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Evaluation of Anterior Chamber Depth and Anterior Chamber Angle Changing After Phacoemulsification in the Primary Angle Close Suspect Eyes

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Abstract

BACKGROUND: Phacoemulsification surgery has the ability to deeply alter the segment anterior morphology, especially in eye with shallow anterior chamber (AC), narrow anterior chamber angle (ACA). However, the changes of anterior chamber depth (ACD) and ACA on the close angle suspect eyes after phacoemulsification have not been mentioned in many studies. So, we conduct this research.

AIM: To evaluate the alteration in the ACA and ACD after phacoemulsification in the close angle suspect eyes.

METHODS: Interventional study with no control group. Subjects were the primary angle closure suspect (PACS) eyes, that were operated by phacoemulsification with intraocular lens (IOL) at Glaucoma Department of VNIO from December 2017 to October 2018.

RESULTS: 29 PACS eyes with cataract were operated by phacoemulsification with intraocular lens. After 3 months of monitoring, the average ACD augmented from 2.082 ± 0.244 to 3.673 ± 0.222 mm. AOD500 increase from 0.183 ± 0.088 to 0.388 ± 0.132 µm, AOD750 increased from 0.278 ± 0.105 to 0.576 ± 0.149 µm. The TISA500 enlarged from 0.068 ± 0.033 to 0.140 ± 0.052 mm^2, TISA750 enlarged from 0.125 ± 0.052 to 0.256 ± 0.089 mm^2 at the third month ($p < 0.01$).

CONCLUSION: Phacoemulsification surgery increases the ACD and enlarged the angle in the PACS eyes.

Introduction

There have been many studies showing that lens extraction and intraocular lens implantation, especially phacoemulsification surgery in cataract patients can increase the ACD, widening the angle and solving the pupil blockade to increase the aqueous humour outflow [1], [2], [3]. Therefore, phacoemulsification surgery is considered an angle-closure glaucoma treatment method and has a preventive effect on the eyes with narrow AC [4].

Anterior segment optical coherence tomography (AS-OCT) is a non-contact and non-invasive imaging technique that provides high quality images and it offers rapid and easy calculable of anterior segment, especially angle irido-corneal and AC [5].

There have been many studies on images of anterior segment by AS-OCT have shown that after phacoemulsification surgery AC was deeper, ACA was wider on the normal eye group, primary angle closure glaucoma (PACG) group and primery open angle glaucoma (POAG) group.

Altan (2004) studied 53 nonglaucomatous eyes, the results showed that before surgery the

average IOP was 15.1 ± 2.8 mmHg decreased to 13.3 ± 2.7 mmHg after surgery 3 months; Preoperative ACD mean was 3.06 ± 0.49 mm, increased to 3.70 ± 0.36 mm 3 months postoperative (P < 0.05) [1].

The study by Martha Kim (2012) [6] performed phacoemulsification surgery on both PACG and POAG, which showed mean ACD results of PACG groups enlarged from 1.63 ± 0.23 mm to 3.65 ± 0.19; ACD of POAG also enlarged from 2.62 ± 0.47 mm to 3.93 ± 0.26 mm on the second day after surgery (p < 0.001). The ACA in the nasal and temporal quadrants both increased twice in PACG and 1.5 times in POAG.

However, the changes of AC and ACA on the close angle suspect eyes after phacoemulsification have not been mentioned in many studies. So, we conducted this research with the aim to evaluate changes in the ACA and ACD after phacoemulsification surgery in PACS eyes using AS-OCT.

Materials and Methods

This interventional study was performed in the Glaucoma Department of Vietnam institute of ophthalmology, between December 2017 and October 2018. The research was carried out in accordance with the tenets of the Declaration of Helsinki.

We conducted the research on 29 eyes of 25 cataract patients with close angle suspect (The eye has at least 3 quadrants angles at grade 2 according to the Shaffer classification on gonioscopy without indentation and eye in the primary position, with normal intraocular pressure (IOP), normal optic disc and visual fields and ACA under 25° on both nasal and temporal angle quadrants on AS-OCT images). All patients underwent preoperative evaluation including visual acuity testing, slit lamp examination, gonioscopy, Goldmann applanation tonometry and indirect fundoscopy. IOL was calculated by IOLMaster 500 (Zeiss Meditec, Dublin, CA, USA).

Surgeries were performed by one surgeon (ATV). Surgical technique involving phacoemulsification and aspiration through a 2.2 mm temporal clear corneal incision then acrylic hydrophobic IOL was implanted in the capsular bag. Patients with surgical complication which required other surgical approaches were excluded.

AS-OCT (Visante, Zeiss Meditec, Dublin, CA, USA) was carried out 1 day before surgery, and 1 and 3 months after surgery. One examiner achieved all images under indistinguishable lighting conditions. The following parameters were measured: - Central ACD, described the distance from the back surface of the cornea to the front of the lens in the center; - Angle opening distance at 500 µm or 750 µm (AOD500/750) – measured by the length of the line perpendicular between a point 500µm or 750 µm from the scleral spur and the opposing iris; and - Trabecular iris space area (in mm^2) up to 500 µm or 750 µm (TISA500/750) – the area of the quadrilateral define by the AOD 500 or 750, the corneal endothelium, trabecular meshwork and anterior iris surface.

Data are presented as mean values ± standard deviation of the mean. Differences between preoperative and postoperative measurements were evaluated using Friedman test. All results were well thought out significant at $p < 0.05$.

Results

Ours study include 29 eyes of 25 patients; 4 male (16%) and 21 females (84%). The mean age was 70.28 ± 8.95 years, from 47 to 88 years old. All patients were making a diagnosis with senile cataract and narrow angle.

Table 1: Alterations of anterior chamber depht (ACD)

ACD (mm)	$\bar{X} \pm SD$	p*
Preoperative	2.082 ± 0.244	
1 months postoperative	3.620 ± 0.307	
3 months postoperative	3.673 ± 0.222	
ACD difference after surgery 1 month	1.538 ± 0.312	0.000
ACD difference after surgery 3 month	1.592 ± 0.293	0.000
ACD difference between 1 month and 3 months	0.054 ± 0.186	0.131

* Friedman test, comparing before and after surgery.

After surgery, the AC was notably profounder in all postoperative periods. The mean expansion in ACD postoperative was 1.538 ± 0.312 mm after 1 month, and was 1.592 ± 0.293 mm after 3 months, about 73% profounder than before surgery. But the difference of ACD between 1 month and 3 months postoperative is not statistically significant (p = 0.131) (Table 1).

Table 2: Changes in angle opening distance (AOD)

AOD (µm)	AOD500	p*	AOD750	p*
Before surgery	0.183 ± 0.088		0.278 ± 0.105	
1 months after surgery	0.370 ± 0.090		0.569 ± 0.108	
3 months after surgery	0.388 ± 0.132		0.576 ± 0.149	
AOD difference after surgery 1 month	0.187 ± 0.080	0.00	0.291 ± 0.127	0.00
AOD difference after surgery 3 month	0.205 ± 0.108	0.00	0.298 ± 0.149	0.00
AOD difference between 1 month and 3 months	0.018 ± 0.074	0.204	0.007 ± 0.083	0.654

*Friedman test.

Angle opening distance were also significantly augmented. AOD500 average was 0.183 ± 0.088 µm before surgery. One month after surgery mean AOD500 was 0.370 ± 0.090 µm and 0.388 ± 0.132 µm at the third month. AOD750 also augmented from 0.278 ± 0.105 µm to 0.569 ± 0.108 µm at the first month and 0.576 ± 0.149 µm at the third month. However, the change in AOD500 and AOD750 at 1

month and 3 months postoperative is not statistically significant (p > 0.05) (Table 2).

Table 3: Changes in trabecular iris space area (TISA)

TISA (mm^2)	TISA500	p*	TISA750	p*
Before surgery	0.068 ± 0,033		0.125 ± 0.053	
1 months after surgery	0.132 ± 0,038		0.248 ± 0.058	
3 months after surgery	0.140 ± 0,052		0.256 ± 0.089	
TISA difference after surgery 1 month	0.064 ± 0,023	0.00	0.123 ± 0.042	0.00
TISA difference after surgery 3 month	0.072 ± 0,040	0.00	0.132 ± 0.07	0.00
TISA difference between 1 month and 3 months	0.009 ± 0,026	0.087	0.008 ± 0.049	0.373

*Friedman test.

Trabecular iris space area increased roughly 2 times after surgery 1 month in both the temporal and nasal angle (p < 0.001). But the difference of TISA500 and TISA750 at 1 month and 3 months postoperative is not statistically significant (p > 0.05) (Table 3).

Discussion

Recent developments in morphological evaluation of angle irido-cornean, specifically by means of AS-OCT, have exposed that all indicators of the width of angle are increased after lens extraction on all subjects, especially in Asians patients [3].

Lens volume expansions when age increases and the anterior lens surface move toward the cornea [7]. Therefore, almost cataractous lenses are thicker than normal lenses [8]. After cataract extraction and replaced the thinner intraocular lens the iris to back out, extending the anterior chamber and angle irido-cornean.

In this study, we only selected patients at risk of angle closure, so ACD was lower than other studies [9]. The average of ACD before surgery only was 2.082 ± 0.244 mm, but 1 month after surgery ACD was measured at 3.620 ± 0.307 mm. This depth is equivalent to the postoperative ACD value on the senile cataract in normal eye [10], [11].

Among 25 study patients, the rate of women was 5.25 times higher than men. This ratio is also consistent with epidemiology of closed angle glaucoma because the anterior chamber in women are shallower than men, and the average life expectancy for women is higher than for men.

Similar to ACD, the indicators of the AC width are significantly increased at first and third postoperative month, statistically significance with p < 0.001. Many researches have shown that the lens plays an important role in primary angle closure [7]. ACA closure is generally established in eyes with a shallow AC, narrow angle. Studies have revealed an important lens participation in these eyes [12], [13]. One of the mechanisms of angle closure is said to be an augmented lens volume. Also, it has been proclaimed that lens curvature might have a bigger role in angle closure than an enlarged diameter of the lens. A continuous increase in lens volume and lens curvature are suspected to be related to the pathogenesis of angle closure particularly in women in the 3rd or 4th decade.

Therefore, lens removal has special effects on the treatment and prevention of PACG [6]. There are studies that demonstration a diminution in the IOP up to 8,5 mmHg [4] after phacoemulsification. In close angle and close angle suspect eyes, lens removal can enlarge the angle, extend the anterior chamber, and reduce the irido-trabecular contact. This attribute has been related with a stable reduction in the IOP. Some studies have also displayed a diminution in peripheral anterior synechiae after phacoemulsification surgery [14].

Pereira [2] found significant intensify in the ACA opening after cataract extraction. There was a exceptional correlation between the ACA preoperative values and after surgery alterations: "*the shallower the preoperative AC, the greater the postoperative deepening; the narrower the preoperative angle, the greater the postoperative opening of the angle"*.

In ours study, the indicators of anterior chamber angle AOD500, AOD750, TISA500, TISA750 all increased approximate 2 times after surgery. This result is completely consistent with the others studies, the change of the ACA after cataract extraction on angle-closure glaucomatous eyes [9], [10]. Even on normal eyes and open-angle glaucoma, phacoemulsification surgery also extends the ACA but with a smaller margin compare with closed-angle glaucoma [4]. Amount alteration on these parameters was always lesser in the open angle glaucoma against angle close group [6]. The study of Nonaka (2005) on 13 eyes were taken phacoemulsification in 27 eyes residual angle closure after laser peripheral iridotomy. Before surgery, all eyes are positive or suspected positive responses to the prone position test in the dark room. After surgery all eyes becames negative with that test and IOP lowered 4.5 mmHg compared to before surgery.

In conclusion, through studying 29 eyes on 25 PACS patients by AS-OCT machine, we found that phacoemulsification surgery and foldable intraocular lens *increases the ACD and widens the ACA of the PACS eyes*. Results of this research suggest that phacoemulsification might be considered as an effective treatment option for patients at risk of angle-closure glaucoma.

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