



Incidence of Cataract Surgery after Vitrectomy for Vitreous Opacities

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Purpose: A computational model of vitreous oxygen consumption and transport predicts that limited vitrectomy will result in lower retrolental oxygen levels than extensive vitrectomy, and that higher retrolental oxygen would promote cataractogenesis. This study compared the incidence and timing of cataract surgery after limited versus extensive vitrectomy for vitreous opacities.

Methods: Ninety-six phakic eyes in 75 patients (aged 55±14 years) underwent limited 25 G vitrectomy with preservation of 3 to 4 mm of retrolental vitreous and without surgical posterior vitreous detachment induction. Of these 96 eyes, 48 eyes in 37 patients (aged 56±14 years) had a minimum of 24 months' follow-up and were compared with 23 eyes from 18 patients (aged 63±8 years) who underwent extensive vitrectomy.

Results: Limited vitrectomy patients were older than extensive vitrectomy patients ($P < 0.015$), yet only 17 of 96 eyes (18%) required cataract surgery after limited vitrectomy (mean follow-up = 20±17 months). In eyes with a minimum follow-up of 24 months, 17 of 48 eyes (35%; age = 53–81 years) with limited vitrectomy required cataract surgery, versus 20 of 23 eyes (87%; age = 50–75 years) with extensive vitrectomy ($P < 0.0001$). Just before cataract surgery, visual acuity was comparable in each group (0.47±0.18 in the limited vitrectomy group vs. 0.54±0.30 in the extensive vitrectomy group; $P = 0.23$). Cataract surgery occurred an average of 12.4±5.1 months after limited vitrectomy, compared with 7.3±3.9 months after extensive vitrectomy ($P < 0.002$).

Conclusions: The incidence of cataract surgery was lower after limited vitrectomy, which had a longer interval until cataract surgery compared with extensive vitrectomy. These findings are consistent with the computational model of oxygen consumption and transport and suggest clinical strategies to mitigate post-vitrectomy cataractogenesis. *Ophthalmology Retina* 2016;■:1–4 © 2016 by the American Academy of Ophthalmology

It is currently expected that most patients who undergo vitrectomy will develop sight-impairing lens opacification within 24 months of surgery.¹ Previous studies have shown that the incidence of cataract surgery was 63.2% after vitrectomy for vitreomacular traction (follow-up range = 3–35 months),² 80% after macular pucker surgery (follow-up average = 29 months; range = 6–99 months),³ and 64.6% after macular hole surgery (follow-up to 12 months).⁴ The preponderance of clinically significant lens opacification occurs during the first 6 months after vitrectomy, depending on the use of adjunctive intravitreal air/gas tamponade.^{1,5–7} The mechanism of cataract formation is hypothesized to relate to increased intravitreal oxygen levels and resultant oxygen radicals in the retrolental vitreous, believed to promote oxidative stress and cross-linking of lens crystallins, resulting in protein aggregation and nuclear sclerosis.^{8,9} Age-related vitreous liquefaction increases retrolental oxygen levels,^{10–12} as does extensive surgical removal of vitreous,¹³ both promoting cataract formation.¹⁴

A computational model of oxygen transport and consumption in human vitreous¹⁵ predicts that increased retrolental oxygen will increase oxidative stress to the lens by increasing convection and oxygen transport to the lens.

According to this model, an eye with an intact vitreous body and no posterior vitreous detachment (PVD) will have retrolental partial pressure of oxygen (pO₂) levels ranging from 4 to 6 mmHg, whereas an eye that has undergone vitrectomy with PVD induction will have significantly higher levels, with pO₂ ranging from 10 to 12 mmHg. Vitrectomy also increases lens exposure to oxygen by removing endogenous vitreous antioxidants such as ascorbate.^{16–19}

It is therefore hypothesized that performing limited vitrectomy without intraoperative induction of PVD and with preservation of 3 to 4 mm of anterior vitreous will be associated with a relatively lower incidence of cataract surgery compared with extensive vitrectomy.

Methods

The research protocols were approved by the institutional review board and adhered to the tenets of the Declaration of Helsinki. Informed consent was obtained from all patients. Each patient underwent sutureless vitrectomy using 3-port pars plana entry and 25 G instruments. BSS Plus solution (Alcon, Fort Worth, TX) was infusion during all surgeries. Operating time was approximately the same in all cases (10–15 minutes).

Limited Vitrectomy

There were 96 phakic eyes from 75 patients (47 men, 28 women; age 55 ± 14 years) who underwent limited vitrectomy for vitreous opacities under local anesthesia by a single surgeon (J.S.). In patients without PVD at the time of vitrectomy ($n = 43$, 45%), PVD was not induced intraoperatively, and great care was taken to preserve 3 to 4 mm of anterior vitreous adjacent to the lens in all cases. Of the 96 eyes, 48 eyes from 37 patients (18 men, 19 women; age 58 ± 13 years; range = 23–81 years) had a minimum follow-up of 24 months.

Extensive Vitrectomy

Twenty-three phakic eyes from 18 patients (10 men, 8 women; age 63 ± 8 years; range = 44–75 years) underwent extensive vitrectomy by a single surgeon at the University of Amsterdam. PVD was induced intraoperatively in all patients who did not have preoperative PVD.

Analysis

Patients who underwent vitrectomy for vitreous opacities were followed to determine the timing and incidence of cataract surgery, if any. The incidence of cataract surgery was also compared in patients with a minimum of 2 years' follow-up after limited vitrectomy versus extensive vitrectomy. The Fisher exact test was used to analyze the significance of any difference in the incidences of cataract surgery in limited vitrectomy versus extensive vitrectomy. The time between vitrectomy and subsequent cataract surgery was also compared in the 2 groups using the Student *t* test.

Results

All eyes had a minimum follow-up of 3 months. Of the 96 phakic eyes that had limited vitrectomy, only 17 (18%) required cataract surgery after a mean follow-up of 20 ± 17 months. Of the 17 eyes that required cataract surgery after limited vitrectomy, 10 (59%) had PVD before vitrectomy, perhaps contributing to cataract formation. Of the 48 limited vitrectomy eyes with a minimum follow-up of 24 months, 17 (35%) underwent cataract surgery after vitrectomy. The incidence of cataract surgery after extensive vitrectomy was significantly higher, with 20 of 23 eyes (87%) requiring cataract surgery within 24 months of extensive vitrectomy ($P < 0.0001$). The mean decimal visual acuity before cataract surgery was 0.47 ± 0.18 in eyes that underwent limited vitrectomy and 0.54 ± 0.3 in eyes that had extensive vitrectomy ($P = 0.23$).

The average time between limited vitrectomy and cataract surgery was significantly longer (12.4 ± 5.1 months) than the average time between extensive vitrectomy and cataract surgery (7.3 ± 3.9 months; $P < 0.002$). A Kaplan-Meier analysis of the cumulative incidence of cataract surgery after limited vitrectomy ($n = 48$) versus extensive vitrectomy ($n = 23$) reveals that after 1 year the cumulative incidence of cataract surgery was nearly 3 times less after limited vitrectomy ($\sim 20\%$) compared with extensive vitrectomy ($\sim 70\%$; $P < 0.001$) (Fig 1). Two years after vitrectomy the cumulative incidence of cataract surgery was more than twofold greater after extensive vitrectomy (87%) compared with limited vitrectomy (35%; $P < 0.001$).

The average age of patients requiring cataract surgery after limited vitrectomy was greater (63.4 ± 6.8 years; range = 53–81 years) than the average age of patients requiring cataract surgery after extensive vitrectomy (57.9 ± 6.1 years; range = 48–70 years)

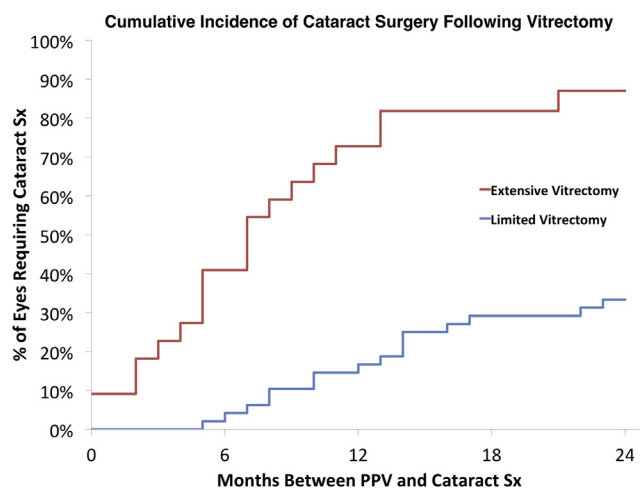


Figure 1. By 12 months after vitrectomy the cumulative incidence of cataract surgery is more than 70% in patients who underwent extensive vitrectomy with posterior vitreous detachment (PVD) induction, but just around 20% in the limited vitrectomy group without PVD induction ($P < 0.001$). At 2 years, the cumulative incidence of cataract surgery after extensive vitrectomy is 87%, whereas after limited vitrectomy only 35% of patients required cataract surgery ($P < 0.001$). The mean time to cataract surgery was longer after limited vitrectomy (12.4 months) than extensive vitrectomy (7.3 months; $P < 0.002$). PPV = pars plana vitrectomy; Sx = surgery.

($P < 0.015$). Fourteen eyes from patients younger than 40 years of age had an average follow-up of 21 ± 12 months (range = 6–70 months) after limited vitrectomy, but none have required cataract surgery. Five of these patients had more than 4 years of follow-up, with 1 patient having 70 months of follow-up.

Discussion

Previous studies have found that the incidence of cataract surgery was 63.2% after vitrectomy for vitreomacular traction,² 80% after macular pucker surgery,³ and 64.6% after macular hole surgery.⁴ In the present study, the incidence of cataract surgery after limited vitrectomy for vitreous opacities is low (18% in this series of 96 eyes), substantially lower than after extensive vitrectomy ($P < 0.001$). The 87% incidence of cataract surgery 24 months after extensive vitrectomy for vitreous opacities is similar to the 80% incidence of cataract surgery 29 months after vitrectomy for macular pucker.³ That extensive vitrectomy promotes cataract formation more than limited vitrectomy is further suggested by the observation that the average time interval between limited vitrectomy and cataract surgery was significantly longer (12.4 months) than after extensive vitrectomy (7.3 months; $P < 0.002$). The statistically significant older age of the patients who underwent limited vitrectomy rules out age as a confounder.

The lower incidence of cataract surgery and longer duration before cataract surgery was performed after limited vitrectomy may be the result of lower retrolental oxygen levels, as predicted by the finite model of cataractogenesis, which predicts that extensive vitrectomy will double

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