Evaluation of anterior segment parameters using pentacam in silicone oil–injected patients after pars plana vitrectomy

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Background: The aim of this study is to evaluate anterior segment changes with Pentacam Scheimpflug camera after pars plana vitrectomy (PPV) and silicone oil injection. Materials and Methods: In all, 44 eyes of 44 patients who underwent PPV by one surgeon were evaluated with Pentacam preoperatively, first week, and first month after surgery. The patients were divided into two groups, eyes with silicone injection after PPV and eyes with PPV and no endotamponade. Main outcome measures were preoperative and postoperative anterior chamber volume (ACV), anterior chamber depth (ACD), anterior chamber angle (ACA), and central corneal thickness (CCT) obtained with pentacam. Results: Each group consisted of 22 patients. In both groups no significant difference was detected among preop and postop changes in ACV and ACA values (P > 0.05). The increase in ACD in silicone oil–injected group and the decrease in ACD in PPV group at postop 1 week were statistically significant (P < 0.05). The increase in CCT in silicone oil–injected group at postop 1 week and then decrease in postop 1 month were also significant (P < 0.05). Surgically induced astigmatism (SIA) was 3.7 Dioptry (D) in silicone oil–injected group and 2.4 D in PPV group at postop 1 week. SIA decreased to 1.7 D and 1.5 D, respectively, at postop 1 month. Changes in SIA were significant (P < 0.05). Conclusion: PPV effects cornea and anterior segment. Changes in cornea and anterior segment after PPV seem to return to preoperative values among 1 month after surgery.

Key words: Anterior segment parameter, pars plana vitrectomy, pentacam, silicone oil injection

Scheimpflug imaging (Pentacam) is one of the anterior segment imaging systems in clinical use today.[1] The effects of ocular surgery on the anterior segment have been better understood with the use of imaging systems.

Silicone oil can be used in patients who are not recommended for gas tamponade, who will have air travel and in children after pars plana vitrectomy (PPV).[2]

The aim of this study is to evaluate anterior segment changes with Pentacam Scheimpflug camera after PPV and silicone oil injection, compare these changes with PPV group lacking endotamponade and calculate the surgically induced astigmatism (SIA).

Materials and Methods

In all, 44 eyes of 44 patients who underwent PPV by one surgeon were included in this study. Patients were divided into two groups. Group 1 consisted of 22 patients with silicone injection after PPV, 14 men and 8 women. Group 2 consisted of 22 patients with PPV and no endotamponade, 14 men and 8 women. The mean age of the patients was 57.64 ± 12.52 years. Patients with a history of previous PPV or scleral buckle surgery, gas injection after vitrectomy, combined cataract, and vitreoretinal surgery were excluded. Also, those with corneal opacity, who uses topical or systemic medication which would affect anterior segment parameters, and patients who would not come for regular follow-up were not included.

Indications for PPV included rhegmatogenous retinal detachments; vitreous hemorrhage secondary to age-related macular degeneration; macular hole; epiretinal membrane; vitreomacular traction syndrome (VMTS); uveitis with vitreous condensation; and diabetic retinopathy with persistent vitreous hemorrhage, fibrovascular proliferation, and tractional retinal detachment involving the macula.

All patients had undergone a complete ophthalmic examination preoperatively. Systemic and ophthalmologic history of the patients, uncorrected visual acuity (UCVA), and best-corrected visual acuity (BCVA) using Snellen chart were recorded. Anterior segment and lens were examined with slit-lamp biomicroscopy. Intraocular pressure (IOP) was measured using Goldmann applanation tonometry. After examining, the fundus with a 90D lens, all pathologic retinal findings were documented. The boundaries of retinal detachment were drawn. Anterior chamber angle (ACA), optic nerve, and peripheral retina were evaluated using Goldmann’s Three Mirror Contact Lens. In patients with ocular opaque media, B-scan ultrasonography was performed. Before the surgery, anterior segment parameters were evaluated with Pentacam’s automatic release mode in which 50 Scheimpflug images could be captured in 2 s.

Pupillary dilatation was achieved by administration of cyclopentolate hydrochloride 1% and tropicamide 1% 30 min before the surgery. After retrobulbar block, periorbital skin, and ocular surface were cleaned with povidone-iodine. A standard 3-port 20-gauge PPV was performed. Posterior hyaloid membrane was removed using triamcinolone acetonide. In patients with retinal detachment, perfluorocarbon liquids were used in the drainage of subretinal fluid. Fibrous membranes were excised using microsurgical instruments. Retinal breaks and tears were treated...
with endolaser photocoagulation. In patients with proliferative diabetic retinopathy (PDR), panretinal photocoagulation (PRP) was completed. Twenty-two of the 44 patients were injected with 5000 cSt silicone oil after air–fluid exchange. After closure of sclerotomies and conjunctiva, prophylactic subconjunctival antibiotic and steroid were administered.

The patients were examined with Pentacam Scheimpflug system at 1 week and 1 month after surgery. Anterior segment parameters of Group 1 and Group 2 were compared before and after surgery. Changes in central corneal thickness (CCT), anterior chamber volume (ACV), anterior chamber depth (ACD), and anterior chamber angular width (ACAw) were evaluated. Superior, inferior, nasal, and temporal angles were recorded separately. Both groups were compared in terms of SIA. SIA with the angle of 45°-135° was accepted as “with-the-rule,” while the angle of 0°45° and 135°-180° was accepted as “against-the rule” astigmatism.

Statistical analysis
Statistical analysis was made with SPSS (Statistical Package for Social Science) (SPSS Inc., Chicago, IL, USA) version 11.5 for Windows. Chi-square and Fischer tests were used to compare the frequency and percentages between the groups. T-test and paired sample t-test were used to compare the mean values of the two groups. SIA was calculated according to Pentacam keratometry values using Vector Analysis software. The results were recorded in diopters and angles. P < 0.05 was accepted as statistically significant.

Results
In all, 44 eyes of 44 patients were included in the study. Twenty-two patients underwent PPV and silicone oil injection (Group 1), of whom 14 were male and 8 were female. Twenty-two patients underwent PPV only (Group 2), of whom 14 were male and 8 were female with a mean age of 57.64 ± 12.52 years. In Group 1, 18 patients had rhegmatogenous retinal detachment and 4 patients had PDR. In Group 2, 12 patients with PDR, 3 patients with VMTS, 3 patients with epiretinal membrane, 2 patients with vitreous hemorrhage, 1 patients with macular hole, and 1 patient with vitreous condensation associated with uveitis were indicated for surgery.

Changes in ACV
Despite an increase in the mean ACV in Group 1 at 1 week and 1 month after surgery, this change was not statistically significant. In Group 2, ACV decreased at the first week and increased again 1 month after surgery. These changes were not statistically significant. In Table 1, mean ACV of both groups before and after surgery is shown.

Comparing Group 1 and 2, rate of change in ACV at 1 week after surgery was statistically significant (P < 0.05). In Fig. 1 comparison of changes in ACV after surgery in Group 1 and 2 is shown.

Change in CCT
In Group 1, an increase in CCT at 1 week and a decrease in CCT at 1 month after surgery was statistically significant (P < 0.05). On the other hand, CCT change after surgery was not statistically significant in Group 2. Table 3 shows the mean CCT of both groups before and after surgery.

Comparing Groups 1 and 2, change in CCT after surgery was not statistically significant. In Fig. 3, changes in CCT after surgery in Group 1 and 2 are shown.

Change in ACAw
Increase in the ACAw in both groups after surgery was not statistically significant. Table 4 shows the mean ACA of both groups before and after surgery.

Although increase in ACV in Group 1 is higher compared to Group 2, it was not statistically significant. In Fig. 1 comparison of changes in ACV after surgery in Group 1 and 2 is shown.

Changes in ACD
While increase in the ACD at 1 week after surgery was not statistically significant, decrease in the ACD between 1 week and 1 month period was statistically significant (P < 0.05). In Table 2, mean ACD values of both groups before and after surgery were shown.

Comparing Group 1 and 2, rate of change in ACD at 1 week after surgery was statistically significant (P < 0.05). In Fig. 2 comparison of changes in ACD after surgery in Group 1 and 2 is shown.
Comparing Groups 1 and 2, change in ACA width after surgery was not statistically significant. Fig. 4 shows changes in ACA width after surgery in Groups 1 and 2.

Surgically induced astigmatism
Although the mean value of SIA was 3.69 ± 2.74 D 57° at 1 week after surgery in eyes with PPV and silicone oil injection, it regressed to 1.69 ± 1.82 D 50° at 1 month after surgery. In Group 1, mean change in astigmatism between the first week and the first month was statistically significant ($P < 0.05$).

While the mean value of SIA was 2.42 ± 2.04 D 85° at 1 week after surgery in eyes with PPV, it regressed to 1.53 ± 1.79 D 107° at 1 month after surgery. In Group 2, mean change in astigmatism between the first week and the first month was statistically significant ($P < 0.05$). In Table 5, the mean SIA values of both groups are shown. Fig. 5 compares changes in SIA after surgery in Groups 1 and 2.

Changes in angular width in four quadrants
Changes in angular width in superior, inferior, nasal, and temporal quadrants before and after surgery were compared. Angular changes in both groups were not statistically significant.

Intraocular pressure
IOPs of 44 patients were below 21 mmHg before the surgery and none of them had a history of glaucoma. In PPV with silicone oil injection group (Group 1), two patients had IOP levels of 30 and 40 mmHg, respectively, at 1 week after surgery. Increased IOP was found to be associated with increased ACV. These patients were initiated medical treatment for IOP control. In PPV group (Group 2), none of the IOP readings exceeded 21 mmHg at any time after surgery.

Discussion
The use of silicone oil in retinal reattachment surgery was introduced by Paul Cibis in early 1960s, based on the experimental work of Stone. Indications for silicone oil tamponade include retinal detachment complicated by severe proliferative vitreoretinopathy, severe PDR, giant retinal tears, chronic uveitis with profound hypotony, selected cases of macular hole, infectious retinitis, and vitreus hemorrhage after penetrating ocular trauma. Long-term retinal tamponade effect, supression of anterior segment neovascularization in

| Table 1: The mean ACV of Groups 1 and 2 before and after surgery |
|-----------------------------|------------------|------------------|------------------|------------------|------------------|
| ACV (mm$^3$) | Group | Before surgery | 1 week | 1 month |
|----------------|----------------|----------------|----------------|----------------|----------------|
| 1 | 162.3±57.76 | 166.27±43.95 | 165.0±35.07 | ($P>0.05$) | ($P>0.05$) |
| 2 | 150.6±37.19 | 143.8±26.95 | 156.0±43.97 | ($P>0.05$) | ($P>0.05$) |

| Table 2: The mean ACD of Groups 1 and 2 before and after surgery |
|-----------------------------|------------------|------------------|------------------|------------------|------------------|
| ACD (mm) | Group | Before surgery | 1 week | 1 month |
|----------------|----------------|----------------|----------------|----------------|----------------|
| 1 | 2.60±0.81 | 3.01±0.95 | 2.71±0.55 | ($P<0.05$) | ($P<0.05$) |
| 2 | 2.99±1.06 | 2.40±0.40 | 2.64±0.80 | ($P<0.05$) | ($P<0.05$) |

| Table 3: The mean CCT of Groups 1 and 2 before and after surgery |
|-----------------------------|------------------|------------------|------------------|------------------|------------------|
| CCT (µm) | Group | Before surgery | 1 week | 1 month |
|----------------|----------------|----------------|----------------|----------------|----------------|
| 1 | 535.6±43.51 | 561.9±48.84 | 526.8±54.27 | ($P<0.05$) | ($P<0.05$) |
| 2 | 559.9±40.49 | 563.1±50.45 | 555.1±42.18 | ($P<0.05$) | ($P<0.05$) |

| Table 4: The mean ACAw of Groups 1 and 2 before and after surgery |
|-----------------------------|------------------|------------------|------------------|------------------|------------------|
| ACA width (degrees) | Group | Before surgery | 1 week | 1 month |
|----------------|----------------|----------------|----------------|----------------|----------------|
| 1 | 35.5±10.95 | 36.6±15.59 | 36.3±8.26 | ($P<0.05$) | ($P<0.05$) |
| 2 | 33.6±8.59 | 35.0±16.18 | 34.5±11.09 | ($P<0.05$) | ($P<0.05$) |

Figure 4: Comparison of changes in ACA width after surgery in Groups 1 and 2

Figure 5: Comparison of changes in SIA after surgery in Groups 1 and 2
The influence of phacoemulsification on the IOP, ACD, and anterior chamber angle width (ACAw) has been investigated largely. Allan et al. reported that in nonglaucomatous eyes with an open iridocorneal angle (ICA) preoperatively, uneventful phacoemulsification reduced IOP, increased ACD, and widened the ICA.\(^3\)

After PPV, anterior segment changes have been rarely investigated.

Park et al. studied morphologic changes in the anterior segment in patients with PDR who had combined phacoemulsification and intraocular lens implantation with PPV (phacovitrectomy).\(^8\) Thirty patients who had phacovitrectomy and 30 patients who had PPV only were evaluated with ultrasound biomicroscopy (UBM). ACD and ACAw decreased in both groups. The decrease was more prominent after phacovitrectomy. The frequency of supraciliary effusion was higher in the phacovitrectomy group (80%) than in the PPV-only group. PPV can result in the destruction of blood-aqueous barrier and is responsible for the anatomical changes around ciliary body like supraciliary effusion. Supraciliary effusion after PPV can cause decrease in ACD and ACAw.

In our study, we compared preoperative and postoperative anterior segment changes of 22 patients who had silicone oil injection after PPV and 22 patients who had PPV only.

Preoperative ACV in silicone oil-injected eyes increased in the postoperative first week and then decreased in the postoperative first month. In the PPV only eyes, ACV decreased in first week and then increased again in the first month. The increase in ACV in silicone oil-injected eyes at the first week can be related to the cohesive power of the silicone on the posterior lens surface. Lens diaphragm is pushed back from the ciliary body by the cohesive power of the silicone on the posterior lens surface. In the PPV-only group, ACV decrease can be related to supraciliary effusion around ciliary body. As the effusion regresses, ACV increases. On biomicroscopic examination, shallow anterior chamber was not noted although ACV was decreased.

Another anterior segment parameter we compared was ACD. In one study, ACD was 2.76 mm in 24 patients whose ages were between 60 and 77.\(^7\) In our study in silicone oil-injected eyes, ACD increased in the first week and the first month. Change in the postoperative first week and first month was statistically significant (\(P < 0.05\)). ACD in the PPV-only group decreased in the first week and slightly increased in the first month. ACD changes between two groups in the first week were statistically significant (\(P < 0.05\)). ACD and ACV changes are observed to be compatible in both groups.

In a study, Pentacam, Orbscan, and ultrasound were compared for CCT measurement and reproducibility with the Pentacam was found to be the highest of all modalities.\(^9\) The increase in CCT in silicone oil-injected eyes in the first week and the decrease in the first month were statistically significant (\(P < 0.05\)). Increase in CCT can be related to corneal edema of more complicated surgery in silicone-enjected eyes. Corneal edema was documented on biomicroscopical examination in patients with increased CCT.

ACA changes in both groups were not statistically significant. Angle changes among four quadrants measured with Pentacam returned to preoperative values in the first month.

IOP increased in two patients in silicone-enjected group in the first week. ACD was evaluated with gonioscopy and grade 4 open angle and pigmentation was recorded. In some cases, open angle glaucoma with anterior chamber reaction is observed secondary to rhegmatogenous detachment.\(^9\) In these patients with Schwartz–Matsu syndrome, photoreceptor outer segments flowing from the subretinal space through the peripheral retinal break into the aqeous humor, cover the trabecular meshwork, and cause a decrease in the coefficient of outflow.\(^9\) Using silicone oil after PPV can facilitate this flow. PPV is said to decrease reaction and IOP. In our two patients, photoreceptor outer segments in the angle can be responsible for IOP increase. IOP decreased with topical medication in both.

Since visual acuity after PPV has been increasing with newer techniques, astigmatism induced by the surgery is becoming more important. Surgically induced refractive change can be calculated with vector analysis.\(^11\) Vector analysis describes the total astigmatic change, characterized by both astigmatic magnitude and direction.\(^12\)

The effect of scleral buckling surgery on corneal topography, corneal thickness, and ACD has been investigated.\(^13\) In all, 32 patients who underwent encircling buckling surgery for rhegmatogenous retinal detachment were evaluated with Orbscan II topography. Corneal thickness and astigmatism increased after surgery but the cornea almost resumed its preoperative parameters in 3 months’ time. However, it was reported that the anterior chamber remained shallow during the 3 months follow-up period.

In our study, SIA in silicone oil injected eyes was 3.69 ± 2.74 D at 57° at first week, it regressed to 1.69 ± 1.82 D at 50° at the first month. This change between the first week and first month was statistically significant (\(P < 0.05\)). At first month, we found astigmatic change of 1.7 D with the rule.

In the PPV-only group, SIA was 2.42 ± 2.04 D at 85° at the first week and 1.53 ± 1.79 D at 107° at the first month. This

| Table 5: The mean SIA in Groups 1 and 2 after surgery |
|----------------------------------------------|----------------|
| **Group** | **After surgery** |
|  | 1 week | 1 month |
| 1 | 3.69±2.74 D/57° | 1.69±1.82 D/50° |
| 2 | 2.42±2.04 D/85° | 1.53±1.79 D/107° |
change was also statistically significant ($P < 0.05$). Astigmatic change was 1.5 D with the rule.

Wirbalauer et al. investigated corneal shape changes in 36 patients after PPV. The mean SIA was $2.92 \pm 1.98$ D ($P < 0.0001$) during the first postoperative week. After 4 weeks and 4 months, they reported that the values decreased to $1.01 \pm 0.97$ D and $0.67 \pm 0.43$ D, respectively. In subgroup analysis, suture diameter and the use of gas endotamponade were found to influence the induced astigmatism, and stabilization at preoperative values was observed after several weeks.

Slusher et al. studied 135 patients who had PPV, 7 patients had persisting astigmatism over 3-4 months. The average astigmatism in these seven eyes was 4.5 D. Five of these patients had repeated PPV through the same sclerotomies. They reported that astigmatism can be a wound-related complication of PPV.

The SIA in our two groups at the first week can be related to sclerotomy sizes, cauteryization of sclerotomies, or too tight sutures at the sclerotomy sides. As the wound healing process goes on, sutures are absorbed, astigmatism with the rule regresses at the first month. More astigmatism in the silicone-injected group may be a result of more tight sutures to prevent silicone leak. As the sutures were absorbed in both groups, astigmatism had decreased.

As the sclerotomy size decreases, astigmatism tends to be less. Yanyali et al. evaluated corneal topographic changes after PPV with 25-gauge transconjunctival sutureless vitrectomy (TSV) system. They reported no significant change in average corneal power, corneal surface cylinder, surface asymmetry index, and surface regularity index parameters at the first day, the first week, and the first month after the operation.

In conclusion, like in other surgeries, PPV has effects both on cornea and anterior chamber. Since silicone oil-injected eyes are more complicated, changes after the surgery are more prominent. But these changes after PPV come closer to preoperative values at the first month. In 1 month after PPV with or without silicone oil, anterior segment changes become less significant.

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