Polskie Towarzystwo Okulistyczne
www.pto.com.pl

KLINIKA OCZNA 2023, 125, 3: 163-166
Received: 15.06.2022 Accepted: 11.08.2022

ORIGINAL ARTICLE

Access this article online

Website:
www.klinikaoczna.pl

DOI:
https://doi.org/10.5114/ko.2023.124697

Lens opacities after pars plana vitrectomy with intraocular SF6 gas tamponade

Aleksandra Górska[1], Sebastian Sirek[1,2], Irmina Jastrzębska-Miazga[1], Piotr Gorostowicz[1], Rafał Leszczyński[1], Ewa Mrukwa-Kominek[1,2]

[1]Department of Adult Ophthalmology, Prof. K. Gibiński University Clinical Center, Medical University of Silesia, Katowice, Poland
[2]Department of Ophthalmology, Medical University of Silesia, Katowice, Poland

ABSTRACT

Aim of the study: To analyse development and progression of cataracts after pars plana vitrectomy (PPV) with intraocular SF6 gas tamponade.

Material and methods: For this study, the authors analysed the data of 19 patients who underwent PPV with intraocular SF6 gas tamponade prior to cataract phacoemulsification.

Results: In the group of 19 patients (19 eyes; 12 women and 7 men; mean age 65 ±8.4 years) average time between PPV with intraocular SF6 gas tamponade and cataract phacoemulsification was estimated as 267 days (9 months). Average visual acuity a month after vitrectomy was 0.2. Average visual acuity at the time of qualification for cataract surgery was 0.08. The multiple linear regression model showed that time to cataract surgery was associated with visual acuity a month after vitrectomy ($p = 0.006$).

Conclusions: The development and progression of nuclear cataracts may be influenced by many factors such as the process of lens oxidation, the use of infusion fluids, light toxicity, duration of vitrectomy or the type of endotamponade. The key to preventing cataract formation after vitrectomy is still elusive.

KEY WORDS: vitrectomy, nuclear cataracts, lens oxidation.

INTRODUCTION

Pars plana vitrectomy (PPV) allows the treatment of many vitreous, retina or choroid disorders. Over time PPV has become widely used in the treatment of many eye pathologies such as vitreous haemorrhage, macular hole, epiretinal membrane and vitreomacular traction syndrome.

However, due to the many potential complications, close monitoring of the patient's condition is required during the early and late postoperative period. Those complications may include e.g. endophthalmitis, increased intraocular pressure, retinal detachment, maculopathy and cataract. The development of a nuclear cataract or its progression is considered to be the most common late complication of vitrectomy. The exact pathogenesis of cataract formation or opacity progression following vitrectomy is unknown. Previous research suggests that underlying reasons might include light toxicity, excessive oxygenation of lens proteins, gas endotamponade and prolonged time of surgery [1-4]. Many studies suggest that PPV may contribute to increased intraocular oxygen pressure and that oxygen exposure leads to progressive cataract formation [5, 6].

MATERIAL AND METHODS

This study included 19 patients (12 women and 7 men; mean age 65 ±8.4 years) who underwent PPV with intraocular SF6 gas tamponade before cataract phacoemulsification. Operations were performed at the Department of Ophthalmology, the University Clinical Center Medical University of Silesia in Katowice, during the period between January 1st, 2018 and December 31st, 2021. Demographic details and clinical outcome data were retrospectively collected in our department's database. All patients underwent a complete ophthalmological examination, including best corrected visual acuity (BCVA), intraocular pressure measurement, anterior segment examination with slit lamp biomicroscopy, and dilated fundoscopy. Visual acuity was measured by Snellen chart. All surgical procedures were performed using a standard local anaesthesia protocol.

Statistical analysis

Continuous variables with normal distribution were presented as the mean ± standard deviation, and those with non-normal distribution were presented as the median as

CORRESPONDING AUTHOR
Aleksandra Górska, MD, Department of Adult Ophthalmology, Prof. K. Gibiński University Clinical Center, Medical University of Silesia, 35 Ceglana St., 40-514 Katowice, Poland, e-mail: aleksandra.m.gorska@gmail.com

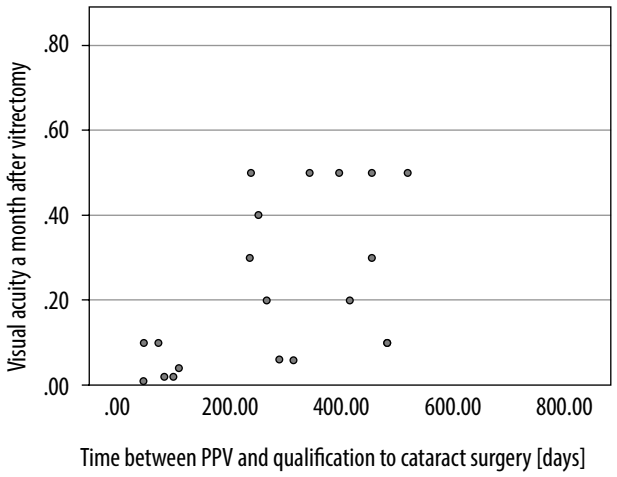

Figure 1. Linear regression model shows the relationship between visual acuity a month after vitrectomy and time between PPV and qualification for cataract surgery

well as lower and upper quartiles. Categorical variables were reported as counts and percentages. The *p*-value under 0.05 was considered statistically significant in all the statistical tests. The data were analysed using IBM SPSS Statistics version 22.

RESULTS

In the group of 19 patients (19 eyes), the average time between PPV with intraocular SF6 gas tamponade and cataract phacoemulsification was 267 days (9 months) ±161 days. The indication for the procedure was a retinal detachment in 7 cases, epiretinal membrane in 4, macular hole in 4, vitreous haemorrhage in 3 and vitreoretinal traction in 1 patient.

The average visual acuity was as follows: 0.2 a month after vitrectomy (VA1), 0.08 at the time of qualification for cataract surgery (VA2) and 0.3 after cataract surgery (VA3).

Qualification time for cataract surgery did not depend on age and visual acuity at qualification for cataract surgery ($p > 0.05$). A multiple linear regression model demonstrated that time to cataract surgery was associated with VA1 ($p = 0.006$) (Figure 1). Therefore, the better VA1 was, the longer it took to qualify for phacoemulsification.

DISCUSSION

Nuclear cataract arises due to increased rigidity of nuclear lens cytoplasm. However, the exact mechanism is still unknown. Lens transparency is possible due to a very high concentration of proteins. To protect those proteins from oxidation, oxide reducing substances – such as glutathione and ascorbate – are meant to lower oxygen levels in the surrounding environment [7, 8]. Therefore, the intraocular oxygen level is usually low and strictly regulated. Most of the eye's oxygen metabolism takes place in the retina and molecular oxygen diffuses to the vitreous from the retinal vascular system where a significant part of it is used in reaction with ascorbic acid [7, 9]. This process results in a reduced oxygen gradient from the vitreous to the lens [8, 10]. Oxygen consumption guarantees maintenance of low oxygen levels in the lens environment, which is believed to be an important factor in maintaining lens transparency. Oxygen supply to the avascular lens is provided by retinal diffusion. Increased oxygen concentration in the vitreous leads to increased oxygen concentration in the lens, which can play a significant role in nuclear cataract formation [11]. When age-related vitreous humour liquefaction or surgical vitreous removal occurs, liquefied vitreous humour may circulate, providing more oxygen to the lens [12]. Holekamp *et al.* observed an increased oxygen level in the lens after PPV, which is believed to be the factor responsible for nuclear cataract formation.

Cataract progression is more frequent in older patients. When a nuclear cataract occurs naturally it is usually bilateral, in contrast to unilateral post-operative lens opacification.

In their control trial, Cheng et al. observed the frequency of cataract development after PPV in the case of 74 eyes [13]. Six months after surgery cataract was diagnosed in 81% of eyes which underwent PPV compared to only 18% of eyes in the control group. In two years after PPV surgery cataract progression was observed in 100% of eyes after vitrectomy and only in 8% of eyes in the control group. This study shows that PPV needs to be recognized as a risk factor of cataract development and progression. Similar conclusions are also presented in our study showing the progression of cataracts in the eye after PPV with SF6 endotamponade.

A similar analysis was performed by Cherfan *et al.*, who retrospectively examined 100 eyes after PPV due to epiretinal membrane. After a mean time of 29 months (from 5 to 99 months) clinically significant nuclear cataract was observed in 80% of eyes in the post-operative group and only in 24% of eyes in the control group [2].

Phacoemulsification and implantation of an artificial intraocular lens are often recommended for people with visible lens opacity. The authors point out that the lens nucleus is stiffer in patients after PPV than in those with age-related cataracts, therefore requiring longer surgery. Additionally, the lack of a vitreous body in the posterior segment caused by the PPV affects the larger mobility of the posterior capsule, increasing the risk of its rupture. Therefore, cataract surgery after PPV may be fraught with a higher incidence of complications, although there is a lack of comparative research on that topic [14]. Compared with eyes without prior PPV there is a worse mean postoperative vision acuity, a higher rate of zonular dialysis and dropped nuclear fragments [15].

It was proved that "face-down positioning" practised by patients after PPV with SF6 tamponade can significantly reduce development of post-operative cataract [16].

Frequency of lens opacification after PPV with gas-fluid exchange also depends on the patient's age – in patients younger than 50 years PPV is minimally cataractogenic [17]. Furthermore, the rate of increase in nuclear sclerotic cataract in patients older than 50 years old is significantly greater than in patients younger than 50 years old [18].

Even though the most probable cause for nuclear cataracts is oxidative stress, there are many hypotheses concerning

the pathomechanisms of lens opacification due to PPV. Cataract progression might also be caused by multiple factors such as light toxicity, use of infusion fluids, prolonged surgery, type of used endotamponades and size of systems used to perform the surgery [2, 3, 19-21].

Eyes without intraocular gas tamponade had a statistically significantly lower rate of nuclear sclerosis progression compared to eyes with gas bubbles [18]. Also oil endotamponade is an important risk factor of cataract development [22].

Lens touch, which is a frequent PPV complication, is not associated with increased lens opacification although it significantly increases the risk of posterior capsule rupture [23].

In the Vitrectomy for Macular Hole Study it was found that duration of vitrectomy does not increase the risk of cataract progression [13].

The time intervals between PPV and cataract extraction is longer in surgeons with > 20 practice years [24].

The available literature provides evidence for cataract progression in eyes treated with gas tamponade [25, 26]. In the case of SF6 endotamponade, nuclear sclerosis was found 0.6 times more often than in the case of no gas use. According to Hsuan *et al.*, nuclear cataract was found in 67% of SF6 tamponade cases and 30% of non-tamponade cases [25]. Similarly, Van Effenterre *et al*. reported nuclear opacity in 63% of gas-filled eyes [27]. Another study found that after PPV with gas tamponade, the nucleus of the lens density increased almost 24-fold compared to the baseline value [28].

Cataract formation is one of the most common complications after vitrectomy, with increased oxidative stress as the most probable cause. Oxygen in the avascular lens is provided by diffusion, meaning that the surrounding oxygen content is crucial for the oxygen content within the lens and thus for the formation of reactive oxygen species. Knowledge of the different cataract types, their frequency and causes may help to develop strategies to prevent this complication. Despite those facts, the key to prevent cataract progression after PPV is still unknown. There is a great need to conduct randomized, controlled studies in order to evaluate the advantages, disadvantages and potential risk of cataract extraction after PPV [22].

CONCLUSIONS

The development and progression of nuclear cataracts may be influenced by many factors such as the process of lens oxidation, the use of infusion fluids, light toxicity, duration of vitrectomy or the type of endotamponade. The key factor to preventing cataract formation after vitrectomy is still elusive; therefore more research on this subject is required.

DISCLOSURE

The authors declare no conflict of interest.

References

1. Do DV, Vedula SS, Hawkins BS. Surgery for post-vitrectomy cataract. Cochrane Database Syst Rev 2013; 2: CD006366.
2. Cherfan GM, Michels RG, de Bustros S, et al. Nuclear sclerotic cataract after vitrectomy for idiopathic epiretinal membranes causing macular pucker. Am J Ophthalmol 1991; 111: 434-438.
3. de Bustros S, Thompson JT, Michels RG, et al. Nuclear sclerosis after vitrectomy for idiopathic epiretinal membrane. Am J Ophthalmol 1988; 105: 160-164.
4. Ogura Y, Takanashi T, Ishigooka H, Ogino N. Quantitative analysis of lens changes after vitrectoy by fluorophotometry. Am J Ophthalmol 1991; 111: 179-183.
5. Holekamp NM, Shui YB, Beebe DC. Vitrectomy surgery increases oxygen exposure to the lens: a possible mechanism for nuclear cataract formation. Am J Ophthalmol 2005; 139: 302-310.
6. Palmquist BM, Philipson B, Fagerholm P. Nuclear cataract – a microradiographic study. Acta Ophthalmologica 1988; 66: 671-677.
7. Keyal K, Liao X, Liu G, et al. Post-vitrectomy cataract acceleration in phakic eyes: a review. Discov Med 2017; 24: 305-311.
8. Beebe DC, Holekamp NM, Siegfried C, Shui YB. Vitreoretinal influences on lens function and cataract. Philosophical Transactions of the Royal Society of London. Series B, Biological Sci 2011; 366: 1293-1300.
9. Alder VA, Niemeyer G, Cringle SJ, Brown MJ. Vitreal oxygen tension gradients in the isolated perfused cat eye. Curr Eye Res 1986; 5: 249-256.
10. Shui YB, Holekamp NM, Kramer BC, et al. The gel state of the vitreous and ascorbate-dependent oxygen consumption: relationship to the etiology of nuclear cataracts. Arch Ophthalmol 2009 (Chicago, Ill. 1960); 127: 475-482.
11. Eaton JW. Is the lens canned? Free Radic Biol Med 1991; 11: 207-213.
12. Harocopos GJ, Shui YB, Mckinnon M, et al. Importance of vitreous liquefaction in age-related cataract. Invest Ophthalmol Vis Sci 2004; 45: 77-85.
13. Cheng L, Azen SP, El-Bradey MH, et al. Duration of vitrectomy and postoperative cataract in the vitrectomy for macular hole study. Am J Ophthalmol 2001; 132: 881-887.
14. Ahfat FG, Yuen CHW, Groenewald CP. Phacoemulsification and intraocular lens implantation following pars plana vitrectomy: a prospective study. Eye (Lond) 2003; 17: 16-20.
15. Soliman MK, Hardin JS, Jawed F, et al. A Database Study of Visual Outcomes and Intraoperative Complications of Postvitrectomy Cataract Surgery. Ophthalmology 2018; 125: 1683-1691.
16. Schaefer H, Al Dwairi R, Singh P, et al. Can Postoperative Accelerated Lens Opacification be Limited by Lying in „Face-Down Position" after Vitrectomy with Gas as Tamponade? Klin Monbl Augenheilkd 2015; 232: 966-975.
17. Melberg NS, Thomas MA. Nuclear sclerotic cataract after vitrectomy in patients younger than 50 years of age. Ophthalmology 1995; 102: 1466-1471.
18. Thompson JT. The role of patient age and intraocular gases in cataract progression following vitrectomy for macular holes and epiretinal membranes. Trans Am Ophthalmol Soc 2003; 101: 485-498.

19. Edelhauser HF, Gonnering R, van Horn DL. Intraocular irrigating solutions. A comparative study of BSS Plus and lactated Ringer's solution. Arch Ophthalmol 1978 (Chicago, Ill. 1960); 96: 516-520.
20. Sawa M, Saito Y, Hayashi A, et al. Assessment of nuclear sclerosis after nonvitrectomizing vitreous surgery. Am Journal Ophthalmol 2000; 132: 356-362.
21. Mitchell RL. Catalase photoinactivation [report]. Science 1965; 150: 74.
22. Federman JL, Schubert HD. Complications associated with the use of silicone oil in 150 eyes after retina-vitreous surgery. Ophthalmology 1988; 95: 870-876.
23. Elhousseini Z, Lee E, Williamson TH. Incidence of lent touch during pars plana vitrectomy and outcomes from subsequent cataract surgery. Retina 2016; 36: 825-829.
24. Xu YX, Liu LP, Li JB, et al. Vitreoretinal surgeons' experience and time interval from pars-plana vitrectomy to cataract extraction. Int J Ophthalmol 2021; 14: 120-126.
25. Hsuan JD, Brown NA, Bron AJ, et al. Posterior subcapsular and nuclear cataract after vitrectomy. J Cataract Refract Sur 2001; 27: 437-444.
26. Thompson JT. The role of patient age and intraocular gases in cataract progression following vitrectomy for macular holes and epiretinal membranes. Trans Am Ophthalmol Soc 2003; 101: 485-498.
27. Van Effenterre G, Ameline B, Campinchi F, et al. Is vitrectomy cataractogenic? Study of changes of the crystalline lens after surgery of retinal detachment. J Fr Ophthalmol 1992; 15: 449-454.
28. Wong SC, Clare G, Bunce C, et al. Cataract progression in macular hole cases: results with vitrectomy or with observation. J Cataract Refract Surg 2012; 38: 1176-1180.
29. Sirek S, Leszczyński R, Mrukwa-Kominek E. Lens Opacities after Posterior Vitrectomy – Literature Review. Okulistyka 2020; 23: 49-51.