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Assessment of Anterior Chamber Depth and Angle width among Patients undergoing Cataract Surgery in Suez Canal University Hospital in Ismailia City

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ABSTRACT

Background: Cataract causes half of all cases of blindness and 33% of visual impairment worldwide. The sole viable treatment for cataracts is surgery including phacoemulsification and posterior chamber intraocular lens (IOL) implantation. Cataract surgery lowers intraocular pressure (IOP) in both glaucomatous and non-glaucomatous eyes via altering the anterior chamber (AC) architecture.

Objective: This study aimed to assess anterior chamber depth (ACD) and angle width (ACAW) using Pentacam before and after cataract surgery.

Patients and Methods: This study involved 20 eyes of 20 patients having cataract surgery. About 55% were males and 45% were females with mean age of 58.25 ± 8.83 years. Pentacam was used to measure ACD and ACAW before and after cataract surgery.

Results: The study showed significant increase in anterior chamber depth and in angle width after cataract surgery (2.72 ± 0.42 before vs. 3.36 ± 0.77 after, p=0.001). ACD showed significant negative moderate correlation with age before surgery (r=-0.521, p=0.018). Also, there was a significant increase in ACAW after surgery (35.11 ± 10.55 before vs. 45.4 ± 12.01 after, p<0.001). Angle width showed significant direct strong correlation before and after surgery (r=0.785, p<0.001).

Conclusion: Pentacam is a good method for obtaining quantitative data regarding anterior chamber configuration. ACD and angle width significantly increased after cataract surgery.

Keywords: Cataract surgery, Anterior chamber depth, Angle width.

INTRODUCTION

Cataract causes half of all cases of blindness and 33% of visual impairment worldwide [(1)].

The sole viable treatment for cataracts is surgery including phacoemulsification and posterior chamber intraocular lens (IOL) implantation. In phacoemulsification, the lens nucleus is emulsified into smaller pieces and aspirated by the surgeon using an ultrasonic probe that is placed into the incision. The benefits of the more recent method include a smaller incision than with traditional ECCE, the need for fewer or no stitches to close the incision, and a quicker recuperation period for the patient. Its drawbacks include the surgeon's high learning curve and the requirement for specialized equipment. A number of early looks at clinical trials demonstrated that cataract surgery lowers intraocular pressure (IOP) in both glaucomatous and non-glaucomatous eyes via altering the anterior chamber (AC) architecture [(2)].

The AC is the aqueous filled space inside the eye between the iris and the corneal endothelium. Several methods available for measuring changes in AC [(3)].

A medical tool called Pentacam is used to measure the crystalline lens's morphological and functional properties as well as the primary anterior segment features. The Pentacam rotates around the eye from 0° to 180° while taking 25,000 single-slit photographs in 2 seconds using a blue light-emitting diode to image the anterior eye segment. It offers a partially finished picture of the lens and an objective assessment of its opacity at a selected location, yielding a figure associated with its average opacity [(4)].

Several techniques have been employed in earlier research to assess ACD and ACA alterations prior to and following cataract surgery. This study uses Pentacam to examine changes in the ACD and angle width following IOL implantation and phacoemulsification in healthy eyes.

PATIENTS AND METHODS

This prospective clinical case series trial was conducted through the period from January 2023 to December 2023 at the Ophthalmology Department, Suez Canal University Hospital, Ismailia governorate. It involved 20 eyes of 20 cataractous patients of both sexes. The included patients were eligible for cataract surgery with age more than 40 years. Patients had intact clear cornea and intact AC.

Exclusion criteria: Patients with increased intraocular pressure (IOP), corneal conditions (such as pterygium, ulcer, opacity, dystrophy, etc.), symblepharon or conjunctival scar, history of trauma or surgery, and disorders of the posterior segment.

Methodology: Clinical ophthalmic examination, history, and visual acuity assessment using Landolt C chart, refraction, AC slit-lamp biomicroscopy (SL-D7 slit-lamp Topcon Co, Tokyo, Japan, with Galilean magnification changer with converging binocular tubes), IOP measurement (Haag Streit Applanation),

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fundus examination was done [binocular indirect ophthalmoscope (Model AAIO-7 Appasamy Associates 2014, India and Volk double aspheric +20D lens (Volk Optical, Ohio 1988} after instillation of cyclopentolate 1.0% , two times with 10 minutes interval, 30 minutes before examination. Also, external eye and ocular motility evaluation were performed.

Measuring ACD and ACW by Pentacam: Pentacam examinations were performed preoperatively and 1 weak post-operatively. The patient is instructed to fixate straight ahead on the fixation target (blue circular ring) while seated in a dark room with their forehead against the forehead strap and their chin resting on the chinrest. The device marks the pupil's edge, center, and corneal apex as the operator focuses and aligns a real-time image of the patient's eye on the computer monitor. A 3D image of the anterior segment is created by the Pentacam-Scheimpflug imaging system software, which also computes values for astigmatism, keratometry (K1 & K2), central corneal thickness (CCT), and ACA width.

Ethical approval: Faculty of Medicine, Suez Canal University Institutional Review Board approved the study protocol. The study followed the principles of the Declaration of Helsinki. Prior to participation, each subject provided a written informed consent.

Statistical analysis

Data was coded and entered into the computer and statistical analyses were carried out using the statistical program SPSS v 23 (SPSS, Inc., Chicago, Illinois). For quantitative variables, descriptive statistics (means correlation standard deviations) were computed. For parametric data, the two-sided Chi-square, student-t, and ANOVA tests were utilized where applicable. For non-parametric variables, the Mann-Whitney U and Kruskall Wallis tests were used. After calculating the significance level, P < 0.05 was deemed statistically significant, whilst P > 0.05 was deemed statistically non-significant.

RESULTS

This study had 20 cataractous eyes. They were 11 males (55%) and 9 females (45%). The mean age was 58.25 ± 8.83 years (Table 1).

Table (1): Descriptive data of the included patients (n=20).

Gender	Age (years)	ACD		ACA width	
		Before	After	Before	After
F	55	2.87	3.37	44.3	66.9
M	45	2.5	2.41	23.4	33.9
M	64	2.25	3.52	49.5	53.3
F	65	2.94	3.24	31.6	41.7
F	51	3.02	4.15	34.7	44.4
F	55	2.8	3.08	30.6	39.1
M	62	2.73	3	43.2	52.9
M	65	3.25	3.37	40	46.3
M	55	2.87	3.78	27.3	20.5
M	54	2.78	3.77	29.9	53.4
F	45	3.23	4.98	38.9	46.9
F	56	2.3	3.74	34.9	65.2
M	75	2.41	3.54	59.6	62.6
M	65	2.43	2.94	36.4	46.2
F	67	2.08	1.06	21.4	33.5
F	73	2.1	2.9	16	30.7
M	59	3.31	3.23	30.1	43.3
M	49	3.28	3.3	44.8	50.6
M	45	3.11	3.72	42.2	45.6
F	60	2.13	4.12	23.3	30.9
Mean ±SD	58.25 ±8.83				

ACD: anterior chamber depth, ACA: anterior chamber angle, M: Male, F: Female.

The ACD was significantly increased (p < 0.001) after surgery, from 2.72 ± 0.42 mm before surgery to 3.36 ± 0.77 mm after surgery, also ACAW significantly increased (p < 0.001) after surgery, from 35.11 ± 10.55 before surgery to 45.4 ± 12.01 after surgery (Table 2).

Table (2): Comparison of anterior chamber depth and angle width before and after surgery

ACD	Preoperative	One week postoperative	t-test	*P*-value
Range Mean ± SD Median (IQR)	2.08 - 3.31 2.72 ± 0.42 2.79 (2.15-2.91)	1.06 - 4.98 3.36 ± 0.77 3.37 (2.41-3.15)	3.211	<0.001*
ACAW				
Range Mean ± SD Median (IRQ)	16.0-59.6 35.11 ± 10.55 34.8 (19.5-34.5)	20.5-66.9 45.4 ± 12.01 45.9 (23-41.4)	3.696	<0.001*

ACD: anterior chamber depth, ACAW: anterior chamber angle width, IRQ: Interquartile ratio, t unpaired t-test, *p < 0.001: highly significant

In comparison between males and females before surgery, ACD was 2.81 ± 0.38 mm and 2.61 ± 0.45 mm respectively, while after surgery it was 3.33 ± 0.42 mm and 3.4 ± 1.09 mm respectively with insignificant difference (Table 3).

Table (3): Comparison of ACD and ACA width before and after surgery among males versus females

ACD	**Males (n=11) Mean ±SD**	**Females (n=9) Mean ±SD**	**t**	***P*-value**
Before	2.81 ± 0.38	2.61 ± 0.45	1.064	0.287
After	3.33 ± 0.42	3.4±1.09	0.456	0.648
ACA width	**Mean ±SD**	**Mean ±SD**	**t**	***P*-value**
Before	38.76 ± 10.7	30.63 ± 8.97	1.557	0.119
After	46.76 ± 11.21	44.37 ± 13.55	0.874	0.382

ACD: anterior chamber depth, ACA: anterior chamber angle, t: unpaired t-test, p>0.05: non-significant.

Correlation between age with ACD was significantly negative correlation (r = -0.521, p = 0.018) preoperatively, while it was insignificant (r = -0.403, p=0.078) after 1 week of surgery. ACAW showed non-significant negative correlation (p > 0.05) with age before and after surgery (Table 4).

Table (4): Correlation between age with ACD and angle width (n=20)

	Age (years)	
	r	***P*-value**
ACD Before	-0.521	0.018*
After	-0.403	0.078
Angle width Before	-0.047	0.845
After	-0.071	0.766

r = correlation coefficient, ACD: anterior chamber depth

There was no correlation between ACD before and after surgery and also between ACD and ACAW before and after surgery (p > 0.05). Only there was a significant positive correlation between ACAW before and after surgery (Table 5).

Table (5): Correlation between ACD and angle width before and after surgery (n=20)

Correlation coefficient		**ACD before**	**ACAW before**	**ACD after**	**ACAW after**
ACD before	r		0.320	0.266	0.129
	p-value		0.168	0.257	0.589
ACAW before	r	0.320		0.211	**0.785**
	p-value	0.168		0.371	**0.000***
ACD after	r	0.266	0.211		0.254
	p-value	0.257	0.371		0.279
ACAW after	r	0.129	**0.785**	0.254	
	p-value	0.589	**0.000***	0.279	

r: Pearson correlation test, *p <0.001: highly significant. ACD: anterior chamber depth, ACAW: anterior chamber angle width.

DISCUSSION

Senile cataract is an age-related illnesses that change the typical structure of the eyes. In particular, lens opacification causes the anterior chamber depth to shallow and the lens to thicken. These changes become more noticeable with age. The Pentacam is a user-friendly, noncontact biometry instrument that analyzes the anterior segment using a Scheimpflug spinning camera. The system takes quick, user-independent measurements. It has been revealed recently that Pentacam can compute ACD, with a mean SD of 20 μm in eyes in good health [(5)].

There was a statistical significant increase in ACD and in angle width before and after cataract surgery (2.72 ± 0.42 vs. 3.36 ± 0.77, p=0.001). This is similar to **Hafez *et al.*** [(6)] study, which demonstrated substantial angle opening and anterior chamber deepening, which led to an increase in ACV one month following surgery. Both the mean ACA and mean ACD were increased by 1.23 and 1.34 times respectively. Not only did it quantitatively record the expansion of the iridocorneal angle, but it also showed a clear iris backswing in the Scheimpflug images, particularly in eyes with extremely shallow anterior chambers. Similarly, **Beato *et al.*** [(7)] study aimed to assess anterior segment (AS) biometric alterations that take place in type 2 diabetes patients after a smooth Pentacam phacoemulsification procedure. Following surgery, there was a significant rise in all AS parameters (ACD, volume, and angle) (p<0.001). **Kurimoto *et al.*** [(8)] used UBM to report that at three months following surgery, the anterior chamber was 1.37 times deeper and the temporal ACA was 1.57 times broader. According to a different UBM investigation, the angle widened 1.26, 1.26, 1.36, and 1.52 times temporally, nasally, superiorly, and inferiorly, and the ACD increased 1.31 times [(9)]. According to the results of the two subsequent experiments, the anterior chamber modifications were caused by the iris shifting backward by about 10° in angular movement following the removal of the crystalline lens and the relief of any potential relative pupillary block that may have been present in eyes with a shallow anterior chamber.

The preoperative ACD was 2.28 ± 0.32 mm in a prior research. Following surgery, the angle was more than 200° and the ACD rose to 3.04 ± 0.39 mm, indicating that angle closure glaucoma was not possible [(10)]. This is consistent with the **Kim *et al.*** [(11)] study, which had 45 senile cataract patients with a mean age of 67.8 ± 9.7 years; 16 of the patients were men and 29 were women. Before surgery, the average ACD was 2.75 ± 0.43 mm. At two days following cataract surgery, the mean postoperative ACD was 4.14 ± 0.31 mm, which was around 50.5% deeper than it was prior to surgery (p < 0.001). These findings are consistent with those of earlier research projects that examined ACD and ACA changes after cataract surgery [(12)]. ACD and ACA data were collected in a normal Korean population free of cataracts by **Yi *et al.*** **[13].** The mean age of the 81 healthy volunteers was 22.3 ± 3.5 years. In the right eye, the ACA was 45.13 ± 5.89° and 46.18 ± 5.50° in the nasal and temporal quadrants and in the left eye, it was 44.90 ± 5.94° and 46.67 ± 5.98° respectively. For the right and left eyes, respectively, the mean ACD was 3.32 ± 0.26 mm and 3.31 ± 0.28 mm. These outcomes exceeded ours in magnitude. Without intraocular anomalies, the participants in our study were thought to reflect the typical population. Nonetheless, the majority of the study's participants were elderly individuals with cataractous lenses and their mean age was 58.25 ± 8.83 years. As we age, our lenses become thicker and their anterior surface moves closer to the cornea. In addition, a lot of cataractous lenses have larger volumes and thicknesses than healthy lenses. Therefore, we think that this explains why the ACD and ACA in the study's cataractous lens eyes were less than those with normal lenses.

Like another study included 20 patients underwent phacoemulsification, nine (45%) were females and eleven (55%) were males with ages between 60 and 69 years. The average depth gain in the anterior chamber was 0.79 mm, which is 28.11% deeper than it was before surgery. Based on anterior-chamber angle, there was a statistically significant difference between pre and post, with a P value less than 0.001. The preoperative measurement increased by 27.67%, or 8.61°, on average in the anterior-chamber angle. According to angle-opening distance 500 µm, there was a significant statistical difference between the pre and post, with a P value of less than 0.001. The angle-opening distance dramatically increased to 21.42% of the preoperative value with a mean increase of 0.09 mm **[14]**.

Also, **Ghoneim *et al.*** **[15]** found that there was no significant difference in ACD during the first week and first month following surgery, and that postoperative assessments of ACD revealed a considerable rise from the preoperative measure by all employed methodologies. The mean AC depth before surgery, measured with UBM, was 3.02 ± 0.82 mm. It increased to 4.05 ± 0.99 mm during the first week and 4.41 ± 0.75 mm at the first month after surgery.

This is in agreement with **Fayed *et al.*** **[16]** study, which revealed that the mean postoperative ACD on UBM was 4.48 ± 0.42 mm at the first postoperative month, and was 4.45 ± 0.44 mm at the third postoperative month compared to the mean preoperative ACD of 3.36 ± 0.49 mm. Therefore, the mean difference in ACD was 1.1 mm, ~32% deeper than before surgery, which is highly statistically significant. Similarly, **Awnallah *et al.*** **[17]** after the intumescent cataract's phacoemulsification, the mean ACD increased statistically significantly. The average ACD measurements were 3.44 ± 0.28 mm in group I, 3.3 ± 0.39 mm in group II, and 3.33 ± 0.32 mm in group III, with mean relative changes of 30.76%, 52.76% and 80.19%, respectively. This si keeping with the research, which comprised information gathered from 21 cataract-afflicted participants' eyes. Following cataract extraction, the mean anterior chamber depth rose from 2.92 ± 0.54 to 4.24 ± 0.5 mm (P=0.044). Following surgery, there was a notable rise in the AS-OCT parameters for the nasal and temporal angles. The nasal angle quadrant showed an 88.2% rise in AOD500, with a mean difference of 213.9 (±173) µm (P<0.001). In the nasal angle, $TISA_{750}$ increased by 94.4%, with a mean difference of 0.134 (±0.104) µm2 (P<0.001) **[18]**.

In our study, ACD showed significant negative moderate correlation with age before surgery (r=-0.521, p=0.018). This is in agreement with **El-Sobky *et al.*** **[14]** study in which age and ACD differed statistically significantly, with a P value of less than 0.001. Age and ACD correlated negatively in the **Gessesse *et al.*** **[19]** study (r= -0.196, p= <0.001).

The study conducted by **Ghoneim *et al.*** **[15]** provided confirmation for our findings, as they noted that the primary alteration in the anterior portion of the eye following cataract extraction is the enlargement of the iridocorneal angle. Similar to earlier research, a rise in age causes a decrease in ACD, which is explained by the crystalline lens becoming thicker with aging **[20, 21]**.

In our study, there was significant increase (p<0.001) in ACA after surgery than before. Angle width showed significant direct strong correlation before and after surgery (r=0.785, p<0.001). **Kim *et al.*** **[11]** showed that prior to surgery, the study found that the mean ACA widths in the nasal quadrant was 23.21 ± 6.70° and in the temporal quadrant was 24.89 ± 7.66°. These values considerably rose to 35.16 ± 4.65° in the nasal quadrant and to 36.03 ± 4.86° in the temporal quadrant. Similarly, **Baxant *et al.*** **[22]** examined 170 eyes from 119 patients who had posterior-chamber IOL implantation after phacoemulsification. Third week and third month following surgery, they showed a considerable increase in ACD and ACA of patients, primarily in the PACG group. Eliminating the contact between the lens and the iris is a likely reason.

There are some limitations of our study. First, our relatively small sample size despite being on par with previous IOL research. Second, we were unable to pinpoint the exact moment posterior displacement of the IOL optic occurred because to our lack of examination between the first and sixth postoperative months. Third, it would have been ideal to follow up with the patients for more than 24 months, even though it was unlikely that the IOL position would change further. Fourth, failing to compare the results with those from another imaging modalities.

CONCLUSION

Pentacam is a good method for obtaining quantitative data regarding anterior chamber configuration. ACD and angle width significantly increased after cataract surgery.

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