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Original Article

Assessment of Anterior Chamber Angle After Pars Plana Vitrectomy Using Anterior Segment OCT

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ABSTRACT

Background: Although pars plana vitrectomy [PPV] is a posterior segment surgery. It may also affect anterior segment parameters. This study aimed to assess anterior chamber angle [ACA] changes following PPV using anterior segment optical coherence tomography [AS-OCT] imaging.

The aim of the work: This study aimed to assess changes in anterior chamber angle parameters following pars plana vitrectomy for different etiologies using anterior segment OCT imaging

Patients and Methods: This prospective study included twenty-nine cases [thirty eyes] whom indicated for pars plana vitrectomy surgery. AS-OCT imaging of ACA was done before and after three months post-operatively then ACA in degrees and AOD 500 was measured.

Results: In this study, we enrolled 29 patients [30 eyes as one patient was operated bilaterally] undergoing PPV [with or without intraocular tamponade]. The median [IQR] age of them were 50 [35 – 54] years. Twelve patients [40%] were males, and seventeen [60%] patients were females. According to the patient's diagnosis, 40% were tractional retinal detachment [on top of advanced diabetic eye disease], 30% were rhegmatogenous retinal detachment and 30% were diagnosed as diabetic vitreous hemorrhage. The anterior chamber angle parameters were measured using AS-OCT imaging before and 3 months following PPV. The ACA° and AOD 500 values were changed [reduced] significantly following PPV at three months postoperatively [P = 0.001].

Conclusions: Despite the limitations of this study, ASOCT demonstrated that there was a significant difference between preoperative and post-operative ACA & AOD500 measurements following PPV.

Keywords: Anterior Segment; Angle Chamber Angle; Pars Plana; Vitrectomy; Optical Coherence Tomography.

INTRODUCTION

Pars plana vitrectomy [PPV] is a surgical technique originally introduced by ROBERT MACHEMER in 1970 [1]. It is a surgical technique in vitreoretinal surgery that enables access to the posterior segment for management of many conditions such as retinal detachment, persistent vitreous hemorrhage and postoperative endophthalmitis [2]. However, the procedure can also be associated with complications including cataract, cystoid macular edema [CMO], retinal detachment and intraocular pressure [IOP] elevation, the chances are low when performed correctly, but also these complications can cause severe visual compromise and blindness [3].

It is documented that in the early post-op period, there may be an increase in IOP which may be sudden and high to cause optic disc damage and thus cause blindness [4]. This elevation can be due to open-angle [approximately 80% of cases] including tamponade [especially silicone oil] migration into the anterior chamber, gas or oil overfill, steroid response, and post-operative inflammation or closed angle [approximately 20% of cases] via pupillary block [5]. Owing to the great innovation in surgical techniques and advanced technology in machines and instruments, anatomical success of PPV became high but on the other hand it is important to study factors affecting the functional outcome, including refractive changes and postoperative complications resulting from anterior segment changes [6]. Many studies have used different classification systems to assess and quantify the ACA parameters, the standard of which is gonioscopy with Goldmann contact lens examination and grading system introduced by **Gandhi** [7]

Anterior segment OCT and ultrasound biomicroscopy [UBM] are the two most used techniques for anterior segment imaging [8]. Anterior segment OCT is a light-based imaging modality which provides non-contact and rapid in vivo imaging of ocular structures. It has many advantages, such as its resolution is approximately 15 µm which provides excellent visualization of angle structures [9]. Anterior segment OCT imaging allows for assessment of anterior segment structures such as the tear film, conjunctiva, sclera, cornea, anterior chamber angle, and lens. Unlike UBM, AS-OCT is unable to assess the ciliary body due to its limited penetration, as well as necessity of presence of clear cornea [light-based imaging modality] [10].

This study aims to assess anterior chamber angle changes after pars plana vitrectomy for different etiologies using anterior segment OCT imaging.

PATIENTS AND METHODS

This prospective study included twenty-nine cases [thirty eyes] whom indicated for pars plana vitrectomy which was done at department of ophthalmology, Al-Azhar university hospital of New-Damietta. This study followed the Helsinki declaration principles. Ethical approval was obtained from our institutional ethical committee. Written informed consent was obtained from every patient at the time of recruitment. We included the patient according to the following criteria:

Patients indicated for pars plana vitrectomy surgery were included in the study. On the other side, exclusion criteria were 1] patients who refuse to participate in the study, 2] Eyes with shallow AC < 2.5 mm AC depth, 3] IOP by Goldmann tonometry over 21 mmHg, 4] Known glaucomatous patients or Previous glaucoma surgery, 5] Eyes with ACA pathology such as peripheral anterior synechiae, angle neovascularization and angle recession, 6] Eyes with abnormal corneal structure: such as significant corneal opacity, severe edema, and 7] Patients who underwent combined phacoemulsification plus PPV.

Data collection: Full detailed history taking was obtained from every patient. General examination and routine laboratory investigations were also done for every patient. Complete ophthalmological examination was done for every patient including; Uncorrected visual acuity [UCVA] and Best corrected visual acuity [BCVA] which was carried out using Snellen`s chart, Pupil reaction, shape and size and color discrimination. IOP measurement by Goldman applanation tonometry. Slit-lamp examination of anterior segment. Biomicroscopic fundus examination with noncontact 90D lens [**VOLK ®].** Images of the anterior chamber angle were obtained using the **3D OCT 2000 device [JAPAN]** [**TOPCON ®].**

AS-OCT technique: Images of the anterior segment will be obtained using The Topcon 3D OCT 2000 device. Standard resolution scans captured the temporal and nasal quadrants [nasal-temporal 0°-180°] with participants looking straight ahead. All the images will be taken with the patients in sitting position. After several scans, we will select the best image. Angle parameters included anterior chamber angle [ACA] in degrees, and, angle Opening Distance [AOD] 500. B-scan U/S was done in case of opaque media as dense vitreous hemorrhage for diagnosis and documentation of vitreous hemorrhage or RD.

Surgical technique:

Three port PPV was performed by single surgeon [M.O] under general or local [peri-bulbar or retro-bulbar] anesthesia according to patient age, fitness, history of past or present systemic diseases, history of any previous surgery and any complications, the ability of the patient to lie flat and calm all over the operation time, acceptance of the patient after counseling, presence of any communication problem.

Visualization: by using noncontact wide-angle viewing system [Binocular indirect Ophthalmic microscope system [Zeiss RESIGHT®700] held on microscope [Opmi- Lumera Zeiss ®Microscope GERMANY] with use of wide-field lens in core vitrectomy and in the periphery and the high magnification lens while dealing at the macular area. The parameters were set on the vitrectomy machine. Core vitrectomy was done using high vacuum [300-400] and low cutting rate [2500-3500] assisted by Triamcinolone Acteonid [TAAc] to visualise the vitreous. Then the peripheral vitreous was removed, using low vacuum [100-200] and high cutting rate with or without indentation by assistant. Removal of ERM in cases of PDR using different techniques as segmentation, delamination or en-block dissection according to surgical situation with the use of endodiathermy to control bleeding or mark the tear in case of RRD. Air-fluid exchange was done and subretinal fluid was removed in case of RD through retinal tear or break. Application of endolaser around the tear or PRP according to the case. The tamponade which may be Silicone oil , Air [non-expansible], was selected at the end of the case according to the case as prescence of active bleeding , prescence or absence of tears , attached or detached retina and the primary diagnosis. Suturing of sclerotomies was done to avoid post-operative hypotony. All patients were followed up at 1 week, 1 month, and three months postoperatively and AS-OCT was repeated at 3 months postoperatively.

Statistical analysis: Data analysis was performed with SPSS statistical software, version 26 [IBM, Chicago, Illinois, USA]. The normality of the data was tested by the Kolmogrov-Smirnov test. Qualitative data were presented as numbers and percentage. Quantitative data were presented as mean and standard deviations. Paired data were compared by the Freidman test, and Wilcoxon tests. As a result, the p-value was considered significant at the level of <0.05.

RESULTS

A total number of 29 patients [30 eyes as one patient was operated bilaterally] were included in the following study. The median [IQR] age of them were 50 [35 – 54] years. Twelve patients [41.37%] were males, and seventeen [58.6%] patients were females. According to patient's diagnoses, 40% were tractional retinal detachment [on top of advanced diabetic eye disease], 30% were rhegmatogenous retinal detachment and 30% were diagnosed as diabetic vitreous hemorrhage **[Table 1].**

In terms of the BCVA, we found a significant improvement at all postoperative follow up periods, which increased from 0.001 [0.001– 0.01] Decimal at the baseline to 0.01 [0.01– 0.03] at one week postoperatively and to 0.1 [0.03– 0.1] at one month and to 0.1 [0] at three months postoperatively [P = 0.001 for all] **[Table 2].**

According to the IOP changes, we noticed a significant elevation in the IOP value at one week, one month and three months postoperatively in comparison to its value at the baseline, which increased from 14.5 [13–16] mmHg at the baseline to 20.5 [18–22] mmHg at three months postoperative [P =0.001] **[Table 3].** However, some patients developed IOP elevation in the early postoperative period and managed either by medical treatment including topical and systemic antiglaucomatous medication, by laser peripheral iridotomy [in case of iris bombe], or AC wash [in case of silicone oil escape to AC] and all were controlled by conservative management.

As regards the ACA°, there was a significant difference in ACA values as follows, the Nasal ACA was decreased from 45° [38.8°– 61.7°] preoperatively to 35° [28.7°– 39.8°] 3 months postoperatively [P = 0.001]. Al so, the temporal ACA was decreased from 43.7° [38.4°–63.4°] preoperatively to 34° [30°–52.2°] at three months postoperatively [P = 0.001]. Also there was a significant difference in the AOD values [um] as follows, the nasal AOD was decreased from 455 [373–659] preoperatively to 379 [300–400] at 3 months postoperatively [P = 0.001]. Also, the temporal AOD was decreased from 433.5 [325–698] preoperatively to 387 [280–583] at 3 months postoperatively [P = 0.001] **[Table 4]**.

Examples of pre- and postoperative AS-OCT images are shown in [figures 1,2].

In this study we found no statistically significant difference between the phakic and pseudophakic patients according to their ACA° or AOD 500 allover the follow-up periods, however, the degree of ACA° and AOD [um] reduction at 3 months postoperatively was higher in the phakic than in pseudophakic patients. Also we found a statistically significant difference between preoperative and postoperative values [of ACA° and AOD 500] in silicone filled eyes but not in air filled eyes. [Table 4,5]

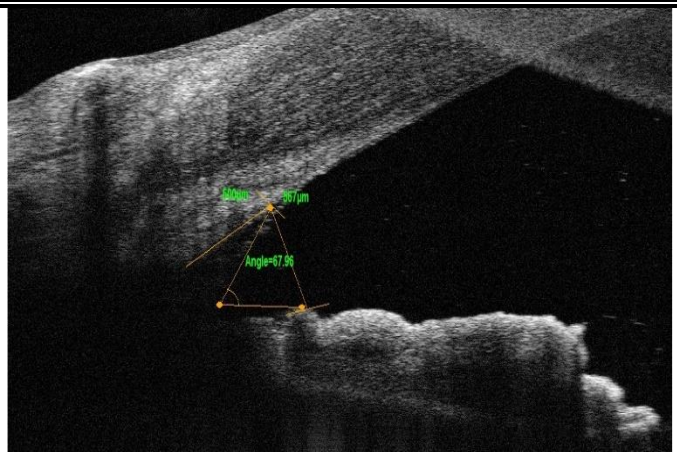

Figure [1A]: Lt nasal ACA captured by ASOCT shows ACA°= 67.69& AOD500= 567 um preoperatively

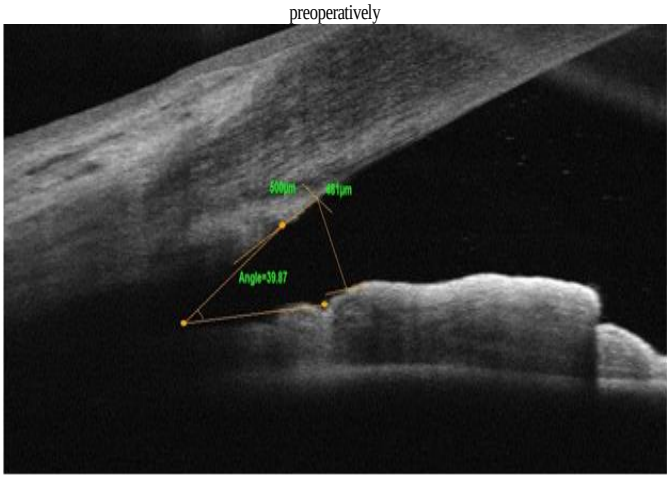

Figure [1B]: Lt nasal ACA captured by ASOCT shows ACA°= 39.78 & AOD500= 481um postoperatively.

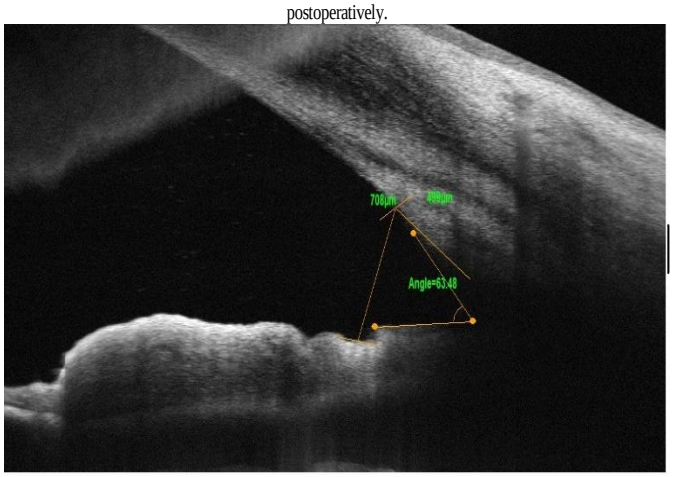

Figure [2A]: Lt temporal ACA captured by ASOCT shows ACA= 63.48 & AOD500= 708 um preoperatively.

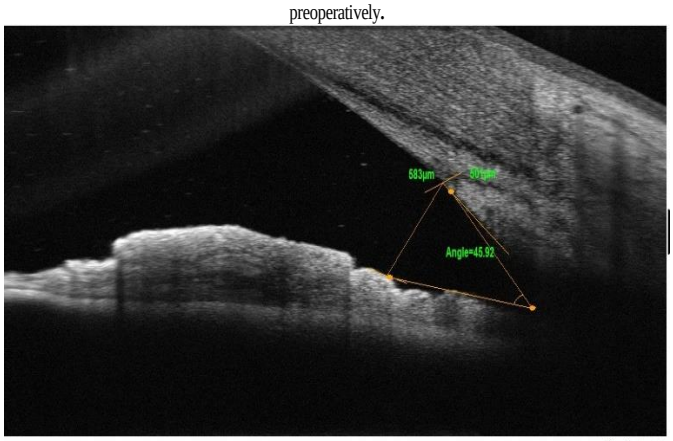

Figure [2B]: Lt temporal ACA captured by ASOCT shows ACA=45.92& AOD500= 583um postoperatively

Table [1]: Demographic and clinical data of studied patients

Variables		Median [IQR] or N [%]
Age	Median [IQR]	50 [35 – 54]
	Range	35 – 65
Gender	Male	12 [41.37%]
	Female	17 [58.6%]
Diagnosis	TRD [PDR]	12 [40%]
	RRD	9 [30%]
	Diabetic vitreous hemorrhage	9 [30%]
Tamponade	Silicone oil	27 [90%]
	Non expansile gas [air]	3 [10%]
Lens status	Phakic	23[76.6%]
	Pseudophakic	7[23.3%]

Table [2]: BCVA of studied patients

Variables	Preoperative	Post 1 week	Post 1month	Post 3 months	P value [a]	P value [b]
BCVA. [LogMar]	3 [2– 3]	2 [1– 2]	1 [1– 1.5]	1 [0]	0.001*	P1=0.001* P2=0.001* P3=0.001*
BCVA. [Decimal]	0.001 [0.001– 0.01]	0.01 [0.01– 0.03]	0.1 [0.03– 0.1]	0.1 [0]	0.001*	P1=0.001* P2=0.001* P3=0.001*

a: Freidman test. b: Wilcoxon test.

Table [3]: IOP of the studied patients.

Variables	Preoperative	Post 1 week	Post 1month	Post 3 months	P value [a]	P value [b]
IOP. [mmHg]	16 [13– 19]	23.5 [17– 30]	20 [15– 25]	19 [14-24]	0.001*	P1=0.001* P2=0.001* P3=0.001*

a: Freidman test. b: Wilcoxon test.

Table [4]: ASOCT of studied patients pre and 3 months postoperatively

Variables	Preoperative	Post 3 months	P value [a]
Nasal ACA °	45 [38.8– 61.7]	35 [28.7– 39.8]	0.001*
Nasal AOD [um]	455 [373–659]	379 [300–400]	0.001*
Temporal ACA °	43.7 [38.4–63.4]	34 [30–52.2]	0.001*
Temporal AOD [um]	433.5 [325–698]	387 [280–583]	0.001*

a: Wilcoxon test.

Table [5]: Comparison between phakic and pseudophakic patients according to their ASOCT of studied patients

	Variables	Phakic	P value [b]	PseudoPhakic	P value [b]	P value [a]
Baseline	Nasal ACA °	49.7 [39.3– 81.4]	-	38.8 [28.4–49.7]	-	0.03*
	Temporal ACA °	47.3 [38.4–78.2]	-	39.2 [29.2–47.3]	-	0.06
3 months postoperatively	Nasal ACA °	37.3 [28.4–39.7]	0.001*	32 [28.2–37.3]	0.001*	0.34
	Temporal ACA °	34.3 [30 –52.5]	0.001*	32.5 [30.2–34.7]	0.001*	0.35

a: Mann Whitney U test. b: Wilcoxon test.

DISCUSSION

In this study, we included thirty eyes of twenty-nine patients who were indicated for PPV and quantitative measurements of the ACA parameters were done using AS-OCT analysis. TIA in degrees and AOD 500 were measured in nasal and temporal quadrants [preoperatively and three months post-operatively] and there was a statistically significant difference between the measured preoperative and post-operative values. Postoperative MTIA and MAOD [500 µm] values were significantly reduced than preoperative values. This results are consistent with some studies that found significant reduction in ACA parameters. **Osman *et al.*** [11] that included 40 eyes with RRD that underwent vitrectomy and silicone oil injection. They were divided equally into two groups: Group 1 included phakic eyes and group 2 included pseudophakic eyes. Anterior segment parameters were documented by using a CSO Camera [*Costruzione Strumenti Oftalmici*] before and 1 month after surgery and they reported that there was a significant reduction in ACA and AOD 500 in phakic and pseudophakic eyes.

On the contrary, results of this study were different from some other studies that found no significant changes in ACA parameters after PPV. **Calik *et al.*** [12] studied 22 cases that underwent vitrectomy and silicone oil injection using the Pentacam Scheimpflug camera before operation, a week and a month after operation. They reported no significant difference between the pre-operative and one-month postoperative mean ACA. The main difference between Calik *et al.* and this study that they used Pentacam Scheimpflug camera while AS-OCT was used in this study, also short follow up period [1 month] in Calik study.

Ghomi and Ghassemi [13] studied seven phakic eyes that underwent PPV, with silicone oil being injected in five eyes, using UBM before and 3 months after

PPV. They reported an increase in the crystalline lens antero-posterior diameter that was explained by the development of nuclear sclerotic cataract, without significant changes in the ACD, TIA or AOD. They explained that by posterior subluxation of the lens, occurring in the supine position of patients during the postoperative UBM, resulting from zonular instability after PPV and the disruption of the hyaloid face.

In this study we found statistically significant difference between the phakic and pseudophakic patients according to their ACA and AOD 500 allover follow-up periods. This may be due to development of cataract in some eyes which increase antero-posterior lens diameter in phakic eyes. These results are consistent with those reported by **Osman *et al.*** [11] that found a more reduction in 3-month post-operative ACA and AOD 500 values in the phakic group as compared to the pseudophakic group in patients whom underwent PPV with SOI. They suggested that the crystalline lens makes the angle narrower than the IOL and makes it more liable to be closed by supraciliary effusion, iris congestion, pressure exerted by silicone oil on iris-lens diaphragm and peripheral anterior synechiae [11].

Also there was significant difference between silicone filled and air filled eyes as regarding ACA and AOD 500 being decreased in silicone filled eyes but not significantly changed in air filled eyes. This consists with results reported by **Khodabande *et al.*** [14] which included 23 patients whom underwent PPV without tamponade for epiretinal membrane. AS-OCT was done preoperatively as well as 1 and 6 months post-operatively, and they found no difference between pre-operative and post-operative [1 and 6 months] ACA and AOD 500 values.

In addition, these results consist with those reported by **Kim *et al***. [15] which studied 15 patients whom underwent PPV without temponade, AS-OCT was done pre-operatively as well as 6 months post-operatively and they reported that there was no significant difference in ACAw, AOD 500 between pre-operative and post-operative values.

In this study there was a significant elevation in IOP values at 1 week, 1 month and 3 months postoperatively in comparison to their values at the baseline. This is consistent with some studies that found a significant IOP elevation after PPV with SOI. **Jabbour *et al***. [5] which is a prospective interventional study that included 254 eyes receiving PPV with SOI. Elevated IOP developed in 48% of eyes postoperatively. The onset of IOP elevation was early [≤1 week] in 61.5% of eyes, intermediate [1–6 weeks] in 28.7%, and late [> 6 weeks] in 9.8%. **Prathapan *et al***. [16] a prospective cohort study which was performed on 46 eyes of 42 patients who underwent PPV with SOI between January 2020 and July 2021. Goldman applanation tonometry was performed preoperatively and on three postoperative visits, [day 7, day 30, and day 90] and they found that there was a statistically significant elevation in IOP at all postoperative visits.

On the contrary these results are different from clinical findings by **Fang *et al.*** [17] which reported that there was no incidence of IOP rise during one-year follow-up of patients who underwent PPV without tamponade, however, 25 cases in this study underwent PPV with SOI and this made comparison difficult.

This study had some limitations. The short follow up period [3 months] and relatively small sample size [30 eyes].

Conclusion: Despite the limitations of this study, ASOCT demonstrated that there was a significant difference between preoperative and post-operative ACA & AOD500 measurements following PPV.

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None to be disclosed.

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