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Optical Coherence Tomography Assessment of Angle Anatomy Changes After Cataract Surgery

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PURPOSE: To evaluate changes in anterior chamber (AC) morphology induced by cataract extraction using anterior segment optical coherence tomography (OCT).
DESIGN: Prospective comparative observational case series.
METHODS: Thirty-two eyes of 32 patients underwent OCT imaging of the angle before and after cataract surgery. Anterior chamber depth (ACD), angle opening distance at 500 μm (AOD_{500}) and trabecular-iris space at 500 μm ($TISA_{500}$) were measured pre- and postoperatively. Preoperative lens thickness (LT) and lens position (LP) were calculated.
RESULTS: ACD, AOD_{500}, and $TISA_{500}$ increased significantly after cataract extraction ($P < .001$). Preoperatively, ACD and LT highly correlated ($P = .0083$) as did ACD and $TISA_{500}$ ($P = .0001$). $TISA_{500}$ correlated with LP ($P = .0001$) but not with LT ($P = .74$).
CONCLUSIONS: Changes in angle morphology after cataract surgery can be imaged and objectively quantified by anterior segment OCT. Lens position may have a greater influence on angle width than LT. (Am J Ophthalmol 2007;144:464–465. © 2007 by Elsevier Inc. All rights reserved.)

CLINICAL EXPERIENCE HAS DEMONSTRATED THAT CATaract extraction causes deepening of the central anterior chamber (AC) and widening of the angle. It is also a common clinical understanding that as lens thickness (LT) increases, there is an increase in angle crowding with predisposition to relative pupillary block. Thus, cataract extraction has been advocated in eyes with primary angle closure.[1]

Gonioscopy has traditionally been used for AC angle grading, but it is subjective and limited by interobserver bias. Ultrasound biomicroscopy is a more objective and reproducible method of angle assessment,[1,2] but the immersion requirement is inconvenient and may cause artifactual angle widening.

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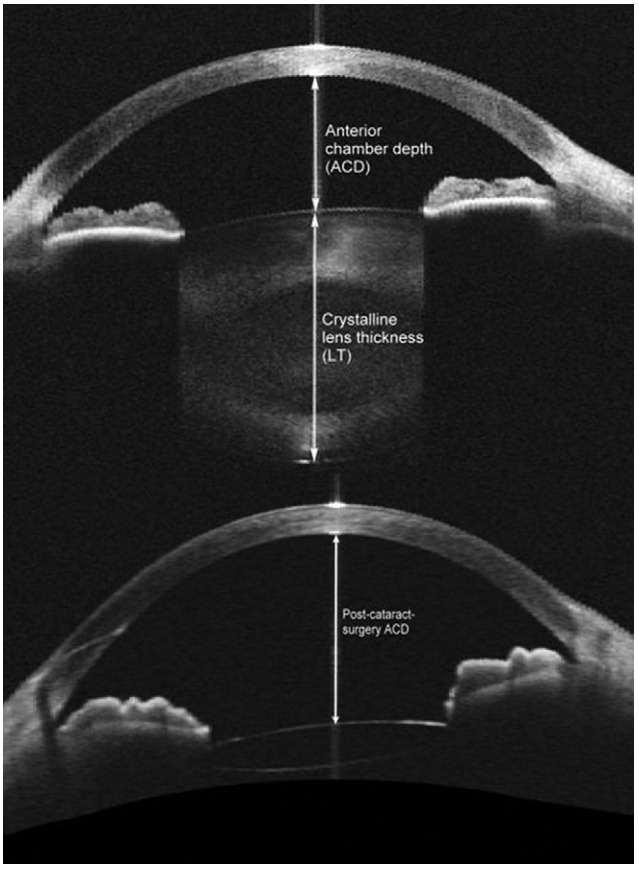

FIGURE. Cross-sectional optical coherence tomography (OCT) image of the anterior segment before (Top) and after (Bottom) cataract extraction and intraocular lens implantation. Note deepening of the anterior chamber depth (ACD), flattening of the convex iris configuration, and widening of the angle after the procedure. ACD is measured from the corneal endothelium. Lens thickness (LT) and ACD are measured along the vertex normal.

Optical coherence tomography (OCT)[3] is an imaging modality that allows cross-sectional imaging of the eye.[4] It requires no contact or immersion and produces images with higher spatial resolution. In this study, we used OCT to quantify changes in anterior segment morphology after cataract extraction and to evaluate the effect of LT and position on angle opening.

We studied 32 eyes of 32 patients undergoing cataract extraction and intraocular lens implantation. After obtaining informed consent, all eyes underwent preoperative measurements of anterior chamber depth (ACD), axial length (AL), LT, lens position (LP defined as ACD + ½ LT) and baseline OCT imaging (Figure). OCT scans and ACD measurements were repeated one month postoperatively.

We used an anterior segment OCT prototype provided by Carl Zeiss Meditec, Inc, (Dublin, California, USA), which uses a 1.3-μm wavelength light source to acquire 2,000 axial scans/second. Cross-sectional images were obtained in nasal and temporal quadrants. Images were analyzed using custom MATLAB software 7.0 (The MathWorks, Inc,

TABLE 1. Biometric Characteristics of Eyes Undergoing Cataract Extraction

Axial length	24.0 mm ± 1.6 mm (21.59 mm to 28.76 mm)
Lens thickness	4.6 mm ± 0.5 mm (3.4 mm to 5.3 mm)
Lens position	5.0 mm ± 0.3 mm (4.42 mm to 5.75 mm)
Anterior chamber depth	2.7 mm ± 0.4 mm (1.93 mm to 3.46 mm)

TABLE 2. Changes in Anterior Chamber Parameters Before and After Cataract Surgery

	ACD (mm)	AOD 500 (μm)	TISA 500 (x 10^{-2} mm^2)
Before surgery	2.7 ± 0.4	351.4 ± 183.9	15.0 ± 7.0
After surgery	4.1 ± 0.4	596.3 ± 204.0	22.0 ± 7.0
P value	<.0001	<.0001	.0002

ACD = anterior chamber depth; AOD = angle opening distance; TISA = trabecular-iris space area.

Natick, Massachusetts, USA). Angle opening distance[2] at 500 μm (AOD_{500}) and trabecular-iris space area[5] at 500 μm ($TISA_{500}$) were calculated. Differences between preoperative and postoperative values were analyzed by Student *t* test. Correlations were assessed using Pearson correlation coefficients. $P < .05$ was considered significant.

The average patient age was 70.9 ± 10.5 years (range, 50 to 84 years). Fifteen were male, and 17 were female. Biometric values are listed in Table 1. ACD, AOD_{500}, and $TISA_{500}$ all increased significantly postoperatively (Table 2). Figure shows pre- and postoperative images in one case. ACD is correlated with $TISA_{500}$ ($r = 0.63$, $P < .001$) and LT ($r = -0.46$, $P = .008$). Change in ACD is highly correlated with LT ($r = 0.73$, $P = .001$). There is no significant correlation between LT and $TISA_{500}$ ($P = .55$) or the change in $TISA_{500}$ ($P = .74$). LP and $TISA_{500}$ are highly correlated ($r = 0.52$, $P = .001$).

Various studies have used ultrasound biomicroscopy to look at effects of cataract surgery on angle morphology,[1,2] but few have used anterior segment OCT to quantify such changes. OCT is a light-based system that produces images with high spatial resolution. Its noncontact nature enhances patient comfort and allows rapid image acquisition in the sitting position without risk of mechanical distortion of the angle.

Our OCT images demonstrate that after cataract extraction, the convex iris configuration flattens and AC depth and the angle widens (Figure). These changes can be quantified using custom software that has been previously validated in comparison to ultrasound biomicroscopy and gonioscopy.[4]

We also found that LT was highly correlated with ACD but not correlated with $TISA_{500}$. LP, however, was highly correlated with $TISA_{500}$ suggesting that an age-related forward shift in LP[5] may have greater influence on angle opening than LT. Another potential explanation is that peripheral LT may have a larger effect on angle opening than central LT, although this was not assessed here.

Our experiences have shown that OCT is a valuable tool for evaluating the effects of cataract surgery and peripheral iridotomy[6,7] on the AC angle. This technology can be of use in evaluating patients with narrow angles and cataracts who are undergoing cataract extraction for the therapeutic purpose of widening the angle.

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Common Forms of Childhood Strabismus in an Incidence Cohort

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PURPOSE: To report the prevalent forms of childhood strabismus.
DESIGN: Retrospective, population-based cohort study.
METHODS: The medical records of all Olmsted County, Minnesota, residents younger than 19 years diagnosed