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Comparison of ultrasound biomicroscopic parameters following laser iridotomy in eyes with primary angle closure

Bora Yüksel, Tümay Örsel, Memed Acar, Sevgi Onat

Department of Ophthalmology, Izmir Bozyaka Teaching and Research Hospital, Bozyaka, Izmir, Turkey
Correspondence to: Bora Yüksel. Department of Ophthalmology, Izmir Bozyaka Teaching and Research Hospital, Bozyaka, Izmir, Turkey. drborayuksel@ gmail. com

Abstract

• AIM: To compare the ultrasound biomicroscopy(UBM) parameters before and after laser iridotomy in eyes with primary angle closure(PAC).

• METHODS: A prospective clinical trial was carried out in 46 cases (74 eyes) with PAC included in the study. Mean age was 58.04 ± 11.33 (range 24. 0-82. 0) years. Complete ophthalmic examination, gonioscopy A-scan biometry and UBM (Vu-max, Sonomed Inc., NY, USA) and Standard Achromatic Perimetry (SAP) using the 24-2 was performed (Humphrey Visual Field Analyzer-II i, Carl Zeiss Meditec Inc., Dublin, CA, USA) in all cases. Changes in mean values between baseline and follow-up were assessed using a paired Student's *t* test.

• RESULTS: The mean anterior chamber angle increased from $8.02 \pm 4.61(0.10\text{-}19.60)$ degree to 17.66 ± 6.39 (0.10-32.70) degree ($P = 0.000$), angle opening distance 500 (AOD 500) increased from 0.11 ± 0.06 (0.01-0.30) to 0.23 ± 0.07 (0.13-0.50) mm ($P = 0.000$), mean iris thickness (IT) decreased from $0.58 \pm 0.11(0.33\text{-}0.99)$mm to 0.52 ± 0.10 (0.25-0.77) mm ($P = 0.000$) after laser peripheral iridotomy (LPI). No statistically significant changes were found in trabecular-ciliary process distance (TCPD), iris-ciliary process distance (ICPD) and ciliary body thickness (CBT).

• CONCLUSION: AOD 500, iridolenticular distance (ILT) and anterior chamber angle (ACA) increases, IT and iridolenticular height (ILH) decreases after LPI in Caucasian eyes with PAC. It means that LPI relieves the pupillary block, deepens the anterior chamber, widens the ACA, decreases the anterior bowing and thickening of the iris.

• KEYWORDS: ultrasound biomicroscopy; laser peripheral iridotomy; angle closure

INTRODUCTION

Primary angle closure (PAC) occurs more frequently in East Asian people than Europeans. The disease is asymptomatic at least half of this group of patients[1,2]. Approximately 28. 2 million indivuduals in China are under the risk of this condition[3]. The disorder is characterised by the iris apposition to the trabecular meshwork. It is thought to start with an anatomically narrow drainage angle (Primary Angle Closure Suspect: PACS), proceeding to established angle closure in which appositional or synechial closure of the angle occurs in the presence of raised intraocular pressure (PAC). This stage places people at risk for angle closure with glaucomatous optic neuropathy (PACG).

It is generally agreed that eyes with anatomically narrow angles should undergo laser peripheral iridotomy (LPI)[3]. LPI results in a significant increase in the angle width in both European and Asians with narrow angles[1,2]. In acute PAC, LPI prevents the recurrence of acute attacks, and eliminates the risk of an acute attack in the fellow eye. LPI may also help in reversing appositional angle closure and controlling the intraocular pressure (IOP) in PAC [4]. LPI creates an opening to bypass the pupillary block and equalizes the pressures between the posterior and anterior chambers and thereby allows a convex iris to flatten and widen the anterior chamber angle. Ultrasound biomicroscopy (UBM) is a high resolution imaging of the anterior segment that allows an objective evaluation of the angle morphology using an automated software [1,5,6]. This study was planned to quantify the changes in the angle morphology after LPI in patients with PAC by using UBM.

MATERIALS AND METHODS

Materials　In this prospective, nonrandomised clinical study, patients with PAC were the study subjects who consecutively recruited from the glaucoma service from January 2009 to January 2010. 74 eyes of 46 patients with PAC were included in the study. The diagnosis of various subtypes of PAC were established according to the International Society of Geographical and Epidemiological Ophthalmology classification system[7] as follows: (1)PACS: An eye in which appositonal contact between the peripheral iris and posterior trabecular meshwork or an angle in which equal or higher than 270 degree of the anterior trabecular meshwork cannot be seen were considered as PACS; (2)PAC: An eye with an occludable drainage angle and features indicating trabecular obstruction

by the peripheral iris has occured, such as peripheral anterior synechiae, elevated IOP, iris whorling, lens opacities or excessive pigment deposition on the trabecular surface without any glaucomatous optic disc damage;(3)PACG:PAC together with the evidence of glaucoma.

Methods　Each patient underwent an complete ophthalmic examination including slit-lamp biomicroscopy, gonioscopy, ±fundus biomicroscopy with 90D lens, applanation tonometry, A-scan biometry and UBM(Vu-max, Sonomed Inc., NY, USA). Standard Achromatic Perimetry(SAP)using the 24-2 testing protocol by SITA- standard strategy was also performed (Humphrey Visual Field Analyzer-II i, Carl Zeiss Meditec Inc., Dublin, CA, USA). Gonioscopy was performed by one investigator(Tümay Örsel)in a darkened room under minimal slit-lamp illumination. The angles were graded in all four quadrants according to Shaffer's classification. The presence of PAS was noted. In cases where the angle structures could not be visualised, a four-mirror Zeiss indirect gonioscopy lens (Ocular instruments Inc., Bellevue, WA, USA) was used. Glaucomatous optic nerve damage was defined as cup/disc ratio over 6/10 or more than 0.2 cup/disc ratio assymmetry between two eyes. Also a glaucomatous field defect was defined as MD and PSD values outside 95% confidence interval and Glaucoma Hemifield Test classified as "outside normal limits".

All UBM examinations were performed by single trained ophthalmologist(Memed Acar)with a 35mHZ transducer under topical anesthesia. UBM images were acquired before the administration of miotic eye drops. The eyes were examined using an eye cup filled with serum physiologic, with care not to exert pressure on the globe. Scanning was performed while the patient was in supine position and fixating the contralateral eye on a distance target on the ceiling to minimize accommodation. Two axial images showing the superior and inferior anterior chamber angle and the ciliary body were frozen and recorded for each eye. In high resolution mode lens thickness and anterior chamber depth were also noted. The same procedure was repeated one month after LPI intervention.

Using special caliper within the instrument following parameters were measured:(1)UBM anterior chamber depth (UACD): Distance between the corneal endothelium and anterior lens surface along the geometric axis of the eye;(2) UBM lens thickness(ULT): The central axial distance between the anterior and posterior surfaces of the lens;(3) The angle opening distance 500(AOD500): Distance between the posterior corneal surface and anterior iris surface measured on a line perpendicular to the trabecular meshwork at 500μm from the scleral spur;(4)The trabecular ciliary process distance(TCPD): Measured distance on a line extending from the corneal endothelium at 500μm from the scleral spur perpendicularly through the iris to the ciliary processes;(5)The iris ciliary process distance(ICPD): From the posterior iris surface to the ciliary process along the same line as the TCPD;(6)The iris thickness(IT500): A

circle was drawn with radius of 500μm, with the scleral spur used as the centre. The point of intersection at the anterior surface of the iris was identified. The shortest distance from this point to the posterior surface of the iris was calculated as IT500;(7)Anterior chamber angle(ACA): Measured with its apex in the iris recess and arms of the angle passing through a point on the trabecular meshwork at 500μm from the scleral spur and the point on the iris perpendicularly opposite; (8)Iridolenticular distance(ILT): Measured along the iris pigmented epithelium from the pupillary border to the point where the anterior lens surface leaves the iris;(9) Iridolenticular height(ILH): ILH is a novel parameter that has been described by our clinic and never been used before in any study. It is the distance between the posterior surface of the iris and the anterior surface of the lens along the perpendicular line where the anterior bowing of the iris is maximum;(10)Ciliary body thickness(CBT): Measured along a line perpendicular to the inner surface of the sclera passing through a point located 1mm posterior from the scleral spur. Before LPI, topical pilocarpin 2%(Pilosed 2%, Bilim Ila Inc., Kartal, Istanbul, Turkey) was instilled to constrict the pupil. LPI was performed using Nd:YAG laser(Visulas YAG III, Carl Zeiss Meditec, Jena, Germany) set at 3-6mJ depending upon the thickness of the iris. The intended minimum size of the iridotomy was approximately 0.1mm as considered large enough to be patent. All patients received dexamethasone topical drops q.i.d and timolol maleate 0.50% twice a day for one week after procedure.

Statistical Analysis　This study was analyzed by SPSS for Windows version 9.5(SPSS Inc., Cary, NC, USA). Frequency histograms and one sample Kolmogorov-Smirnov test was used to assess the distribution of numeric data from parametric characteristics. Differences in mean values of parametric data between study groups were examined using an independent samples Student's t test. Changes in mean values between baseline and follow-up were assessed using a paired Student's t test. For parametric data a Mann-Whitney U test was used to compare means and the Wilcoxon Signed Rank test for the distrubution of two related variables. A P value of less than 0.05 was considered as statistically significant.

RESULTS

Mean age was 58.0 ± 11.3(range 24.0-82.0)years. Eleven of the patients were male(23.9%)and 35 were female(76.1%). There was no statistically significant difference between the mean age of male and female subjects(57.9 ± 11.4　vs 58.3 ± 11.8).

Except one eye, anterior chamber angle increased in all 73 eyes after LPI. The UBM anterior chamber angle recordings revealed that the mean anterior chamber angle increased from 8.02 ± 4.61(0.10-19.60)degree to 17.66 ± 6.39(0.10-32.70)degree($P = 0.000$).

After LPI mean AOD 500 increased from 0.11 ± 0.06(0.01-0.30)mm to 0.23 ± 0.07(0.13-0.50)mm($P = 0.000$). AOD 500 increased in 71 eyes whereas decreased in 2 eyes and remained the same in 1 eye. IT500 decreased in 53 eyes,

increased in 20 eyes and remained the same in 1 eye. The mean IT500 decreased from $0. 58 \pm 0. 11$ (0. 33-0. 99) mm to $0. 52 \pm 0. 10$ (0. 25-0. 77) mm ($P = 0. 000$). However, no statistically significant change was found in TCPD (from $0. 83 \pm 0. 12$ mm to $0. 84 \pm 0. 14$ mm, $P = 0. 980$), ICPD (from $0. 14 \pm 0. 09$ mm to $0. 14 \pm 0. 10$, $P = 0. 804$) and CBT (from $1. 17 \pm 0. 16$ mm to $1. 18 \pm 0. 16$ mm, $P = 0. 629$) after LPI.

ILT increased in 71 eyes, decreased in 3 eyes. The mean ILT increased from $0. 48 \pm 0. 15$ (0. 19-0. 97) mm to $0. 79 \pm 0. 24$ (0. 31-1. 51) mm ($P = 0. 000$). ILH value decreased in all except one patient after LPI and remained the same in another patient. Mean ILH decreased from $0. 45 \pm 0. 9$ mm to $0. 28 \pm 0. 8$ mm ($P = 0. 000$) after LPI. The maximum ILH was 0. 74mm before LPI, and it was 0. 51mm after LPI. LT and ACD before and after LPI were shown in Table 1.

DISCUSSION

LPI has been used as the standard treatment in eyes with PAC. Very few studies have been performed to asssess the short-term effect of LPI on the anterior segment anatomy. Gazzard et al[1] documented the effect of LPI on the anterior segment anatomy in angle closure suspects using UBM. Dada et al[4] compared the UBM parameters after LPI in eyes with PAC and PACG. Until recently gonioscopy was the only tool available for the angle assessment but now UBM allows detailed imaging of both qualitative and quantitative changes in anterior segment morphology following LPI. To date various observers have looked at the effects of LPI by using UBM. This study demonstrates the effects of LPI on PAC patients by using UBM.

Kaushik et al[2] showed that AOD 500 values increased after LPI by using UBM. Likewise, He et al[3] showed TCPD and ICPD change after LPI. However in our study no significant change was found in ICPD in contrast to this study. Gazzard et al[1] studied the effect of LPI on 55 fellow eyes of acute PACG patients. Central pachymetric ACD did not change significantly however they observed an increase in the ACD after LPI as measured by UBM. They also showed widening of the anterior chamber angle with significant changes in AOD 250, AOD 500 and angle recess area after LPI. Yoon et al[8] studied the changes in 13 eyes with PACG following LPI and trabeculectomy. They reported a statistically significant increase in AOD 500, anterior chamber angle, and ILCD, however no significant change in ACD, TCPD and IT. Caronia et al[9] demonstrated that the mean AOD value increased from 0. 11 to 0. 18mm and the mean trabecular iris angle increase from 8. 3 to 18. 6 degree after the LPI. The mean ILCD increased from 0. 58 to 1. 18 mm whereas the ACD remained unchanged. The authors concluded that flattening of the iris after LPI for pupillary block causes an increase in the iris-lens contact.

Lim et al[10] showed shallower anterior chamber values using ultrasound pachymetry in acute PAC patients. Maraffa et al[11] reported anterior chamber angle increased from a mean 10. 69 to 21. 03 degree after LPI. Dada et al[4] studied the effect of LPI on 54 eyes of PAC and 39 eyes of PACG. They found a

Table 1 Ultrasound biomicroscopic parameters of lens thickness and anterior chamber depth before and after laser peripheral iridotomy

	Before LPI	After LPI	P
Lens thickness (mm)	$4. 34 \pm 0. 37$ (3. 35-5. 50)	$4. 30 \pm 0. 42$ (3. 23-5. 15)	<0. 05 *
ACD(mm)	$2. 06 \pm 0. 26$ (1. 20-2. 61)	$2. 16 \pm 0. 24$ (1. 25-2. 67)	<0. 01 * *

Note: * ausing t test; * * busing Wilcoxon Signed Rank test.

significant ACA increase along with an increase in the AOD, TCPD and scleral spur to iris distance in PAC. However no significant change was seen in PACG. There was a decrease in the ILCD after LPI in PAC group. The mean IT500 and ILPD showed no significant change after LPI in either group. Although deepening of the ACD was noted in PAC, no significant change was found in the mean ACD after LPI in PACG.

ILH is a novel parameter used in present study. It reflects the height of iris from the anterior lens surface. ILH showed a decrease as a result of pressure balance between anterior and posterior chambers which was allowed by the aqueus humor collected behind the iris entered into the anterior chamber through the iridotomy site. However, this study has some limitations. Subtypes of angle closure glaucoma were not considered during interpretation of the results. Immersion technique might have caused a discomfort to the patients. Optical coherence tomography (OCT) is suggested as an alternative to UBM since it is light based, not requiring contact with the eye and less time consuming[12]. UBM allows to detect some anatomic variations such in Sakata et al's[13] study reporting long ciliary processes with no ciliary sulcus in Brasilian eyes. Likewise, anasymptomatic ciliary body cyst was diagnosed in two of our patients incidentally during UBM examinations.

In conclusion, this UBM study showed that AOD500, ILT, ACA increased, IT500 lessened and ILH decreased after LPI in Caucasian eyes with PAC. It means that LPI relieves the pupillary block, deepens the anterior chamber and widens the anterior chamber angle. The thickening as well as anterior bowing of the iris before treatment in eyes with PAC are relieved by LPI.

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原发性房角关闭眼激光虹膜切除术后 UBM 测量参数比较

Bora Yüksel, Tümay Örsel, Memed Acar, Sevgi Onat
(作者单位:土耳其伊兹密尔,伊兹密尔 Bozyaka 教学研究医院眼科)
通讯作者:Bora Yüksel. drborayuksel@gmail.com

摘要

目的:比较激光虹膜切开术前后原发性房角关闭(primary angle closure,PAC)眼超声生物显微镜(ultrasound biomicroscopy, UBM)参数。

方法:对 46 例 74 眼 PAC 患者进行了一项前瞻性临床试验。平均年龄 58,04±11.33(24.0-82.0)岁。所有病例行完整的眼科检查,前房角镜 A 超生物测量和超声生物显微镜检查(Vu-max, Sonomed Inc., NY,USA)及 24-2 标准无色差视野检查(SAP,Humphrey Visual Field Analyzer-II i, Carl Zeiss Meditec Inc., Dublin, CA, USA)。使用配对 t 检验评估基准和随访的平均值之间的变化。

结果:激光周边虹膜切除术(laser peripheral iridotomy, LPI)术后,平均房角从 8.02±4.61(0.10-19.60)度增加到 17.66±6.39(0.10-32.70)度($P = 0.000$),房角开放距离 500(angle opening distance 500, AOD 500)从 0.11±0.06 (0.01-0.30)mm 增加到 0.23±0.07(0.13-0.50)mm($P = 0.000$),平均虹膜厚度(iris thickness, IT)从 0.58±0.11 (0.33-0.99)mm 下降到 0.52±0.10(0.25-0.77)mm($P = 0.000$)。小梁睫状突距离,虹膜睫状突距离和睫状体厚度均未发现显著统计学差异。

结论:LPI 术后 PAC 的白种人眼睛的 AOD 500,虹膜晶体距离和前房角增加,IT 和虹膜晶体高度减少。这说明 LPI 解除了瞳孔阻滞,加深了前房,扩大了房角,减少了虹膜前凸和增厚。

关键词:超声生物显微镜;激光周边虹膜切除术;房角关闭