Published in final edited form as:

Am J Ophthalmol. 2007 May ; 143(5): 877–879.

Anterior Segment Optical Coherence Tomography for Imaging the Anterior Chamber Following Laser Peripheral Iridotomy

Farnaz Memarzadeh, MD, Yan Li, MS, Vikas Chopra, MD, Rohit Varma, MD, Brian A Francis, MD, and David Huang, MD, PhD

From the Doheny Eye Institute and the Department of Ophthalmology, Keck School of Medicine of the University of Southern California, Los Angeles, California

Primary angle closure glaucoma is common in certain regions of the world and is an important cause of blindness worldwide. Currently accepted treatment for patients with anatomically narrow angles is laser peripheral iridotomy (LPI).

Gonioscopy is currently the standard clinical tool for detecting occludable angles. However, this subjective technique is limited by interobserver bias and is difficult to perform in a reproducible fashion. Ultrasound biomicroscopy (UBM) is a more objective and reproducible method of angle assessment,^{1, 2} but the contact or immersion requirement is inconvenient and may cause artifactual widening of the angle.

Optical coherence tomography (OCT)³ is a new imaging modality that allows high-resolution, cross-sectional imaging of the eye.⁴⁻⁵ OCT requires no contact or immersion and has higher spatial resolution than ultrasound. In this study, we used OCT to quantify changes in anterior segment morphology after LPI.

PATIENTS AND METHODS

This study was approved by the Institutional Review Board of University of Southern California and was HIPAA compliant.

AC angle width was graded in four quadrants according to the Shaffer⁶ grading system. Angles with grading score ≤ 1 were classified as narrow. Ten eyes of 10 patients were enrolled in the study after obtaining informed consent and underwent manifest refraction, axial length measurement and baseline OCT imaging before LPI. Imaging was again performed 1 week post LPI.

We used an anterior segment OCT prototype provided by Carl Zeiss Meditec, Inc. (Dublin, California). This model uses a 1.3- μ m wavelength light source to acquire 2000 axial scans/second. Cross-sectional angle images were obtained in the nasal and temporal quadrants. OCT images were analyzed using custom MATLAB software version 7.0 (The MathWorks, Inc., Natick, MA). AC parameters measured were: angle opening distance¹ at 500 μ m (AOD 500),

Correspondence: David Huang, MD, PhD., Doheny Eye Institute, 1450 San Pablo Street, DEI5702, Los Angeles, CA 90033. Tel: 323-442-6448; Fax: 323-442-6515; Email: dhuang@usc.edu

Contributions of authors: Design and conduct of the study (DH, YL); collection, management, analysis and interpretation of the data (FM, YL, VC, RV, BAF, DH); preparation, review and approval of the manuscript (FM, VC, RV, BAF, DH).

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angle recess area² at 500 μ m and 750 μ m (ARA 500 and 750) and trabecular-iris space area⁵ at 500 μ m and 750 μ m (TISA 500 and 750).

Statistical analysis

Changes in mean values between baseline and post-LPI visits were assessed using paired Student's *t* test and Wilcoxon signed-rank test. *P* value < 0.05 was considered statistically significant.

RESULTS

Ten eyes of 10 patients with occludable angles were enrolled in the study. Patients included five males and five females. Six patients were Hispanic, two were white, and two were Asian. Average patient age was 63.6 years ($\pm$ 15.85; 41-83 years). Spherical equivalent refraction was +0.8 diopters (D) ($\pm$ 2.2 D; -2.75 D to +2.25 D). Average axial length was 21.8 mm ($\pm$ 2.0; 20.87 - 23.24 mm).

The gonioscopy grades increased from 0.56 ± 0.8 before LPI to 2.6 ± 0.8 after LPI (*P* < 0.001). AOD 500, ARA 500, ARA 750, TISA 500, and TISA 750 all were significantly increased after LPI (Table).

DISCUSSION

Several studies have used UBM to look at the effects of LPI on AC angle morphology,^{1, 2} but few have used anterior segment OCT to quantify such changes.⁷ OCT has several advantages over UBM. It is a light-based system that produces images with high spatial resolution. Its non-contact nature enhances patient comfort and allows rapid image acquisition in the sitting position without mechanical distortion of the angle. Our OCT images show that after LPI, the convex configuration of the iris flattens and the AC angle widens (Figure). The degree of angle widening can be quantified using custom software that has been previously validated⁵ in comparison with gonioscopy and UBM. These LPI-induced changes in angle parameters agree well with gonioscopic angle opening.

We believe that the ease of image acquisition and analysis with OCT, together with its non-contact nature, make it a desirable tool for large-scale screening for narrow angles. By using cut-off values on the OCT parameters we can determine which angles are occludable and would benefit from LPI. Future studies with larger numbers of subjects are needed to more clearly define the role of OCT for this potential application.

ACKNOWLEDGEMENTS/DISCLOSURE

Grant support from NIH R24 EY 13015, National Eye Institute, Bethesda, MD and an unrestricted grant from Research to Prevent Blindness, Inc., New York, NY. Research equipment and grant support from Carl Zeiss Meditec, Inc., Dublin, CA. David Huang receives royalties from OCT patents licensed to Carl Zeiss Meditec, Inc., Dublin, CA. David Huang and Yan Li receive research grant support from Carl Zeiss Meditec, Inc. None of the other authors has any proprietary interest in the subject of this manuscript.

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Figure.
Cross-sectional OCT image of an angle before and after laser peripheral iridotomy (LPI). Note flattening of the convex iris configuration and widening of the angle after the procedure.

Table

Changes in OCT parameters and gonioscopy before and after LPI

	AOD 500 (μm)	ARA 500 ($\times 10^{-2} \text{ mm}^2$)	ARA 750 ($\times 10^{-2} \text{ mm}^2$)	TISA 500 ($\times 10^{-2} \text{ mm}^2$)	TISA 750 ($\times 10^{-2} \text{ mm}^2$)	Gonioscopy
Pre LPI	83.4 $\pm$ 80.9	4.7 $\pm$ 4.0	7.5 $\pm$ 6.8	3.8 $\pm$ 3.3	6.0 $\pm$ 5.6	0.56 $\pm$ 0.8
Post LPI	220.6 $\pm$ 141.6	14.5 $\pm$ 11.5	17.1 $\pm$ 6.3	7.8 $\pm$ 4.1	14.6 $\pm$ 9.2	2.6 $\pm$ 0.8
P value	0.02	0.02	0.004	0.03	0.02	<0.001

OCT = optical coherence tomography; LPI = laser peripheral iridotomy; AOD = angle opening distance; ARA = angle recess area; TISA = trabecular-iris space area.