Visually Disturbing Vitreous Floaters following Neodymium-Doped Yttrium Aluminum Garnet Capsulotomy: A Single-Center Case Series

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Keywords
Neodymium-doped yttrium garnet laser · Posterior capsule opacification · Vitrectomy · Vitreous opacity

Abstract
This study aimed to report the risk factors and treatment outcomes of visually disturbing vitreous opacities after neodymium-doped yttrium aluminum garnet (Nd:YAG) laser posterior capsulotomy. This was a retrospective observational case series study that included 6 patients who underwent vitrectomy for vitreous opacities after Nd:YAG laser capsulotomy. The patients’ medical records from January 2017 to June 2020 were reviewed. Seven eyes of 6 patients who underwent pars plana vitrectomy for visually disturbing vitreous opacities were included in this study. The mean duration between Nd:YAG capsulotomy and vitrectomy was 8.57 ± 1.27 months. The posterior capsule opacification was proliferative with a pearl form in all patients. Visual acuity improved significantly after vitrectomy. Nd:YAG laser causes visually disturbing vitreous opacities. Vitrectomy was an effective treatment for these opacities.

Introduction
Age-related cataract is a major cause of visual impairment and blindness worldwide, and cataract extraction is the most frequently performed eye surgery [1]. Even though cataract surgery is generally safe and effective, sometimes certain complications could arise [2].
Posterior capsule opacification (PCO) is the most common visually disabling complication of cataract surgery [3]. PCO occurs when the remaining lens epithelial cells rapidly grow behind an implanted lens and ultimately encroach on the visual axis, where light scattering changes induced by the cells can give rise to secondary visual distortion [4].

Neodymium-doped yttrium aluminum garnet (Nd:YAG) laser capsulotomy is the treatment of choice for PCO. Although Nd:YAG laser capsulotomy is safe and effective, complications, including elevated intraocular pressure (IOP), retinal detachment, anterior uveitis, intraocular lens damage and dislocation, and cystoid macular edema may occur [5, 6].

Vitreous floaters are most commonly caused by posterior vitreous detachment [7] and are frequently symptomatic. Most patients can tolerate the symptoms; however, a significant minority, particularly young myopic patients and those with pseudophakia, find their floaters very uncomfortable [8]. Nd:YAG vitreolysis and pars plana vitrectomy (PPV) have been advocated as effective treatments for vitreous opacities [9, 10]. In this retrospective case series study, we report the clinical manifestation, treatment, and prognosis in seven eyes of six patients with visually disturbing vitreous opacities after Nd:YAG laser posterior capsulotomy.

Case Report/Case Presentation

This retrospective case series study was conducted at the Department of Ophthalmology at the Sanggye Paik Hospital of the Inje University of Korea in Seoul, Korea. The study protocol was approved by the Sanggye Paik Hospital Institutional Review Board (No. 201903013) and was conducted in accordance with the Declaration of Helsinki. The medical records of all patients who underwent PPV for vitreous floaters after Nd:YAG laser capsulotomy at the Sanggye Paik Hospital between January 2017 and June 2020 were retrospectively reviewed.

Data on demographic characteristics, clinical manifestation, and past medical history were collected and reviewed. Ophthalmic examinations included slit-lamp examination, initial and final best corrected visual acuity (BCVA), Goldmann applanation tonometry or non-contact tonometry, and fundus examination.

We included patients who underwent PPV for visually disturbing vitreous floaters caused by Nd:YAG capsulotomy and had a medical record of summated energy of Nd:YAG laser capsulotomy. We excluded cases of ocular abnormalities, including diabetic retinopathy, age-related macular degeneration, and history of PPV. A standard 23-G three-port PPV was performed under general anesthesia using the CONSTELLATION Vision System (Alcon Laboratories, Fort Worth, TX, USA).

A total of seven eyes from six patients were included in this study. The mean age of patients was 53.29 ± 4.11 years. Cataract surgery and Nd:YAG laser capsulotomy were performed at local clinics, and PPV was performed at the Sanggye Paik Hospital. Elschnig’s pearl-type PCO was observed in all patients. The mean duration between cataract surgery and Nd:YAG capsulotomy was 11.14 ± 2.79 weeks, and the average duration between Nd:YAG capsulotomy and PPV was 8.57 ± 1.27 months. The mean overall follow-up period was 19.28 ± 6.21 months. The initial mean BCVA was 0.39 ± 0.20, and the BCVA after cataract surgery was 0.01 ± 0.03. The mean BCVA before Nd:YAG capsulotomy was 0.31 ± 0.21, and it improved to 0.06 ± 0.07 after Nd:YAG capsulotomy. The mean summated energy of Nd:YAG capsulotomy was 56.45 ± 7.97 mJ. The mean BCVA before PPV was 0.24 ± 0.13, and it improved to 0.04 ± 0.05 after PPV. Table 1 shows the baseline characteristics, initial BCVA, and final BCVA of the patients.

Case 1 and Case 2

A 53-year-old Korean man was referred to our clinic due to decreased visual acuity and visually disturbing vitreous floaters in both eyes. He underwent cataract surgery in both eyes.
5 months earlier with Nd:YAG laser capsulotomy in both eyes. On ocular examination, the BCVA was 20/32 in both eyes. As measured by a non-contact tonometer, the IOP was 16/20 mm Hg in both eyes. On fundus examination, vitreous floaters were observed in both eyes. We performed PPV in the left eye under general anesthesia, and after 1 month, we performed PPV in the right eye. After 3 months, the final BCVA was 20/20 in both eyes.

Case 3

A 52-year-old Korean man consulted an ophthalmologist from a local clinic for vitreous floaters and decreased visual acuity in the left eye. He underwent cataract surgery in both eyes 6 months earlier and Nd:YAG laser capsulotomy in both eyes after 3 months. The summated energy of capsulotomy was 38.8 mJ and 69.8 mJ in the right and left eyes, respectively. BCVA was 20/20 and 20/63 in the right and left eyes, respectively. On fundus examination, vitreous floaters were observed in the left eye. We performed PPV in the left eye under general anesthesia, and after 3 months, the final BCVA was 20/25 in the left eye.

Case 4

A 47-year-old Korean man was referred to our ophthalmology department for decreased visual acuity in the left eye. He underwent cataract surgery in both eyes at a local clinic and Nd:YAG laser capsulotomy in both eyes 5 months earlier. The summated energy of capsulotomy was 28.6 mJ and 46.0 mJ in the right and left eyes, respectively. On ocular examination, the BCVA was 20/32 and IOP was 22 mm Hg in the left eye. On fundus examination, vitreous floaters were observed in the left eye. We performed PPV in the left eye under general anesthesia, and after 3 months, the final BCVA was 20/25 in the left eye.

Case 5

A 51-year-old Korean man was referred to our clinic for visually disturbing vitreous floaters in the right eye. He underwent cataract surgery in both eyes 3 months earlier and Nd:YAG laser capsulotomy in both eyes after 1 month. The summated energy of capsulotomy was 57.2 mJ and 48 mJ in the right and left eyes, respectively. On ocular examination, the BCVA was 20/32 in the right eye. On fundus examination, vitreous floaters were observed in the right eye. We performed PPV in the right eye, and after 3 months, the final BCVA was 20/20 in the right eye.

Case 6

A 59-year-old Korean woman consulted an ophthalmologist from a local clinic for visually disturbing vitreous floaters in the left eye. She underwent cataract surgery in both eyes 5

| Eye no. | Sex | Age | BCVA before YAG | BCVA after YAG | BCVA before PPV | BCVA after PPV | Summated energy (mJ) |
|---------|-----|-----|-----------------|----------------|-----------------|-----------------|---------------------|
| 1       | Male| 53  | 0.2             | 0              | 0.2             | 0               | 48                  |
| 2       | Male| 53  | 0.18            | 0              | 0.2             | 0               | 55                  |
| 3       | Male| 52  | 0.54            | 0.2            | 0.54            | 0.1             | 69.8                |
| 4       | Male| 47  | 0.7             | 0.1            | 0.2             | 0.1             | 46                  |
| 5       | Male| 51  | 0.1             | 0              | 0.2             | 0               | 57.2                |
| 6       | Female| 59 | 0.18           | 0              | 0.1             | 0               | 59.8                |
| 7       | Female| 58 | 0.3             | 0.1            | 0.3             | 0.1             | 59.4                |

BCVA, best corrected visual acuity, LogMAR; PPV, pars plana vitrectomy; YAG, yttrium aluminum garnet.
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months earlier and Nd:YAG laser capsulotomy in both eyes after 2 months. The summated energy of capsulotomy was 55 mJ and 59.8 mJ in the right and left eyes, respectively. On ocular examination, the BCVA was 20/25 in the right eye, and the IOP was 12/10 mm Hg in both eyes. On fundus examination, vitreous floaters were observed in the left eye. We performed PPV in the left eye, and after 3 months, the final BCVA was 20/20 in the left eye.

Case 7
A 58-year-old Korean woman was referred to our ophthalmology department for decreased visual acuity and vitreous floaters in the left eye. She underwent cataract surgery in both eyes 4 months earlier and Nd:YAG laser capsulotomy in both eyes 1 month later. The summated energy of capsulotomy was 59.4 mJ and 56 mJ in the right and left eyes, respectively. On ocular examination, the BCVA was 20/40 in the left eye, and vitreous floaters were observed in the left eye. We performed PPV in the left eye; the final BCVA was 20/25 in the left eye at 3 months following PPV.

Discussion/Conclusion

Previous studies have reported that the incidence of PCO was 20.7% at 2 years and 28.5% at 5 years after cataract surgery [3]. The proportion of patients requiring laser capsulotomy is approximately 5–20% at 3–5 years post-cataract surgery [11, 12]. In this study, the mean age of patients was 53.29 ± 4.11 years, which is a relatively young age among those who have undergone cataract surgery [13]. The incidence of PCO and risk factors for Nd:YAG capsulotomy are higher in younger people [12, 14]. According to a previous report, epithelial cell growth occurs at a greater rate in capsular bags from younger human donors than in those from older donors [15].

The mean duration between cataract surgery and Nd:YAG capsulotomy was 11.14 ± 2.79 weeks in this study, which was shorter compared to previous studies [13–15]. In this report, Elschnig's pearls were observed in all patients. Elschnig's pearls comprise swollen globular cells that can encroach upon the visual axis and cause significant visual disruption [16]. Elschnig's pearls can affect the shorter duration of Nd:YAG capsulotomy after cataract surgery. Findl et al. [16] reported that Elschnig's pearls can be dynamic; initially, the pearls were small, but they continued to grow in volume, fragment, or shrink. It is hypothesized that these dynamic characters of Elschnig’s pearls could have affected the vitreous opacity.

Ari et al. [17] reported that high energy levels of Nd:YAG laser capsulotomy affect the macular thickness and increase IOP. In this study, the mean summated energy of capsulotomy was 56.45 ± 7.97 mJ in eyes that underwent PPV and 45.28 ± 11.59 mJ in the opposite eyes that did not undergo PPV, except for 1 patient who underwent PPV in both eyes. The mean energy was higher in eyes that underwent PPV; however, the small sample size makes statistical analysis difficult. Furthermore, the size of capsulotomy is related to laser energy, and lower amounts of energy for perhaps a smaller capsulotomy may benefit from fewer complications of IOP rise and cystoid macular edema [18, 19]. Because we did not measure the capsulotomy size, we could not analyze the effect of capsulotomy size on vitreous floaters.

We performed PPV if the symptoms persisted for more than 6 months, and the patient failed to adapt to the symptom despite the sufficient explanation for it. In addition, PPV was performed if laser vitreolysis was not possible owing to the close distance of the floater to the retina or when symptoms persisted following laser vitreolysis. PPV was performed at average of 8.57 ± 1.27 months following YAG laser.

The development of posterior vitreous detachment among patients undergoing Nd:YAG capsulotomy laser treatment can result in subsequent vitreoretinal traction, retinal tears, and
detachment [20]. However, the effect of Nd:YAG capsulotomy on the development of posterior vitreous detachment is controversial [21]. The exact mechanism of retinal tears and detachment after Nd:YAG laser capsulotomy is not yet known. The photodisruption effect of Nd:YAG laser may affect the vitreous fibers [22]. One possible explanation for the occurrence of vitreous floaters is that due to the inaccurate focusing during laser treatment, the laser may hit the anterior vitreous and affect the vitreous fibers.

This study has some limitations. First, the small sample size of this study makes statistical analysis difficult. Second, since the visual disturbances caused by vitreous floaters are subjective symptoms, we could not analyze the symptoms and outcomes objectively. Third, we did not analyze the capsulotomy size. Fourth, we only performed PPV to treat vitreous floaters; therefore, we could not compare the efficacy of PPV and Nd:YAG vitrectomy in the treatment of vitreous floaters. Fifth, surgical skills such as polishing could have affected the occurrence of PCO. The participants of this study were patients who were requested for further examinations following cataract surgery at private clinics; thus, the surgical skills of the ophthalmologists associated with these clinics would vary considerably.

In conclusion, Nd:YAG laser capsulotomy causes visually disturbing vitreous floaters. PPV was an effective treatment for visually disturbing vitreous opacities.

**Statement of Ethics**

Written informed consent was obtained from all patients for publication of this case report and any accompanying images. The study protocol was approved by the Sanggye Paik Hospital Institutional Review Board (No. 201903013) and was conducted in accordance with the Declaration of Helsinki.

**Conflict of Interest Statement**

The authors have no conflicts of interest to declare.

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**Author Contributions**

Conceptualization and validation: Je-Hyung Hwang; data curation and writing – original draft preparation: Ha Eun Sim; writing – review and editing: Ha Eun Sim and Seung Hwa Baik. Ha Eun Sim, Seung Hwa Baik, and Je-Hyung Hwang have read and agreed to the published version of the manuscript.

**Data Availability Statement**

All data generated or analyzed during this study are included in this article, and further inquiries can be directed to the corresponding author.
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