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Original Article

Anterior Chamber Configuration Changes after Phacoemulsification and Intraocular Lens Implantation Measured by Anterior Segment Optical Coherence Tomography

Khalid Mahmoud Ragheb [1], Ahmed Mahmoud Amin [1]; Younes Elsaied Abdelhafez [2]

Department of Ophthalmology, Faculty of Medicine, Al-Azhar University, Egypt [1]
Department of Ophthalmology, Damietta Faculty of Medicine, Al-Azhar University, Egypt [2]

Corresponding author: Khalid Mahmoud Ragheb
Email: khalid.elachrey@gmail.com

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ABSTRACT

Background: Phacoemulsification can cause changes in the measurements of the anterior segment. Anterior segment optical coherence tomography [AS-OCT] is a disconnected probe device that can detect variations in the anterior segment parameters.

The aim of the work: The current study aimed to investigate changes in anterior chamber angle [ACA] morphology and intraocular pressure [IOP] after phacoemulsification of cataract and intraocular lens implantation by comparing two groups of patients using two brands of IOL [Sensar 1 hydrophobic one-piece IOL] and [Eyecryl hydrophilic one-piece IOL] in patients with senile cataract using [AS-OCT].

Patients and Methods: Our study was a prospective randomized study including 30 eyes with impaired vision due to cataract, as the only cause of visual regression selected from the patients who attended Al-Azhar University Hospital [Damietta branch] Ophthalmic outpatient Clinic and were randomized into two groups. Group A [15 eyes] was implanted with [Sensar 1 hydrophobic IOL] and Group B [15 eyes] was implanted with [Eyecryl hydrophilic IOL].

Results: the results revealed that there was a significant increase in the AC angle in both groups, except for the AC depth in group A, but the difference between groups was statistically non-significant.

Conclusion: Phacoemulsification with IOL implantation led to an increase in the ACA, a marked increase in BCVA and a reduction in IOP, if using [Sensar 1 hydrophobic one-piece IOL] or [Eyecryl hydrophilic one-piece IOL]. However, we cannot generalize the results because of the small sample size.

Keywords: Optical Coherence Tomography; IOL Implantation; Anterior chamber Depth; Eyecryl hydrophilic one-piece; Senile Cataract

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* Main subject and any subcategories have been classified according to the research topic.

INTRODUCTION

Cataracts and glaucoma are among the main sources of visual disability worldwide. Cataract is an age-related sickness that prompts helpless visual perception and is characterized by slow blurring and thickening of the lens of the eye [1].

Glaucoma is a group of disorders with distinct types of optic nerve damage. Glaucoma is ranked as the second cause of blindness worldwide, and the commonest cause of blindness that cannot be treated. The most effective way to prevent this damage is to lower the eye pressure [2].

Both cataracts and glaucoma are serious conditions that can cause vision loss. Vision loss due to cataracts is reversable, e.g., by surgery. However, vision loss due to glaucoma is irreversible. Modern extracapsular cataract surgery includes removal of the lens fibers constituting the cataract nucleus and cortex, leaving intact posterior epithelial capsule to grasp the new intraocular artificial lens [IOL] and preventing the vitreous humor to reach the anterior chamber. Phacoemulsification is a type of mechanically assisted extracapsular cataract extraction surgery [3].

Anterior segment OCT imaging with a longer wavelength of 1310 nm has the benefits of better infiltration through the sclera and ongoing imaging at 8 frames per second [4]. An important parameter that must be identified when interpreting anterior segment OCT images [ASOCT] is sclerotrophic stimulus. This appears as an internal projection of the sclera at the junction between the internal scleral curvatures and the cornea. The position between the iris and the inner wall of the cornea has been used in many studies as a qualitative method for detecting angle blockage [5].

AIM OF THE WORK

The current study aimed to investigate changes in anterior chamber angle [ACA] morphology and intraocular pressure [IOP] after phacoemulsification of cataract and intraocular lens implantation by comparing two groups of patients using two brands of IOL [Sensar 1 hydrophobic one-piece IOL] and [Eyecryl hydrophilic one-piece IOL] in patients with senile cataract using [AS-OCT].

PATIENTS AND METHODS

Our study was a prospective randomized study including 30 eyes with visually significant cataracts, as the only cause of visual regression, selected from patients who attended Al Azhar University Hospital [Damietta] Ophthalmic outpatient Clinic and was randomized into two groups. Group A [15 eyes] was implanted with [Sensar 1 hydrophobic IOL] and Group B [15 eyes] was implanted with [Eyecryl hydrophilic IOL].

The sample size was calculated using the EPI-INFO 2002 software package designed by WHO and centers of disease control and prevention revealed that, at least 28 eyes were required to find a significant difference in AC-depth, AS-angle and intra-ocular pressure.

Written informed consent was obtained from all the participants in the study. The research convention adhered to the principles of the Declaration of Helsinki and was endorsed by the Ethics Board of Al-Azhar University.

Inclusion criteria included the following: 1] Patient without a history of chronic disease, Diabetes mellitus [DM] or Hypertension [HTN]; 2] Patient with circular, round and reactive pupils; 3] Patients with senile cataract; 4] Refractive lens exchange in healthy patients aged **>** 50 years; 5] Patient with normal range Intraocular pressure [IOP]; 6] Normal anterior chamber depth, and 7] Normal corneal structure.

Exclusion criteria were 1] Eyes with history of penetrating intra-ocular surgery; 2] Complications related to cataract surgery, like as posterior capsular rupture, zonular dialysis, and vitreous loss; 3] Eyes with corneal disease like as edema, abrasion or dystrophy, pterygium and other degenerative changes, and 4] Eyes with peripheral anterior synechiae

Methods:

A- Preoperative evaluation: History taking and examination: -Uncorrected visual acuity [UCVA]. -Best corrected visual acuity [BCVA]. -intraocular pressure measurement using Goldman applanation tonometry, - Slit-lamp examination, -a Biomicroscopic fundus examination with 90D lens.

B- Investigations: Photographs of the anterior segment were captured using a Topcon 3D-OCT-2000 device [Figure 1]. Standard resolution scans captured the temporal and nasal quadrants with patients looking straight ahead. All photos were taken with the patients in a sitting position. After repeated scans, we selected the optimum image, as shown in [Figure 3] in one of the studied cases.

The Anterior chamber depth was measured using the IOL Master 500 Zeiss device [Figure 2], which has a measurement range of anterior chamber depth of 1.5 – 6.5 mm, which was printed out as shown in [Figure 4] in one of the studied cases.

Figure [1]: Topcon3D-OCT-2000 device

Figure [2]: IOL Master 500 Zeiss device.

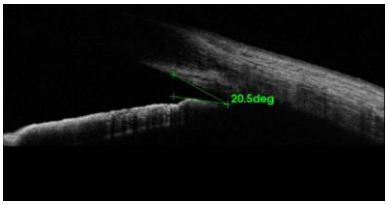

Figure [3]: Preoperative ASOCT image for one of our studied cases.

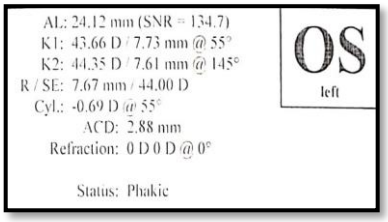

Figure [4]: Preoperative IOL Master print out in one of the studied cases.

C- Phacoemulsification procedure:

It was performed under local anesthesia with sedation or general anesthesia]: Before surgery, all pupils were mydriases with 1% tropicamide and 2.5% phenylephrine, also globe sterilization with drops of povidone iodine 5% was used. Anterior limbal incision using keratome, two side ports were made by MVR, formation of the AC, by viscoelastic material, anterior continuous circular curvilinear capsulorhexis done under viscoelastic material, hydro dissection and hydro delineation, Phacoemulsification of the nucleus, bimanual irrigation aspiration, and implantation of an intraocular lens [Sensar 1 hydrophobic one piece IOL or Eyecryl hydrophilic one piece] in the bag, last step hydration of the wound and 2 paracentesis ports. After the surgery, all patients received the same standard medications for 1 month, consisting of a combination of steroid [Prednisolone acetate] and antibiotic [Ofloxacin or Tobramycin] eye drops beginning four times daily.

Post-operative follow-up visits: One day postoperatively, one week postoperatively and one month postoperatively/ASOCT were repeated using the same pre-operative parameters as shown in [Fig. 5] in one of the studied cases. The anterior chamber depth was measured using the IOL Master Zeiss device, which was printed as shown in [Figure 6]. in one of the studied cases**.**

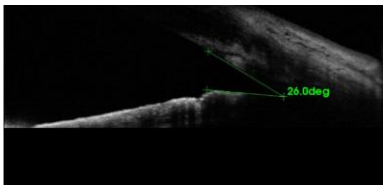

Figure [5]: Postoperative ASOCT in one of the studied cases.

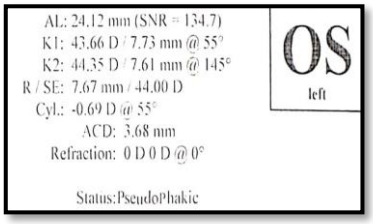

Figure [6]: Postoperative IOL Master print out in one of the studied cases.

RESULTS

Our study was a prospective randomized study including 30 patients with visually significant cataract, as the only cause of visual impairment was randomized

into two groups. Group A [15 eyes] was implanted with [Sensar 1 hydrophobic IOL] and Group B [15 eyes] was implanted with [Eyecryl hydrophilic IOL]. There were no statistically significant differences between the two groups, [Table 1]. There was a significant increase in the ACA in both groups except for the AC-depth in group A but there were no statistically significant differences between the groups, [Table 2].

There was a strong statistically significant increase in BCVA in both groups, but there were no significant differences between the groups. Meanwhile, there was a mild statistically significant reduction in IOP in group B, but there was no statistically significant difference between the groups, [Table 3].

Table [1]: Demographic distribution of the two studied groups

Variable		***Group A*** *[n=15]*	***Group B*** *[n=15]*	***t***	***p***
Age *[years]*	*Mean ± SD*	39.47 ± 5.54	41.73 ± 7.42	0.945	0.353
	Range	46 – 58	45 – 60		
Sex	*Female*	6 [40%]	7 [46.7%]	0.136	0.713
	Male	9 [60%]	8 [53.3%]		
UCVA [*Mean ± SD]*		0.15 ± 0.054	0.14 ± 0.071	0.434	0.668
Laterality	*OD*	10 [66.7%]	9 [60%]	0.145	0.705
	OS	5 [33.3%]	6 [40%]		

Table [2]: Changes in anterior chamber parameters between the two studied groups

			Group A: With Implant of hydrophobic IOL [sensar 1 brand] *[n=15]*	***Group B: With Implant of hydrophilic IOL [Eyecryl brand]*** *[n=15]*	***t***	***p***
Nasal angle ASOCT	***Preoperative*** *[Mean±SD]*		25.65 ± 8.31	27.74 ± 7.35	.729	.472
	Postoperative *[Mean ± SD]*		34.21 ± 9.57	35.45 ± 9.86	.349	.729
	Paired t-test	***t***	**2.62**	**2.43**	--	--
		p	**0.014***	**0.022***		
Anterior chamber depth measured by IOL master	***Preoperative*** *[Mean ± SD]*		3.07 ± 0.228	3.03 ± 0.215	.494	.625
	Postoperative *[Mean ± SD]*		3.22 ± 0.213	3.21 ± 0.244	.121	.906
	Paired t-test	***t***	1.86	**2.14**	--	--
		p	0.073	**0.041***		
Temporal angle ASOCT	***Preoperative*** *[Mean± SD]*		26.34 ± 7.25	27.61 ± 8.54	.439	.664
	Postoperative *[Mean±SD*		35.75 ± 7.33	35.71 ± 7.62	.352	.728
	Paired t-test	***t***	**3.54**	**3.08**	--	--
		p	**0.001***	**0.005***		

Table [3]: Best corrected visual acuity and intra ocular pressure before and after operation among the two studied groups

			Group A *[n=15]*	***Group B*** *[n=15]*	***t***	***p***
BCVA	***Preoperative [****Mean ± SD]*		0.315 ± 0.138	0.274 ± 0.175	.713	.482
	Postoperative [*Mean ± SD]*		0.762 ± 0.157	0.645 ± 0.186	1.86	.073
	Paired t-test	***t***	**8.28**	**5.62**	--	--
		p	**<0.001***	**<0.001***		
IOP	***Preoperative [****Mean ± SD]*		16.84 ± 2.75	17.61 ± 2.83	.756	.456
	Postoperative [*Mean ± SD]*		14.95 ± 3.87	15.17 ± 3.62	.161	.873
	Paired t-test	***t***	1.54	**2.06**	--	--
		p	0.134	**0.049***		

DISCUSSION

This study aimed to detect changes in the ACA morphology and intraocular pressure [IOP] after phaco emulsification of cataract and IOL implantation by comparing two groups of patients using two brands of IOL [Sensar 1 hydrophobic one-piece IOL] and [Eyecryl hydrophilic one-piece IOL] in patients with senile cataract using AS-OCT. The mean age was 39.47± 5.54 years in group A, and 41.73 ± 7.42 years in group B; the majority of patients in both groups were men. The mean UCVA in group A was 0.15 ± 0.054 and 0.14 ± 0.071 in group B. The majority of cases were OD in both groups, and there were no significant differences between the two groups regarding age, sex, laterality or UCVA. This was in comparison with the study by Kim et al [6], who included 23 eyes of 23 participated [11 eyes affected by acute congestive glaucoma and 12

eyes affected by open angle glaucoma]. A total of 23 eyes underwent phacoemulsification cataract surgery with IOL implantation, and the mean age of the patients was 69.4±6.6 years. No significant differences were found between the two groups in terms of age, sex, laterality and visual acuity. In another study, Lee et al [7], investigated a sum of 110 patients. Four patients [Three from group 1, and one from group 2] were excluded due to loss of follow-up. Group 1 included 64 eyes of 64 patients [30 men and 34 women]. Group 2 included 42 eyes of 42 patients [24 men and 18 women]. The mean age was 68.87±8.68y in group 1, and 68.00±10.66y in group 2.

Anterior segment OCT is a light-based framework that quickly produces high-quality images. Its non-contact technique, patient solace and takes into account the fast picture obtained in the sitting situation, without the danger of mechanical distortion of the angle. It also permits quantitative and dynamic information examination with high reproducibility and repeatability [8].

In the present study, there was a significant increase in the anterior chamber angle in both groups except for the anterior chamber depth in group A but there was no significant difference between the groups. In addition, we found that there were no statistical differences between groups as regard nasal angle, and there was significant increase in temporal angle in each group, with no differences between two groups and as regard anterior chamber depth, there was significant increase only in group B [With Implant of Eyecryl hydrophilic IOL], and no differences between two groups. This was compared with the study by Said et al. [9]. It was a prospective, non-randomized comparative study, which decided the adjustments in the AC parameters and IOP following phaco-emulsification of cataract, and revealed that adjustments in [ACA] at temporal side before and after cataract removal. The ACA at nasal side increased from 23.33±6.93, to 34.16± 6.99, and the angle-opening distance [AOD] increased from 415.90± 148.9 m to 738.60±281.78 m after cataract surgery. Similarly, preoperative AS-OCT of the corrected eye showed the following values [ACA=13.00, AOD 750 =270 m, TISA 750=o.139 mm^2 and nasal ACA=14.4, AOD 750=230 m, TISA750= 0.102 mm^2], that changed to [ACA=22.9, AOD 750 =466 m, TISA 750=o.232 mm2 and Nasal ACA=23.7, AOD 750=530 m, TISA750= 0.273 mm^2]. Nolan et al [10] investigated the changes in the AC angle plan after phacoemulsification in 21 patients using AS-OCT and found that the mean AOD500 for the nasal quadrant extended from 243 to 457 m. Their assessment included 7 eyes with iridotrabecular contact or peripheral anterior synechiae in at least one quadrant and 14 OA eyes. Nonetheless, IOP data was not associated with the level of angle opening. Kim et al [6]. reported that the mean preoperative ACD was 2.75 ± 0.43 mm. The mean postoperative ACD was 4.14 ± 0.31 mm, two days after cataract removal, roughly 50.5% more profound than before surgery [$p < 0.001$]. Changes in ACD and preoperative ACD were negatively correlated [$r = - 0.680$, $p < 0.01$]. All angle boundaries dissected with AS-OCT showed a critical increase after phacoemulsification of cataract for both the nasal and temporal angles.

Our study is different in using IOL master device to measure ACD which is a noncontact device, more specialized in measuring AC depth, IOL calculation and corneal thickness. Yi et al [11]. accumulated ACD and ACA information in a typical Korean participance without lens opacification. They included 81 healthy participances with a mean age of 22.3 ± 3.5 years [range, 18-33 years]. The AC angle in the nasal and temporal quadrants was 45.13 **±** 5.89 and 46.18 ± 5.50 in the OD eyes and 44.90 ± 5.94 and 46.67 ± 5.98 in the OS eyes, individually. The mean AC depth was 3.32 **±** 0.26 mm in the OD eyes and 3.31 ± 0.28 mm in the OS eyes. These outcomes were greater than those reported in the current study. Patients in our examination were considered to represent normal participants without intraocular abnormalities. Lens thickness increases with age and the anterior lens surface come toward the corneal inner surface [12]. Moreover, the cataractous lens are greater in volume and thickness, contrasted with ordinary lenses [13].

Our study showed that the AC depth significantly increased following cataract extraction with post-operative implant of Eyecryl hydrophilic IOL by using IOL master device to ensure the study that conducted in non-contact procedures and in the sitting position, central ACD has been shown on ultrasound bio-microscopy to increase following cataract surgery in Pereira and Cronemberger [14]. In particular, Kurimoto et al [15]. found a greater postoperative change in eyes

with shallower AC. Similarly, Shin et al [16]. reported a significant increase in the mean AC depth after surgery for their patients with closed angles and found that the anterior AC depth was inversely related to before surgery AC depth. These findings have also been reported in a study using AS-OCT [17]. An increase in AC depth after cataract surgery was explained by Kurimoto et al. [15], as described before.

There are multiple clinical implications of our findings. Similar to our study, Werner et al [18]. proved that, AC of the human eye is not geometrically round. Moreover, we also found that the superior AC is shallower than inferior AC before and after surgery.

In our study, we used a different type of IOL that implanted in patients after cataract extraction by phacoemulsification and they were divided patients into two groups. Group A of 15-eye implant Sensar 1 hydrophobic one-piece IOL, Group B of 15 eyes implant Eyecryl hydrophilic one-piece IOL. We found that there were no statistically significant differences between the two studied groups. Baikoff [19] recommended adaption of the angle supported IOLs to the largest internal diameter of the anterior chamber and implanting them along this axis to prevent the propeller action [spinning of the IOL in the anterior chamber on Z axis], that happens when the IOL is smaller than the axis on which it has been positioned.

As of late, anterior segment swept source optical coherence tomography [AS-SS-OCT] has been used for assessment of [AS] configuration, also for past assessments just utilized gonioscopy. Ultrasound biomicroscopy [UBM] to detect AC-angle measure is more objective and reproducible, however its contact might be danger to the patients in some cases [20].

Furthermore, as regards best corrected visual acuity and intra-ocular pressure before and after operation among the two groups, there was a strong significant increase in BCVA in both groups, but there is no significant difference between the groups. Meanwhile, there is a statistically significant decrease in IOP in group B only but there is no significant difference between the groups. Notwithstanding, the effect of IOP decrease in cataract surgery procedure stays questionable. In Lee et al. [6] study, group 1 [group of cataracts] additionally had small diminished in IOP at 6mo after phacoemulsification procedure. As per point enlarging, non-glaucoma patients may likewise have brought down IOP, although the value may not be highly significant [P=0.082]. The normal IOP of non-glaucomatous eye was 13.4±2.9 mm Hg.

According to Szalai et al [21, study the normal IOP in this examination was marginally lower than that of Szalai study; notwithstanding, preoperative IOP of two gatherings [group 1 and 2] it was not have significantly different. Moreover, more IOP decrease was acquired in group 2 at postoperative status. In the interim, Prata et al. [22]. detailed that cataract surgery procedure could decrease IOP during the first few days after phacoemulsification procedure. however, IOP was not definitively diminished for longer time [normal 5 years]. Among numerous investigations, the mean reduction of IOP esteems differed somewhere in the range of 1.1- and 5.3-mm Hg. Hayashi et al [23]. demonstrated by imaging that the width and depth of the AC angle of CA glaucoma and OA glaucoma increase significantly after phacoemulsification and IOL implantation. They also found that the IOP decreased significantly after cataract removal and that the amount of reduction in the AC glaucoma group was higher than that in the OA glaucoma and OA groups. However, no association was noted between AC angles widening and IOP decrease in their study Li et al. [24].

The study has a few restrictions. To start with, the duration of this examination was only one month; cataract patients are known to require a longer follow-up. Second, this examination incorporated small number of participants. Third, we didn't assess the diurnal variety of IOP.

Conclusion: Phacoemulsification with IOL implantation leading to widening of the ACA, with a marked increase in BCVA and reduction of IOP reduction of IOP, if using [Sensar 1 hydrophobic one-piece IOL] or [Eyecryl hydrophilic one-piece IOL] but we cannot generalize the results due to the small sample size.

Financial and Non-financial Relationships and Activities of Interest

None

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