anterior segment parameters faster than the conventional gonioscopy. This machine has been shown to be accurate and reproducible for the measurement of the anterior chamber parameters ^[7,21]. The rotating Scheimpflug camera allows precise visualization of the angle structure and the scleral spur ^[22, 23]. Although the Pentacam is an accurate method in anterior segment imaging, light of the rotating Scheimpflug camera cannot penetrate the corneoscleral limbus. This weakness in illumination system might justify this observation that the Pentacam had the lowest repeatability in measurement of the ACA^[7].

Table 2 Gonioscopic Shaffer grading before and after laser treatment

Quadrants	Pre-LI (Shaffer degrees)	Post-LI (Shaffer degrees)	Change	P (Wilcoxon)
Superior	1.33±0.47	1.87±0.39	0.54	¹ 0.000
Inferior	1.79±0.50	2.35±0.56	0.65	¹ 0.000
Nasal	1.50±0.50	1.94±0.24	0.50	¹ 0.000
Temporal	1.50±0.50	2.00±0.29	0.44	¹ 0.000

¹Statistically significant.

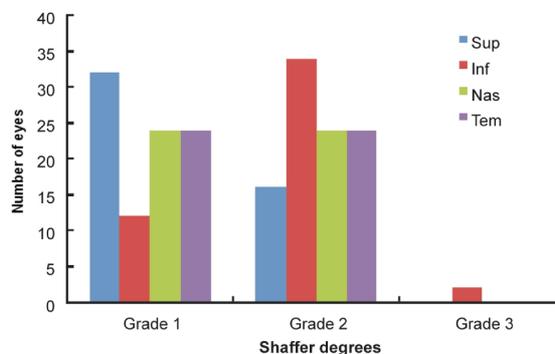


Figure 1 Number of eyes in each quadrant according to Shaffer classification before laser iridotomy treatment (There were no eyes with grade 0 and 4).

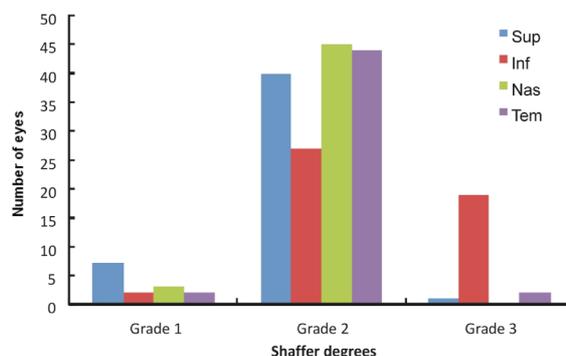


Figure 2 Number of eyes in each quadrant according to Shaffer classification after laser iridotomy treatment (There were no eyes with grade 0 and 4).

Our results showed that the PD did not change significantly after the LI. As it is known, PD could affect the measurement of anterior chamber parameters ^[24]. In order to validate our experiment, we tried to control the lighting and fixation to ensure that the PD remained the same in 2 sessions of the measurements. Although the PD could be influenced during the LI treatment, previous study suggested that even exactly after LI, anterior segment assessment by the Pentacam could provide valuable information regarding the treatment outcome^[25].

The results of the present study showed the insignificant increase in ACD after the LI. Previous studies reported inconsistent results for the changes in central ACD after the LI ^[26-28]. While López-Caballero *et al* ^[27] study showed significant deepening of the ACD after LI, in Li *et al*'s^[24] and Antoniazzi *et al*'s ^[26] studies the increase in ACD did not reach the significant level. The LI moves the iris toward the posterior chamber, however, the location of the lens is not affected; thus the irido-lens contact will increase. Regarding

the magnitude of the ACD increase, our results are in agreement (0.02mm increase) with a recent study by Talajic *et al* [28]. These researchers measured the anterior chamber parameters after the LI in 37 eyes of patients with PACS using the Pentacam.

Results of the ACA and ACV measurement before and after the LI showed widening of the angle (0.87°) and increase in the volume of the anterior chamber (13.28mm³) which agree well with previous studies comprised PACS subjects [29]. In Li *et al*'s [24] study, the ACV was 55.54±14.25mm³ before the LI that increased to 82.65±17.63mm³ after the LI (more than 27mm³ increase). One reason for the difference between these two studies might be the variety of participants' ethnicity. The Asian eyes are known to have shorter ACD and consequently lower ACV compared to the other ethnicities. Another reason could be explained by enrollment of the PACG in addition to PACS patients in their study, whereas the current study only included PACS subjects.

The central corneal thickness post-LI was slightly thicker than pre-LI that is in line with a previous study [25]. This increase could be confined to the oedema that was resulted from the contact lens wear during the LI process.

The main objective of the gonioscopy examination is visualization of the ACA and detection of the most likely closed and occludable angles. Gonioscopic angle grading system has been shown to be reliable, but the subjective nature of the grading and the lack of defined cutoff points between normal, closed and suspected to closed angles make the comparison challenging and examiner dependent. In the present study, there was an overall 0.5 increase in Shaffer angle grade (average of 4 quadrants) that was smaller in magnitude than the one reported for the fellow eyes of the Chinese with PACG [20]. This difference between 2 studies could be due to higher severity of the disease in their study. Since in general populations, PACS commonly have wider angle compared to the PACG, we could expect more changes after the LI in PACG subjects. In the present study, the narrowest angle in pre-LI measurements by Gonioscopy was the inferior quadrant and it also had the second highest successful angle opening after the LI. It is believed that the widening of the angle is due to an overall displacement of the iris after the LI. As the inferior angle was the narrowest in the beginning, higher degree of iris movement is expected in this quadrant compared to the other quadrants. Furthermore, the findings in this study indicated an overall significant increase in angle measurement values (from 25.59 to 26.46 degrees) by the Pentacam that was equal to 1 degree of increase in Shaffer grade (from Shaffer grade 1 to 2)

To our knowledge this study reported the first documentation of the changes in the anterior segment parameters after LI in

Iranian subjects with narrow angles. The present study confirmed previous reports on the increase in ACV and ACA values after the LI. Pentacam could provide valuable and helpful information concerning the anterior segment of the eye after the LI and consequently the efficacy of the LI.

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