Changes of Anterior Chamber Biometry and Relationship to Intraocular Pressure Changes after Phacoemulsification Emulsification Surgery in Non-Glaucomatous Eyes

Mohammed Qasim Al Nuwaini[1] ; Giyathaldeen T. Neameh[1]; Farook M. Albusultan[1], Alyaa Abood Kareem[2], MD Mustafa A. Al Zubaidi [3], MD Zainab Basim[4]

[1]Faculty Of Medicine College/Jabber Ibn Hayyen Medical University, [2]Faculty Of Medicine College Kufa University, [3]Ophthalmic Department /Al Sadder Teaching Hospital, [4]Ibn al Haitham Teaching Eye Hospital

Abstract

Fifty percent of blindness worldwide is attributed to cataract, and cataract surgery is the most common surgery performed by ophthalmologist. Cataract surgery has its effects on the structures of the anterior segment, and hence the aqueous humor outflow, these may include more space in anterior chamber, wider angles, as the thick aging lens would be replaced by the thinner intraocular lens. So this study to investigate the changes in anterior segment parameters and its correlation to IOP changes after phacoemulsification. A prospective Cohert study that was done at Ibn Al-Haitham Teaching Eye Hospital for patients planned to have phacoemulsification, for 55 patients during 8 months, from the 1st of July/2018 until the 28th of February/2019. The data included full preoperative and postoperative assessment, key parameters were: axial length measurement, intraocular lens, anterior chamber depth, anterior chamber volume, anterior chamber angle for the four quadrants and their mean value was calculated. It was done before the operations and after two months from the operation. Findings were the mean age of the study group was 56.9years, with 30 (54.5%) males and 29 (52.7%) right eyes,. The mean axial length was 23.12±1.11 mm. There were statistically significant differences in preoperative compared to postoperative values of IOP (decreased by 4.55 mmHg), anterior chamber depth (increased by 0.74 mm), volume (increased by 32.75 µl), and mean angle (increased by11.78 degree) maximum inferiorly (12.31 degree) and minimum superiorly. There were no statistically significant correlation between IOP changes with anterior chamber depth, volume, or angles, but there was a statistically significant correlation with preoperative IOP .Conclusions cataract surgery significantly decreases the IOP, and increase anterior chamber depth, volume, and angle. The decrease in IOP does not correlate with anterior chamber depth, volume, and angle. The decrease in IOP was significantly higher in patients with higher preoperative values of IOP.

Keywords *: cataract; phacoemulsification: anterior segment parameters pre and post -surgery ; IOP*

Introduction

A cataract is a degradation of the optical quality of the crystalline lens that affects vision. Mostly related to aging. They can occur in one or both eyes .the changes that affect the quality of lens optics with subsequent change of vision known as cataract[(1)] ;still the world wide main cause of blindness and also in Iraq[(2)].cataract may affect vision from mild decline in early stages to clinically blind (VA 3/60), and is may be unilateral or bilateral [(2)]

The cataract surgery rate is known as correlation between number of surgically treated cataract to millions of country pupation, that previous study state that Iraq occupied the 30rd position to 50 countries involved[(3,4)]

Corresponding author:
Mohammed Qasim Al Nuwaini
M.QASIM@JMU.EDU.IQ
Jabber Ibn Hayyen Medical University.
Republic of Iraq. Najaf provenance

Histologically, the crystalline lens consisted of following structures a cellular capsule ,epithelium ,cortex and nucleus and provide one third of refractive index power of the eye, in the un-accommodated state, the average adult lens parameters are about 4–5mm thickness, with a 10mm anterior radius of curvature, a 6mm posterior radius of curvature, a refractive index of 1.386 (1.406 centrally), with the dioptric power of 18D [5] .The other important parameters of anterior chamber is the follow of aqueous humor that occur through Trabecular Outflow and uveoscleral pathway [6]. It is known that trabecular meshwork is pressure sensitive site of aqueous outflow and act as one way valve i,e without energy demand aqueous get out of the anterior chamber ,but there is no return . in the Schlemm's canal the path of aqueous not well clear and presence of intracellular and intercellular pores might cause bulk flow , the direct connection of inter trabecular spaces (giant vacuole) suggested active transport[7]. Mathematically The facility of outflow (C in the Goldmann equation;) is the inverse of outflow resistance and varies widely in normal eyes, with mean value ranging from 0.22 to 0.30 μL/min/mm Hg. it's supposed that Outflow facility decline with age and is affected by several factors like surgery, trauma, medications, and endocrine factors. Also the glaucomatous or ocular hypertension Patients IOP typically have decreased outflow facility [8]

the remaining outflow by non-trabecular pathway is by uveoscleral outflow , start from anterior chamber into the ciliary muscle and then into the supraciliary and suprachoroidal spaces then exits the eye through the intact sclera along the nerves and the vessels that penetrate it, some evidence that outflow via the uveoscleral pathway is has important roles in human eyes, about to 45% of total aqueous outflow ,also there is significant effect of aging process on this pathway, that cause decline of its and also in glaucomas patients. This pathway known to be pressure insensitive (independent) path and increased by some pharmacological agents like prostaglandin analogues ,while miotics cause reduction in it . The exact calculation cannot be done in non -invasive method and calculated by the Goldmann equation [9] as it is known that cataract surgical interversion is most common surgery in the world that aiming to achieve best correct vision, and become direct from large incision (10 mm) to very small wound less than (3mm) with better and faster visual outcome by using phacoemulsification[10].The effect of cataract surgery on IOP had been studied in several studies With different period of fellow up ranged from 6 month until 3 years , and conclude that the phacoemulsification had generally IOP lowering effect that fall in a range 1.5 to 9 mmHg. The explained effect is by the mechanical influence of the lens removal, also increment uveoscleral outflow and increased trabecular outflow [11, 12]. So this reduction in IOP may be useful in patient with glaucoma or ocular hypertension[13].The suggested mechanism for surgery effect on IOP not well understood that might be change of anatomical structures of AC especially in angle closure glaucoma ,also the effect that obtained by lens removal would lead to high movement of the posterior capsule to posterior that displacing the zonula over the ciliary body, and subsequent facilitates more aqueous outflow as a result of Schlemm's canal expansion[13,14], the role of inflammatory mediators IL-1 that released by phacoemulsification and IOP sudden rising during surgery will cause more aqueous outflow[15,16]. There are published studies for evaluating the relationship between ocular biometric parameters and post-op IOP reduction in normal eye patients [17], anterior chamber volume (the area that extend from the anterior iris plane to the endothelium) [18], axial length , angle opening distance, anterior chamber area, central corneal thickness, lens thickness, iris thickness, and pupil diameter [19, 20]. By any means, exact explanation of those changes still not understood well, but there is an increasing fact that the greatest factor among them is the level of the preoperative IOP. Also the axial length, "the distance from the anterior corneal surface to the retinal-pigmented epithelium" would contribute a significant role in predicting IOP changes following cataract surgery [21]. In the end the previous researches showed that there is a potential association between the observed reduction in IOP and axial length of the eye [22]

Aim of the study: To investigate the changes in anterior segment parameters and there correlation to IOP changes after phacoemulsification.

2. Subjects and methods:

Cohert prospective study that was done at Ibn Al-Haitham Teaching Eye Hospital in Baghdad for patients planned to have phacoemulsification, the data was collected from 55 patients by the researchers, from

the 1st of July/2018 until the 28th of February/2019. The data included both preoperative and postoperative assessment: VA, slit-lamp examination, routine fundus examination, Gonioscopy(grade2 angles and below were excluded), and IOP measured by Goldmann applanation tonometer. The fundus was examined by using condensing lens, some cases the posterior segment was assessed by B-scan ultrasonography.

1. Axial length measurement and the intraocular lens (IOL) power calculation was done using IOL MASTER (Zeiss, Jena, Germany)

2.Anterior segment imaged by a Pentacam (PTC, Oculus Inc., Wetzlar, Germany) for anterior chamber depth (ACD) from the corneal epithelium to the anterior lens capsule [23] (or anterior IOL surface postoperatively), anterior chamber volume (ACV), anterior chamber angle (ACA) for the four quadrants (Inferior, Superior, Nasal, and Temporal) and their mean values were calculated. It was done before the operations and after two months from the operation, in standard setting (dimly illuminated room) by experienced technician. Selection was Adult patients older than 18 years, Patients' acceptance, no other ocular pathologies or surgery also surgical and post-surgical complications persons excluded.

The collected data was handled and analyzed by IBM© SPSS© Statistics Version 23. Independent samples T-test was used for numerical and normally distributed data. Pearson Correlation was used to identify the possible linear correlation between the study variables. All analyses were done with 95% confidence intervals (CI). P-values less than 0.05 were considered statistically significant throughout this study.

Findings

In the current study, the mean age was (56.9±9.9) years; the commonest age group was (60 – 70) years (50.9%) , very close gender distribution , this applied also to laterality as there were 29 (52.7%) right eyes, compared to 26 (47.3%) left eyes. The mean axial length was 23.12±1.11 mm.

Table (1): baseline characteristics of patients included in this study

Variables		Number	%
Age groups	30-49	12	21.8
	50-59	15	27.3
	60-70	28	50.9
Age (mean ±SD)	56.96±9.99		
Gender	Male	30	54.5
	Female	25	45.5
Laterality	Right eye	29	52.7
	Left eye	26	47.3
Axial length (mean±SD)	23.12±1.11		

There were statistically significant differences in IOP (decreased by 4.55 mmHg), ACD (increased by 0.74 mm), ACV (increased by 32.75 µl), and mean AC angle (11.78 degree) maximum inferiorly (12.31 degree) and minimum superiorly (8.29 degree).

Table (2): comparison between preoperative and postoperative IOP and

Variables	Preoperative	Postoperative	Difference	P-value
IOP	18.65± 2.84	14.11±2.61	4.55	<0.001
ACD	2.62±0.43	3.36±0.71	0.74	<0.001
ACV	139.84±37.20	172.58±35.97	32.75	<0.001
Anterior chamber angle width table (3)				
Superior	32.09±7.06	40.38±6.54	8.29	<0.001
Inferior	31.71±6.60	44.02±5.84	12.31	<0.001
Temporal	34.95±7.58	44.72±6.29	9.77	<0.001
Nasal	34.04±6.19	45.93±4.87	11.89	<0.001
Mean angles	32.80±4.92	44.58±4.32	11.78	<0.001
Paired samples T-test				

There were no statistically significant correlation between IOP changes with ACD, volume, or angles, but there was a statistically significant correlation with preoperative IOP (correlation coefficient 0.513), as showed in Table (4) and Figure (1).

Table (4): correlation of IOP changes with axial length and changes of other parameters

Changes	Correlation coefficient	P-value
AL	-0.174	0.204
ACD	-0.019	0.888
ACV	-0.133	0.332
Superior angle	0.030	0.830
Inferior angle	-0.058	0.675
Temporal angle	-0.012	0.933
Nasal angle	-0.073	0.597
Mean of angles	-0.035	0.798
Preoperative IOP	0.513	<0.001
Pearson correlation		

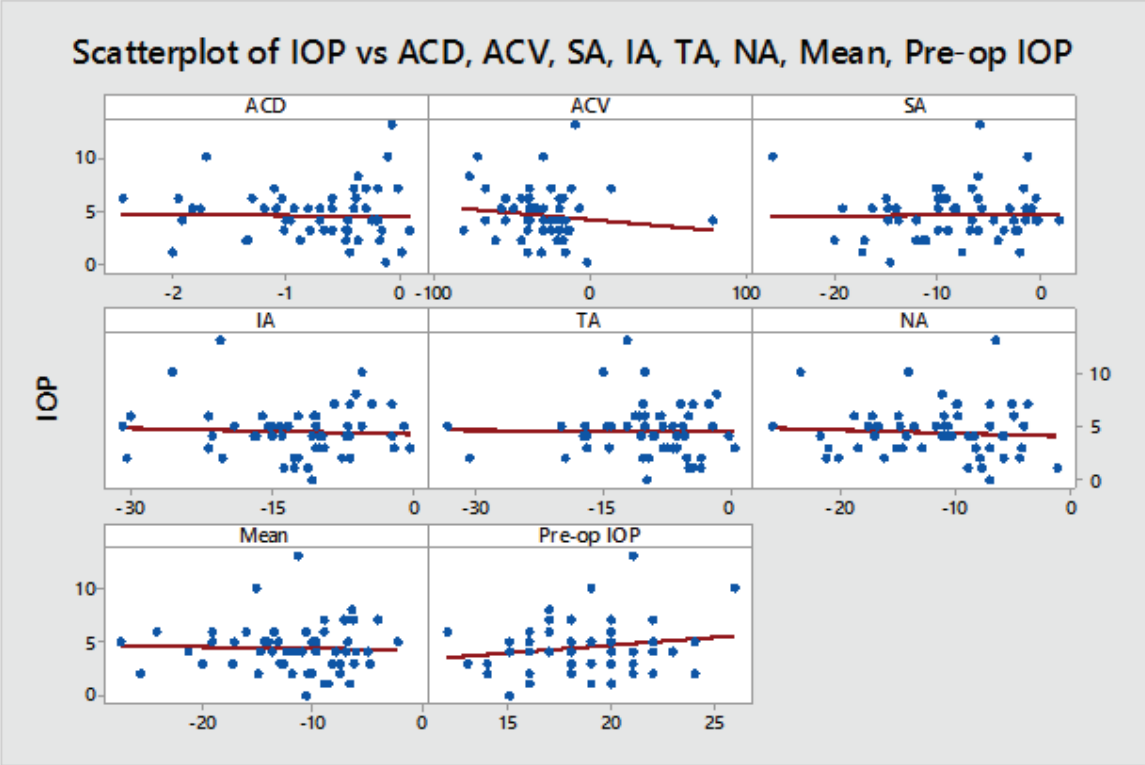

Figure (1): Scatterplot of IOP changes versus changes in ACD, ACV, SA, IA, TA, NA, mean chamber angle, and preoperative IOP.

Discussion

This study showed a significant decrease in IOP post cataract surgery in non-glaucomatous eye with significant increase in ACD, ACV and ACA. Although ; there is no relationship between IOP and ACD, ACV, and ACA.

In the current study, there was a significant decrease in mean IOP preoperative and postoperative, with a statistically significant mean difference of 4.55 mmHg. This was comparable to the results reported by Sengupta et al [24],also Yang et al [25], reported significant IOP reduction postoperatively. This could be explained by the different proposed mechanisms, which could be an inflammatory response that may lead to increase in uveoscleral outflow, blood-aqueous barrier changes, effects on the ciliary body, in addition to anatomical alterations in the anterior segment which could be the pivotal factor explaining aqueous humor dynamics post cataract surgery.

In the current study, there was a statistically significant increment by 0.74 mm in ACD and by 32.75 mm^3 in ACV postoperatively. This was lower than the results of Huang etal [26]. While our results were close to result of Simsek et al [27] . In the current study, the mean increase in ACA was maximum inferiorly and minimum superiorly. This was comparable to results of Dooley [28], also Huang et al [29] and Simsek et al [27]. The crystalline lens continue to grow throughout life, and when doing so, it's pushing the iris anteriorly, shortening the AC and decreasing the angle opening, with lens removal and the smaller size of the implanted PC IOL, there won't be a structure that pushes the iris, which may be related to IOP decrement postoperatively, together with dysregulation of pre-inflammatory mediators after cataract extraction [30].

The study showed no statistically significant correlation between IOP changes with ACD, ACV, or ACA, but there was a statistically significant correlation with preoperative IOP. This was in agreement with the results of Huang etal [31]. Also our results were similar to results of Sengupta etal [24]. These differences might

be attributed to patients' selection, that was whether they had open or closed angle, and considering the proposed relationship between the ACD and angle closure, as suggested by Pakravan etal[32], there will be a greater proportion of patients that will be considered to have narrow angles, with significant high risk for developing angle closure (ACD ≤2.1 mm). Another factor might be related to the way of measuring the ACD (AC OCT in Huang etal [31] and Sengupta etal [24], and Pentacam in our study.

Conclusions

1. Phacoemulsification in Iraqi patients , get lower IOP, and increase ACD, ACV, and ACA.

2. The decrease in IOP does not correlate with ACD, ACV, and angle. . So IOP seems not related to anatomical changes directly but to facility of drainage change after the surgery or uveoscleral outflow increase.

3. The decrease in IOP was significantly higher in patients with higher preoperative values of IOP.

List of abbreviations

Abbreviation	Explanation
ACA	Anterior chamber angle
AC	Anterior chamber
ACD	Anterior chamber depth
ACV	Anterior chamber volume
AL	Axial length
CCT	Central corneal thickness
IA	Inferior angle
IOP	Intraocular pressure
IOL	Intraocular lens
PA	Posterior angle
SA	Superior angle
TA	Temporal angle

Recommendation

Further studies should be done measuring the changes of IOP in patients with open, narrow, and closed angle glaucoma as a therapeutic action to decrease need for multiple anti-glaucoma medications.

Conflict of Interested: Nil

Source of Funding: by group of researchers their on

Ethical Clearance: The research Ethical Committee at scientific research by ethical approval of both environmental and health and higher education and scientific research ministries in.

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