

# Intraocular Pressure Changes After Pars Plana Vitrectomy for Rhegmatogenous Retinal Detachment

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## ABSTRACT

**Purpose:** The aim of this study was to describe intraocular pressure (IOP) changes after pars plana vitrectomy (PPV) for the management of rhegmatogenous retinal detachment (RRD) and factors influencing IOP.

**Materials and methods:** Fifty-eight eyes of 58 patients (34 male, 24 female, mean age: 58,7 ±13,5 years) who underwent PPV for RRD were retrospectively studied. IOP values of the operated eyes and fellow eyes were compared at the postoperative 1<sup>st</sup> week, 1<sup>st</sup>, 3<sup>rd</sup> and 6<sup>th</sup> months. The need for glaucoma medications was further recorded at each time point.

**Results:** LogMAR best corrected visual acuity (BCVA) improved significantly after PPV ( $p<0.001$ ). There was no significant difference in postoperative IOP between the operated eyes and fellow eyes ( $p=0.54$ ). However, the number of glaucoma medications was significantly higher in the operated eyes at the final visit ( $p<0.001$ ) and the maximum number of glaucoma medications needed during the follow-up was also significantly higher in the operated eyes ( $p<0.001$ ). The number of eyes needing glaucoma medications was significantly higher in the operated eyes (36%) compared to fellow eyes (3.4%) ( $p<0.001$ ). There was not any difference in the mean age of the patients who needed glaucoma medications treatment and who did not ( $p=0.74$ ).

**Conclusion:** We observed that the need for glaucoma medications increased significantly after PPV for RRD. Contrary to the previous reports, this increase in the risk of ocular hypertension was not influenced by patient age.

**Keywords:** Retinal detachment, Intraocular pressure, Glaucoma, Pars plana vitrectomy.

Primary rhegmatogenous retinal detachment is separation of sensory retina from retinal pigment epithelium due to a retinal tear and subsequent accumulation of subretinal fluid under the detached sensorineural retina.<sup>1</sup> If retinal detachment is observed without proliferative vitreoretinopathy (PVR), this condition is defined as a non-complicated retinal detachment.<sup>2</sup> These cases can be treated by pneumatic retinopexy, scleral buckling or pars plana vitrectomy (PPV). Complicated cases with PVR usually almost always require a PPV surgery with or without scleral buckling.

Pneumatic retinopexy is a simple technique, but it is applicable only for a limited number of cases.<sup>3</sup> Scleral buckling is a good alternative for the management of these cases. It also has its unique complications including retinal incarceration, iatrogenic retinal tears, exposure of

encircling bands, refractive changes and ocular motility problems.<sup>4</sup> With the developments in the technology of vitrectomy systems, vitrectomy is increasingly preferred for the management of retinal detachment cases. The improvements in the instrumentation and surgical experience with PPV reduced surgical complications. However, even after very successful PPV surgery, still the risk of cataract formation increases significantly as the most common complication of this procedure.<sup>5</sup> The second most common complication of this procedure is intraocular pressure elevation. However, the rate of this complication changes according to different ocular pathologies necessitating PPV.<sup>6</sup> Development of ocular hypertension (OHT) was reported around 7 to 48% of the cases after PPV.<sup>7</sup> Transient rise in IOP in the early postoperative period can develop due to many conditions such as remaining

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ocular viscosurgical device (OVD) remnants in the anterior chamber, inflammation, hemorrhage, or steroid use.<sup>8</sup> This acute transient elevation of IOP can usually be controlled medically and does not cause a long term problem when managed properly. However, late-onset IOP elevations can also develop after PPV, probably due to an oxidative damage on the trabecular meshwork.<sup>9</sup> The aim of this study was to document IOP changes in patients with RRD after PPV and reveal clinical characteristics of these changes.

## MATERIAL AND METHODS

The records of fifty-eight eyes of 58 patients with RRD, who underwent PPV between 2016 and 2018, were retrospectively studied. The study was approved by the local institutional review board and ethics committee. The operations were performed under subtenon anesthesia (lidocaine 2% and bupivacaine 0.75%) or general anesthesia. During combined procedures, phacoemulsification was performed through a clear corneal incision and a foldable hydrophobic acrylic intraocular lens was implanted. After placement of 23G scleral trocars 3.5-4 mm away from the corneoscleral limbus, core vitrectomy was performed. Triamcinolone acetonide was used for the visualization of vitreous. Perfluorocarbon liquid was used to relocate and stabilize the detached retina. Retinal tears were treated with endolaser photocoagulation and prophylactic 360 degree photocoagulation was performed in all cases. Retinectomies or retinotomies were performed to reattach the retina, whenever the retina could not be relocated due to retinal structural damage. Silicone oil (1000 cst) or perfluoropropane gas (C3F8) was used for internal tamponade. The head positioning of patients were adjusted according to the location of the retinal tear. Topical steroids and antibiotic drops were routinely used after the surgery, then tapered over a month.

All of the patients had a detailed ophthalmologic examination including evaluation of BCVA, slit-lamp examination, IOP measurement with Goldmann applanation tonometry, and retinal examination with indirect ophthalmoscopy. The findings of the last retinal surgery were selected for the analysis if the patient needed multiple retinal surgeries.

If the postoperative IOP was above 24 mmHg or 10 mmHg higher from the preoperative IOP, the patient was considered as an OHT case. Medical treatment was preferred for the initial management of OHT. BCVA was evaluated with a Snellen chart at 6m and converted to LogMAR (logarithm of minimal angle of resolution) for statistical analysis.

The statistical analysis was performed with SPSS 22.0

software. The distribution of data was evaluated with Kolmogorov-Smirnov test. Preoperative and postoperative IOP values were compared with paired samples T test and Wilcoxon test. Subgroup analyses were performed with Mann Whitney test. The distribution of categorical data was compared with Chi square test. The statistical power was calculated with G\*Power 3.1 software. In a posthoc power analysis for the change in the numbers of needed glaucoma medications, we have calculated that the effect size of our sample was 0.936 and the required sample size was 15 for a statistical power of 0.90 and  $\alpha$  value of 0.05.

## RESULTS

Fifty-eight patients were included in the study. Thirty-four patients (58.6%) were male, 24 patients (41.4%) were female and the mean age of the patients was  $58,7 \pm 13,5$  years. LogMAR best corrected visual acuity (BCVA) improved significantly after PPV ( $1.86 \pm 0.83$  vs.  $0.65 \pm 0.44$ ,  $p < 0.001$ ). In 34 (58.6%) eyes only PPV was performed, while combined surgery (phacoemulsification cataract surgery and PPV) was needed in 24 (41.4%) eyes. Silicone oil tamponade preferred in 49 eyes (84.5%) and C3F8 tamponade was preferred in 9 eyes (15.5%). Silicone oil was removed within 6 months after PPV in 29 eyes (59.2%), and silicone oil tamponade was kept within the eye for more than 6 months in 20 eyes (40.8%).

Intraocular pressure levels were not significantly different between the operated eyes and the fellow eye at postoperative 1<sup>st</sup> week, postoperative 1<sup>st</sup> month, 3<sup>rd</sup> month and 6<sup>th</sup> month (Table 1). However, the number of glaucoma medications was significantly increased after PPV compared to the fellow eye at the last visit and the maximal number of glaucoma medications during the postoperative period was also significantly higher in the operated eyes (Table 1). The need for glaucoma medications (36%) was significantly more in the operated eyes compared to the fellow eyes (3.4%) at the 6<sup>th</sup> month visit ( $P < 0.001$ ). Intraocular pressure levels were slightly increased in postoperative 1<sup>st</sup> month but long term IOP levels were similar between the PPV only and combined surgery groups (Table 2). The maximum number of glaucoma medications needed during the follow-up was slightly higher in the PPV only group, but the need for glaucoma medications became similar between the PPV only and combined surgery groups at the final postoperative visit (Table 2). We have also compared the mean age of the patients ( $57.0 \pm 12.7$  years) who needed glaucoma medications ( $56.9 \pm 14.6$  years) and who did not, but there was no statistically significant difference ( $p = 0.75$ ).

**Table 1.** Intraocular pressure changes and the number of glaucoma medications needed in the operated eyes and fellow eyes.

|  | Operated eye (n=58) | Fellow eye (n=58)  | P*     |
|--|---------------------|--------------------|--------|
| Postop 1 <sup>st</sup> week IOP (mmHg, IQR)  | 13.0 (9.0-15.0)     | 14.0 (11.75-16.25) | 0.93   |
| Postop 1 <sup>st</sup> month IOP (mmHg, IQR) | 14.0 (12.0-18.0)    | 14.0 (12.0-16.0)   | 0.44   |
| Postop 3 <sup>rd</sup> month IOP (mmHg, IQR) | 14.0 (11.0-17.0)    | 14.5 (12.0-17.75)  | 0.29   |
| Postop 6 <sup>th</sup> month IOP (mmHg, IQR) | 15.0 (12.0-17.5)    | 14.0 (12.0-16.0)   | 0.54   |
| Preop number of glaucoma medications (IQR)   | 0.0 (0.0-0.0)       | 0.15 ±0.11         | 0.31   |
| Final number of glaucoma medications (IQR)   | 1.0 (0.0-3.0)       | 0.15 ±0.11         | <0.001 |
| Maximum number of glaucoma medications (IQR) | 3.0 (0.0-3.0)       | 0.15 ±0.11         | 0.001  |

**IQR:** interquartile range, preop: preoperative, postop: postoperative, **IOP;** intraocular pressure, \*Wilcoxon test

**Table 2.** Intraocular pressure changes and the number of glaucoma medications needed in patients who had pars plana vitrectomy alone and combined surgery.

|  | PPV only (n=26)   | Combined surgery (n=32) | P*    |
|--|-------------------|-------------------------|-------|
| Median age (years, IQR)                      | 63.0 (48.75-69.5) | 58.0 (49.0-67.0)        | 0.58  |
| Postop 1 <sup>st</sup> week IOP (mmHg, IQR)  | 14.0 (10.5-16.5)  | 12.0 (9.0-14.25)        | 0.31  |
| Postop 1 <sup>st</sup> month IOP (mmHg, IQR) | 16.0 (13.0-20.50) | 12.0 (10.0-16.0)        | 0.007 |
| Postop 3 <sup>rd</sup> month IOP (mmHg, IQR) | 15.0 (12.0-18.0)  | 13.0 (11.0-16.75)       | 0.15  |
| Postop 6 <sup>th</sup> month IOP (mmHg, IQR) | 16.0 (12.75-19.0) | 14.5 (12.0-15.75)       | 0.21  |
| Preop number of glaucoma medications (IQR)   | 0.00 (0.00-0.00)  | 0.00 (0.00-0.00)        | 0.61  |
| Final number of glaucoma medications (IQR)   | 2.0 (0.0-3.0)     | 0.0 (0.0-2.0)           | 0.12  |
| Maximum number of glaucoma medications (IQR) | 3.00 (3.00-4.00)  | 1.0 (0.0-3.0)           | 0.04  |

**IQR:** interquartile range, preop: preoperative, postop: postoperative, **IOP;** intraocular pressure, \*Mann-Whitney test

## DISCUSSION

Early acute postoperative elevation of IOP after PPV was previously reported due to many factors including postoperative inflammation, vitreous hemorrhage, hyphema, remaining OVD remnants etc.<sup>8</sup> We have also observed a transient rise in IOP following PPV that could be controlled with topical glaucoma medications. We found that the need for glaucoma medications was significantly higher in the operated eyes. But the mean IOP levels remained unchanged after PPV in the operated eyes due to strict medical control of IOP. We have also observed that IOP levels and the number of glaucoma medications were higher at the early postoperative period and decreased gradually until the 6<sup>th</sup> month.

There is conflicting data in the literature regarding IOP changes after PPV. While some studies report an increase in OHT, some others report no significant changes in IOP levels.<sup>5, 9-15</sup> The main contributing factor is probably the underlying etiology necessitating PPV and the amount of vitrectomy performed. Other studies performed with

RRD patients also reported an increase at the incidence of ocular hypertension in the operated eyes.<sup>11, 12, 16</sup> Chang et al. reported that patients who underwent PPV had a higher risk of open angle glaucoma development and they interpreted this outcome was due to a damage to the trabecular meshwork inflicted by increased oxidative stress in the anterior chamber.<sup>9</sup> Luk et al, also reported similar results after PPV.<sup>13</sup> In contrary, the studies that report PPV outcome of patients with epiretinal membranes, macular hole, or vitreous hemorrhage did not find an increase in IOP after PPV compared to the fellow eyes.<sup>5, 15</sup>

Yu et al. compared pseudophakic and phakic eyes that underwent PPV for various retinal diseases and did not find any significant difference in IOP levels of the pseudophakic and phakic eyes.<sup>5</sup> Only around 25% the patients had RRD in that study and probably this scarcity of RRD patients in the study population was the reason why they did not observe an increase in IOP after PPV. Retrolental vitreous is an important ocular barrier that limits the passage of the oxygen and tamponade materials to the anterior chamber and lens; therefore, its removal has

the potential to cause open angle glaucoma and cataract formation.<sup>16</sup> Chang et al. compared the timing of OAG development after PPV alone and combined surgery in phakic eyes. The timing of glaucoma development was only related with the timing of cataract surgery, as the time period until glaucoma development was the same after the cataract surgery of the patient (either with combined surgery or phacoemulsification alone in a separate session after PPV). Therefore, they concluded that the absence of the lens was an important contributing factor for the glaucoma development in vitrectomized eyes.<sup>9</sup>

Chang et al. also observed that OAG developed earlier after PPV in pseudophakic patients compared to the phakic patients. They suggested that the excess oxygen coming from the vitreous cavity after PPV might be metabolized by the lens fibrils, which would limit the access of oxygen radicals to the trabecular meshwork.<sup>9</sup> Luk et al. reported that the development of OAG after PPV was higher in pseudophakic patients compared to phakic patients. They have further suggested that this was additionally influenced by the differences in patient age, since the pseudophakic patients were older and glaucoma prevalence is also increases by age.<sup>13</sup> In our study all of our patients were pseudophakic after the PPV and we did not observe a significant difference between the ages of the patients who developed OHT and who did not. Therefore, we believe that pseudophakia is a more important risk factor in the development of glaucoma after PPV, rather than patient age. Yu et al. also compared phakic and pseudophakic vitrectomized eyes with non-operated fellow eyes. They have observed that IOP did not change significantly after PPV in both phakic and pseudophakic eyes. Therefore they concluded that crystalline lens was not protective for OHT.<sup>5</sup> However, RRD cases in this study constituted around a quarter of the cases and they didn't analyze RRD cases separately. Therefore, these results are also controversial.

In the current study, we did not find any significant difference between the IOP levels and the number of glaucoma medications between the PPV alone and combined surgery groups. However, all of the patients in PPV only group were pseudophakic in our study. Therefore, we were unable to evaluate the influence of the absence of crystalline lens. However, our study demonstrated for the first time that the inflammation induced by cataract surgery did not influenced glaucoma development in these eyes. Our preference is not to abstain from removing the lens at the same session with PPV, when shaving of the vitreous basis could not be completed due to the fear of lenticular

touch. Another advantage of this approach is saving the patient from the stress of another surgery, since it is almost always certain that the rate of cataract development will increase after PPV.

Vitreous base shaving is very important for the long term success of retinal detachment surgery and is extensively performed in cases with RRD. However, this is not needed in patients with other pathologies such as epiretinal membrane, macular hole, or noncomplicated vitreous hemorrhage. Among the above mentioned studies, the ones that reported higher glaucoma rates also had more RRD cases, while it is the opposite in reports describing cases that predominantly have patients with other pathologies such as epiretinal membrane, macular hole, or vitreous hemorrhage.<sup>5,9,13</sup> Probably, the absence of peripheral vitreous allows easier diffusion of oxygen from the vitreous cavity to the anterior chamber and contributes to the above-mentioned damage to the trabecular meshwork. Therefore, PPV patients who had an extensive vitreous base shaving need a closer follow-up for glaucoma development to prevent glaucomatous optic neuropathy.

This work has some limitations. As mentioned above, all of the patients in this study were either pseudophakic or had a combined surgery. Therefore, we could not evaluate the influence of the absence of crystalline lens on postoperative IOP changes. However, this limitation also allowed us to evaluate whether the surgical stress inflicted during phacoemulsification had an influence on IOP. Another limitation of this work was its retrospective design. Our patient number did not allow us to perform extensive subgroups analyses. Prospective studies with larger study populations can have the potential to provide more data in future work.

## CONCLUSIONS

This study confirmed that the incidence of ocular hypertension increases after PPV for RRD. We have demonstrated for the first time that the long term IOP changes were not affected by the surgical stress inflicted during combined procedures compared to PPV alone and the mean age of the patients was not a risk factor for IOP rise. This work confirms the hypotheses that the absence of peripheral vitreous and crystalline lens are the main risk factors that affect the risk of IOP elevation after PPV. Therefore, it is important to follow patients that needed extensive vitreous base shaving during PPV for glaucoma development in order to prevent optic disc damage.

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