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Anterior chamber configuration changes after phacoemulsification and IOL implantation measured by anterior segment optical coherence tomography

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Abstract
Objective: To measure early changes in anterior chamber morphology after phacoemulsification and IOL implantation using anterior segment optical coherence tomography.
Materials and Methods: Prospective consecutive interventional study measuring the anterior chamber configuration changes in twenty (20 eyes) after 1 month of phacoemulsification and posterior chamber IOL implantation.
Results: Showing significant difference regarding nasal, superior, temporal and inferior angle measured by anterior segment optical coherence tomography before and after phacoemulsification operation with p.value were (0.027_0.009_0.02_0.012) respectively.
Conclusion: Quantitative values showed the anterior chamber angle (ACA), measured using AS-OCT, has increased following uneventful phacoemulsification and IOL implantation.

Keywords: anterior, implantation, chamber

Introduction
Anterior segment optical coherence tomography (ASOCT) is noninvasive and noncontact methods that enables in-vivo visualization of tissues and provides key information about the pathophysiology of diseases. Many optical or ultrasonic methods are being used to analyze the anterior segment of the eye [1]. Gonioscopy and ultrasound biomicroscopy (UBM) have mainly been used to evaluate the effectiveness of angle widening after cataract surgery [2]. However, because gonioscopy and UBM require contact with the ocular surface, infection or wound dehiscence may occur. Thus, gonioscopy and UBM are inappropriate for observation just after surgery, and their early postoperative use has not been reported. ASOCT provides high resolution images by using a long wavelength (1,310 nm) of light; it offers rapid and easy quantitative analysis of various structures [3-5] with good repeatability and reproducibility with low intraobserver and interobserver variability [6, 7]. ASOCT provides better resolution compared to conventional UBM. ASOCT is a noncontact technique that can be performed in a short time, but ASOCT for angle analysis after cataract surgery has seldom been reported [8]. ASOCT is useful for angle evaluation; the degree of angle widening can be quantitatively assessed, and the imaging procedure is convenient, imposing fewer burdens on the patients, and can be performed in a shorter time [9].

Materials and Methods
This is a prospective consecutive interventional study carried out on twenty (20eyes) using ASOCT imaging to compare anterior chamber configuration before and 1 month after phacoemulsification and IOL implantation. We analyzed the anterior chamber angle (ACA).these study was done at Benha University Hospital Ophthalmology Department.
Inclusion criteria were Senile cataract and Postoperative clear cornea.
Exclusion criteria were Complicated and infantile cataract, previous intraocular surgeries, corneal opacity and intraoperative complication.
All patients completed an ophthalmologic examination including best-corrected visual acuity (BCVA) in snellen decimal units and manifest refraction, slit-lamp biomicroscopy to detect the grade of cataract and any anterior segment abnormality, Goldmann applanation tonometry,

gonioscopy, and indirect ophthalmoscopy. Anterior segment optical coherence tomography (AS-OCT) was used preoperative and 1 month postoperative to analyze anterior chamber angle (ACA). Gonioscopy was done to all patients preoperative and 1 month postoperative using Goldmann three-mirror goniolens. Patients were re-examined 1 month postoperative, when all measurements were repeated.

Statistical analysis was done using IBM SPSS (version 22.0) program for windows

Patients were required to sign a written consent agreeing to participate in the study.

Results

A total of twenty (20 eyes), (14) females (70%) and (6) males (30%) underwent ASOCT imaging to compare anterior chamber angle(ACA) before and 1 month after phacoemulsification and IOL implantation. The mean age was 59.8±4.8 years (range 45-65).

Table 1: Mean and standard deviation for age and uncorrected visual acuty among the studied population

Age	
Mean±SD	59.8±4.8
Median	60
Range	45-65
UCVA	
Mean±SD	0.13±0.06
Median	0.13
Range	0.05-0.20

Table 2: Frequency distribution for gender and kind of the eye among the studied population

Sex	**No**	**%**
Male	6	30%
Female	14	70%
Kind of the eye		
OD	13	65%
OS	7	35%

Table 3: Showing that there is significant difference regarding nasal, superior, temporal and inferior angle measured by anterior segment optical coherence tomography before and after phacoemulsification operation with p.value were (0.027_0.009_0.02_0.012) respectively.

	Pre	**Post**	**t. test**	**P. value**
NA. Asoct				
Mean±SD	24.98 ±7.8	31.11±9.01	-2.294	0.027
Median	24.5	29.5		
Range	11.5-38.5	18.1-50.6		
SA. Asoct				
Mean±SD	23.83±5.99	29.57±6.83	-2.761	0.009
Median	23.65	28.05		
Range	11.8-32	19.6-42.2		
TA. Asoct				
Mean±SD	27.63±8.9	33.96±7.53	-2.429	0.020
Median	26.85	33.15		
Range	10-38.8	20.2-43.2		
IA. Asoct				
Mean±SD	31.42±8.9	38.78±9.11	-2.647	0.012
Median	32.45	36.5		
Range	12-40	22.3-52.5		

NA ASOCT: Nasal angle ASOCT; **SA ASOCT:** Superior angle ASOCT; **TA ASOCT:** Temporal angle ASOCT; **IA ASOCT**: Inferior angle ASOCT

Table 4: There is significant difference regarding nasal, super, temporal and inferior angle measured by gonioscopy before and after phacoemulsification operation with p.value (0.04_0.038_0.0358_0.043)

	Pre		**Post**		**X^2**	**P.value**
NA. Gonioscopy	No	%	No	%		
II	5	20%	2	10%	6.429[a]	0.04
III	15	80%	13	65%		
IV	0	0%	5	25%		
SA. Gonioscopy						
II	8	40%	3	15%	6.553[a]	0.038
III	12	60%	14	70%		
IV	0	0%	3	15%		
TA. Gonioscopy						
II	3	15%	0	0%	5.692[a]	0.0358
III	12	60%	9	45%		
IV	5	25%	11	55%		
IA. Gonioscopy						
II	3	15%	0	0%	6.273[a]	0.043
III	9	45%	5	25%		
IV	8	40%	15	75%		

NA Gonioscopy: Nasal angle Gonioscopy; **SA Gonioscopy:** Superior angle Gonioscopy

TA Gonioscopy: Temporal angle Gonioscopy; **IA Gonioscopy**: Inferior angle Gonioscopy

Quantitative values showed the anterior chamber angle (ACA), measured using AS-OCT, has increased following uneventful phacoemulsification and IOL implantation.

Cases:

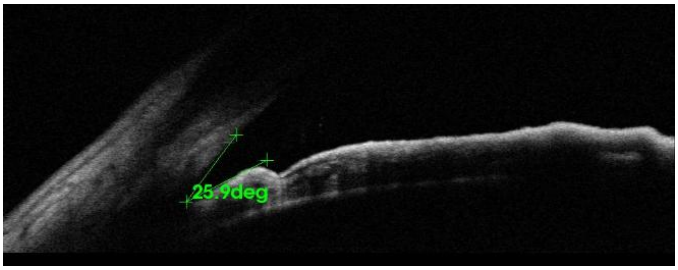

Fig 1: Case 1, AS-OCT shows preoperative anterior chamber temporal angle (ACTA) measured in degrees (25.9o).

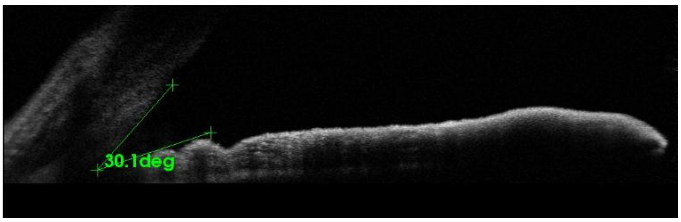

Fig 2: Case 1, AS-OCT shows postoperative anterior chamber temporal angle (ACTA) measured in degrees (30.1o).

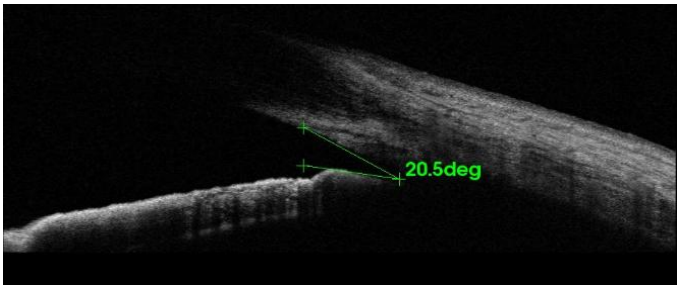

Fig 3: Case 2, AS-OCT shows preoperative anterior chamber nasal angle (ACNA) measured in degrees (20.5o).

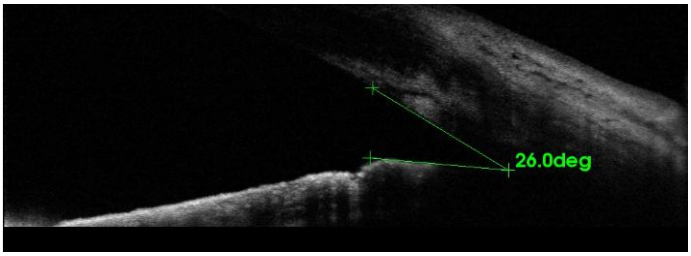

Fig 4: Case 2, AS-OCT shows postoperative anterior chamber nasal angle (ACNA) measured in degrees (26.0o).

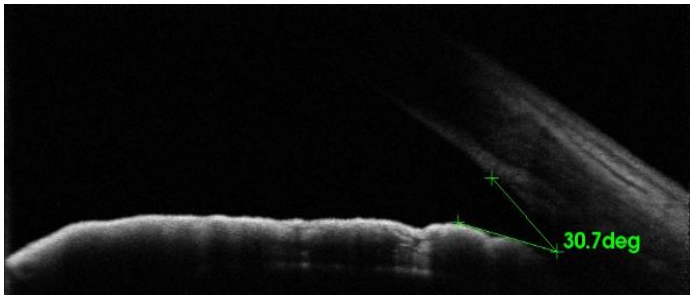

Fig 5: Case 3, AS-OCT shows preoperative anterior chamber inferior angle (ACIA) measured in degrees (30.7o).

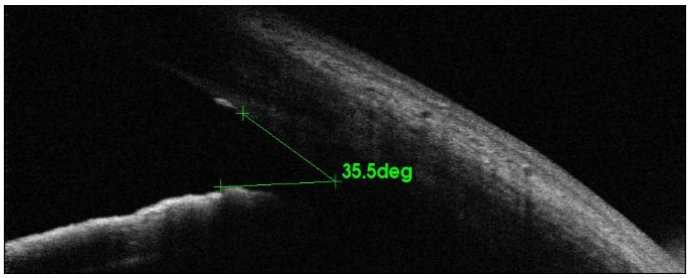

Fig 6: Case 3, AS-OCT shows postoperative anterior chamber inferior angle (ACIA) measured in degrees (35.5o).

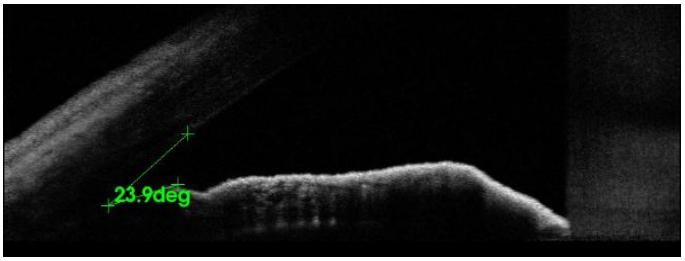

Fig 7: Case 4, AS-OCT shows preoperative anterior chamber superior angle (ACSA) measured in degrees (23.9o).

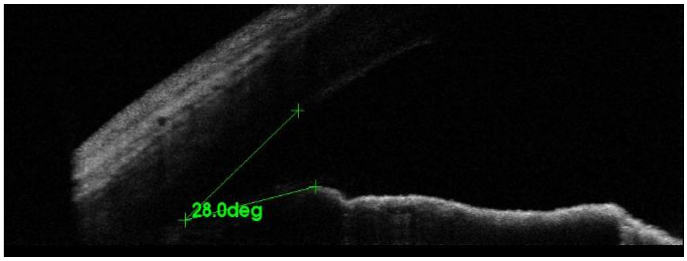

Fig 8: Case 4, AS-OCT shows postoperative anterior chamber superior angle (ACSA) measured in degrees (28.0o).

Discussion

Intraocular pressure was measured in our study with the Goldmann applanation tonometer. Documented changes in anterior chamber parameters following phacoemulsification and IOL implantation have been reported to be accompanied by significant decreases in IOP in several studies in both normotensive eyes (Cekic *et al*., 1998; Hayashi *et al*., 2000) [10, 11] and in eyes with OAG (Hayashi *et al*., 2000) [11] or ACG (Cekic *et al*. 1998; Hayashi *et al*. 2000) [10, 11]. In these studies, there was follow up in measuring IOP up to 9 month but in our study mean IOP measured one time at 1 month post operative, was non significant compared with the mean preoperative measurement; timing may be the cause of difference in results. In our study, there was statistically significant difference regarding nasal, super, temporal and inferior angle measured by gonioscopy before and after phacoemulsification operation and posterior chamber IOL implantation with p. value (0.04_0.03_0.03_0.04) respectively. We analyzed the changes in anterior chamber angle after phacoemulsification surgery and posterior chamber IOL implantation using SD-ASOCT to quantitatively measure parameters. Our results differed significantly from pre- to post-surgery. Nasal angle increased from 24.98 ± 7.8o to 31.11± 9.01o with (p= 0.027), temporal angle increased from 27.63± 8.9o to 33.96± 7.53o with (p= 0.02), inferior angle increased from 31.42± 8.9o to 38.78± 9.11o with (p= 0.012) and superior angle increased from 23.83 ± 5.99o to 29.57 ± 6.83o with (p= 0.009).Hayashi *et al*. (2000) [11] examined the changes in anterior chamber angle width and depth induced by intraocular lens (IOL) implantation in 77 eyes with angle-closure glaucoma (ACG), 73 eyes with open-angle glaucoma (OAG), and in 74 eyes with no evidence of glaucoma or ocular hypertension using AS-OCT (Visante, Carl Zeiss Meditec, CA, USA). In their study ACA, using angle measured in degrees, significantly increased after surgery. Kim *et al*. (2011) [8] evaluated the changes in anterior chamber depth (ACD) and angle width induced by phacoemulsification and intraocular lens (IOL) implantation in normal eyes using anterior segment optical coherence tomography (AS-OCT). Forty-five eyes (45 patients) underwent AS-OCT imaging to evaluate anterior chamber configuration before and 2 days after phacoemulsification and IOL implantation. They analyzed the central ACD and angle width using different methods: anterior chamber angle (ACA), trabecular-iris angle (TIA), angle opening distance (AOD), and trabecular iris surface area (TISA) in the nasal and temporal quadrants. Comparison between preoperative and postoperative measurement was done. Before surgery, the mean anterior chamber angle widths were 23.21 ± 6.70° in the nasal quadrant and 24.89 ± 7.66° in the temporal quadrant. After phacoemulsification and IOL implantation, the anterior chamber angle width increased significantly to 35.16 ± 4.65° in the nasal quadrant (p = 0.001) and 36.03 ± 4.86° in the temporal quadrant (p = 0.001). Also, AOD, and TISA, increased significantly after cataract surgery and showed positive correlation with ACA. Differences from our study is the use of Visante, enabling them to compare pre and postoperative changes in ACD, AOD and TIA. Kim *et al*. (2012) [12] evaluated changes in anterior chamber depth (ACD) and angle width induced by phacoemulsification and intraocular lens (IOL) implantation in eyes with glaucoma, using anterior segment optical coherence tomography (AS-OCT). Eleven eyes of 11 patients with angle-closure glaucoma (ACG) and 12 eyes of 12 patients with open-angle glaucoma (OAG) underwent phacoemulsification and IOL implantation. Using TD-ASOCT Visante prototype, ACD and angle parameters were measured before and 2 days after surgery. After surgery, central ACD and angle parameters increased significantly in eyes with glaucoma ($p < 0.05$). Prior to surgery, mean ACA in ACG group was 14.06 ± 4.33o in nasal quadrant and 15.40 ± 4.92o in temporal quadrant. After phacoemulsification and IOL implantation, the

anterior chamber angle width increased significantly to 30. 4 ± 5.75° in the nasal quadrant (p = 0.001) and 29.68 ± 9.92° in the temporal quadrant (p = 0.001). The increase in AOD500 was 123% in nasal quadrant and 99% in temporal quadrant, while increase in TISA500 was 103% in both quadrants. Kasai *et al*. (2015) [13] evaluated the serial changes in angle parameters early after cataract surgery using anterior segment optical coherence tomography (ASOCT). This was a retrospective chart review, case-control study; 150 eyes of 106 patients who underwent cataract surgery. Based on anterior chaber angle findings, the eyes were classified into two groups, open-angle eyes (87 eyes) and narrow-angle eyes (63 eyes). ASOCT was used to measure anterior chamber angle parameters (angle opening distance, angle recess area, trabecular iris space area, and trabecular iris angle. Serial changes in each group were measured before and 1 day, 1 week, and 1 month after cataract surgery. All angle parameters in both groups at each examination time after cataract surgery were significantly different from the preoperative values (p<0.01). Cataract surgery increased all angle parameters early after the surgery. However, the degree of angle widening in narrow-angle eyes was not as much as that in open-angle eyes, suggesting that factors other than the lens influenced the angle closure

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